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Phytoremediation and Soil Health: Restoring Microbial Diversity and Functionality in Degraded Lands

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Abstract

Degradation of soil due to heavy metal contamination and industrial effluents is a critical threat to soil fertility, microbial diversity, and ecosystem services. Phytoremediation, in addition to removing pollutants, can restore soil health by improving physicochemical properties and enhancing biological activity. The review discusses how phytoremediation influences soil pH, organic carbon, and nutrient cycling, leading to microbial biomass development and enzymatic activities being enhanced. Brassica juncea and Helianthus annuus are some of the plants that facilitate recolonization by microbes as they exude sugars, amino acids, and secondary metabolites that promote microbial growth. Co-remediation strategies like composting, biochar, and microbial consortia are also addressed. Such treatment has the potential to facilitate soil recolonization, trigger plant-facilitative microbe interaction, and increase crop productivity following remediation. Soil health indicator monitoring is highlighted in phytoremediation assessment protocols. By establishing a biologically active and resilient microbial community in the soil, phytoremediation can be an integral part of sustainable land management and ecological rehabilitation.

Keywords: Soil fertility, Microbial diversity, Soil enzymes, Co-remediation, Soil health, Land restoration