

Mycorrhizal Fungi in Sustainable Agriculture and Land Restoration

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The term ‘Mycorrhiza’ refers to the symbiotic relationship between fungi and plant roots, particularly in terrestrial environments [1]. There are seven different types of mycorrhizae: endo (arbuscular), ecto, ectendo, arbutoid, monotropoid, ericoid, and orchidaceous, among which endo- and ectomycorrhizae are the most abundant and widespread [2]. The earliest fossil records suggest that endomycorrhizal interactions evolved circa 400 to 450 million years ago, and these associations have played an essential role in the colonization of land by plants [3]. Almost 90% of plants in the earth’s ecosystem have mycorrhizal associations. However, mycorrhizal fungi’s distribution depends on their host plants’ distribution and various climatic and edaphic factors [4]. In recent years, the development of several molecular techniques, such as next-generation sequencing (NGS) and genome/transcriptome analyses, has increased our knowledge regarding identifying new functions of these mycorrhizal fungi, understanding their community compositions in ecosystems, and the pathways of interaction between different mycorrhizal fungi and their host plants [5].

Additionally, mycorrhizal fungi are essential in terrestrial ecosystems as they regulate nutrient cycles and influence various ecosystem processes [6]. It is now well known that mycorrhizae protect plants against several biotic and abiotic stresses and influence plant growth and performance, i.e., seedling survival and productivity [7]. In recent decades, interest in mycorrhizal symbiosis has increased regarding sustainable agriculture, forestry, and land restoration management [8].

To create and spread a better understanding of this exciting research area, we proposed the research topic “Mycorrhizal Fungi in Sustainable Agriculture and Land Restoration”. For this research topic, we accepted six articles: five original articles and one review on different aspects of mycorrhizal fungi. The scientific content of this research topic is summarized below.

Shafiq et al. presented a sustainable intercropping system using *Rhizophagus irregularis* as a biostimulant with eco-friendly growing substrates and revealed their effects on above- and belowground parameters in onions and tomatoes under greenhouse conditions. Their research results showed that a sand-mixed growth substrate is the main driver in producing the beneficial effects of arbuscular mycorrhizal fungi (AMF). This work further suggests that a combination of AMF with cheap and environmentally friendly substrates can be used in commercial agriculture. Thind et al. investigated mycorrhizal diversity in the rhizospheric soils of *Cenchrus ciliaris* in the Layyah District of Pakistan, as well as its subsequent impact on mycorrhizal colonization in soil and on *C. ciliaris* and its growth and physiological characteristics. This study concluded that these mycorrhizal fungi significantly improve the mycorrhizal characteristics of *C. ciliaris* and its rhizosphere soil and eventually enhance the growth and physiological parameters of *C. ciliaris*. Al Hadidi et al. set up a pilot study to investigate the effects of a mycorrhizal inoculum, Symbivit, and whether Symbivit could form a symbiotic relationship with two potato varieties: orange and purple. The



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results of this study suggested that Symbivit inoculation in sweet potatoes could lead to the development of AMF, improving sweet potato growth, nutrient uptake, and yield.

Dłużniewska et al. investigated whether laser stimulation and irradiated biological material affect the morphological parameters of soybean plants and their health statuses. They concluded that laser stimulation significantly reduced the occurrence of *Fusarium* root rot and *Septoria* brown spot in different degrees. Liu et al. applied easily extractable glomalin-related soil protein (EE-GRSP) and difficultly extractable GRSP (DE-GRSP) at different concentrations to trifoliolate orange seedlings and evaluated the effects on biomass production, soil aggregate stability, soil organic carbon (SOC), phosphatase, and pH values. The authors concluded that exogenous EE-GRSP application considerably increases plant biomass, stimulates the formation and stability of soil WSAs, reduces soil pH values, and elevates SOC content and soil phosphatase activity. The review by Ediriweera et al. discusses work on ectomycorrhizal (EM) fungi's potential as a natural bio-indicator of heavy metal contamination in soil and how EM mushrooms can be successful bio-indicators. In addition, this review presents an overview of the physiology of EM fungi, the supportive mechanisms of metal homeostasis, and the characteristics of EM mushrooms as a successful bio-indicator. Furthermore, it also discusses the analysis of heavy metal concentrations adsorbed onto EM mushroom fruiting bodies and the suitability of mushrooms for human consumption when harvested from contaminated substrates.

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