Ammonium transporters in grasses : molecular and functional characterization with special reference to the arbuscular mycorrhizal symbiosis

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Most herbaceous plants live in symbiosis with arbuscular mycorrhizal (AM) fungi. AM fungi colonize the roots of their host plant symbionts and provide them with mineral nutrients, especially phosphorus (P) and nitrogen (N) and receive, in exchange, photosynthetically fixed carbon. In this work, we focused on the role of N in the AM symbiosis formed between Glomus mosseae or Rhizophagus irregularis and different plants belonging to the Poaceae: sorghum (Sorghum bicolor), maize (Zea mays), rice (Oryza sativa), foxtail millet (Setaria italic) and purple false brome (Brachypodium distachyon). It had been shown that AM fungi can take up N in form of nitrate, ammonium and amino acid and transfer it to the plant in form of ammonium. Thus, we hypothesized that some plant ammonium transporters (AMT) might be up-regulated at the interface between plant and fungus in the AM symbiosis. As described in chapter 2, we established mycorrhized and non-mycorrhized sorghum plants and gave them different N treatments: no nitrogen, nitrate or ammonium. We found out that two AMTs, AMT3;1 and AMT4 were induced in mycorrhized plants (AM-inducible AMTs) independently of their N status. In sorghum, the pattern of expression of AMT3;1 and AMT4 was assessed with a split-root experiment combined with laser microdissection technology. Expression of both AMTs was not systemic in the roots of the plant. However, at a small scale, systemic expression around cells containing arbuscules could be observed. We conclude that expression of AMT3;1 and AMT4 could be part of the prepenetration response of the plant, preparing the cells to receive a new arbuscule. In addition, using immunolocalization, we localized the protein of AMT3;1 at the level of mature arbuscules. As described in chapter 3, the up-regulation of AMT3;1 and AMT4 was conserved in all four Poaceae species studies. As the core Poaceae divided in two groups about -55 million years ago separating sorghum, foxtail millet and maize from rice and purple false brome, we assume that AMT3;1 and AMT4 were already induced by AM fungi in a common ancestor of all these plants. In chapter 4, we looked at the fungal side and at the effect of the different N treatments on the expression of fungal transporters and enzymes of the N cycle. Our results show that the source of N has an impact on the transcriptional regulation of enzymes from the fungal N cycle. Expression of the corresponding genes was modified in the fungal extraradical mycelium as well as in the intraradical mycelium. In chapter 5, we studied the time needed by the AM fungus Glomus mosseae to transfer N from a 15N-labeled source to sorghum plants. Labeled N was present in the plant leaves already after 48 hours revealing a very rapid transfer. This finding highlights the underestimated role of AM symbiosis in N-acquisition by the plant.

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