An Investigation into the Mechanistic Impacts of Conventional and Alternative Plastics on Plant Growth and Carbon Dynamics

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Introduction

There is a strong research focus on fibrous microplastics, with **films** neglected [1, 2].

Despite applications of biodegradable plastics as mulching films increasing, knowledge on the ecological risks of **biodegradable** plastics is limited: preliminary research shows they may have **equal impacts** to **conventional** polymers [3, 4, 5, 6].

Little research on toxic effects of **aged** microplastics within soil ecosystems exists [7] and ecotoxicological effects induced by plastic **additives** and **leachates** released from biodegradable plastics [8].

Research Questions and Hypotheses

(1) What are the effects of conventional versus alternative plastic films on plant growth, soil carbon dynamics and soil biota? → *Pilot study and full-scale study*

(2) What are the effects of unaged versus aged conventional and alternative plastic films on plant growth, carbon dynamics and soil biota? → *Full-scale study*

(3) What are the effects of chemical effects of leachate from alternative and conventional plastics versus the physical effects of alternative and conventional plastic films on plant growth, carbon dynamics and soil biota? → *Full-scale study*

It is **hypothesised** that alternative plastic films will be as detrimental to plant growth, soil carbon dynamics and soil biota as conventional films; that the effects of plastics will escalate as they age; and that chemical effects of plastics are as significant as the physical effects.

Results

The **pilot study** results for **unaged** aspect of experiment suggest:

All plastic treatments caused:

↓ Root biomass
Soil pH
Soil OM content **(Fig. 1)**

↑ Soil respiration rate **(Fig. 1)**

Most plastic treatments caused:

↓ Shoot chlorophyll-a and -b content

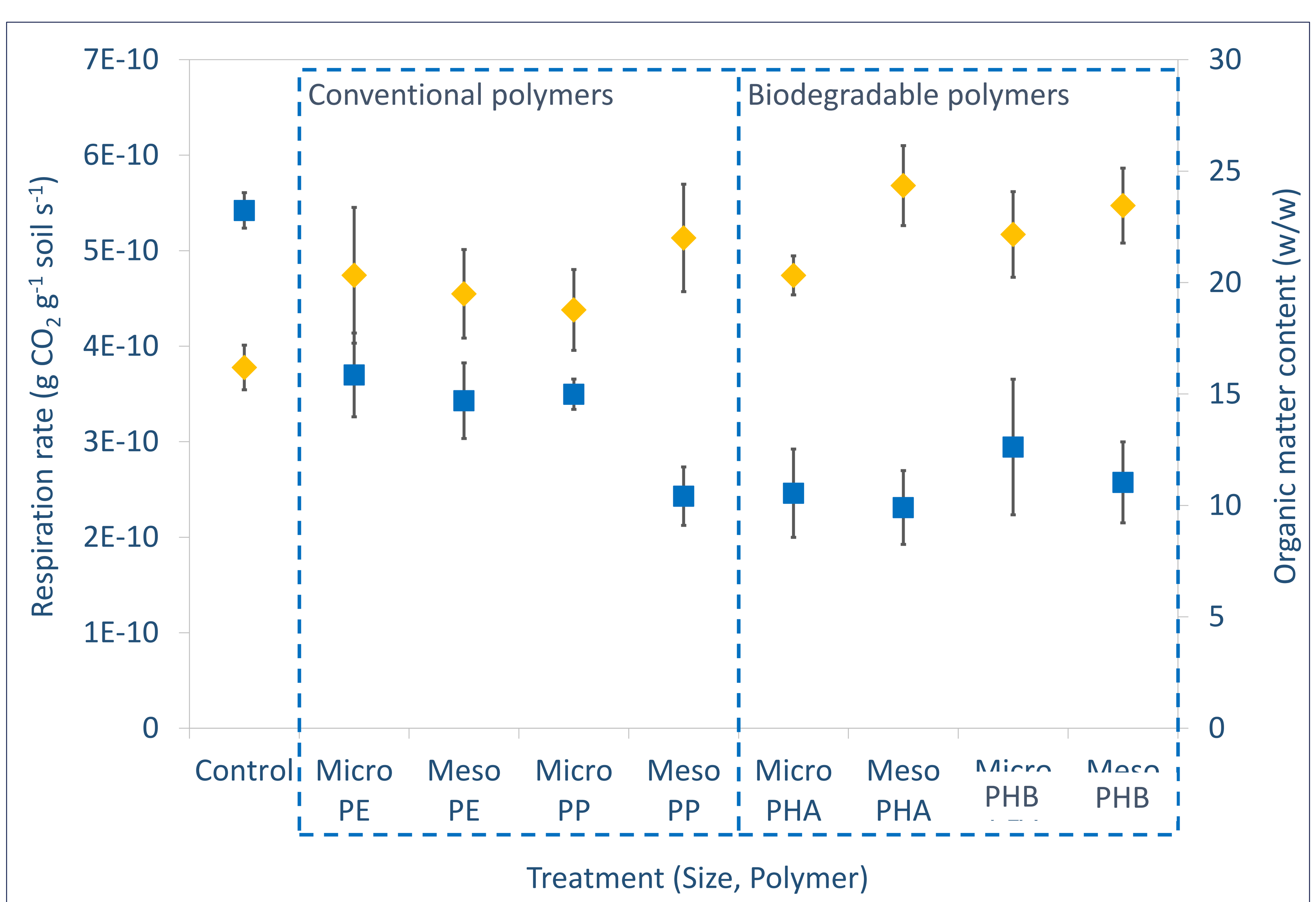
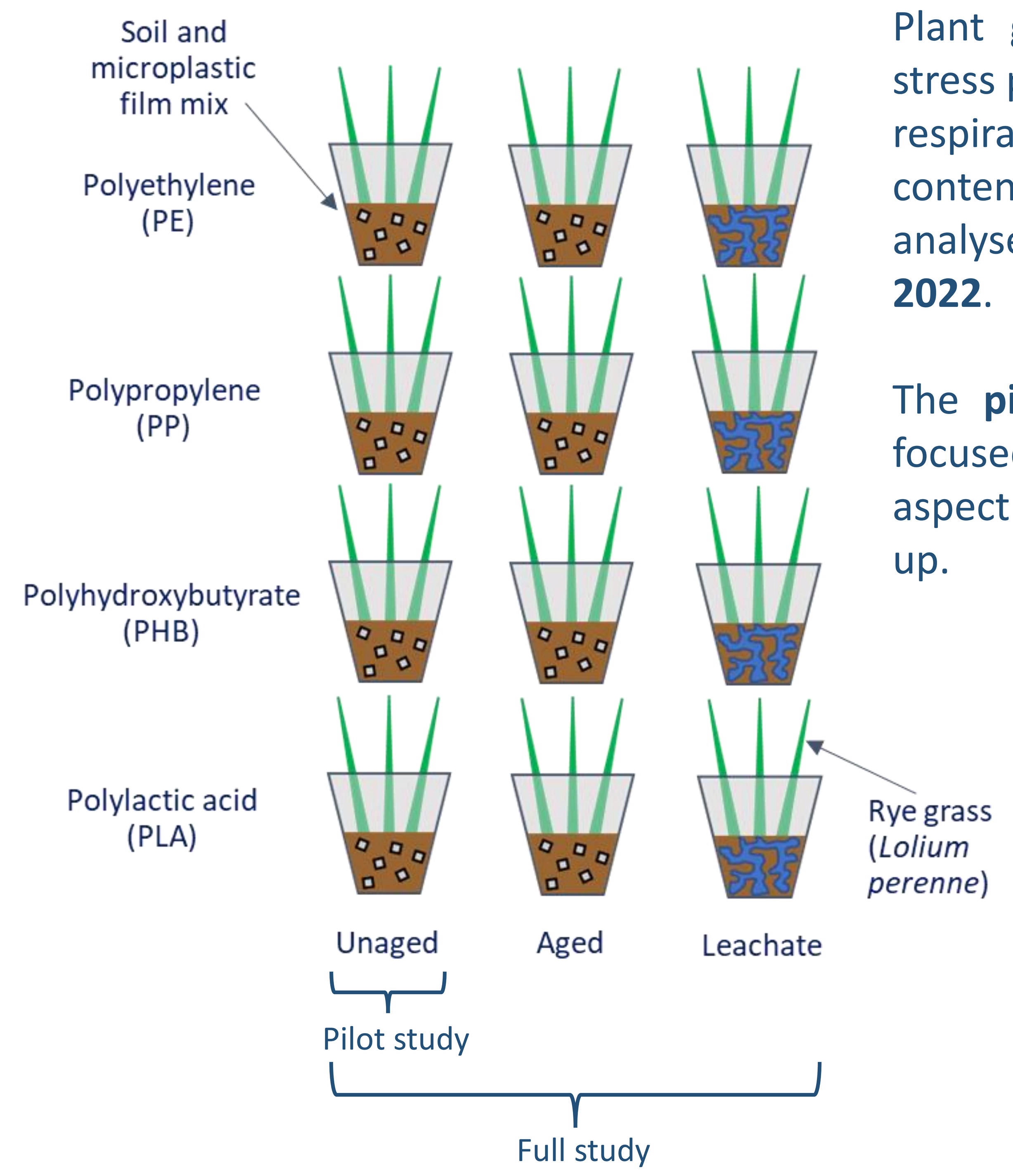


Figure 1. (◆) Mean respiration rate (g CO_2 g^{-1} soil s^{-1}) and (■) mean organic matter content (%) for soils treated with micro- and meso- conventional and alternative, biodegradable plastic films, and control soils. Error bars represent standard deviation, n=5.

Methods

Microplastic films were aged to extract leachate by shaking in water (0.25% w/v) at 120 rpm under UV light at 50°C for 3 weeks.

In the full-study, unaged and aged plastics, and plastic leachate, were added to soils (0.1% w/w) and *Lolium perenne* was grown in a 30 day pot experiment **Nov 2022**. This will be repeated with **mesoplastic** films.



Plant growth and oxidative stress parameters, soil respiration rate and carbon content and soil DNA analyses will follow in **Dec 2022**.

The **pilot study April 2022** focused only on **unaged** aspect of experimental set-up.

Conclusions

Alternative plastic treatments were as detrimental as conventional plastic treatments to root biomass and shoot chlorophyll content.

Some biodegradable plastics treatments caused greater decreases in OM content and greater increases in respiration rate than conventional plastics.

Further Work

Future work will look at **mechanisms** behind decrease in soil OM (a proportion of which is organic carbon) and increases in soil respiration rate CO_2 flux to the atmosphere.

Field study March 2023: conventional plastics, biodegradable plastics, and biotransformation plastic technology to be added to soils in **lysimeters** at Cambridge University Botanic Garden.

Effects on plant growth, carbon dynamics and microbial communities to be measured.

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