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Plant-Microbiota Interactions Under Drought and Salinity Stresses: A Mini Review

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Abstract

This mini-review explores the intricate relationships between plants and their associated microbiota under the influence of abiotic stresses, focusing on microbial community dynamics during drought and salinity stresses.

Keywords: Drought; Microbiota; Salinity; Phytohormone signaling; Wheat seedlings

Introduction

Abiotic stresses significantly impact plant physiology, leading to adaptive responses in growth, root and shoot architecture, germination rate, and developmental transitions. While these adaptations are crucial for plant survival, they often result in reduced crop yields, posing a threat to food security [1-3].

Plant-Microbiota Interactions

In nature and agriculture, plants form complex associations with diverse microbial communities, collectively referred to as the plant microbiota [4-8]. These microbes, originating from soil, air, precipitation, seeds, and other organisms, create a holobiont, emphasizing the interconnectedness of the host plant and its associated microbes [7,9,10].

Role of Microbes in Plant Growth and Health

Plant-associated microbes contribute to plant growth and health through mechanisms such as increasing mineral solubility, modifying phytohormone signaling, providing nutrients, and enhancing pathogen resistance [11-14].

Microbial Impact Under Abiotic Stress Conditions

Under abiotic stress conditions, plant-associated microbes play a crucial role in influencing plant physiological conditions, promoting plant growth, and enhancing abiotic stress tolerance. Researchers are increasingly exploring the application of plant-associated microbes in agriculture under stress conditions [15-19].

Dynamics of the Bacterial Community Under Drought Stress

Drought stress affects the structure of bacterial communities in the rhizosphere and root endosphere, influencing the alpha diversity and relative abundance of specific bacterial taxa, such as *Actinobacteria* [20,21]. The enrichment of *Actinobacteria*, particularly *Streptomyces*, in the belowground parts of plants during drought appears to be a conserved response among various plant species [22].

Mechanisms Behind Microbial Responses to Drought

The enrichment of *Actinobacteria* is not only attributed to their drought-tolerant nature but also to their active adaptation to the drought environment, as revealed by metatranscriptome analysis [21]. The regulation of *Streptomyces* spp. enrichment during drought involves complex interactions, including plant iron metabolism and the secretion of phytosiderophores [23].

Fungal Community Responses to Drought

While the effects of drought on fungal communities are generally smaller than those on bacterial communities, certain studies highlight changes in arbuscular mycorrhiza (AM) and ectomycorrhizal (ECM) fungi, crucial for drought stress mitigation [24,25]. Co-inoculation of AMF plants with *Glomus* sp. has shown potential for improving plant growth in saline soils by enhancing phosphate acquisition and reducing Na^+ concentration in shoots [26].

Microbial Contributions to Drought and Salinity Stress Tolerance

The plant-associated microbiome has been recognized for its potential role in enhancing plant adaptation to drought stress [27]. Specific strains, such as *Achromobacter piechaudii* ARV8, have been identified for their ability to enhance drought stress tolerance in pepper and tomato through ACC deaminase activity [28]. Additionally, bacterial priming has shown promising results in improving wheat seedlings' biomass and photosynthesis under severe drought conditions [29,30].

Conclusion

In conclusion, deciphering the intricate dynamics governing the interplay between plants and microbes under abiotic stress conditions stands as a crucial endeavor for unlocking the full potential of plant microbiota in the realm of sustainable agriculture. There exists a pressing need for further research endeavors aimed at unraveling the underlying molecular mechanisms, thereby facilitating the optimization of practical applications in agricultural contexts. A comprehensive understanding of the dynamic and intricate interactions between plants and microbes during abiotic stress is imperative for effectively harnessing the capabilities of plant microbiota in agriculture. This mini-review has offered valuable insights into the impact of abiotic stresses on microbial communities, underscoring their pivotal role in fostering plant adaptation and stress tolerance. The elucidated mechanisms shed light on the promising applications of microbial interventions, paving the way for sustainable agricultural practices.

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