Colorado State University
Extension

Choosing a Soil Amendment

Fact Sheet No. **7.235** Gardening Series | **Basics**

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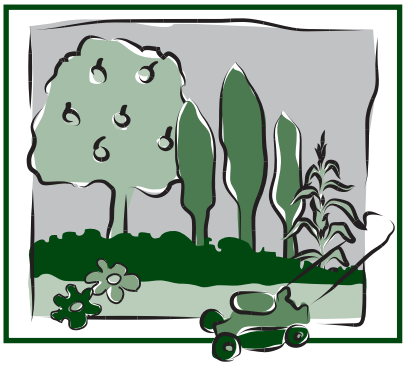

A soil amendment is any material added to a soil to improve its physical properties, such as water retention, permeability, water infiltration, drainage, aeration and structure. The goal is to provide a better environment for roots.

To do its work, an amendment must be thoroughly mixed into the soil. If it is merely buried, its effectiveness is reduced, and it will interfere with water and air movement and root growth.

Amending a soil is not the same thing as mulching, although many mulches also are used as amendments. A mulch is left on the soil surface. Its purpose is to reduce evaporation and runoff, inhibit weed growth, and create an attractive appearance. Mulches also moderate soil temperature. Organic mulches may be incorporated into the soil as amendments after they have decomposed to the point that they no longer serve their purpose.

Organic vs. Inorganic Amendments

There are two broad categories of soil amendments: organic and inorganic. Organic amendments come from something that was alive. Inorganic amendments, on the other hand, are either mined or man-made. Organic amendments include sphagnum peat, wood chips, grass clippings, straw, compost, manure, biosolids, sawdust and wood ash. Inorganic amendments include vermiculite, perlite, tire chunks, pea gravel and sand.

Not all of the above are recommended by Colorado State University. These are merely examples. Wood ash, an organic amendment, is high in both pH and salt. It can magnify common Colorado soil problems and should not be used as a soil amendment. Don't add sand to clay soil — this creates a soil structure similar to concrete.

Organic amendments increase soil organic matter content and offer many benefits. Over time, organic matter improves soil aeration, water infiltration, and both water- and nutrient-holding capacity. Many organic amendments contain plant nutrients and act as organic fertilizers. Organic matter also is an important energy source for bacteria, fungi and earthworms that live in the soil.

Application Rates

Ideally, the landscape and garden soils are improved to 4-5% organic matter. At this level, the *mineralization* (release) of nitrogen from the organic matter will be adequate for most plants without additional fertilizers. Many cities now require that the landscape soils be brought up to this level in new developments as a water conservation technique. With the improved aeration and deeper rooting, plants are more efficient in capturing rain events.

Table 1 gives the routine application rates. Where the soil amendments may be high in salts, the rate is limited due to the salt problem. Salt burn of roots and death of landscape and garden plants is common from over application of salty soil amendments.

Wood Products

Wood products can tie up nitrogen in the soil and cause nitrogen deficiency in plants. Microorganisms in the soil use nitrogen to break down the wood. Over several months to years, as microorganisms complete the rapid decomposition process, the nitrogen is released and again becomes available to plants. This hazard is greatest with sawdust, because it has a greater surface area than wood chips.

Compost wood products, before using them as soil amendments. For these products to decompose rapidly, add a nitrogen

Quick Facts

- On clayey soils, soil amendments improve the soil aggregation, increase porosity and permeability, and improve aeration, drainage, and rooting depth.
- On sandy soils, soil amendments increase the water and nutrient holding capacity.
- A variety of products are available bagged or bulk for soil amendments. However, soil amendments are not regulated. Many are extremely high in salts.
- With Colorado's large livestock industry, manure and manure-based compost are readily available. These are often high in salts, limiting application rates. Use with caution.
- Plant-based composts are low in salt. These may be applied at higher application rates, more effectively improving the soil. Plant-based composts are typically higher in price.

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source to the compost pile. This could be plant residues high in nitrogen (such as grass clippings or manure), or a nitrogen fertilizer. Do not use uncomposted wood products or sawdust as a soil amendment. It is slow to break down, ties up nitrogen, interferes with seedbed preparation, and interferes with soil and water movement through the soil profile.

Sphagnum Peat vs. Mountain Peat

Sphagnum peat is an excellent soil amendment, especially for sandy soils, which will retain more water after sphagnum peat application. Sphagnum peat is generally acid (i.e., low pH) and can help gardeners grow plants that require a more acidic soil.

Sphagnum peat is harvested from bogs in Canada and the northern United States. The bogs can be revegetated after harvest in this moist environment. However, the harvest rate greatly exceeds the vegetation rate of the peat bogs, so it is considered a semi-renewal resource.

Colorado mountain peat is not a good soil amendment. It often is too fine in texture and generally has a higher pH.

Mountain peat is mined from high-altitude wetlands that will take hundreds of years to rejuvenate, if ever. This mining is extremely disruptive to hydrologic cycles and mountain ecosystems.

Are Biosolids Safe?

Biosolids are byproducts of sewage treatment. They may be found alone or composted with leaves or other organic materials.

The primary concerns about biosolids are heavy metal content, pathogen levels and salts. Use only Class A biosolids, it has been treated to reduce the bacterial content. Class A biosolids are approved for use in production agriculture. However, it is advisable to avoid application to vegetable gardens due to the potential for heavy metals (such as cadmium and lead).

Some cities sell or give away biosolids or compost made with biosolids. It is often extremely high in salts. Ask about the salt content. Use with caution.

Manure

Fresh manure can harm plants due to elevated ammonia levels. To avoid this problem, use only aged or composted manure.

Table 1: Routine application rate for soil amendments.

Site		Depth of soil amendment prior to incorporation[A] (based on an incorporation depth of 6-8 inches)[B]	
		Plant-based composts and other soil amendments low in salts[C]	Manure, manure-based compost, biosolids, biosolid-based compost and other soil amendments that may be high in salts[D]
One-time application to new landscapes prior to planting trees, shrubs, perennials, and lawns.		2-3 inches	1 inch[E]
Annual application to vegetable garden and annual flowerbeds	First three years	2-3 inches	1 inch[E]
	Fourth year and beyond	1-2 inches	1 inch[E]

[A] Three cubic yards (87 bushel) covers 1,000 square feet approximately 1 inch deep.
[B] Cultivate the soil amendment into the top 6-8 inches of soil. On compacted/clayey soils, anything less may result in a shallow rooting depth predisposing plants to reduced growth, low vigor, and low stress tolerance. Rate should be adjusted if incorporation depth is different.
[C] Plant-based compost are derived solely from plant materials (leaves, grass clippings, wood chips, and other yard wastes). Use this application rate for other soil amendments know to be low in salt.
[D] Use this application rate for any soil amendment with maure or biosolids, unless the salt content is actually known, by soil test, to be low. Excessive salts are common in many commercially available bagged and bulk products. Use with caution.
[E] For soil amendments with high salts, this routine application rate may be too high. Use with caution.

Human pathogens, including *E coli*, are another potential problem with fresh manure, especially on vegetable gardens. For vegetables with direct contact with the soil, fresh manure must be applied at least four months prior to harvest. For other fruits and vegetables, fresh manure must be applied at least three month prior to harvest. In simple words, fresh manure would be only fall applied for the spring garden. For additional information on *E.coli*, refer to fact sheet *9.369 Preventing E. coli from Garden to Plate*.

Aged manure refers to manure that has been piled for at least six months. Excessive ammonia will have escaped. Salt levels may be higher as the salts concentrate in the decomposing material, or may be leach out with high rainfall. Weed seeds will be viable.

Composted manure technically refers to manure that has been through multiple active heating cycles and turned in between. If heated above 145 degrees F, it will kill pathogens and weed seeds. In composted manure, the organic matter is stabilized

Table 2: Permeability and water retention of various soil types.

Soil Texture	Permeability	Water Retention
Sand	high	low
Loam	medium	medium
Silt	low	high
Clay	low	high

Table 3: Permeability and water retention of various soil amendments.

Amendment	Permeability	Water Retention
Fibrous		
Peat	low-medium	very high
Wood chips	high	low-medium
Hardwood bark	high	low-medium
Humus		
Compost	low-medium	medium-high
Aged manure	low-medium	medium
Inorganic		
Vermiculite	high	high
Perlite	high	low

(through the rapid decomposition process) making it an ideal soil amendment. Salt level may be concentrated or may be leach out with high rainfall.

As a point of clarification, composts and manures are not regulated. Many commercially available products are labeled as "composted." However, this does not mean that it has been through the active decomposition process.

Compost

Compost refers to decomposed organic matter. It is not regulated, so there is no standard about the state of decomposition. In commercially available products the term "compost" is often used generically, and does not infer that the product has been through the actively heating, decomposition process.

In Colorado, a wide variety of compost products are available in bagged and bulk products. These may be a combination of plant-based compost, manure-based composts, biosolids, and other agriculture by-products (such as chicken feathers).

With the large livestock industry in Colorado, manure-based composts are most common. These are often high in salts. Use with caution.

Compost made solely from plant-based products (such as wood chips and yard wastes) are low in salts. These are preferred over manure based composts which are often higher in salts. However, they are generally more expensive.

Working with Dr. Jean Reeder, the Colorado Master Gardener Program had soils tests done on samples of locally available, bagged, manures and composts. The majority had high salts. Use with caution!

Factors to Consider When Choosing an Amendment

There are at least four factors to consider in selecting a soil amendment:

- how long the amendment will last in the soil,
- soil texture,
- soil salinity and plant sensitivities to salts, and
- salt content and pH of the amendment.

Laboratory tests can determine the salt content, pH and organic matter of organic amendments. The quality of bulk organic amendments for large-scale landscape uses can then be determined.

Longevity of the Amendment

The amendment you choose depends on your goals.

- Are you trying to improve soil physical properties quickly? Choose an amendment that decomposes rapidly.
- Do you want a long-lasting improvement to your soil? Choose an amendment that decomposes slowly.
- Do you want a quick improvement that lasts a long time? Choose a combination of amendments.

Soil Texture

Soil texture, or the way a soil feels, reflects the size of the soil particles. Sandy soils have large soil particles and feel gritty. Clay soils have small soil particles and feel sticky. Both sandy soils and clay soils are a challenge for gardeners. Loam soils have the mixture of different size soil particles.

When amending sandy soils, the goal is to increase the soil's ability to hold moisture and store nutrients. To achieve this, use organic amendments that are well decomposed, like composts, peat, or aged manures.

With clay soils, the goal is to improve soil aggregation, increase porosity and permeability, and improve aeration and drainage. Fibrous amendments like peat, wood chips, tree bark or straw are most effective in this situation.

Use Tables 2 and 3 for more specific recommendations. Because sandy soils have low water retention, choose an amendment with high water retention, like peat, compost or vermiculite. Clay soils have low permeability, so choose an amendment with high permeability, like composted wood chips, composted hardwood bark or perlite. Vermiculite is not a good choice for clay soils because of its high water retention.

Soil Salinity and Plant Sensitivity to Salts

Many forms of compost made with manure, and biosolids are high in salts. Avoid these amendments in soils that are already high in salts (above 3 mmhos/cm) or when growing plants that are sensitive to salts. Raspberry, strawberry, bean, carrot, onion, Kentucky bluegrass, maple, pine, viburnum and many other landscape plants are salt sensitive. In such cases, choose plant-based composts or sphagnum peat.

Salt Content and pH of the Amendment

Always beware of salts in soil amendments. High salt content and high pH are common problems in Colorado soils. Therefore, avoid amendments that are high in salts or that have a high pH. Amendments frequently high in salts and/or pH include wood ash, Colorado mountain peat and manures, and manure-based compost, biosolids, and biosolid-based compost.

An amendment with up to 10 mmhos/cm total salts is acceptable if mixed well into low-salt soils (less than 1 mmhos/cm). Amendments with a salt content greater than 10 mmhos/ cm are questionable. Choose a low-salt amendment for soils testing high in salts.

Sphagnum peat and compost made from purely plant sources are low in salts and are good choices for amending Colorado soils.

Ask for an analysis of the organic amendments that you are considering, and choose your amendments wisely. If no analysis is available, test a small amount of the amendment before purchasing a large quantity.

Use caution as the salt content in compost may vary from batch to batch.