MASTER'S THESIS

The roles of arbuscular mycorrhizal fungi in arsenic uptake and tolerance of upland rice

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Date of Award:
2011

The Roles of Arbuscular Mycorrhizal Fungi in Arsenic Uptake and Tolerance of Upland Rice

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A thesis submitted in partial fulfillment of the requirements

for the degree of

Master of Philosophy

Principal Supervisor: Prof. WONG Ming Hung

Hong Kong Baptist University

August 2011

Abstract

The main objectives of the present study were to: (1) investigate the colonization rates of arbuscular mycorrhizal fungi (AMF) associated with different nurse plants; grown in different phosphorus concentrations and their effects on the total phosphorus and yield of the next crop: upland rice cultivar: Yanghan 1; (2) determine the roles of mycorrhizae in arsenic uptake of upland rice cultivar: Zhonghan 221 either with single or AMF species via combinations; (3) study the uptake kinetics of arsenic species of upland rice cultivar: Zhonghan 221 inoculated with mycorrhizae.

In the present study, *Glomus geosporum*, *G. versiforme* and *G. mosseae* were associated with maize, sudangrass and upland rice cultivar: Yanghan 1 grown in the aeroponic chambers with 10, 30, 50 and 100% phosphorus of original Hogaland's solution. The biomass of the roots of three nurse plants inoculated with AMF were used as inoculums and planted with Yanghan 1 in the pot trial. The AMF colonization rates, total phosphorus and dry weights of plant tissues were significantly increased ($p<0.05$) in the next crop rice: Yanghan 1 using maize and sudangrass as nurse plants in the aeroponic chambers and grown in 10, 30% phosphorus concentrations previously, when compared to 50 and 100% phosphorus conditions. There were significant differences ($p<0.05$) in the AMF colonization rates, total phosphorus and dry weight of the shoots and roots for the next crop rice: Yanghan 1 within AMF species; and these parameters of the treatments using indirect inoculation (maize and sudangrass as nurse plants) were significantly higher ($p<0.05$) than the treatment using direct inoculation (rice: Yanghan 1 as nurse plant) in the pot trial.

The roles of mycorrhizae in arsenic uptake in upland rice cultivar: Zhonghan 221 were also investigated. Zhonghan 221 was inoculated with *G. geosporum*, *G. versiforme* and *G. mosseae* either using single or AMF species via combinations and grown in control and arsenic contaminated soils. Although there were no significant differences ($p>0.05$) between the AMF colonization rates of single and combined AMF treatments, the total arsenic in rice grains inoculated with single AMF treatments were significantly lower ($p<0.05$) than combined AMF treatments when grown in As contaminated soils generally. To conclude, the treatment mixed with *G. geosporum* and *G. mosseae* increased the total phosphorus uptake and decreased the total arsenic uptake in rice husks and grains, while *G. mosseae* significantly increased ($p<0.05$) the biomass of rice grains and total arsenic uptake in husks when grown in As contaminated soils, when compared to the non-mycorrhizal plants.

The arsenic influxes of Zhonghan 221 inoculated with *G. geosporum* and *G. mosseae*, non-mycorrhizal in both the low- (0-0.05 mM) and high- affinity (0.5-2.5 mM) systems of arsenite, arsenate and MMA were studied. *G. geosporum* reduced arsenite uptake significantly ($p<0.05$) in the low-affinity system, when compared to the non-mycorrhizal plants. Moreover, *G. geosporum* significantly decreased ($p<0.05$) arsenate uptake in both the low- and high-affinity uptake systems when compared with the non-mycorrhizal plants, which showed that phosphate transporters may be affected by *G. geosporum* inoculation; *G. geosporum* also significantly decreased ($p<0.05$) MMA uptake in the high-affinity system, when compared to the non-mycorrhizal plants, which showed that Lsi1 may be affected by *G. geosporum* inoculation. On the other hand, *G. mosseae* significantly increased ($p<0.05$) arsenate and MMA uptake in the high-affinity uptake system when compared to non-mycorrhizal plants, which were opposite to the results of *G. geosporum*. To conclude, *G. geosporum* would be recommended for use in reducing arsenic uptake in upland rice in order to mitigate the problem of arsenic contaminated soils in rice fields.

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