Fragmentation of Soil-Biodegradable Mulch Film: The Difference Between Fragments Released from Certified Soil-Biodegradable Products and Persistent Microplastics

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Conventional plastic mulch films boost agricultural yields, but films thinner than 25 µm can contaminate soil with persistent microplastics, primarily through mechanical abrasion, UV-induced embrittlement, and incomplete recovery after field use. Certified soil-biodegradable plastics are designed to avoid this problem by fully biodegrading in the environment. Here we present how we systematically investigated the biodegradation and fragmentation behavior of the certified soil-biodegradable mulch film ecovio® M2351 with the central aim of differentiating transient biodegradable fragments from persistent microplastics.

Biodegradation was assessed under standardized laboratory conditions and quantified via CO_2 evolution (ISO 17556). Fragmentation was assessed through an optimized µ-FTIR microscopy workflow capable of particle-level identification down to 25 µm. With this approach we could monitor how the mulch film biodegrades and breaks into smaller pieces over time. Experimental data were integrated with the mechanistic FRAGMENT-MNP model to better understand the interplay between fragmentation and biodegradation.

Mulch film made from ecovio® M2351 showed very good biodegradation with more than 90% of the material converted into CO_2 within a few months. We observed that the film first breaks into many small pieces, but these fragments then continue to biodegrade and become fewer over time. This shows that fragmentation is only a transient step on the way to complete biodegradation.

At the end of the biodegradation experiment (CO2 > 90%), only very small amounts of solid material remained. These leftovers had a lower molecular weight than the original film, meaning they were still actively biodegrading. Using the FRAGMENT-MNP model we could predict that after about 600-700 days we achieve less than 1 particle / g_{soil}.

Overall, our results show that the certified soil-biodegradable mulch film based on ecovio® M2351 does not create persistent microplastics. Transient fragments are part of the natural biodegradation process, but they continue to biodegrade. The combination of laboratory measurements and modelling helps us better understand these processes and can support future environmental risk assessments, policy developments and product improvements.