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Agricultural Plastic Mulch Films: Sources, Fragmentation, and Microplastic Contamination in Crop Soils

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Abstract

Agricultural plastic mulch films have become an integral component of modern intensive cropping systems worldwide, yet their contribution to soil microplastic pollution remains insufficiently characterized. Global annual consumption of agricultural plastic mulch exceeds 2 million metric tonnes, with China, the Mediterranean basin including Turkey, and the United States representing the largest application zones. Field degradation studies demonstrate that conventional low density polyethylene mulch films undergo embrittlement and fracturing within 120 to 180 days of field exposure, driven by ultraviolet radiation, thermal cycling, mechanical abrasion, and microbial colonization. Analytical intercomparison reveals that microplastic concentrations in agricultural surface soils range from 50 to 950 particles per kilogram of dry soil under short term mulch use, while long term application exceeding ten consecutive seasons yields concentrations between 800 and 4,500 particles per kilogram. The predominant morphotypes identified are fragments accounting for 65% to 85% of total particles. Polymer characterization confirms polyethylene as the dominant constituent, comprising 70% to 90% of recovered plastics. Soil texture and tillage intensity significantly influence vertical migration, with microplastics detected at depths exceeding 30 centimetres in conventionally tilled fields. Emerging evidence indicates that microplastic contaminated soils exhibit altered bulk density, water holding capacity, and aggregate stability, with potential implications for crop productivity. Research gaps persist regarding long term accumulation rates, transport pathways to groundwater, and uptake of nanoscale plastic particles by edible crop tissues. The aim of this review is to synthesize current scientific knowledge on the sources, fragmentation behaviour, and microplastic contamination levels associated with agricultural plastic mulch films and to identify critical research priorities for assessing soil health risks.

Keywords: *Agricultural soils; fragmentation; low density polyethylene; microplastic contamination; mulch films; soil pollution*