

Table of contents

TABLE OF CONTENTS	I
LIST OF TABLES	III
LIST OF FIGURES	IV
1. CHAPTER 1: GENERAL INTRODUCTION	1
1.1 PHOSPHOROUS.....	2
1.2 PHOSPHORUS AVAILABILITY IN SOIL.....	2
1.2.1 <i>Phosphorus chemical behaviors in soil</i>	3
1.2.2 <i>Phosphorus transport in soil</i>	6
1.3 PHOSPHORUS ACQUISITION BY PLANT	9
1.4 RHIZOSPHERE AND ROOT EXUDATES.....	12
1.5 ROOT EXUDATES AND P MOBILIZATION IN SOIL	15
1.6 HPLC-MS TECHNIQUE TO ANALYZE ROOT EXUDATES.....	19
1.7 OBJECTIVES OF STUDY AND OUTLINE OF THE THESIS	23
2 CHAPTER 2: PHOSPHORUS UPTAKE EFFICIENCY OF CROPS AS EFFECTED BY P INFLUX AND A MECHANISTIC MODEL EVALUATION TO ESTIMATE P CHEMICAL MOBILIZATION.....	25
2.1 INTRODUCTION.....	26
2.2 MATERIALS AND METHODS	28
2.2.1 <i>Pot Experiment</i>	28
2.2.2 <i>Soil and Plant analysis</i>	29
2.2.2.1 Soil solution P concentration.....	29
2.2.2.2 Available P by the CAL-P method.....	29
2.2.2.3 Phosphorus concentration in shoot, roots and seeds	30
2.2.3 <i>Root length</i>	30
2.2.4 <i>Calculation and model parameters</i>	31
2.2.4.1 Phosphorus influx and relative shoot growth rate	31
2.2.4.2 Model parameters	31
2.2.5 <i>Statistics</i>	33
2.3 RESULTS.....	34
2.3.1 <i>CAL- P and soil solution P</i>	34
2.3.2 <i>Shoot dry matter</i>	36
2.3.3 <i>Relative shoot dry matter yield</i>	37
2.3.4 <i>Relative growth rate (RGR)</i>	40
2.3.5 <i>Shoot P concentration</i>	41
2.3.6 <i>Phosphorus uptake</i>	42
2.3.7 <i>Root system</i>	44
2.3.7.1 Root length	44
2.3.7.2 Root-shoot ratio	45
2.3.8 <i>Phosphorus influx</i>	46

2.3.9	<i>Modeling of P influx</i>	48
2.4	DISCUSSION	58
2.4.1	<i>Phosphorus uptake efficiency</i>	59
2.4.2	<i>Phosphorous influx and model calculation</i>	61
3	CHAPTER 3: RESEARCH ARTICLE	67
	IDENTIFICATION OF SOIL P MOBILIZING COMPONENTS OF SUGAR BEET ROOT EXUDATES AFTER DIFFERENTIAL METABOLIC PROFILING BY HPLC-MS	67
3.1	ABSTRACT	68
3.2	INTRODUCTION.....	69
3.3	MATERIALS AND METHODS	72
3.3.1	<i>Hydroponic experiment</i>	72
3.3.2	<i>Root exudates collection</i>	72
3.3.3	<i>Preparation of samples and standards for HPLC-MS analysis</i>	73
3.3.4	<i>HPLC-MS instruments and analysis</i>	73
3.3.4.1	<i>Metabolic profiling of root exudates</i>	73
3.3.4.2	<i>Targeted analysis and identity verification for selected metabolites</i>	74
3.3.5	<i>P solubility experiment</i>	75
3.4	RESULTS AND DISCUSSION.....	77
3.4.1	<i>Shoot dry weight and shoot P concentration</i>	77
3.4.2	<i>Exudation rate</i>	78
3.4.3	<i>HPLC-MS analysis of root exudates</i>	79
3.4.4	<i>Phosphorus Mobilization in soil</i>	80
3.4.5	<i>Identification of salicylic and citramalic acids in root exudates</i>	81
3.5	REFERENCES.....	85
4	CONCLUDING DISCUSSION	88
5	SUMMARY	92
6	REFERENCES OF CHAPTERS 1 AND 3	94
7	ACKNOWLEDGEMENTS	103
8	CURRICULUM VITA	104