Practice abstract n°16: Conventional and biodegradable agricultural microplastics effects on soil properties and microbial functions

The degradation of plastics used in agriculture, such as mulching films, can produce microplastics that can enter and then contaminate the soil. Therefore, PAPILLONS researchers studied the impact of microplastics stemming both from conventional and biodegradable mulching films on soil properties and microbial function (i.e. the essential roles that microorganisms - mainly bacteria and fungi - play in maintaining soil health and supporting plant growth). This study aims to understand how even small amounts of microplastics affect soil health. Researchers focused on both conventional (polyethylene) and biodegradable (PBAT-based) mulching films, looking at their impact on soil structure, chemistry, and especially on soil microorganisms, which play a key role in maintaining fertility and supporting crop growth.

Methodology

The research was conducted in **three different field sites in Finland, Germany, and Spain,** chosen for their different climates and soil types. At the start of the experiment, two types of microplastics (biodegradable and conventional) were mixed into the top layer of soil at concentrations of 0.005% and 0.05% by weight. These levels are considered realistic for agricultural soils contaminated by plastic residues in Europe. Then, over two growing seasons (2022 and 2023), barley was planted and harvested.

With **samples** taken from the plants and soil in both 2022 and 2023, scientists **monitored**:

- **Microbial activity** (such as respiration and fragmentation of nitrogenous substances)
- **Microbial diversity** (types and abundance of bacteria and fungi)
- **Soil** chemical **properties** (like pH, organic carbon, and nitrogen content)
- Greenhouse gas **emissions** (only in Finland) and the decomposition rate of plant material.

Main results

- **Soil microbial activity**: Microbial activity (which includes key functions like breaking down organic matter and nitrogen cycling) **consistently decreased** in soils with both types of microplastics. This was more noticeable with higher plastic concentrations and during the second year of the experiment. This suggests that long-term exposure—even at low levels—

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- may hinder microbial functions.
- **Microbial diversity**: did **not change significantly** in most cases, but fungal biomass and diversity declined, notably in Spain, which had warmer and drier conditions.
- **Soil properties**: There were only **minor** and inconsistent **effects** on soil chemistry (e.g., pH, carbon content), and no major changes in soil structure were observed.
- **Decomposition and greenhouse gases:** The rate at which plant material decomposed **slightly decreased** in some cases with the presence of microplastic. A temporary increase in nitrous oxide (N_2O) emissions was observed in Germany, however, overall greenhouse gas emissions were not consistently affected.

Conclusion

The study shows that **microplastics**—composed of both conventional and biodegradable polymers—**can affect important soil functions**, especially microbial activity and fungal communities, even at low, environmentally relevant concentrations. While no dramatic changes in soil properties were seen, the reduction in microbial activity over time is cause for concern, as it may undermine long-term soil fertility and resilience.

These **impacts vary depending on the region and climate.** The findings suggest that biodegradable plastics, while potentially less persistent, are not free from environmental impacts, and their use should be carefully managed and further studied under real agricultural conditions.

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