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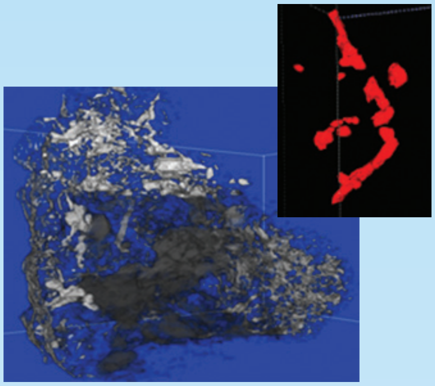

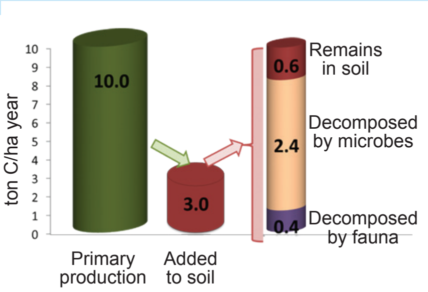

Pictures shown, from top to bottom, are: Soil samples with high (left) and low (right) SOM; computer processed X-ray image of a soil aggregate and particulate organic matter (red) identified within the aggregate; diagram of plant production processing in soil; CSCAP experimental field at Mason, MI.

Soil Organic Carbon Cycle

Dr. Sasha Kravchenko, Michigan State University

Soil contains ~1500 Pg of carbon (C) which plays a key role in the global C cycle. Most of the soil C is part of soil organic matter (SOM) and is stored in the upper 1 m of the soil profile. Soils vary widely in their organic matter content from 90% in wetland originated soils of boreal forests to less than 1% in arid deserts. SOM is a vital component of soil quality and productivity that provides plant nutrients and creates air and water regimes suitable for plant growth. It is also the form in which atmospheric C is captured and stored in soil. Enhanced soil C sequestration is one of the tools for mediating climate change.

Soil C cycle begins with plants that acquire atmospheric CO_2 and synthesize biomolecules from it by a process of photosynthesis. The synthesized organic material ends up in soil as leaf and root residues of the dead plants as well as root exudates of living plants. There, residues are subjected to decay and decomposition via soil fauna and especially via activities of myriads of soil microorganisms. As a result, most of it is completely decomposed and released back to the atmosphere mainly as CO_2, while a smaller portion which is in a form of complex organic macro-molecules is stabilized into what is becoming SOM.

SOM consists of a huge variety of organic compounds that are difficult to separate and study in a pure form. Thus, for the purpose of addressing its functional properties and modeling its behavior in soil, SOM is classified into stability pools based on how quickly microorganisms decompose them. Three commonly considered pools are fast, slow, and passive with turnover rates of several years, decades-to-centuries, and thousand years, respectively. Latest research suggests that under auspicious water/air/temperature conditions microbes can rapidly decompose any of the SOM compounds which they can reach and that the main mechanism of SOM protection is via limited microbial access to it. This can occur by sorption of organic molecules on surfaces of soil particles or by physical barriers disconnecting microbes and their enzymes from SOM. As an infinitely complex and intricate system of hierarchically aggregated particles, soil provides a wealth of such barriers. However, plowing destroys soil aggregation and exposes SOM to microorganisms and subsequent rapid decomposition. No-till management preserves complexity and heterogeneity of soil structure, while cover crop based management enhances it, thus both can contribute to physical protection of SOM and soil C sequestration.

Additional resources on this topic:

http://soils.usda.gov and http://csite.esd.ornl.gov

For more information, contact:

Dr. Sasha Kravchenko, Associate Professor, Michigan State University, kravche1@msu.edu, 517-355-0271 extension 1241
Lynn Laws, Communication Specialist, Climate and Corn-based Cropping Systems CAP, lynnlaws@iastate.edu, 515-294-7380
Project web site and e-mail: sustainablecorn.org | info@sustainablecorn.org

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USDA United States Department of Agriculture National Institute of Food and Agriculture

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