Mycorrhiza and soil quality

Chantal Hamel[1] and Denis Angers[2]

[1]*Environmental Health/Nutrients and Organic Residues, Agriculture and Agri-Food Canada, Swift Current, Saskatchewan, Canada S9H 3X2;* [2]*Agriculture and Agri-Food Canada, 2560 Hochelaga Blvd., Sainte-Foy, Quebec, Canada G1V 2J3.*

The field of mycorrhizal research has traditionally been occupied by plant scientists. Until the 1980s, efforts were devoted to identifying the plant species forming arbuscular mycorrhizae, developing the taxonomy of arbuscular mycorrhizal (AM) fungi, and demonstrating the so-called mycorrhizal effect. In May 1987, the 7th North American Mycorrhizal Conference (NACOM) was held in Gainesville, Florida, under the theme "Mycorrhizae in the next decade: Practical applications". This meeting was intended to set the stage for exciting developments in the applications of mycorrhizae, particularly in agriculture. The potential contribution of AM symbiosis management was clearly evidenced. The level of understanding of the symbiosis, however, was still low. Arbuscular mycorrhizal fungi are difficult to study because they are concealed in the soil and their biotrophic character greatly limits our ability to study them. Hypha and spore extraction was tedious and yielded only limited information. It became clear that before we could effectively utilize AM fungi in agricultural production, a better understanding of their ecology and their specific interactions with cropping systems had to be obtained.

Progress in the management of AM fungi in agriculture since the 7th NACOM has been modest and, today, the main challenge is still to understand the ecology of AM symbioses. The introduction of molecular techniques such as polymerase chain reaction (PCR) to the study of AM fungi initiated a revolution. Tremendous progress in the genetics, physiology and taxonomy of AM fungi has been made, and research in these fields is very active. However, the research possibilities opened by PCR and other new technologies in molecular biology have drained mycorrhizologists from of the field of practical applications in plant production. While plant scientists were turning into "molecule-oriented biologists", a few soil scientists and ecologists persisted in researching at the field scale how the AM symbiosis interacts with its environment. They found, in particular, that AM fungi were important not only for plant function but also for the maintenance of soil quality. Mycorrhizal research had become an aspect of soil science.

The fourth International Conference on Mycorrhizae (ICOM 4) was held in Montréal, Québec, in August 2003, jointly with the Canadian Society of Soil Science (CSSS) and the Canadian Society of Agronomy (CSA) under the theme "Mycorrhizae: Fundamental and multipurpose". Two joint symposia were organized in an attempt to initiate collaboration between soil scientists, agronomists and mycorrhizologists. The papers from the CSA-ICOM joint symposium will be published in the *Canadian Journal of Plant Science* (Vol. 85 issue no. 1). Four keynote papers were presented at the joint symposium with CSSS and are published in this issue of the *Canadian Journal of Soil Science*. In addition, two poster and oral sessions were held, for a total of 53 papers concerned with the interactions between mycorrhizae and soil quality.

This symposium clearly showed that AM fungi have a significant role in maintaining soil quality. Their effects on soil structure, water retention capacity and nutrient cycling are of critical importance to the maintenance of soil function in both natural and cultivated ecosystems. A major consequence of the growth of AM fungi in soils is their contribution to the maintenance of soil structure. Like many other soil organisms, AM fungi act as ecosystem engineers at the micro-scale and above. Recent research has shown that an AM-fungi-produced soil glycoprotein, glomalin, is positively correlated with aggregate water stability. The persistence of glomalin in soils may be related to the lasting effects of AM fungi on aggregate stability or to the possible hydrophobic nature of this protein. However, the chemical nature and actual mode of action of glomalin are still unclear, and more research is needed to better understand the mechanisms of the well-recognized role of AM fungi on soil structure.

Since mycorrhizal colonization typically affects soil structure, it seems likely that AM fungi also affect soil water relations and, consequently, the water relations of the host plants. Experimental evidence supports this hypothesis, and also strengthens the assertion that AM fungal colonization of soil may be as important as the colonization of roots with regard to how AM symbiosis affects the water relations of host plants.

Arbuscular mycorrhizal fungi also have an important role in other fundamental soil functions, such as cycling of C, N and P. The enhanced ability for absorption provided by AM fungi improves the host plants' ability for nutrient uptake. Mycorrhizal plants appear to be effective competitors, which, under conditions of N and P limitations, could reduce the size of mineralizing populations in soil or change the quality of the decomposing litter.

We hope that these texts will be stimulating and instrumental to the formation of symbiotic interdisciplinary research relationships.