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The Role of Mycorrhizal Fungi in Enhancing Soil Fertility

(*Divya D[1], Mayank Kumar[2], Dr. Ningombam Bijaya Devi[3] and Dr. Anil Kumar[4])
[1]PhD. Research Scholar, Department of Soil Science, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Iruvakki, Shimoga, Karnataka, India
[2]Ph.D Research Scholar, Department of Soil Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh- 208002, India
[3]Department of Botany, G.P. Women's College, Dhanamanjuri University, Imphal, Manipur-795001, India
[4]Assistant Professor, Department of Agronomy, Eklavya University, Damoh, Madhya Pradesh-470661, India
*Corresponding Author's email: divyadnaik8@gmail.com

Mycorrhizal fungi are significant in improving soil fertility and plant productivity through symbiotic association with the roots of plants. These fungi increase nutrient uptake, especially phosphorus, through extensive hyphal networks that reach beyond the root zone. They also enhance water absorption, improve soil structure, and enhance plant resistance to biotic and abiotic stresses. Mycorrhizal fungi enhance soil aggregation through glomalin production and support microbial diversity, which further enriches soil health. Their application in sustainable agriculture, such as biofertilizers and integrated nutrient management, offers eco-friendly alternatives to chemical inputs. Despite challenges such as variability in efficacy and scalability, advances in research and technology hold immense potential for leveraging mycorrhizal fungi in soil fertility management, contributing to sustainable farming and global food security.

Introduction

Soil fertility in sustainable agriculture is the backbone of high crop productivity and environmental protection. Among the many biological input factors that determine soil fertility, mycorrhizal fungi play a very strategic role because of their beneficial relationship with plant roots. The fungi increase nutrient intake but also improve soil structures, water retention, and protection of plants against environmental stresses. Mycorrhizal fungi - mechanisms, benefits, and applications in improving soil fertility - are discussed in this article.

Mycorrhizal Fungi

Mycohryzal fungi are microscopic organisms that develop mutualistic with most terrestrial plants roots. The two main types:

1. Arbuscular Mycorrhizal Fungi (AMF)-They penetrate the root plant cells and form arbuscules, thereby acting as an exchange channel between nutrient uptakes.

2. Ectomycorrhizal Fungi (EMF)-They form the external mycelium networks around plant roots, thereby assisting in obtaining nutrients.

These fungi increase the hyphal surface area within the soil, hence improving the availability of phosphorus, nitrogen, and micronutrients to the plant.

Mode of Action

1. Mobilization of Nutrients: Mycorrhizal fungi contribute significantly to nutrient mobilization. One such nutrient, which is very immobile in the soil, is phosphorus. Fungal hyphae exude various enzymes and acids, solubilizing bound nutrients so that the latter are absorbed by the plants.

2. Water Absorption: The extensive hyphal networks act as extensions of plant roots, accessing water from micropores in the soil. This enhances the plant's drought tolerance and ensures better hydration during water stress periods.

3. Soil Structure Improvement: Mycorrhizal fungi secrete glomalin, a glycoprotein that binds soil particles into aggregates. This improves soil aeration, reduces erosion, and enhances water infiltration and retention.

4. Enhancing Microbial Communities: The fungi create a diverse microbial ecosystem around the root zone (rhizosphere) by releasing organic compounds. Such microbes also enhance nutrient cycling and soil health.

5. Disease Resistance: Mycohizal fungi could inhibit the pathogens that exist within the soil through competing for space or nutrients, or through inducing host plant defense mechanisms.

Benefits of Mycorrhizal Fungi in Soil Fertility

Increased Nutrient Uptake Efficiency: The efficiency of phosphorus uptake and assimilation of micronutrients such as zinc, copper, and iron improves.

Sustainable Soil Use: Mycorrhizal fungi enhance natural nutrient cycling and soil resilience, making them an essential component of sustainable agriculture.

Increased Crop Yield:

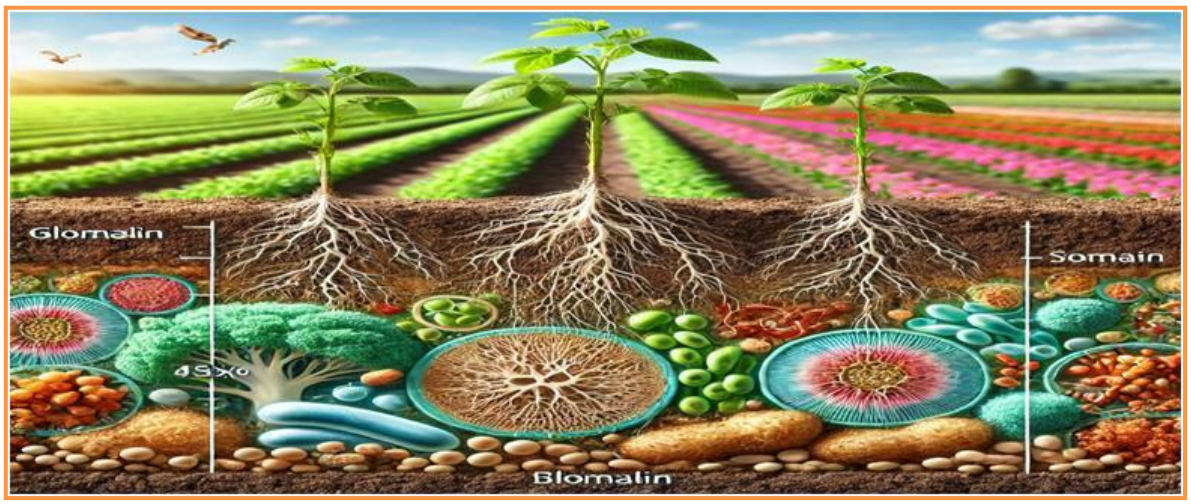
•Better yield due to enhanced nutrient availability and better plant health.

•Improved tolerance to abiotic stresses such as drought and salinity.

Environmental Benefits:

•Decreased nutrient leaching and groundwater contamination.

•Carbon sequestration in soil through the production of glomalin.



Applications in Contemporary Agriculture

1. Biofertilizers: Mychorrhizal fungi commercial formulations are applied as biofertilizers to promote soil fertility and crop performance in an eco-friendly way.

2. Integrated Nutrient Management (INM): Mycorrhizal fungi are an integral part of INM strategies, reducing reliance on synthetic inputs while maintaining productivity.

3. Reclamation of Degraded Soils: These fungi can recover soil fertility and promote growth of vegetation in degraded and nutrient-poor soils.

4. Organic and Sustainable Farming: Mycorrhizal inoculants are used extensively in organic farming to enhance natural cycling of nutrients and reduce chemical inputs.

Challenges and Future Directions

1. Understanding Variability: The effectiveness of mycorrhizal fungi is different for each soil type, crop species, and environmental condition. Thus, the solution must be customized for a specific agro-ecosystem.

2. Scalability Problems: The production and application of mycorrhizal inoculants at large scales necessitate low-cost technologies.

3. Research Needs: More research needs to be conducted on the mechanisms of mycorrhizal interaction with different crops and varied climatic conditions.

4**. Integration with Advanced Technologies:**Combining applications of mycorrhizal fungi with precision agriculture and microbial genomics could be the future revolution in soil fertility management.

Conclusion

Mycorrhizal fungi are truly the perfect natural and long-term fertilizer for enhancing soil quality. By improving nutrient uptakes, water retention within the soil, and eventually, enhancing soil structure; mycorrhizal fungi can help modern agriculture. The proper implementation of these fungi in farmers' processes will help save a world from chemical dependence, increasing crop resilience, and environmentally safe productivity. Further unlocking this scientific potential will reveal its greater role in achieving safe global food security and quality soil.

References

1. Buscot, F., & Varma, A. (2007). *Microorganisms in Soils: Roles in Genesis and Functions*. Springer Science & Business Media.
2. Cardon, Z. G., & Whitbeck, J. L. (2011). *The Rhizosphere: An Ecological Perspective*. Elsevier.
3. Hasanuzzaman, M., Fujita, M., Oku, H., Nahar, K., & Hawrylak-Nowak, B. (2018). *Plant Nutrients and Abiotic Stress Tolerance*. Springer.
4. Srivastava, A. K. (2012). *Advances in Citrus Nutrition*. Springer Science & Business Media.