Biodegradable Mulches Report

ORGANIC FARMING
RESEARCH FOUNDATION

2017 Organic Agriculture Research Symposium
Biodegradable Mulches Report

Introduction

OARS 2017 featured a special workshop on biodegradable mulches. Organic farmers rely on black plastic mulch for weed management. Biodegradable plastic mulches (BPMs) have the potential to be more sustainable than non-biodegradable polyethylene mulches, because they can be tilled into the soil after harvest, and decompose into carbohydrates and other substances that can be consumed by soil organisms. Most plastic mulches currently on the market are made from petrochemicals. They are non-biodegradable, which means they do not decompose in the soil, cannot be recycled, and need to be landfilled at the farmer's expense. The USDA Organic Standard requires that non-biodegradable plastic mulch must be removed from the field and cannot be reused. BPMs have the potential to reduce labor and disposal costs if they can be incorporated in the soil. Other biodegradable mulches can be made from paper (cellulose) and straw.

Life Cycle of Biodegradable Plastic Mulches for Specialty Crop Production

Douglas G. Hayes (Presenter), Larry C. Wadsworth, Carol Miles, and Annette L. Wszelaki

The objectives of the project are to (1) evaluate the impacts of repeated use of plastic mulch on the agricultural soil ecosystem, including soil quality, microbial communities, and carbon storage; (2) identify degradation mechanisms and interrelationships among life-cycle stages: fossil-fuel or biobased, the role of weathering, and biodegradation in the soil or composting; (3) evaluate degradation in diverse climates to improve performance and evaluation methods; (4) compare results of lab-scale standardized tests for biodegradability and weathering with results from field studies; and identify potential crop weed, disease and insect pest problems. The beginning of the life cycle is when manufactured from biobased materials. These may include sources that are genetically engineered. Biobased materials are also not always biodegradable. Preliminary results showed that biodegradation varies significantly between field conditions. Decomposition is increased by warm, moist conditions, and is inhibited by cold, dry conditions. Soil texture and biological activity also appear to be factors. On-going research over several years will need to be done to collect data to determine the cumulative effects on soil quality and health, and to perform a life-cycle analysis.

Suitability of Biodegradable Plastic Mulches for Organic and Sustainable Agriculture

Carol Miles, Lisa DeVetter, Shuresh Ghimire (Presenter), and Douglas G. Hayes

The objective of the study is to evaluate whether specific BPMs meet the biodegradability requirements in the USDA National Organic Program's National List. It appears that no biodegradable plastic mulch product currently on the market meets the USDA Organic standard

for being completely biobased and produced without genetically modified organisms (GMOs). The USDA Organic standards define biodegradable mulches as either compostable according to specific recognized industry standards or 90% biodegradable into microcrystalline cellulose in two years. That means the soil may retain as much as 10% of the mulch after two years, and the non-biodegradable portion can accumulate over time. Also, the laboratory methods currently used do not necessarily reflect biodegradation under field conditions. The results showed that the paper / cellulose based mulch degraded completely, but the plastic mulches failed to meet the USDA Organic standard for biodegradability. Significant amounts of undegraded plastic remained in the soil and could be expected to accumulate over time. Additional testing is needed under diverse field conditions to accurately quantify the rate and extent of biodegradation of mulch products. The research may help with the development of mulches that meet organic standards. Before using any plastic mulch, producers should check with their certifying agent to see if it is an approved product.

Where the Rubber Meets the Road: Can Biodegradable Mulches Produce Comparable Yields to Black Plastic Mulch for Pumpkin?

Annette Wszelaki (Presenter), Jennifer Moore, Shuresh Ghimire and Carol Miles
The objectives of this on-going project are to (1) evaluate the performance of biodegradable plastic mulches over multiple years, multiple crops, and multiple environments; (2) gain a better understanding of the biodegradation of commercially available mulches in different environments; (3) gather information on mulch accumulation after multiple applications; (4) develop technology to measure mulch degradation in soil; and (5) advance good agricultural practices to hasten mulch biodegradation. Field experiments compared five different commercial BPMs with bare ground, non-biodegradable polyethylene, and biodegradable paper mulch. Pumpkins were selected as the model crop. Wszelaki shared preliminary results and observations. Polyethylene had the highest marketable yield, but most of the BPMs were comparable. Paper mulch yielded less than plastic, but still better than bare ground. Nutsedge will poke through plastic mulch, but will be smothered by paper mulch. Weedguard is fully biodegradable. Biodegradable mulches can result in product defects. One defect discovered with the use of certain biodegradable mulches is that they may stick to fruiting bodies or other harvestable portions of the fruit or vegetable that is are contact with the mulch. An example was given of pumpkins that had black biodegradable plastic attached to the surface, causing a defect. Further research is needed to determine biodegradation, costs, and impacts on soil quality.

Impact of Biodegradable Plastic Mulches on Soil Quality and Ecology
Jennifer M DeBruyn (Presenter), Sreejata Bandopadhyay, Henry Sintim, Marie English, Sean Schaeffer, Markus Flury, Douglas G. Hayes

The objective of this project is to determine the effects of biodegradable mulches on soil quality. A review of the scientific literature on the subject showed a small number of studies with mixed results. In general, mulches increase moisture and temperature, and reduce tillage and

cultivation. In non-organic systems, mulches also decrease herbicides, which has a beneficial effect on soil biological activity. However, what mulches do for populations of decomposition organisms, plant pathogens, and nutrient cycling organisms is not clear. Preliminary results from field trials conducted in Tennessee and Washington State do not show significant differences. Future work will include looking at the long-term effect on water stable aggregates, infiltration rates, bulk density, soil respiration, soil electrical conductivity, pH, nitrate, carbon, enzyme activity, microbial biomass, and microbial community structure. Results will lead to a better understanding of the effects that biodegradable mulches have on soil quality and ecology.

Is Soil Sampling with a Soil Core an Accurate Method to Specify the Amount of Mulch Remaining in the Field?

Shuresh Ghimire (Presenter), Arnold M. Saxton, and Carol Miles

The project developed a protocol to measure the amount of mulch in the field that has not biodegraded. Random sampling with a soil core showed that the amount of mulch recovered varied over four-fold—between 13% and 53%. Plot-to-plot recovery varied between 3% and 83%. None of the sampling techniques used provided an accurate estimate of mulch fragments. More mulch was consistently found at the edges of plots than in the middle. To determine how much plastic is left in the field, new methods must be developed. The current USDA Organic Standard allowing BPMs have very specific requirements that cannot be verified with existing technology. Unless a reliable way to determine what mulches are compatible with organic farming systems, it is not possible to evaluate their use in organic farming systems.

Conclusion

Biodegradable plastic mulch has many potential benefits. Organic farmers are concerned that incorporation of BPM in the soil may pose risks to soil health. Studies are needed to determine whether decomposition is unpredictable; if incompletely decomposed BPM has adverse effects on soil biological, physical, or chemical properties; or if some of the substances contained in the BPM are harmful to soil organism. No BPMs are known to meet the USDA Organic standards. At the present time many questions remain about BPM’s seasonal effectiveness and long-term sustainability. The development of a BPM compatible with organic farming systems will take more research on its performance, compatibility with sustainable farming systems, and long-term ecological effects.