Microplastic fate in soil environments: Drivers of the vertical transport of mulching film fragments

Rachel Hurley*†[1], Chiara Consolaro[2], Sam Van Loon[3], Nina Buenaventura[4], Lotte De Jeu[3], Laura Julia Zantis[5], Cornelis A. M. Van Gestel[6], and Luca Nizzetto[4]

[1]Norwegian Institute for Water Research (NIVA) – Økernveien 94, Oslo 0579, Norway
[2]Norwegian Institute for Water Research (NIVA) – Økernveien 94, Oslo, N-0579, Norway
[3]Amsterdam Institute for Life and Environment (A-LIFE), Faculty of Science, Vrije Universiteit Amsterdam (VUA) – De Boelelaan 1085, 1081 HV Amsterdam, Netherlands
[4]Norwegian Institute for Water Research (NIVA) – Økernveien 94, 0579 Oslo, Norway
[5]Institute of Environmental Sciences [Leiden University] (CML) – Einsteinweg 2, Leiden, 2333 CC, Netherlands
[6]Amsterdam Institute for Life and Environment ((A-LIFE)) – Vrije Universiteit Amsterdam, Faculty of Science, Amsterdam, Netherlands

Abstract

Soil environments have been identified as key recipients of microplastic pollution. One important source of microplastic is related to the degradation and fragmentation of plastic mulching films during and after use. Pollution emerging from this use and (mis-)management has already been documented in several occurrence studies globally. Yet, the environmental fate of mulching film fragments remains poorly understood. This study addressed this critical knowledge gap by investigating the vertical transport of mulching film fragments in soils, specifically assessing the influence of different potential drivers of this transport: bioturbation and soil water inputs. Vertical transport was tracked in a mesocosm experiment, utilising the CLIMECS (CLImatic Manipulation of ECosystem Samples) facility at Vrije Universiteit Amsterdam, which comprises 40 soil columns that simulate ecosystems – with soil, vegetation, and fauna – and are individually controlled for different environmental conditions. Two different types of mulching film fragments – one conventional (LLDPE) and biodegradable (starch-PBAT blend) – were used to spike the upper portion of 40 cm soil columns. Different treatments comprised high, medium, and low microplastic concentrations, the presence and absence of two species of earthworm, and a high and low watering regime. The columns were maintained for a period of 12 weeks and, at the end of the experiment, were broken down into six different soil depths to assess the vertical transport of mulching film fragments. The results show how earthworms represent important drivers of the downward mobilisation of microplastic particles in soils, with limited selectivity based on particle size or material composition. This provides crucial context related to the exposure of soil environments to soil microplastic pollution derived from mulching film use.

Keywords: microplastic, agricultural plastic, mulching film, mobilisation, vertical transport, earthworms

*Speaker
†Corresponding author: rachel.hurley@niva.no