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Commentary

Benefits of Arbuscular Mycorrhiza Colonization in Plant Development

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DESCRIPTION

Arbuscular Mycorrhiza (AM) is a type of endomycorrhiza. AM fungi belong to the phylum Glomeromycota, which has a single class Glomeromycetes with four orders Glomerales, Diversisporales, Paraglomerales and Archaesporales. There are 11 families, genera and 228 species of AM fungi. The AM forming genera of the family includes Acaulospora, Entrophospora, Gigaspora, Glomus, Sclerocystis and Scutellospora. Arbuscular Fycorrhizal Fungi (AMF) is ubiquitous in soil habitats and form beneficial symbiosis with the roots of angiosperms and other plants. Arbuscular mycorrhizal symbiosis is probably the most widespread beneficial interaction between plants and microorganisms. This association between plant and fungi from the Glomeromycota phylum dates back to the first appearance of land plants (about 400 million years ago). AM fungi develop symbiotic relationship with around 2,50,000 species of plants belonging to angiosperm, gymnosperm and pteridophytes, including many arable crops worldwide. Plants belonging to Cruciferae, Chenopodiaceae, Caryophyllaceae, Juncaceae, Cyperaceae and Polygonaceae are considered non-mycorrhizal due to the presence of toxic glucosinolates and their hydrolysis product isothyocyanates in and around the roots. The AM fungi are the most complex group of mycorrhiza which forms intra radical structures: intracellular hyphae forming coils, often found in the outer layers of cortical parenchyma, the intercellular hyphae and intracellular hyphae with numerous ramifications, i.e. the arbuscules, and the inter or intracellular hypertrophied hyphae, i.e. the vesicles. The mycelial network surrounding the roots is dimorphic: with coarse thick walled irregular non-septate hyphae, and smaller, thin walled ephemeral lateral branches. The thick-walled hyphae penetrate the host root and cause internal infection. At the entry point, the penetrating hyphae form appresoria in the host plants. Arbuscular Mycorrhizal Fungi (AMF) is obligate biotrophs, which can form mutualistic symbiosis with the roots of around 80% of plant species. AM symbiosis can establish extra radical mycelia, which disperse outside the roots to have access to a greater quantity of water and soil minerals for the host plants. In return the symbiosis receives plant carbohydrates for the completion of its life cycle. The mycorrhizal symbiont almost occurs in all fruit tree tree species grown in nursery or field. Mycorrhizal plants have two routes of nutrient acquisition, the Direct Pathway (DP) through the root epidermis and its root hairs, (representing the only uptake route of non-mycorrhizal plants), and the Mycorrhizal Pathway (MP) through the fungal mycelium that delivers nutrients to the root cortex through the arbuscules. Arbuscular Mycorrhiza Colonization Arbuscular mycorrhiza colonization begins with the hyphae that arise from soil-borne propagules, large resting spores of the AM fungi or mycorrhizal root fragments. The 5 fungal hyphae penetrate the root between the epidermal cells and form an appresoria in the first cell layers. This stage marks the autotrophic growth of the fungus. The colonizing hyphae pass through the intercellular spaces and then enter the root tissues spreading between and through cells of the cortical root layers. Once the hyphae have reached the inner cortex they grow into the cells and form tree-like structures called 'arbuscules'. These branched hyphae are closely surrounded by the intact host plasmalemma and represent a large surface of cellular contact between both symbionts. These facilitate the exchange of metabolites between host and fungus. The arbuscules are probably the main transfer site of mineral nutrients, mainly phosphorus, from the fungus to the plant and of carbon compounds to the fungus.

CONCLUSION

As internal colonization spreads, the extraradical hyphae ramify, and grow along the root surface forming more penetration points. They also grow outwards into the surrounding soil, thus developing an extensive tridimensional network of mycelium which interfaces with soil particles. Smith and Gianinazzi-Pearson had demonstrated that the length of the external hyphae growing in soil associated with mycorrhizal roots reaches an average of 1cm (1 root), but values of up to 10-14 cm (1 root) have also been recorded. These mycelial network can extend several centimetres outwards from the root surface, bridging over the zone of nutrient depletion around roots to absorb low-mobile ions from the bulk soil (mineral nutrients). In return the plant provides the fungus with sugars, amino acids and vitamins essential for its growth.

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