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Editorial Note

The Contribution of Bacteria, Fungi, and Neighboring Plants to Mycorrhizal Symbiosis, Hides yet a lot of Secrets

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Mycorrhizal symbiosis, the mutualistic association between plant roots and fungi, plays a crucial role in sustaining the productivity and health of natural and agricultural ecosystems. Mycorrhizal fungi are of great importance for agriculture as they help increase crop yields and reduce fertilizer use. In addition, they contribute to the improvement of soil structure, water retention, and erosion control, resulting in more sustainable and environmentally friendly agricultural practices. The benefits of mycorrhizal symbiosis also extend to forest ecosystems, where they have been shown to enhance the growth and survival of trees, promote biodiversity, and improve soil quality. Despite their ecological and agricultural importance of mycorrhizal fungi and their associated functions, the biorhizospiric interactions that mediate and facilitate the formation of this association are still not well understood. The purpose of this editorial is to shed light on the major biotic interactions involved in the success of mycorrhiza and that need to be more studied, that hides yet a secrets.

The neighboring plants can have a significant impact on the success of mycorrhizal associations. For example, it has been proven that the presence of certain plant species can stimulate the growth of mycorrhizal fungi. In particular, the release of carbon compounds from the roots of some plant species, such as legumes, has been shown to enhance the colonization of roots by mycorrhizal fungi. This process, known as "mycorrhizal network," involves the transfer of nutrients and signaling molecules between plants via mycorrhizal fungi hyphae, leading to the establishment of a complex underground network of interconnected plants. Additionally, research has also revealed that the success of mycorrhizal associations can be influenced by the presence of non-mycorrhizal plants in the community. In particular, some non-mycorrhizal plant species have been shown to compete with mycorrhizal plants for resources, leading to reduced mycorrhizal colonization and nutrient uptake. These findings demonstrate the complex and dynamic interactions that occur between plants and mycorrhizal fungi, and highlight the importance of considering the role of neighboring plants in the success of mycorrhizal associations. It will be important that future research includes investigations on (i) the role of mycorrhizal-non-mycorrhizal plant interactions in ecosystem structure and function under different environmental conditions, such as nutrient availability and climate change; (ii) The potential use of mycorrhizal networks as a tool to stimulate mycorrhizal association, including the introduction of non-mycorrhizal plant species to promote plant growth and establishment; (iii) the development of molecular tools to better understand the genetic and molecular bases of mycorrhizal-non-mycorrhizal plant and fungus interactions. By addressing these research perspectives, we can gain a better understanding of the intricate and complex relationships between plants and mycorrhizal fungi.

On the other hand, the bacteria can play an important role in the success of mycorrhizal associations. These bacteria, known as mycorrhiza helper bacteria (MHB), can facilitate the colonization of plant roots by mycorrhizal fungi and enhance the efficiency of nutrient exchange between the plant and the fungus. MHB have been shown to promote the growth and activity of mycorrhizal fungi through various mechanisms. For example, they can produce plant growth-promoting substances such as auxins, cytokinins, and gibberellins, which stimulate roots architecture and enhance colonization by mycorrhizal fungi. Moreover, recent research has shown that

the composition and diversity of bacterial communities in soil can also influence the success of mycorrhizal associations. For example, it has been shown that the presence of certain bacterial taxa, such as Rhizobium and Bradyrhizobium, can enhance mycorrhizal colonization of plant roots and improve plant growth and nutrient uptake. These findings suggest that bacteria can play a critical role in the establishment and maintenance of mycorrhizal associations. Therefore, we can suggest that future research could include investigating (i) the mechanisms underlying the interactions between MHB and mycorrhizal fungi, and how these interactions are influenced by soil and environmental factors; (ii) the identification and characterization of key bacterial taxa and genes involved in promoting mycorrhizal colonization and nutrient exchange; (iii) the development of microbial inoculants containing MHB for use in agricultural and forestry practices to enhance plant mycorhization.

Recent studies have shown that the presence of neighboring fungi, including non-mycorrhizal fungi, can have both positive and negative effects on the success of mycorrhizal associations. Certain species of non-mycorrhizal fungi have been shown to promote the growth and activity of mycorrhizal fungi. For example, some saprotrophic fungi can help to decompose organic matter in the soil, releasing nutrients that are then available for uptake by mycorrhizal fungi and plants. In addition, some pathogenic fungi can stimulate the production of defensive compounds by mycorrhizal fungi and their host plants, enhancing their ability to resist other pathogens and environmental stresses. On the other hand, other non-mycorrhizal fungi can have negative effects on mycorrhizal associations. For example, some ectomycorrhizal fungi have been shown to compete with arbuscular mycorrhizal fungi for nutrients and carbon in the soil, potentially reducing the extent of mycorrhizal colonization and nutrient exchange. Similarly, some non-mycorrhizal fungi can release allelopathic compounds that inhibit the growth and activity of mycorrhizal fungi and their host plants. These findings suggest that the interactions between neighboring fungi and mycorrhizal fungi are complex and can have both positive and negative effects on the success of mycorrhizal associations. Further research is needed to understand the underlying mechanisms of these interactions and to develop strategies to enhance the positive effects of neighboring fungi and mitigate their negative effects on mycorrhizal associations.

The success of mycorrhizal associations in natural and agricultural ecosystems is influenced by a complex array of factors, including neighboring plants, bacteria, and fungi. While these factors can have both positive and negative effects on mycorrhizal associations, therefore, understanding these complex interactions can be harnessed to enhance ecosystem functioning and promote sustainability.

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