Article type: Editorial

Home Page URL: https://www.alliedacademies.org/journal-plant-biotechnology-microbiology/

Rooted in partnership: An introduction to plant–microbe interactions.

Ahmed Prommeenate*

Department of Biochemical Engineering, King Mongkut's University of Technology Thonburi, Thailand

***Corresponding to:** Ahmed Prommeenate, Department of Biochemical Engineering, King Mongkut's University of Technology Thonburi, Thailand, E-mail: Ah.peerada@biotec.or.th

Received: *02-Feb-2025, Manuscript No. AAPBM-25-169146;* ***Editor assigned:*** *03-Feb-2025, PreQC No.AAPBM-25-169146(PQ);* ***Reviewed:*** *17-Feb-2025, QC No.AAPBM-25-169146;* ***Revised:*** *22-Feb-2025, Manuscript No. AAPBM-25-169146(R);* ***Published:*** *28-Feb-2025, DOI: 10.35841/aapbm-8.1.178*

Introduction

In degraded soils, inoculating plants with beneficial microbes can restore fertility and promote revegetation. Microbes also play a role in phytoremediation, helping plants detoxify polluted environments. Recent breakthroughs in metagenomics and next-generation sequencing have unveiled the complexity of plant microbiomes. Plants are not solitary organisms. Beneath the soil and across their surfaces, they engage in complex relationships with a vast array of microorganisms bacteria, fungi, viruses, and archaea. These interactions, collectively known as plant–microbe interactions, are essential for plant health, growth, and survival. From nutrient acquisition to disease resistance, microbes play pivotal roles in shaping plant life. This article introduces the fascinating world of plant–microbe partnerships, highlighting their types, mechanisms, and significance in agriculture and ecology [1, 2].

The rhizosphere the narrow region of soil surrounding plant roots is a bustling hub of microbial activity. Plants release root exudates, including sugars, amino acids, and organic acids, which attract and nourish microbes. In turn, these microbes influence root development, nutrient uptake, and immunity. The rhizosphere is home to beneficial microbes like rhizobacteria and mycorrhizal fungi, as well as potential pathogens. The dynamic interactions in this zone determine the overall health and productivity of the plant [3, 4].

Researchers now study entire microbial communities rather than isolated strains. The concept of the holobiont the plant and its associated microbes as a single ecological unit is gaining traction. Understanding this unit is key to improving crop performance and resilience. Plant microbe relationships can be broadly categorized into three types: Both partners benefit. Examples include: Rhizobia bacteria forming nodules on legume roots to fix atmospheric nitrogen. Arbuscular mycorrhizal fungi (AMF) enhancing phosphorus uptake in exchange for carbon. Microbes benefit without affecting the plant. Many soil bacteria fall into this category, living off root exudates without harming or helping the plant [5, 6].

Microbes harm the plant. Pathogens like Fusarium, Pseudomonas syringae, and Phytophthora cause diseases that reduce yield and quality. Plant–microbe interactions are governed by intricate molecular signaling. Plants recognize microbial molecules called microbe-associated molecular patterns (MAMPs) through pattern recognition receptors (PRRs). This triggers pattern-triggered immunity (PTI) [7, 8].

Plant microbe interactions influence ecosystem dynamics. They affect nutrient cycling, soil structure, and plant community composition. In natural ecosystems, microbial diversity supports resilience against environmental stresses. Beneficial microbes often suppress PTI to establish symbiosis. For example, rhizobia produce nod factors that are recognized by legume receptors, initiating nodule formation. Similarly, mycorrhizal fungi release myc factors to facilitate colonization. Pathogens, on the other hand, deploy effectors to bypass plant defenses, leading to effector-triggered susceptibility (ETS). Plants counter this with effector-triggered immunity (ETI), often resulting in localized cell death to contain the invader [9, 10].

Conclusion

The future of agriculture lies in microbiome engineering designing microbial communities to optimize plant health. Synthetic biology may allow us to create custom microbes that deliver nutrients, resist pests, or adapt to climate change. However, challenges remain in ensuring consistency across environments and understanding long-term ecological impacts. Plant microbe interactions are fundamental to life on Earth. They shape plant health, productivity, and adaptation. For beginners, exploring these relationships offers insights into the hidden partnerships that sustain ecosystems and feed the world. As research advances, harnessing these interactions will be key to building a more sustainable and resilient agricultural future.

References

1. Yu Q, Powles SB. Resistance to AHAS inhibitor herbicides: current understanding. Pest Manag. 2014;70(9):1340-50.
2. Hu M, Liu K, Qiu J, et al. Behavior of imidazolinone herbicide enantiomers in earthworm-soil microcosms: Degradation and bioaccumulation. Sci Total Environ. 2020;707:135476.
3. Choi YJ, Thines M. Host jumps and radiation, not co-divergence drives diversification of obligate pathogens. A case study in downy mildews and Asteraceae. PloS one. 2015;10(7):e0133655.
4. Colla G, Rouphael Y, Di Mattia E, et al. Co-inoculation of Glomus intraradices and Trichoderma atroviride acts as a biostimulant to promote growth, yield and nutrient uptake of vegetable crops. J Sci Food Agric. 2015;95(8):1706-15.
5. Yu D, Wang J, Shao X, et al. Antifungal modes of action of tea tree oil and its two characteristic components against Botrytis cinerea. J Appl Microbiol. 2015;119(5):1253-62.

Citation: Prommeenate A. Rooted in partnership: An introduction to plant–microbe interactions. J Plant Bio Technol. 2025;8(1):178