Arbuscular Mycorrhizal Fungi in Agriculture

Subjects: Microbiology

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Arbuscular mycorrhizal (AM) fungi are biotrophic symbionts forming close relationships with an estimated 80% of terrestrial plants suitable as their host. Via an established AM fungal–host relationship, soil-bound nutrients are made available to the host plant through root cortical arbuscules as the site of exchange. At these sites, photosynthetic carbohydrates are provided to the AM fungus—carbohydrates that cannot be produced by the fungus. AM fungal–host symbiosis is very sensitive to soil disturbance, for example, agricultural tillage practices can damage and reduce AM fungal abilities to interact with a host and provide plant growth-promoting properties.

arbuscular mycorrhizal fungi | conservational | glomalin | soil quality | sustainable | symbiosis | tillage

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Arbuscular mycorrhizal (AM) fungi are symbiotic biotrophs that form close relationships with a host plant via intracellular fungal structures, namely arbuscules, in root cortical cells [1]. It is currently estimated that AM fungi began their associations with host plants between 400 and 480 million years ago, contributing to the initial land colonisation by terrestrial plants. Approximately 80% of terrestrial plant species are in close symbiotic relations with AM fungi [2] for several plant-promoting properties, such as nutrient acquisition, increases in crop mass and yield, as well as reduced stress from abiotic pressures, e.g., soil salinity and drought [3].

AM fungi contribute to soil structure, stability and function through increased growth and mass from a hostâs root system. One way in which they contribute to this is from the production of glomalin [4][5], a glycoprotein, with soil adhesive properties between microaggregates [4][6]. Additionally, branching mycelial networks produce exploratory hyphae through soil pores [7]. This exploration allows hyphae to wrap around glomalin-adhered microaggregates to form larger more stable macroaggregates, this also aids in the reduction of soil erosion by wind and water [8][9]. The management of soils, however, has the ability to preserve or damage AM fungal networks, their associations with a host plant, and their influences on soil properties [10].

Tillage, as a method of seedbed preparation, can be detrimental to AM fungalâhost relations and wider mycelial network establishment [11][12]. This is indicative of conventional tillage (CT) which typically inverts soils to a maximum depth of 30 cm (20 cm within the UK [13]) forming the zone of tillage, with the formation of a densely compacted layer below (plough pan). Such a degree of soil inversion and disturbance breaks and homogenise AM fungal mycelia through the zone of tillage [13] and negatively impacts AM fungal life cycles by reducing the likelihood of AM fungi finding a host plant to form a symbiotic establishment, additionally seen in the use of excessive fertiliser use. This is a critical part of the AM fungal life cycle [14]. In contrast, zero tillage (ZT) does not invert or disturb soils. ZT practices utilise direct seed drilling. This method of land management is comparably more conservative to AM fungal abundance [9][15]. However, ZT management strategies are known for their employment of glyphosate as a means of weed removal as an alternate method to CT soil inversion [10]. Glyphosate was shown to be detrimental to AM fungi and their host crop interactions. Such disturbances to AM fungi, from both soil disturbance and chemical interaction, interfere with the AM fungal life cycle.

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