Performance and Adoptability
Biodegradable Mulch
biodegradablemulch.org

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Authors:

Marie English
Sean Schaeffer
Jennifer DeBruyn
Markus Flury
Carol Miles
Douglas Hayes
Sreejata Bandopadhyay

Summary

Soil carbon, in the form of living microbes, litter and humus, provides many benefits to crop growth. The USDA Specialty Crops Research project, Performance and Adoptability of Biodegradable Mulch for Specialty Crop Production*, will determine how biodegradable plastic mulches are contributing to soil carbon.*

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

Soil Carbon and Biodegradable Mulches

IMPORTANCE OF SOIL CARBON

Soils are one of the largest stores of carbon on the planet, containing more carbon than the atmosphere and above-ground biomass combined. **Soil carbon** includes both organic and inorganic carbon. Soil inorganic carbon exists in the form of carbon dioxide and carbonates. Soil organic carbon (SOC) includes living microorganisms, dead material (residues and detritus), and stable carbon molecules called humus. SOC is important for crop production because it provides a carbon-energy source for soil organisms whose presence adds vitality to the soil. As these organisms consume SOC, they release important nutrients for plants.

WHERE DO BIODEGRADABLE PLASTIC MULCHES END UP?

Biodegradable plastic mulches (BDMs) can be biodegraded or "digested" by soil microbes into carbon dioxide, water, and microbial biomass as part of the soil carbon cycle. Unlike polyethylene plastic mulches, BDMs consist of polymers that microorganisms occurring naturally in the soil can use as an energy source or "food." The rate of consumption is dependent on physical and biological characteristics of the soil. Over just one growing season in the hot, moist climate of TN, some BDMs showed considerable signs of degradation (Figure 1).

Figure 1. Biodegradable plastic mulch entering the soil carbon cycle. BioAgri, a commercially available biodegradable plastic mulch, before the growing season (left) and after (right). Photos: WSU Mt. Vernon (left), Marie English (right).

SOIL CARBON CYCLING

Learning how carbon cycles in the soil helps inform the management of soils for crop production. Soil carbon is decreased by erosion and tilling and increased by adding organic manure and compost. The turnover of carbon in the soil varies widely based on its form. **New SOC** refers to recently introduced soil carbon, resulting from crop residues, BDM fragments, roots and microbial biomass. This new SOC can be quickly turned over to carbon dioxide that is lost to the atmosphere, or it can be converted to stable SOC, a form that is more resistant to decomposition. **Stable SOC** or humus can remain in the soil for many years and provides the soil with a nutrient supply, an increased water holding capacity, and aggregate stability.

A goal of this project is to study the short and long-term fate of BDMs in order to determine how the mulches contribute to the soil carbon cycle (Figure 2). If new SOC is not continually added, soil carbon will be decomposed at a rate faster than replenishment, resulting in a net loss of SOC and a concurrent decrease in soil quality. Since BDMs contain carbon, their addition to the soil could help preserve soil quality.

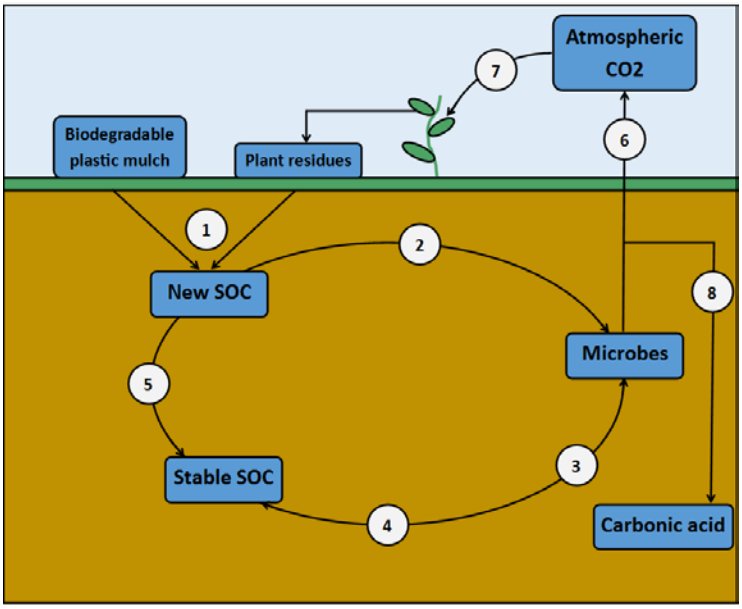

Figure 2. Soil Carbon Cycle

1) Small pieces of BDM and plant residue enter the soil where they become new SOC.
2) Microbes decompose SOC at a rate determined by soil pH, temperature, moisture, and oxygen availability.
3) Microbes decompose SOC at a rate determined by soil pH, temperature, moisture, and oxygen availability.
4) Incomplete decomposition can lead to the synthesis of stable compounds that enter the stable SOC pool.
5) Stable SOC is formed when new SOC chemically adheres to minerals, or gets incorporated into aggregates.
6) During decomposition, microbes incorporate some carbon into their cells and respire some in the form of CO_2.
7) Plants take up CO_2 during photosynthesis and incorporate it into biomass.
8) Depending on the pH and moisture content of the soil, some CO_2 is leached into the soil as carbonic acid.

References and Further Reading

USDA-NRCS: Nutrient Cycling http://soilquality.org/functions/nutrient_cycling.html
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