Connections between Compost, Soil Carbon and Climate Change

By Sally Brown, Ph.D.
Research Associate Professor
University of Washington

The images that come to mind when you think about the causes of climate change are big cars and trucks and coal-fired power plants that emit carbon to the atmosphere. Although the popular press is filled with discussions on the relative merits of different sources of “green energy,” little attention is being paid to how we manage the carbon in our soils. Soil has an important role in the carbon cycle; managing soil organic matter (SOM) can be critical in climate change and can provide a key tool for storing carbon and mitigating the impact of the changes that are likely to occur.

CARBON IN SOILS

Soil contains carbon as both a component of SOM and as inorganic carbonates, commonly known as limestone. In fact, soil carbon is the third largest pool of carbon, after the oceans and geologic stores of carbon (e.g., fossil fuels). In short, there is more carbon in the soil than in the atmosphere or in the mass of plants and animals (biomass) on the surface of the Earth. Carbon makes up between 50 percent and 60 percent of the SOM the remainder is calcium, nitrogen, phosphorus, and other elements. Thus a soil with 5 percent organic matter is about 2.75 percent organic carbon. Just the top foot of an acre of soil with 5 percent organic matter may hold about 50 tons of carbon. Peats have been the most common types of amendments used in turfgrass management. However, in recent years, turfgrass managers have increasingly turned to composts for use as amendments on high maintenance turf. Composts are prepared from a variety of organic wastes such as leaves, grass clippings, animal manures, industrial by-products such as municipal biosolids, food residuals, and mixed solid waste (MSW). These materials are gaining greater use and acceptance as widely available and high quality amendments.

ROLE OF ORGANIC CARBON IN SOILS

The importance of organic matter in relation to healthy soils and supporting plant growth is well understood and recognized by soil scientists who study soils and by farmers and horticulturalists who grow plants. SOM helps soil to form aggregates. These make the soil lighter, improve soil structure, and help to improve plant growth. Organic matter is also vital for soils to absorb and retain water. Organic matter also contains vital plant nutrients. SOM is food and an energy source for the animals and micro-organisms that live in the soil.

CARBON CYCLING IN SOILS

Organic matter and thus soil carbon doesn't hang around for very long in a soil system. Compared to carbon that is stored in geologic pools, soil carbon lasts only for a blink of an eye; an average residence time for carbon in soils is about 22 years. Nevertheless, because of the huge amount of carbon that is in the soil, the management of the SOM is very important on a global perspective and is critical to main¬taining healthy soils to support plant growth.

Plants take carbon dioxide (CO2) from the atmosphere and transform it into organic carbon compounds (e.g., carbohydrates and cellulose). As plants or parts of plants die, these carbon compounds become food for the animals and microorganisms that live in soils. The plant matter is decomposed into smaller and smaller particles, becoming chemically altered in the process and forming stable organic compounds, such as humus, that can persist in the soil for hundreds of years. This carbon that is held in the soil is considered "sequestered." In the soil-carbon cycle, a portion of the carbon is returned to the atmosphere as CO2, some is transformed into plants and animals, and some is retained in the soil as stable organic matter.

In general, soils with high amounts of organic matter and high amounts of carbon will promote healthier and faster plant growth and thus promote the removal of carbon dioxide by plants from the atmosphere. In contrast, when SOM and carbon are low, plant growth is poor and, therefore, much less carbon dioxide is removed by the plants.

BUILDING CARBON RESERVES IN SOIL

Practices that result in decreasing the amount of organic matter in the soil release carbon to the atmosphere. Release of CO2 from soils is partially due to deforestation and urbanization. But a large part of it is due to the use of large-scale tillage equipment in modern agriculture. Turning over soils in the field and burying crop residues introduce large quantities of oxygen into the soils and break up soil aggregates. This speeds up the decomposition of SOM and releases large quantities of CO2. Those practices that result in increasing levels of organic matter in the soil and the direct addition of organic matter to the soil can result in less carbon being released to the atmosphere.

When crop residues or leaves and yard wastes from urban sites are not returned to the soil, organic matter levels will decrease over time. When plant residues and organic matter, such as food wastes, are composted rather than incinerated or disposed of in landfills, organic matter levels are increased. Additionally, composting plant residues and other organic wastes provides a means of replen¬ishing the soil's carbon reserves. In comparison with the raw or un¬composted plant material, the carbon in compost is relatively stable and will decompose more slowly and likely remain in the soil for longer periods.

While some of the carbon will be lost to the atmosphere, as described above in the carbon cycle, much of it will persist for many years; repeated applications of compost will result in a gradual accumulation of SOM and increase the carbon that is held in the soil. In addition, compost not only puts carbon back into soil, the compost provides organic nutrients that enhance the growth of the plants, increasing healthy plant growth, and thus, furthering the removal of CO2 from the atmosphere.