

The Role of Beneficial Mycorrhizal Fungi in Grapevine Nutrition

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Arbuscular mycorrhizal fungi are beneficial organisms that colonize plant roots. These fungi are members of the Order Glomales, and their ancestors are some of the oldest known fungi in the fossil record. They form elaborate structures called arbuscules. The fungus actually grows within the root itself, within the space between the cell walls and cell membranes of the root cortex. These fungi are obligate colonizers, meaning they cannot grow in the absence of a root. Their fungal filaments or hyphae extend outside of the root into the soil. This increases the surface capacity of the root system since the hyphae are very fine relative to the root dimensions (10 μm in diameter as compared to 3 mm) (Fig. 1). The fungus can absorb nutrients from the soil that can be transported to the root system via the hyphae of the fungus. The association of the fungus with the plant also permits colonization of and access to more challenging soils and is lower in “cost” to the plant in terms of carbon consumption needed to produce new roots versus feeding the fungal biomass. Both the plant and the fungus gain from this association. The fungus is provided with carbon by the plant. Mycorrhizal grapevines have improved shoot and root growth, higher tissue concentrations of phosphorus, and improved water relations and drought tolerance. Mycorrhizal grapevines have been shown to resist certain fungal diseases. Given the clear benefits of these mycorrhizal fungi, it is important to understand when and how they associate with root systems and what environmental factors stimulate this association.

The spores of mycorrhizal fungi germinate and colonize plant roots. It has been shown that methyl bromide will kill these spores in the soil. The fungi can associate with a wide range of plants. They are found associated with weeds and cover crops in vineyard soils. Mycorrhizal weeds and cover crops can, therefore, be an important reservoir or source of these fungi for young grapevine roots.

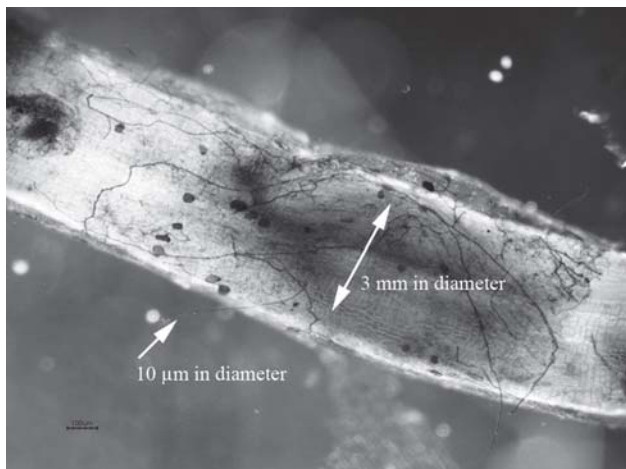


Figure 1 Arbuscular mycorrhizal root system and hyphae.

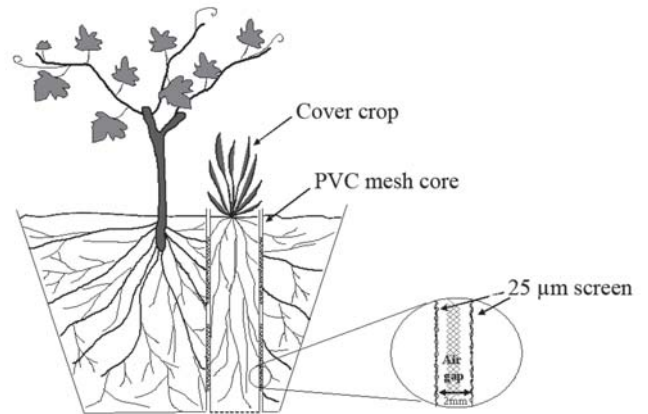


Figure 2 ^{15}N -transfer from no-till cover crops to grapevines via external hyphae (Cheng and Baumgartner, 2004. *Biol. Fertil. Soils* 40:406-412).

The fungi can also form large colonies or networks in the soil spanning the root systems of multiple plants. A mycorrhizal network may be simultaneously associated with a cover crop root system and with a grapevine root system. The external hyphae can serve as a “bridge” for nitrogen transfer between plants and can take up nitrogen from decaying cover crops that can then be transferred to the grapevine. This was demonstrated by showing transfer of labeled nitrogen from a cover crop to a grapevine using a fine mesh that separated their root systems, but that did allow external hyphae to colonize both root systems (Fig. 2). When hyphal connections between the cover crop and the grapevine were severed, no labeled nitrogen was transferred to the grapevine from the cover crop. When the hyphal connections were intact, nitrogen transfer was observed. The presence of mycorrhizal fungi is of greater importance in nutrient-limiting soils, where their contribution to nutrient uptake may be more critical to the plant. Since the fungi receive carbon directly from the grapevine, turnover of their external hyphae provides an important source of carbon to feed other microbes in the soil, whose populations are responsible for nutrient cycling.

Arbuscular mycorrhizal fungi are obviously important to grapevine nutrition, particularly in marginal soils. Cover-crop management strategies can increase the likelihood of fungal colonization of grapevine roots and can facilitate transfer and uptake of nutrients from cover crops to grapevines. Site characteristics and vineyard management strategies that foster root growth, such as planting vines in soil with adequate texture and structure and irrigating vines during periods of rapid root growth, benefit grapevine roots and mycorrhizal fungi. Such practices will likely have greater effects on grapevine nutrition than practices that focus solely on enhancing populations of mycorrhizal fungi, such as the application of fungal inoculants to vineyard soil. (From a presentation at *Recent Advances in Viticulture and Enology*, UC Extension, Davis; 16 March 2006.)