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Hydrolytic Enzymes in Arbuscular Mycorrhiza

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Summary.- The spores and external mycelium of *Glomus mosseae* possess a complex of pectinase and cellulase enzymes. Studies of the production of pectinases and cellulases in lettuce (*Lactuca sativa* var. Romana) during root colonization by the arbuscular mycorrhizal (AM) fungus *G. mosseae* showed increased activity during the logarithmic stage of AM development. Some of the cellulase activities detected in colonized plant roots can be attributed to the fungus, since endoglucanase activity found in the external mycelium of *G. mosseae* and in mycorrhizal root extracts showed the same electrophoretic mobility. However, some of the endoglucanase activities from extracts of mycorrhizal plants had electrophoretic mobilities different from those observed in the external mycelium and in nonmycorrhizal plants. These results indicate that endoglucanase produced by either the plant or the fungus may be involved in the process of host wall degradation and cell wall material mobilization during colonization.

Keywords: *cellulase*, Glomus mosseae, *hydrolytic enzymes, arbuscular mycorrhiza, pectinase*

Introduction

The enhancement of growth in plants colonized by arbuscular mycorrhizal (AM) fungi is well known (22). The process of mycorrhizal colonization of plant roots takes place through a series of phases, one of which involves the penetration of hyphae along or through cell walls. The colonization of plant roots by AM fungi involves the formation of intercellular hyphae, highly branched intracellular arbuscules and vesicles scattered throughout the root (5). These observations suggest that the establishment of intracellular symbiosis between fungus and plant roots requires penetration of the host cell by the fungus. Cell wall-hydrolyzing enzymes such as cellulases, hemicellulases and pectinases may be involved in this process (17).

Most phytopathogenic fungi and bacteria are known to produce enzymes that degrade pectic and cellulolytic substances (1). These enzymes degrade the α-1,4 linkages between galacturonyl moieties in polymers of galacturonic acid and the β (1,4) linkages between glucose polymers. These hydrolytic enzymes play a fundamental role in pathogenesis (12, 21). However, research is scarce on these enzymes in plant roots, and on their mode of action in the process of penetration and development of symbiotic microorganisms (10). Infection of roots by mutualistic microorganisms such as *Rhizobium* and *Azospirillum* appears to be mediated by cell wall–hydrolysing enzymes (11, 30). In spite of the low production of hydrolytic enzymes by these mutualistic microorganisms (24), these enzymes seem to be involved in the dissolution of the cell wall which permits *Rhizobium* to enter the host cell (9).

The observation that AM fungi penetrate the plant cell wall at the site of contact during the establishment of intracellular symbiosis (5) indicates that hydrolytic enzymes may be involved in the AM colonization process. However, since AM fungi have not yet been cultured axenically in the absence of plant roots, it is difficult to confirm the production of hydrolytic enzymes by AM fungi or their possible participation in the colonization of the root, owing to the very low levels of enzyme produced, as occurs with the other mutualistic microorganisms (3, 24).

Indirect evidences of participation of enzymes in root colonization

Attempts to demonstrate pectinase and cellulase production in extracts from AM tissues were not successful (2). However, catabolic repression experiments by Garcia-Romera *et al.* (17) showed that pectolytic enzymes may be involved in the process of root colonization by AM fungi. These experiments were done in glass tubes containing a sand:vermiculite mixture, which was inoculated under sterile conditions with *Glomus mosseae* spores and alfalfa as the host plant. Pectin, Na–pectate and carboxy-methyl-cellulose (CMC) were added to the