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Role of Rhizosphere Micro biome in Plant Biotic Stress Management

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SUMMARY

The soil-borne phytopathogens cause severe damages to plant roots resulting in significant agricultural yield loss. Rhizosphere microbiome, regarded as the second genome of plants, play a vital role in regulating various aspects of plant growth and development. Beneficial microbes favor plant growth by enhancing nutrient absorption, producing plant hormones, and enhancing tolerance to biotic stress mainly through antagonism, niches and resource competition, or microbial diversity and some by activating plant immune response.

INTRODUCTION

The intricate relationship between plant and the associated microbiome, particularly in the root zone, has emerged as a crucial factor in understanding plant responses to biotic stresses. Plant-microbe interactions within the rhizosphere microbiome have been shown to enhance nutrient acquisition, stimulate growth hormones, and fortify the plant's immune system, ultimately bolstering its resilience against biotic stressors (Hassani *et al.*, 2018). Moreover, the composition and diversity of the root microbiome can be shaped by the host plant species over evolutionary timescales, suggesting a co-evolved relationship between the plant and its microbial partners (Fitzpatrick *et al.*, 2018).

Microbial Community Dynamics and Plant Performance

Rhizosphere microbes play a crucial role in improving plant biotic stress tolerance by directly suppressing pathogens, activating plant defense mechanisms, promoting beneficial symbioses, improving root health, and promoting a resilient microbial community. For instance, a study found that greater similarity in root microbiomes among host plants can lead to negative effects on plant performance due to soil feedback mechanisms. Specific microbial taxa within the rhizosphere may affect competitive interactions among plant species, indicating that microbial diversity is essential for resilience against biotic stressors. The rhizosphere microbiomes of different plant species are shaped by their associations with different microbial communities, particularly when those species are grown in the same soil (Fitzpatrick *et al.*, 2018).

Under either favorable or unfavorable conditions, it is expected that plant-specific root exudates will draw rhizosphere bacteria. In the plant below ground environment, exudation from the roots influences both positive and negative stereotypes. While negative root-microbe associations involve the interaction of roots with harmful organisms like pathogens, positive root-microbe associations involve mutualistic interactions between roots and beneficial microorganisms like plant growth-promoting rhizobacteria (PGPR) and mycorrhizal fungi.

According to Pieterse *et al.* (2014), root exudates function as a signaling molecule, support in the recruitment of advantageous root-associated mutualists such as Pseudomonas, Bacillus, Trichoderma, and mycorrhizal species, and eliminate pathogenic microbes from the rhizosphere, thereby altering the composition of the microbial community. Many different types of secondary metabolites, such as terpenoids, alkaloids, and phenolic compounds, some of which are species or genus-specific produced by plants (Dastogeer *et al.,* 2020). For example In barley, to strengthen their defenses against Fusarium graminearum, barley plants infected with the fungus release exudates that are highly concentrated in phenolic compounds which alter rhizosphere microbial community to enhance plant defence against Fusarium graminearum (Afridi *et al.,* 2022).

Furthermore, distinct microbial communities inhabit distinct crop genotypes (Cordovez *et al.*, 2021). For instance, genotypes with rapid growth have a microbiome with greater functional diversity, which enhances plant performance (Brown *et al.,* 2020; Leopold and Busby, 2020). Certain plant-derived compounds are specific to certain plant species; for instance, glucosinolates are primarily found in the Brassicaceae family (Dastogeer *et al.*, 2020), and maize produces aglycone benzoxazinoids (BX), which confer resistance against herbivores in a jasmonic acid-dependent manner (Hu *et al.*, 2018).

CONCLUSION

The rhizosphere microbiome is a critical component of plant health and resilience, particularly in the context of biotic stressors. Current research highlights the importance of microbial diversity and community dynamics in fostering plant adaptation to adverse conditions. However, significant gaps in understanding the underlying mechanisms and optimal microbial compositions remain. Addressing these gaps through targeted research will be essential for harnessing the full potential of root microbiomes in agricultural systems, ultimately contributing to enhanced food security in the face of climate change. Microbiome-based approaches for engineering the rhizosphere seems to be a potent sustainable solution for enhancing biotic stress tolerance without compromising soil health as compared with the conventional approach of utilizing microbes as bioinoculants.

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