A2305

Organic soil conditioners

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Composition

Most Wisconsin soils contain about 1 to 6 percent organic matter. Yet, despite its small percentage in the soil, this material is one of the more important soil components and influences the physical and chemical properties of soil and the way the soil behaves.

Soil organic matter consists of animal and plant remains in various stages of decomposition and the microorganisms (fungi and bacteria) that feed upon these remains. Fresh animal and plant matter begins to decompose as soon as it is added to the soil. At the same time, the microbial population increases rapidly. The microorganisms consume the animal and plant remains as their food supply and then die, thereby adding themselves to the organic material. The end product of decomposition is humus. Humus is dark brown to black and doesn't decompose any further. It is the component responsible for making some soils appear dark brown or black.

Temperature and aeration are the two main factors affecting the organic matter content of soil. Sandy soils and tropical soils, for example, are typically low in organic matter, whereas the poorly drained wetlands of Wisconsin rapidly accumulate it. Because temperature and soil type are rather permanent factors, it is not easy to alter a soil's organic level except through massive additions of plant residues or a drastic alteration in land use. Cultivation, for example, stimulates organic matter decomposition. For this reason, the level of organic matter in a cultivated soil is usually lower than it was before the soil was put into cultivation. However, a new equilibrium becomes established once the land is in this new use for many years.

Importance

As fresh organic matter decomposes, the nutrients it contains are released in inorganic form for use by plants. A portion of the nutrients is utilized by the soil microorganisms, but when they die and decompose the nutrients are again released. Organic matter, therefore, is an important source of nutrients for growing plants, especially those which would otherwise be leached from the soil. Decomposing organic matter supplies most of the nitrogen and sulfur, about half of the phosphorus, and appreciable amounts of the other plant nutrients. In addition, organic acids released during decomposition of organic matter help to release nutrients from the mineral portion of the soil.

As organic matter decomposes, it becomes chemically altered. This change gives it a negative electrical charge that attracts and holds inorganic elements such as potassium, calcium, magnesium, and several of the micronutrients in forms that make them readily available to growing plants. Rain cannot easily wash away elements "held" by organic matter.

Organic matter helps improve the physical condition of clay soils. Microorganisms secrete sticky glue-like materials which bind individual microscopic clay particles into larger, more stable clumps, called aggregates. These aggregates do not break down easily when wet or when the soil is tilled, and they resist compaction. Pore size is small within aggregates, enabling them to retain moisture. Spaces between aggregates are larger, thus improving infiltration, drainage, and aeration. Such a soil is said to have good structure. Roots develop better in a well-structured soil.

Organic matter increases the moisture holding capacity of soil because organic particles absorb water like a sponge. Plants can use some of this water—an important consideration for sandy soils.

In short, organic matter improves nutrient supplying power of the soil, soil structure, and moisture holding capacity.

Limitations

Even though organic matter is very valuable for soil improvement, there are some popular misconceptions concerning its value. Whereas organic material generally supplies some nutrients to plants, it does not always supply 100 percent of a plant's needs. For example, corn grown on soils high in organic matter usually needs less nitrogen than if it were grown on a low organic matter soil; however, some extra nitrogen usually is needed for a successful crop. Also, because potassium leaches readily from fresh plant material, any plant remains that have been exposed to rain before being added to the soil are likely to be low in potassium.

Materials such as sawdust, straw, and wood chips are very low in nitrogen. In order for soil microorganisms to decompose such materials, they pull additional inorganic nitrogen from the soil, thus competing with growing plants. As a result, nitrogen is deficient for plants to use unless more nitrogen is added from another source. On the other hand, an organic material high in nitrogen, such as manure or sewage sludge, could provide too much nitrogen causing excessive top growth or ground water contamination if too much was applied.

Organic amendments do not necessarily improve the nutritional value of the harvested fruits or vegetables. Controlled experiments indicate that plants grown hydroponically (in water) in the complete absence of organic matter have mineral and vitamin contents similar to those grown in soils high in organic matter.

One further point to remember: nitrogen, phosphorus, and sulfur from organic materials cannot be utilized by a growing plant unless they are released in inorganic form through decomposition. The elements supplied by a commercial fertilizer are already in inorganic form. A plant cannot distinguish between a nitrogen atom that originally came from organic amendments from one added as a fertilizer.

Finally, an organic material such as crop residue may increase the incidence of insects and disease, particularly if you leave it on the soil surface, by providing shelter and food for overwintering.

Carbon to nitrogen ratios (C:N)

All organic matter contains some carbon and some nitrogen. The relative amount of each present (the carbon to nitrogen ratio) will determine whether nitrogen, and sometimes other nutrients, will be released or tied up in the decomposition process. Decomposition of materials with a low C:N ratio (less than about 28:1) will release nitrogen, while the decomposition of high C:N material such as straw or sawdust will tie up available nitrogen. The table below gives some average ratios for common organic wastes.

Carbon:nitrogen ratio	
Alfalfa hay	12:1
Food wastes	15:1
Rotted manures	15:1
Grass clippings	19:1
Fruit wastes	35:1
Leaves	60:1
Cornstalks	60:1
Straw	80:1
Sawdust	500:1
Wood	700:1

You can balance the C:N ratio by combining different organic wastes. For example, mixing two parts grass clippings (19:1) with one part leaves (60:1) gives a C:N ratio of about 33:1. You can calculate the new C:N ratio by averaging the values: $(19+19+60) \div 3 = 33$. Making combinations such as this will ensure that your organic soil conditioner maintains or enhances the availability of soil nutrients.

Types of organic matter

The best way to determine what your soil needs is first to determine its composition. You can take your own soil sample, send it in to a reputable soil testing laboratory and receive a soil test report. For more information, consult publication *Sampling Lawn and Garden Soils for Soil Testing* (A2166), available from your county Extension office.

You can add organic matter to soils in the form of crop residue, manure, compost, peat, sawdust, and sewage sludge. You can also grow organic matter in garden soil in the form of green manure or fall cover crops to improve the physical condition of the soil. This is a good method for vegetable and small fruit gardens if space is available and other forms of organic matter are scarce.

Crop residue

Crop residues—the parts of the plant remaining after you have harvested the usable portions—are an important source of organic matter. It requires no extra time or labor to grow the material or to haul it in place. Lawn clippings, for example, are a residue that is best left on the lawn to supply nutrients and improve soil structure. A properly fertilized soil will provide the greatest mass of crop residue. It is often desirable to supplement crop residues with other sources of organic matter. Note, though, that for some garden crops, last year's crop residue may contain disease organisms which can then infect this year's crop. Rotating positions of various crops in the garden eliminates this problem.

Manure

Livestock manure is an excellent source of organic matter. Apply 50 to 100 pounds (1 to 2 bushels) of fresh cow manure or 25 pounds (½ bushel) of fresh poultry manure per 100 square feet to your garden soil. Till fresh manure into the soil in the late fall or early spring. Apply only well-rotted manure in the spring just before planting. Broadcast manure and work it thoroughly into the upper 4 to 6 inches of soil.

Manure is especially valuable as a source of nitrogen, since 1 bushel of cow manure contains 1 to 3 ounces of nitrogen, depending on the amount and kind of litter that was mixed with it. Therefore, you can use it to best advantage on plants with high nitrogen requirements (such as corn, potatoes, tomatoes, and leafy vegetables) or to hasten decomposition of woody material or compost. For more detailed information on the composition and use of manure, see publications *Guidelines for Applying Manure to Pasture and Cropland in Wisconsin* (A3392).

Compost

Compost is made by decaying any organic material such as lawn clippings, leaves, straw, sawdust, household garbage, or other plant waste materials. Make sure compost is well decayed before you use it. Compost is dark brown, crumbly, and earthy-smelling when it is ready to use. Apply compost at the same rate as well-rotted manure (up to 100 pounds/100 square feet) and work it thoroughly into the soil.

To make a compost heap, dig a pit 6 feet by 6 feet by 18 inches deep and frame it with rough lumber. You can also make one above ground using 1-inch mesh woven wire fencing. Begin to fill the pit with plant residues. Add 1 inch of soil after each 6 to 12 inches of fresh organic material. The soil holds moisture (which is essential to the decaying process), adds weight to the compost to prevent blowing, inoculates the material with microorganisms to begin decomposition, absorbs odors, and discourages rodents. Keep the surface level or slightly dipped in the middle so water will soak in evenly. The compost pile should be kept moist, but not wet. Normal decomposition may take 12 to 18 months. To speed the process, grind coarse materials into pieces smaller than ½ inch and add lime and fertilizer. Use a mixture of 25 pounds (25 pints) of 10-10-10 fertilizer and 10 pounds (7.5 pints) of finely ground limestone. Add about 1 pound (1 pint) of this mixture to each 100 pounds of dry refuse or 400 pounds of green material. Or use organic wastes high in nitrogen such as manure in place of fertilizer. Mix one part manure with four parts of plant remains. Occasional mixing of the decaying material will speed the process and give a more uniform product. For additional information on composting, see DNR publication *Home Composting: Reap a Heap of Benefits* (SW-072).

Peat

Peat is partly decomposed plant material which slowly accumulates in lake bottoms or depressions. You may use peat in establishing new lawns, gardens, and flower beds. It is especially recommended where subsoil materials have been used for fill. Use about ⅓ to ½ cubic yard of loose peat or ½ to 1 compressed bale (6 cubic feet) for each 100 square feet. This equals a surface application of 1 to 2 inches of peat. Work it 4 to 6 inches into the soil. If you mix dry peat into the soil, water the mixture and allow it to settle before planting.

Peats are formed from many different kinds of plants. Those associated with waters low in calcium and other bases are usually very acid. They are often called bog peats or peat moss and are a mixture of wood, moss, and sedges. Woody peats are derived from such plants as tamarack, cedar, ash, elm, willow, and poplars. Sedimentary peats are derived from algae, plankton, pond weeds, and similar plant species. Use the very acid peats on calcareous (high pH) soils, and for acid-loving plants such as azaleas, blueberries, and rhododendrons. For general use as a soil conditioner, less acid peats are preferable.

Sawdust

Sawdust is readily available and you can use it to advantage on most garden soils. Apply about 3 to 4 bushels of rotted sawdust to each 100 square feet of soil. Normally the acidity created by applying sawdust is of minor importance. Any negative effects are probably due to nitrogen deficiency rather than to acidity. To avoid this, add ⅓ bushel of rotted manure or ½ pound (⅔ cup) of ammonium nitrate (33-0-0) to each bushel of dry sawdust. If you cannot readily find nitrogen fertilizer, use a lawn fertilizer high in nitrogen (such as 20-10-10 or 25-5-5) at ¾ pound (¾ cup) per bushel of dry sawdust. This does not replace the fertilizer that may be recommended on a soil test report.

Sewage sludge

Sewage sludge is a potential organic soil conditioner and can be used as a source of plant nutrients. The city of Milwaukee has for years marketed such a conditioner as a byproduct of its sewage disposal system. Recently, much attention has been given to the use of liquid sludge—a 2 to 5 percent suspension of heterogeneous solid wastes—as an organic fertilizer and/or soil conditioner. Present studies indicate that liquid sludge is useful on agricultural land. However, its use on home lawns and gardens is limited to well-stabilized sludges which are free of disease-carrying organisms. Some sludges may contain high concentrations of heavy metals and should not be used in gardens.

Green manure

To improve soils low in organic matter, you can grow green manure crops (legumes) and plow them under after one or two years of growth. For example, you can seed a legume such as red clover or alfalfa in the spring and plow it under in the fall to provide organic matter and nitrogen to garden crops the following year. Apply 1 to 2 pounds (1 to 2 pints) of complete fertilizer, such as 5-10-10 or 5-10-5, per 100 square feet of soil before seeding.

Cover crops

Fall cover crops allow you to use the garden in the summer and still add some organic material the following spring. Seed winter rye at ⅕ to ⅓ pounds per 100 square feet in mid-September. Work the rye cover into the soil with a complete fertilizer as soon as you can till the soil in the spring. Cover crops add organic matter, protect soil from winter erosion, and reduce leaching losses by utilizing excess nutrients, especially nitrogen.

Top soil

In some instances, lawn or garden soils may need soil amendments such as top soil (“black dirt”), muck, or peat to provide a suitable medium for good plant emergence and growth. This is often necessary when new lawns are established on home sites where subsoil from excavation has been dumped on the lawn area. When you use topsoil you should have a physical analysis made of it at a soil testing laboratory to determine the percent sand, silt, and clay—to make sure it has the proper texture and will improve the existing soil.

Organic sources of plant nutrients

Organic soil conditioners contain variable amounts of plant nutrients and can supply a portion of the nutrient requirements of home lawns and gardens. The table below shows the range in nitrogen (N), phosphate (P_2O_5), and potash (K_2O) contents for some common organic materials. Some of these materials also contain calcium, magnesium, sulfur, and micronutrients.

Compositions of miscellaneous wastes

Material	Moisture	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)
	%	% “as is”		
Alfalfa hay	15	2.0–3.0	0.2–0.6	2.0–3.2
Brewer’s waste	6–94	0.9–3.2	0.1–0.4	0.5–2.0
Cattle manure	85	0.5–0.7	0.2–0.4	0.5–0.8
Coffee grounds	42–70	0.7–3.1	0.1–12.0	0.01–0.9
Horse manure	80	0.4–0.7	0.2–0.5	0.5–0.8
Leather dust	19–68	0.4–7.5	0.1–0.4	0.02–0.3
Malt fiber	7	0.6–5.7	0.2–3.4	1.1–2.2
Poultry manure	70	1.1–1.7	1.0–1.3	0.5–1.0
Rabbit manure	—	1.0–2.0	0.6–1.0	0.3–1.5
Sawdust	4–66	0.1–0.9	0.01–0.5	0.04–1.4
Sheep manure	70	1.0–2.0	0.7–1.0	0.5–2.0
Spent hops	9–87	0.6–5.7	0.2–3.4	0.01–2.6
Tannery waste	6–85	0.1–14.1	—	—
		% dry weight		
Bone meal		0.2–1.0	12–14	—
Dried blood		13	1.5–2.0	1
Fish meal		9–11	5–8	0–3
Fresh leaves		0.5–1.0	0.05–0.08	0.3–0.6
Grass clippings		2–5	1–2	1–3
Sewage sludge		2–6	2–3	0–1
Wood ashes		0.5–1.0	0.8–10	2.0–3.5

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