Biodegradable microplastics in soils cause carbon dioxide emissions to rise

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Biodegradable microplastic particles in soils can lead to an increased rise in CO_2 emissions to the Earth's atmosphere. This is shown by an interdisciplinary study published in *Applied Soil Ecology* by the

Collaborative Research Centre 1357 "Microplastics" at the University of Bayreuth. In this study, experts in soil ecology and ecological microbiology compare the effects of a conventional and a biodegradable plastic in different soils in a systematic way for the first time. The consequences for the microbial biomass in the soils, especially on bacteria and fungi, are also analyzed.

The Bayreuth scientists selected two plastics for their study: LDPE (low-density polyethylene) is a conventional, non-biodegradable plastic that has been used in the chemical industry for decades. PBAT (polybutylene adipate terephthalate), on the other hand, is a biodegradable plastic that is used, for example, for food packaging, organic waste bags and mulch films.

Particles from three different size ranges (50 to 200 micrometers, 200 to 500 micrometers and 0.63 to 1.2 millimeters) were added in varying concentrations to a sandy loam soil on the one hand and a loamy soil on the other. Over a period of four weeks, the scientists measured the amounts of CO_2 released from the soils.

No impact of LDPE on the soil's CO_2 emissions was identified during the course of the research. In contrast, the effects of PBAT are significant.

"The smaller the biodegradable microplastic particles are and the higher their concentration in the soil, the more CO_2 escapes from the soil into the earth's atmosphere. We observed increases in CO_2 emissions of 13 to 57 percent, depending on the size of the particles, their concentration in the soil and the soil properties. Sandy loam soils released more CO_2 than pure loam soils," reports the study's first author, Adina Rauscher, a master's student from Bayreuth.

As the Bayreuth research team found out, the increase in CO_2 emissions

goes hand in hand with the increase in microbial biomass: If small, biodegradable PBAT particles enter the soil in high concentrations, the amount of bacteria and fungi, which make up the majority of the microbial biomass here, increases.

The biological composition of the biomass may also change in the process.

"The growth of biomass is largely caused by microorganisms in the soil gradually decomposing the microplastic particles and feeding on decay products produced in the process. CO_2 emissions are closely related to these processes. Evidence of this is provided by the differences between pure loamy soils and sandy loam soils. In sandy loam soils, microplastic particles are much more accessible to microorganisms and are therefore degraded more quickly. All the more CO_2 is released in the process," explains co-author Dr. Nele Meyer, a research associate at the Soil Ecology research group at the University of Bayreuth.

"The global input of plastics into soils is a cause for concern. We still know too little about what consequences this has for microorganisms and terrestrial ecosystems. Our study provides important evidence in this regard. Our research findings on emissions of the greenhouse gas CO_2 show that high concentrations of microplastic particles in soils could even have a long-term impact on the climate. It is the biodegradable particles, of all things, that our study has shown to be problematic in this respect," says Prof. Dr. Eva Lehndorff, Chair of Soil Ecology at the University of Bayreuth.

More information: Adina Rauscher et al, Biodegradable microplastic increases CO_2 emission and alters microbial biomass and bacterial community composition in different soil types, *Applied Soil Ecology* (2022). DOI: 10.1016/j.apsoil.2022.104714

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