**Abstract**

The nutrient exchanges between plant and fungus are the key elements of the arbuscular mycorrhizal (AM) symbiosis. The fungus improves the plant uptake of mineral nutrients, mainly phosphate, while the plant provides the fungus with photosynthetically assimilated carbohydrates. Although knowledge about the mechanisms underlying nutrient exchanges between the symbiotic partners still remains very limited, recent advances in mycorrhiza research have allowed identification and functional characterization of fungal sugar transport systems. The present thesis firstly focused on the identification and characterization of sugar transporters from the model arbuscular mycorrhizal fungus (AMF) *Rhizophagus irregularis* as well as on the understanding of their roles in the tight interaction between the microsymbiont and its plant host. Based on the available preliminary genomic data of *R. irregularis*, RiMST5 and RiMST6 were identified as new monosaccharide transporters, bringing to six the current total number of *glomeromycota* MSTs. Functional analyses by yeast complementation and expression profiling by quantitative RT-PCR revealed that RiMST6 is a high-affinity glucose transporter, and that together with RiMST5, have versatile roles and can be recruited during stressful conditions.

Besides getting knowledge on the nutrient transporters that operate in mycorrhizal symbiosis, understanding their regulation patterns during the multitrophic interactions that take place in the rhizosphere of host plants is also required to integrate plant growth responses in the context of quality production and yield. To make a link between the fundamental and applied approaches a concatenation of experiments performed over a two-year time period has been carried out. The effects of different combinations of AMF and Plant Growth Promoting Rhizobacteria (PGPR) on *Fragaria x ananassa* growth and yield have been tested under semi-controlled conditions. We showed that both fruit yield and quality can be improved by one PGPR and one AMF co-inoculated strain and the most satisfactory combination with regard to yield benefits has been selected. Moreover, we highlighted the complexity of such a system in which not only the selected partners are important for fruit yield and quality, but also environmental conditions.

To go deeply into the specific effects of each microorganism on plant growth and production, *F. x ananassa* has been inoculated by the selected combination, namely *R. irregularis* and *Pseudomonas fluorescens* Pf4. In this experiment, co-inoculation did not display significant positive effects on plant development and yield. However, we highlighted that in addition to the different partners, all the environmental parameters have to be taken into consideration and that the commercialization of an adapted combination must be tested under field conditions for several years. Additionally, molecular mechanisms and actors, *e.g.* *F. x ananassa* sugar transporters (FaSUTs), determining sugar partitioning on strawberry plants have been investigated. Based on the conservation of transport capacity, expression profiles and subcellular localization between SUTs orthologs, we suggest the lack of principal phloem loader in *F. x ananassa* and a main role of SUT1 and SUT2 proteins in phloem unloading. Finally, the expression analysis of FaSUTs highlighted a tight regulation of sugar transport upon AMF and PGPR inoculation, which is undoubtedly related to the plant physiological status.

In summary, this study is a combination between fundamental and applied approaches, which provides (i) new insights into transport processes between plant and fungus in the course of the AM symbiosis and (ii) a dataset relative to AMF/PGPR inoculation effects on plant growth and yield that can allow a future commercialization.