

MASTER'S THESIS

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

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

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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.

Table of Contents

Declaration.....	i
Abstract.....	ii
Acknowledgements.....	iv
Table of Contents.....	v
List of Tables.....	ix
List of Figures.....	xi
Symbols and Abbreviation.....	xiii
Chapter 1 General Introduction.....	1
1.1 Background of Research.....	1
1.1.1 The Current Situation of Arsenic Contamination in the World.....	1
1.1.2 Arsenic Contamination in Rice of Bangladesh.....	3
1.1.3 Mitigations in As Contaminated Rice.....	4
1.2 Literature Review.....	5
1.2.1 Types of Mycorrhizae.....	5
1.2.2 The Roles of AMF in Plants.....	7
1.2.3 The Factors Affecting the AMF Colonization Rates in Plants.....	8
1.2.4 Technology of Mass Cultivation of Mycorrhizae.....	10
1.2.5 The Roles of As Uptake in Plants.....	11
1.2.6 Mechanisms of As Uptake in Plants.....	11
1.3 Objectives of the Present Research.....	13
Chapter 2 The Effects of Arbuscular Mycorrhizal Fungi on Nurse Plants on the Yield of Next Crop: Upland Rice Cultivar Yanghan 1.....	14
2.1 Introduction.....	14
2.2 Materials and Methods.....	19

2.2.1 Selection of Host Plants.....	19
2.2.2 Inoculation of AMF in Host Plants.....	20
2.2.2.1 Preparation of Nutrient Solution.....	21
2.2.2.1.1 Preparation of Four Different Concentrations of P.....	21
2.2.3 Selection of AMF Species.....	24
2.2.4 Aeroponic Chamber for the Production of AMF Inoculum.....	24
2.2.5 A Pot Trial to Investigate the Effects of AMF Colonized with Three Nurse Plants on Rice: Yanghan 1.....	25
2.2.6 The AMF Colonization Rates.....	27
2.3 Results and Discussions.....	28
2.3.1 The Dry Weights of Shoots and Roots.....	28
2.3.2 Total P.....	37
2.3.3 The AMF Colonization Rates.....	42
2.4 Conclusion.....	49
Chapter 3 Arsenic Uptake of Upland Rice Inoculated with Single Arbuscular Mycorrhizal Fungi (AMF) or a Combination of AMF Species.....	51
3.1 Introduction.....	51
3.2 Materials and Methods.....	54
3.2.1 Soil Preparation.....	54
3.2.2 Selection of Upland Rice Cultivars.....	55
3.2.3 Selection of AMF Species.....	55
3.2.4 Cultivation of Rice Seedlings.....	56
3.2.5 Addition of AMF in Soil.....	57
3.2.6 Chemical Analyses.....	57
3.2.6.1 Plant Materials.....	57
3.2.6.2 Soil Samples.....	58
3.2.6.3 AMF Colonizations.....	58
3.2.7 Statistical Analysis.....	59
3.3. Results and Discussions.....	60
3.3.1 Soil Properties.....	60
3.3.2 The AMF Colonizations Rates.....	60
3.3.3 The Biomass of Plant Tissues of Zhonghan 221.....	66
3.3.4 Total As Uptake of Four Plant Tissues of Zhonghan 221.....	68
3.3.5 Total P.....	72
3.4. Conclusion.....	75

Chapter 4 Uptake Kinetics of Arsenic in Upland Rice Cultivar Zhonghan 221 Inoculated with Arbuscular Mycorrhizal Fungi..... 77

4.1 Introduction..... 77

4.2 Materials and Methods..... 81

4.2.1 Cultivation of Upland Rice Seedlings..... 81

4.2.2 Kinetics of As Uptake..... 82

4.2.3 Digestion and Analysis..... 82

4.2.4 Statistical Analysis..... 83

4.3 Results and Discussion..... 83

4.3.1 The Kinetics Parameters of Zhonghan 221 Inoculated with AMF in Different Concentrations of Arsenite and Arsenate..... 83

4.3.2 The As Influx of Zhonghan 221 Inoculated with AMF in High-Affinity Uptake System of Arsenite and Arsenate..... 87

4.3.3 The As Influx of Zhonghan 221 Inoculated with AMF in Low- and High-Affinity Uptake Systems of Arsenite and Arsenate..... 90

4.3.4 The As Influx of Zhonghan 221 Inoculated with AMF in High-Affinity Uptake System of Arsenite, Arsenate and MMA..... 94

4.4 Conclusion..... 102

Chapter 5 General Discussion and Conclusion..... 103

5.1 Introduction..... 103

5.2 Association of AMF with their Host Plants..... 105

5.2.1 Association of AMF with Plants and Grown in Different P Concentrations..... 105

5.2.2 Association of AMF with Plants and Grown in Different As Concentrations..... 106

5.3 Effects on the Dry Weights and Nutrient Uptakes of Host Plants Inoculated with AMF..... 107

5.3.1 Dry Weights and Nutrient Uptakes of Nurse Plants Inoculated with AMF and Grown in Different P Concentrations..... 107

5.3.2 Dry Weights and Nutrient Uptakes of Upland Rice Inoculated with AMF and Grown in Different As Concentrations..... 109

5.3.3 The Comparisons of Biomass and Total P of Upland Rice Grown in Different P or As Levels..... 110

5.4 Arsenic Accumulations in Upland Rice after As Short- and Long-Term

Exposure.....	112
5.4.1 Effects of AMF on As Accumulation in Upland Rice.....	112
5.4.2 Mechanisms Involved in As Tolerance in Upland Rice.....	114
5.4.3 The Comparisons of Total As of Upland Rice Grown in Different P or As Levels.....	115
5.5 Future work.....	117
5.5.1 Mechanism of As Tolerance in Upland Rice.....	117
5.5.2 Field Applications of Rice Inoculated with AMF in As Contaminated Soils.....	117
5.5.3 The Applications of Massive Aeroponic Cultivation in Nurse Plants Inoculated with AMF.....	118
5.5.4 Limitations and Improvements of the Present Study.....	120
References.....	122
Curriculum Vitae.....	160