



UPDATES ON ECTOMYCORRHIZAE IN PLANT DISEASE MANAGEMENT

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Introduction

Ectomycorrhizal (ECM) fungi form mutualistic symbiotic associations with the roots of many tree species, playing crucial roles in nutrient uptake, stress tolerance, and ecosystem functioning. In recent years, there has been growing interest in harnessing the potential of ECM fungi for plant disease management. This chapter provides an overview of recent advancements and updates on the use of ECM fungi in plant disease management strategies.

The Role of Ectomycorrhizae in Plant Health Nutrient Acquisition

ECM fungi enhance the nutrient uptake efficiency of their host plants, particularly for phosphorus and nitrogen, which are essential for plant growth and development. By extending their hyphal network into the surrounding soil, ECM fungi access nutrients that may be otherwise unavailable to the host plant, contributing to improved plant health and vigour.

Soil Health and Structure

Ectomycorrhizal fungi contribute significantly to soil health by improving soil structure and fertility. They help in soil aggregation, which enhances aeration and water infiltration.

Disease Resistance and Plant Immunity

Ectomycorrhizae play a protective role against soil-borne pathogens. They can

enhance the plant's immune response and create a physical barrier against invading organisms.

Stress Tolerance

ECM fungi play a crucial role in enhancing the stress tolerance of host plants, including tolerance to drought, salinity, heavy metals, and pathogens. Through mechanisms such as osmotic adjustment, antioxidant production, and hormone regulation, ECM fungi help mitigate the adverse effects of environmental stresses on plant growth and survival.

Stress Tolerance and Environmental Adaptations

Ectomycorrhizal fungi help plants cope with various abiotic stresses, including salinity, heavy metal contamination, and extreme temperatures.

Ectomycorrhizae in Agroforestry Systems

Agroforestry systems benefit from ectomycorrhizal associations through improved soil health, increased plant growth, and enhanced resilience to environmental stresses.

Applications of Ectomycorrhizae in Plant Disease Management

Disease Suppression

ECM fungi can suppress soil-borne plant pathogens through various mechanisms, including competition for nutrients and space, induction of systemic resistance in host plants,

and production of antimicrobial compounds. By colonizing the rhizosphere and forming protective barriers around the roots, ECM fungi can reduce the incidence and severity of diseases caused by fungal, bacterial, and nematode pathogens.

Biocontrol Agents

Certain species of ECM fungi have demonstrated biocontrol activity against plant pathogens, offering potential alternatives to chemical fungicides for disease management. These biocontrol agents can inhibit pathogen growth and colonization through mechanisms such as mycoparasitism, antibiosis, and induction of host defense responses.

Enhancement of Plant Defense Responses

ECM fungi have been shown to enhance the defense responses of host plants, priming them for faster and more effective defense against invading pathogens. This priming effect involves the activation of plant defense pathways and the upregulation of defense-related genes, leading to improved resistance against a wide range of pathogens.

Recent Advances and Research Trends

Metagenomic Approaches

Recent advances in metagenomic sequencing technologies have enabled comprehensive analysis of ECM fungal communities in diverse ecosystems. These studies have revealed the diversity, composition, and functional potential of ECM fungal communities and their interactions with host plants and soil microbes, shedding light on their roles in plant disease management.

Synthetic Biology and Engineering

Advancements in synthetic biology and genetic engineering techniques offer new opportunities to engineer ECM fungi for enhanced disease suppression and other

beneficial traits. Strategies such as targeted gene editing, metabolic engineering, and synthetic symbiosis hold promise for developing customized ECM fungal strains tailored for specific disease management applications.

Challenges and Future Directions

Commercialization and Scale-up

One of the major challenges in harnessing ECM fungi for plant disease management is the commercialization and scale-up of effective biocontrol products. Overcoming barriers such as production costs, formulation stability, and regulatory approval is essential for widespread adoption of ECM-based biocontrol agents in agriculture.

Understanding Microbial Interactions

Further research is needed to unravel the complex interactions between ECM fungi, host plants, and other soil microbes in natural and agricultural ecosystems. Understanding how these interactions influence disease dynamics and ecosystem functioning will facilitate the development of more effective disease management strategies.

Conclusion

Ectomycorrhizae offer promising opportunities for sustainable plant disease management by enhancing plant health, suppressing pathogens, and promoting resilience to environmental stresses. Recent advancements in understanding ECM fungal ecology, biochemistry, and genetics have paved the way for innovative approaches to harness their potential for agricultural applications. By integrating ECM fungi into holistic disease management strategies, we can enhance the resilience and sustainability of agricultural systems while reducing reliance on chemical inputs.