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Editorial

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Mycorrhizal Symbiosis: Enhancing Plant Growth and Soil Health

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Introduction

Mycorrhizal symbiosis is a mutualistic association between plant roots and fungi, forming one of the most widespread and ecologically significant interactions in terrestrial ecosystems. In this relationship, plants supply carbohydrates to the fungi, while the fungi enhance nutrient and water uptake, particularly phosphorus and micronutrients, for the host plant. Mycorrhizal associations are critical for improving plant growth, soil structure, and ecosystem resilience [1,2]. Understanding and leveraging mycorrhizal symbiosis offers significant potential for sustainable agriculture, forestry, and soil conservation.

Discussion

There are two major types of mycorrhizal fungi: arbuscular mycorrhizal fungi (AMF), which penetrate root cortical cells and form arbuscules for nutrient exchange, and ectomycorrhizal fungi (EMF), which form a sheath around roots and extend hyphal networks into the soil. AMF are common in most crop plants, while EMF are often associated with trees in forest ecosystems. Both types enhance the surface area of roots through extensive hyphal networks, allowing plants to access nutrients and water beyond the root depletion zone [3,4].

Mycorrhizal symbiosis also plays a key role in plant stress tolerance. The fungal partners improve water uptake under drought conditions, enhance resistance to soil salinity, and protect plants against pathogens by competing with harmful microbes and inducing systemic resistance. In addition, mycorrhizal fungi contribute to soil aggregation through the production of glomalin and other extracellular compounds, improving soil structure, porosity, and carbon sequestration [5].

In agricultural systems, promoting mycorrhizal symbiosis can reduce dependency on chemical fertilizers and improve sustainability. Practices such as reduced tillage, organic amendments, cover cropping, and inoculation with beneficial mycorrhizal fungi support fungal colonization and activity. These approaches not only increase nutrient use efficiency but also enhance soil microbial diversity and long-term soil fertility.

Recent advances in molecular biology and imaging techniques have enabled a deeper understanding of the genetic and biochemical mechanisms underlying mycorrhizal interactions. Insights into signaling pathways, nutrient transport, and fungal diversity can guide the development of biofertilizers and crop management practices that optimize symbiotic benefits.

Conclusion

Mycorrhizal symbiosis is a vital component of healthy soil ecosystems, enhancing plant nutrient acquisition, stress tolerance, and soil structure. By promoting these associations through sustainable agricultural practices, it is possible to improve crop productivity, reduce chemical inputs, and maintain long-term soil fertility. Harnessing mycorrhizal interactions represents a natural, eco-friendly strategy for resilient and sustainable agriculture, reinforcing the essential link between plant roots, soil health, and ecosystem sustainability.

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