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Microplastic-Induced Changes in Soil Quality and Functioning: Field Scale Trials

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Microplastics represent an emerging threat to terrestrial ecosystems, however, our understanding of the fate and behaviour of microplastics in the plant-soil system remains poor. In this replicated, field-scale study we added microplastics (low density polyethylene) to soil at different dose rates representing contamination levels ranging from 0 to 10 t ha^{-1}. These levels were chosen to cover both agricultural and urban contamination levels. Over a 12 month period, we studied a range of chemical, physical and biological soil quality indicators and wheat productivity to evaluate the impact of microplastics on the delivery of soil-related ecosystem services. Overall, we found little evidence to suggest that microplastics affect plant growth even at high dose rates. In contrast, microplastics had a significant impact on soil quality. The use of PLFA profiling and 16S metabarcoding of the bacterial and archaeal community, revealed changes in key microbial taxa at high microplastic doses. In addition, physiological profiling of the microbial community using lipidomics, untargeted metabolomics and targeted nitrogen metabolomics (using GC-MS platform) revealed significant shifts in microbial physiology. No appreciable effect of microplastics was seen on soil N and P dynamics, earthworm abundance or greenhouse gas emissions (CO_2, N_2O and CH_4). Overall, our results suggest that microplastics do induce changes in soil quality, but that this has little overall effect on the delivery of key soil-related ecosystem services. These results contrast strongly with experiments performed in laboratory mesocosms where microplastics negatively affected plant growth and soil quality, and highlight the need to study the impact of microplastics at the field scale over longer timescales.