Quarterly Progress Report

September 1, 2025 to November 30, 2025

PROJECT TITLE: Quantifying and Minimizing the Environmental Impact of Agricultural Plastic Mulch Film Burning

PRINCIPAL INVESTIGATOR(S):
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PROJECT WEBSITE:
https://pmtl.coe.miami.edu/research/hinkleycenter/index.html

Work Accomplished During This Reporting Period

1. Project Website Development

The project website has been created for effective communication as shown in the figure below. The project documents as well as the Technical Awareness Group (TAG) members, TAG meeting recording, and our acknowledgement to the Hinkley Center are also updated on the website. The website can be accessed via: https://pmtl.coe.miami.edu/research/hinkleycenter/index.html

Figure 1. Website established for this project.

2. Establish combustion and sampling systems (Months 1–2)

The team completed the setup and validation of the tube furnace reactor and open burning reactor. All major particulate matter (PM) and gas measurement instruments, including the scanning mobility particle sizer, the aerodynamic particle sizer, the organic carbon/elemental carbon analyzer, and pollutant gas analyzers (carbon monoxide, carbon dioxide, nitrogen oxides, and sulfur dioxide) were calibrated and tested. Sampling protocols and operational procedures were finalized. We also received the used plastic mulch film samples from Gene Jones, who is one of our TAG members. As shown in the figure below, initial burning experiments were conducted, where plastic mulch film samples (panel a) were loaded on a crucible and placed in the high temperature zone of the tube furnace (panel d). The burned residue (panels b and c, representing different burning temperatures) was collected from the crucible and labeled. The residue samples were then shipped to Dr. Sungyoon Jung's laboratory at the University of Florida for microplastics analysis.

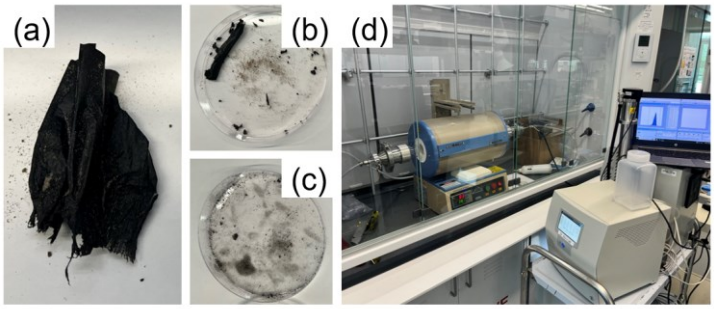

Figure 2. Experimental system established for this project: (a) A sample of the used plastic mulch film. (b) and (c) Burning residue of the plastic mulch film under temperatures of 700°C and 500°C. (d) Tube furnace and PM sizing instruments used in this project.

3. Conduct combustion experiments & collect samples (Months 3 to 5)

Initial combustion experiments were performed using two types of field-collected used plastic mulch film, provided by collaborators. More than 20 furnace burns were completed across a range of temperatures (200 to 700°C) and flow rates (0.5 to 2 LPM). Both PM and gaseous pollutants are measured (Table below). Burning residues were shipped to the University of Florida for microplastic analysis. Preliminary findings include:

- Higher CO emissions at lower temperatures, indicating incomplete combustion.
- Higher PM concentrations at higher temperatures, showing formation of fine (<1 μm) and ultrafine (<100 nm) particles.
- Clear visual differences in residue morphology between low- and high-temperature burns.
- Early indications that white, thicker mulch film produces more microplastics than black film, possibly due to polymer layering or additives.
- Two batches of filter samples and combustion residues were shipped to the University of Florida for microplastic analysis. Key findings include: (1) burning white plastic mulch generated a higher abundance of microplastics (3.33 μg MP/g soil) under the 585°C condition; (2) higher temperatures produced greater MP abundance (18.21 μg MP/g soil at 785°C); and (3) polyethylene (PE) was the dominant polymer type (Figure 3). Based on these findings, we identified the need for larger amounts of burning residue to validate the results and for improved size classification to enhance size-based quantification.

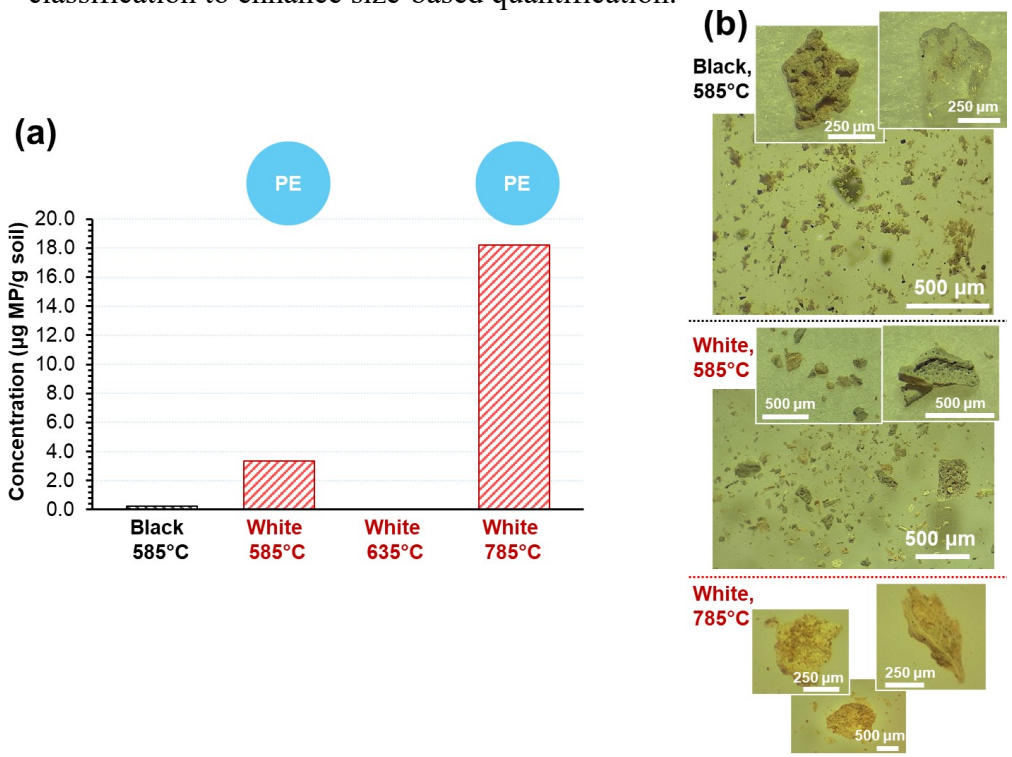

Figure 3. Preliminary results on microplastics released under different burning conditions: (a) microplastic abundance and (b) representative microscopic images.

Table 1. Preliminary results regarding the concentrations of pollutant gases during the burning of the plastic mulch film under different temperatures.

Sample	Burning Temp	Max CO (ppm)	Max CO_2 (%)	Max NOx	Max SO_2 (ppm)
PB04	585	2710	0.52	9	376
PB08	785	1114	0.32	6	265
PB09	785	442	0.38	9	259
PB10	585	1689	0.33	7	248
PB11	585	1147	0.29	8	261
PB12	685	935	0.35	16	371
PB14	785	376	0.27	6	96

4. TAG Meeting #1 (December 4, 2024)

A virtual TAG meeting was held with 12 attendees. Members included

- Sam Sugerman, Sustainability Manager in agricultural sector
- Samir Elmir, Division Director, Florida Department of Health Miami-Dade Environmental Public Health and Engineering
- Nicholas Ciancio, Chief of Resilience Engineering & Environmental Compliance, Department of Solid Waste Management
- Elizabeth Kromhout, Environmental Administrator, Florida Department of Environmental Protection
- Marwa El-Sayed, Associate Professor, Department of Civil Engineering, Embry-Riddle Aeronautical University
- Jiannan Chen, Assistant Professor, Department of Civil, Environmental, and Construction Engineering, University of Central Florida
- Tim Townsend, Program director of the Hinkley Center for Solid and Hazardous Waste Management, Professor, Department of Environmental Engineering Sciences, University of Florida
- Yang Wang, Assistant Professor, Department of Chemical, Environmental and Materials Engineering, University of Miami
- Sungyoon Jung, Assistant Professor, Department of Environmental Engineering Sciences, University of Florida
- Amir Sharafudin, Graduate Student, Department of Chemical, Environmental and Materials Engineering, University of Miami
- Kazi Tahsina Habib, Graduate Student, Department of Environmental Engineering Sciences, University of Florida
- Courtni Spencer, Undergraduate Student, Department of Chemical, Environmental and Materials Engineering, University of Miami

The attendees include representatives from health and policy sector, the agricultural plastics sector, solid waste divisions, and academic institutions. The meeting video and report were posted on the project website. Key TAG feedback included:

- Need to consider mulch film specifications, including additives and thickness variations that may influence emission factors.
- Interest in possible field measurements at University of Florida's Gulf Coast Research and Education Center.
- Importance of assessing the health aspects of agricultural plastic mulch burning and encouragement to explore future health risk modeling using the emission data.
- Recommendations to formulate final outcomes that can be used by farmers in more effective disposal of agricultural plastic mulch films.

Work Planned for the Next Reporting Period

In the next reporting period, we will expanded combustion experiments and pollutant analysis. The detailed tasks include the following:

- Complete additional furnace experiments at 450°C, 700°C, and 950°C.
- Initiate controlled open-burn experiments using liquid fuels (ethanol, gasoline, lighter fluid) and Flame-torch-assisted burns (methane/propane).
- Conduct full analysis of PM mass, size distribution, OC/EC, $CO/CO_2/NOx/SOx$.
- Continue microplastic identification using stereomicroscopy, SEM-EDS, and Py-GC/MS.
- Coordinate with the UF Gulf Coast Research and Education Center to collect surface soil samples from active burn sites and evaluate feasibility of on-site air pollutant measurements during real agricultural burns.
- Compare emission factors against EPA NAAQS and FDEP Soil Cleanup Target Levels.
- Begin preparing emission factor tables for PM, gases, metals, and microplastics.

Metrics

Personnel involved in this quarter:

Name	Role	Department	Institution
Amir Sharafudin	Graduate Student	Department of Chemical, Environmental and Materials Engineering	University of Miami
Kazi Tahsina Habib	Graduate Student	Department of Environmental Engineering Sciences	University of Florida
Courtni Spencer	Undergraduate Student	Department of Chemical, Environmental and Materials Engineering	University of Miami