Practice abstract n°12: Degradation Rates of Agricultural Plastics

Papillons organized a series of dedicated experiments in the field and the laboratory to investigate the degradation and fragmentation mechanisms leading to the generation of micro- and nano-plastics (MNPs) in agricultural soil. The aim of the study was to look into the behaviour of various conventional and biodegradable agricultural plastics (APs) under controlled laboratory, artificial ageing, and real-field conditions, to fill critical knowledge gaps regarding AP degradation, microplastics MNPs generation, while promoting sustainable agricultural practices and end-of-life (EoL) management for agricultural plastic waste (APW).

Main Findings

The main results from this study have been observed on:

1. End-of-life APs management and soil pollution risks
2. Artificial ageing and degradation of agricultural plastics
3. Comparative field experiments on the biodegradation of mulching films in three different geographic regions
4. Release of chemical additives from agricultural plastics

1.End-of-life APs management and soil pollution risks:

- Field observations confirmed that improper disposal practices (e.g., open-air burning, burial, abandonment of plastic waste in fields) occur in Europe, which may have serious environmental and public health impacts.
- The study documented multiple cases where AP residues from burned or buried films, irrigation tapes, and AP fabrics continued to undergo fragmentation over time, generating microplastics in the soil.
- Low-durability plastics used in agriculture (e.g., twines, sacks, protection fleece) showed rapid deterioration, increasing the potential of generating large amounts of microfibers and small plastic fragments or MNPs polluting the soil.

2.Artificial ageing and degradation of agricultural plastics

- Researchers tested how different agricultural plastics break down over time by simulating long-term sun exposure in the lab. They focused on plastics often found mismanaged in the environment. They found, for example, that polypropylene (PP) fabrics, a plastic used in protective fabrics and products bags, breaks down quickly under UV radiation—especially if it lacks protection against sunlight.
- Biodegradable plastics were also tested. These materials lose ductility faster than regular plastics like polyethylene (PE) and PP.

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- Once in the soil, their brittleness helps them break down more quickly, making them more suitable for biodegradation.

3.Comparative field experiments on the biodegradation of mulching films in three different geographic regions:

- Field experiments in Greece, Italy, and Finland were organised to assess the disintegration of biodegradable mulching films under field conditions. Results revealed that:
- Environmental factors like soil characteristics, temperature, and water content significantly influence the disintegration rates.
- In southern Europe (Greece, Italy), biodegradable plastics disintegrated at higher rates due to higher temperatures and microbial activity. In colder climates (Finland), disintegration was slower as it was inhibited during the winter period due to freezing soil temperatures, acidic soil, and other factors.
- Disintegration was incomplete by the end of the experiment, even after prolonged exposure.
- The composition of the mulching films was found to significantly affect the rate of biodegradation.
- Conventional mulching films remain intact longer, leading to persistent contamination (macro and MNPs) in soil due to mismanagement, accumulating over multiple growing seasons in the field.

4.Release of chemical additives from agricultural plastics

- Five additives widely used with agricultural plastics and other commercial plastics, potentially used in conventional and biodegradable mulching films, were selected for analysis.
- When the tested additives, which did not show complete biodegradation, were exposed to soil organisms at a high concentration, ecotoxicity effects were observed.

Conclusion and implications for agricultural sustainability

The findings from this study highlight the urgent need for improved plastic management strategies in agriculture to prevent long-term soil pollution. Key takeaways include:

- Certified biodegradable plastics can help reduce long-term soil pollution, but their biodegradability depends on local climate and soil.
- Proper EoL management practices, stricter rules, improved recycling systems, and cooperation between farmers, policymakers, and industry are needed to manage agricultural plastic waste sustainably.

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