

Microplastic-Induced Changes in Common Bean Rhizosphere Bacterial Communities Revealed by 16S rRNA Sequencing

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Abstract

Microplastic contamination in agricultural soil is an increasing environmental concern, yet its impact on the complicated interactions between plants and microbes within the rhizosphere remains insufficiently understood. While extensive research has shown the accumulation of microplastics in terrestrial ecosystems, fewer studies have revealed how microplastic-induced changes in rhizosphere microbial communities cause plant-specific responses to soil stress. This study investigated whether low-density polyethylene (LDPE) microplastics alter the rhizosphere microbial composition of *Phaseolus vulgaris* and whether these alterations explain cultivar-specific susceptibility or resilience. We hypothesized that LDPE contamination would disrupt microbial diversity, with more pronounced dysbiosis correlating with increased phenotypic stress in susceptible cultivars. Bean cultivars, pinto and kidney, were grown in soil with and without 2.5% (w/w) LDPE microplastics. Following a 14-day exposure period, morphological phenotypes were observed, and rhizosphere bacterial communities were characterized via 16S rRNA gene sequencing. Both cultivars exhibited root darkening and stunted growth under microplastic stress; however, kidney beans had more severe wilting and a more substantial reduction in height. The Shannon Diversity Index decreased by 12.9% in treated kidney beans, compared to a 6.2% reduction in pinto beans. Furthermore, microplastic exposure induced a sharp increase in the relative abundance of Proteobacteria and an overrepresentation of *Pseudomonas* in the kidney bean rhizosphere, whereas pinto beans maintained higher levels of beneficial taxa, such as *Rhizobium*. These findings demonstrate that LDPE microplastics significantly alter rhizosphere microbial dynamics in a cultivar-specific manner, suggesting that host-microbe interactions are pivotal in determining plant resilience to emerging soil contaminants.

Keywords

Microplastics, Rhizosphere, Microbiome, Beans

Biographies

Emily Moon is a high school student at McLean High School in Virginia with a strong academic interest in environmental science, neuroscience, and biomedical research. She is the founder of Harmony With U, a youth-led nonprofit organization dedicated to expanding access to music education for underserved communities. Through her leadership, she has supported over 200 students and collaborated with multiple community organizations. Emily is

actively engaged in scientific research, with a focus on environmental sustainability and the biological impacts of emerging pollutants such as microplastics. Her work explores the intersection of ecological health and human systems, aiming to contribute to sustainable solutions in agriculture and environmental preservation. In addition to her research, she volunteers as a violin instructor and is involved in various community service initiatives. She aspires to pursue a career in environmental science and public health, with the goal of conducting impactful research that improves both human and environmental well-being.

Yu Jin Lee is a Program Coordinator and senior lecturer for the MS in Biotechnology program and an adjunct professor at the Johns Hopkins Carey Business School. Lee has an extensive background in healthcare management in both the public and private sectors. She is also actively involved in medical device related start-ups. She has designed, set up and managed multiple clinical laboratories, leading projects with the most advanced sequencing technology. Lee currently teaches Clinical & Molecular Diagnostics and Advanced Recombinant DNA Laboratory at AAP and Medical Devices and Diagnostics at the Johns Hopkins Carey Business School. Lee has undergraduate and graduate degrees in biology from the Rensselaer Polytechnic Institute and an MBA with a focus on health care management from Johns Hopkins Carey Business School.