Impacts of conventional and biodegradable microplastics on the earthworm Eisenia andrei

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Abstract

Microplastic (MP) contamination of soils has become a critical environmental concern. Conventional plastics are mainly used in agricultural practices, but the use of biodegradable materials has increased. However, the effects of these polymers on the environment are poorly understood.
The objective of this study was to assess and compare the ecotoxicological effects of mulching film-based microplastics, conventional low-density polyethylene microplastics (PE-MPs), and biodegradable polybutylene adipate terephthalate microplastics (PBAT-BD-MPs) on the earthworm Eisenia andrei. The measured parameters were survival, reproduction, growth, and oxidative stress.

The experimental setup included a standard eight-week earthworm reproduction test with seven different microplastic concentrations (0%, 0.005%, 0.05%, 0.1%, 0.5%, 1%, 5%). Oxidative stress was evaluated with six different biomarkers: catalase (CAT), superoxide dismutase (SOD), glutathione reductase (GR), glutathione S-transferase (GST), glutathione (GSH), and lipid peroxidation (LPO). The Integrated Biomarker Response Index (IBR) was derived from biomarker assays, and the soil water-holding capacity and pH were also measured.

The results indicated adverse effects on earthworms from both conventional and biodegradable MPs, although different parameters were impacted. Responses were observed even at low concentrations; however, no clear dose-response relationship was observed. While exposure to PE-MPs resulted in a decline in earthworm biomass with increasing concentrations, PBAT-BD-MP exposure led to enhanced earthworm growth at lower concentrations. MP exposures did not significantly alter the production of juveniles. Both MPs caused oxidative stress at environmentally relevant concentrations. Biomarkers CAT and GR showed significant activation with PE-MP exposure, whereas SOD and LPO levels were impacted by PBAT-MP exposure. Moreover, both MP types increased soil pH and water-holding capacity at the highest concentration, potentially influencing the observed responses in earthworms subjected to these concentrations.
This study provides novel insights into the effects of conventional and biodegradable microplastics on earthworms, influenced by plastic type, concentration, and environmental conditions.

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