



Hidden Helpers Beneath the Soil: How Mycorrhizal Fungi Support Sustainable Agriculture

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Agriculture today faces several challenges, including declining soil fertility, increasing fertilizer costs, and environmental concerns associated with excessive chemical inputs. Farmers are expected to produce more food from limited land while protecting natural resources. In this situation, beneficial soil microorganisms are gaining attention as eco-friendly tools for improving crop productivity. Among these microorganisms, arbuscular mycorrhizal fungi are considered some of the most valuable partners of plants.

AMF are naturally occurring fungi that live in association with the roots of most agricultural crops. This relationship is known as mycorrhiza. The partnership is beneficial to both organisms. The plant supplies carbohydrates produced during photosynthesis, while the fungus helps the plant absorb nutrients and water from the soil more efficiently.

These fungi form a network of microscopic filaments called hyphae. The hyphae extend far beyond the plant root system and explore a much larger volume of soil than roots can reach on their own. Through this extensive network, AMF improve the uptake of essential nutrients, especially phosphorus. In addition to nutrient acquisition, AMF contribute to better water uptake. During periods of limited rainfall or drought stress, plants associated with these fungi often perform better than non-mycorrhizal plants. The fungal network helps plants access water from a wider area of soil.

The benefits of AMF extend beyond plant nutrition and water relations. Researchers have found that these fungi can improve soil structure by helping soil particles bind together into stable aggregates. Better soil aggregation enhances aeration, water infiltration, and root growth while reducing erosion. AMF are particularly important in sustainable agriculture because they reduce dependence on chemical fertilizers. By improving nutrient-use efficiency, AMF enable plants to obtain more nutrients from the soil with lower fertilizer inputs.

Many crops benefit from mycorrhizal associations. Tomato is one such crop where mycorrhizal fungi have shown promising results. Studies have reported improvements in root growth, nutrient uptake, plant vigor, and yield when tomato plants are associated with effective AMF species.

Scientists are developing methods to produce quality AMF inoculum that can be applied to agricultural fields. One modern technique is Root Organ Culture (ROC), which allows the growth of plant roots under sterile laboratory conditions. These roots can be colonized by AMF, enabling the production of clean and high-quality fungal propagules.

Root Organ Culture has become an important tool for studying AMF biology and developing improved biofertilizer formulations. Continued research on mass multiplication techniques and inoculum formulations will help make these fungi more accessible to farmers.

As the world seeks environmentally friendly solutions for food production, the tiny fungal partners hidden beneath the soil surface may play a major role. By supporting plant growth naturally and improving soil health, arbuscular mycorrhizal fungi offer a promising pathway toward productive and sustainable agriculture.