

TABLE OF CONTENT

	Page
Acknowledgement	iii
Abstract (English)	iv
Abstract (Thai)	ix
List of Tables	xvi
List of Figures	xxii
Chapter 1 Introduction	1
Chapter 2 Literature review	5
2.1 Distribution and causes of acid soil	5
2.2 Nutrient disorders in acid soil	8
2.3 Acid soil constraints for legume growth and nitrogen fixation	12
2.4 Role and benefit of Arbuscular mycorrhiza fungi (AMF) in legumes	20
2.5 Management of soil acidity for legume crop	23
<i>2.5.1 Liming</i>	23
<i>2.5.2 Fertilizer application</i>	24
<i>2.5.3 Use acid tolerant legume cultivars and rhizobium strains</i>	25
<i>2.5.4 Mycorrhizal symbiosis</i>	26

Chapter 3 Arbuscular mycorrhizal status of legumes in a shifting cultivation system in northern Thailand	30
3.1 Introduction	30
3.2 Materials and methods	31
3.3 Result	35
3.4 Discussion	42
Chapter 4 Evaluating system for testing effect of arbuscular mycorrhizal fungi on legume growth in acid soil	44
4.1 Introduction	44
4.2 Materials and methods	45
4.3 Result	49
4.4 Discussion	62
Chapter 5 Effects of abuscular mycorrhozal fungi, soil acidity and phosphorus on cowpea	65
5.1 Introduction	65
5.2 Material and method	65
5.3 Result	68
5.4 Discussion	78

Chapter 6 Comparing effectiveness of different arbuscular mycorrhizal fungi (AMF) isolates to alleviate acid soil stress in cowpea	81
6.1 Introduction	81
6.2 Material and method	82
6.3 Result	86
6.4 Discussion	98
Chapter 7 Effectiveness of AMF in different types of inoculum on cowpea growing in acid soil	102
7.1 Introduction	102
7.2 Material and method	103
7.3 Result	108
7.4 Discussion	130
Chapter 8 General Discussion	133
Reference	137
Curriculum vitae	153

LIST OF TABLES

Table	Page
3.1 Correlation coefficient between root colonization, soil pH and soil P and spore density in root zone soil	36
3.2 Distribution of AMF spore in the soil profile at 3 locations in Kayo field in Haui Teecha	37
3.3 Soil pH, soil P concentration and spore density in soil of 6 farmer's field	38
3.4 Correlation coefficient between root colonization, P concentration in YFEL, Soil P and soil pH	42
4.1 Effect of soil pH on mycorrhiza root colonization in cowpea at 25 days after sowing	50
4.2 Effect of soil pH and arbuscular mycorrhizal fungi inoculation on shoot dry weight of cowpea at 25 days after emergence	50
4.3 Effect of soil pH and mycorrhiza inoculation on root dry weight of cowpea at 25 days after emergence	51
4.4 Effect of soil pH and mycorrhiza inoculation on total dry weight of cowpea at 25 days after sowing	51
4.5 Effect of soil pH and mycorrhiza inoculation on nodule dry weight of cowpea at 25 days after emergence	52
4.6 Effect of soil pH and mycorrhiza inoculation on nodule number/pot of cowpea at 25 days after emergence	52

4.7	Effect of AMF and soil acidity on root colonization, shoot, root, nodule and total weight and nodule number of cowpea applied with N fertilizer or inoculated with rhizobium	54
4.8	Effect of AMF and soil acidity shoot P and N concentration, total P and N content of cowpea applied with N fertilizer or inoculated with rhizobium	55
4.9	Soil P concentration (mg P/kg) in varying P application rate of acid (pH 5) and non-acid soil (pH6.7)	58
4.10	Effect of P application treatment on biomass yield and nodulation of cowpea in acid (pH 5) and nonacid (pH6.7) soil	59
4.11	Effect of P application treatment on shoot P and N concentration, total N and P content and P uptake efficiency of cowpea in acid (pH 5) and nonacid (pH6.7) soil	60
5.1	Root colonization in acid and non-acid soil varied with 3 different P levels	68
5.2	Effect of AMF and P application on cowpea shoot dry weight in acid and non-acid soil	69
5.3	Effect of AMF and P application on cowpea root dry weight in acid and non-acid soil	70
5.4	Effect of AMF and P application on cowpea total dry weight in acid and non-acid soil	71

5.5	Effect of AMF and P application on cowpea nodule dry weight in acid and non-acid soil	72
5.6	Effect of AMF and P application on shoot P concentration in acid and non-acid soil	73
5.7	Effect of AMF and P application on total P content of cowpea in acid and non-acid soil	74
5.8	Effect of AMF and P application on P uptake per unit root weight in acid and non-acid soil	75
5.9	of AMF and P application on shoot N concentration in acid and non-acid soil	75
5.10	Effect of AMF and P application on total N content in acid and non-acid soil	76
6.1	Root colonization shoot root and total dry weight of cowpea inoculated with soil inoculum containing different AMF isolates in acid and non acid soil	86
6.2	Nodule number nodule dry weight shoot P concentration and total P content of cowpea inoculated with soil inoculum containing different AMF isolates in acid and non acid soil	87
6.3	Effect of soil acidity on root colonization of cowpea inoculated with spores of different AMF isolates in acid and non acid soil with 3 P levels	88

6.4	Shoot dry weight of cowpea inoculated with spores of different AMF isolates in acid and non acid soil with 3 P levels	90
6.5	Root dry weight of cowpea inoculated with spores of different AMF isolates in acid and non acid soil with 3 P levels	91
6.6	Total dry weight of cowpea inoculated with spores of different AMF isolates in acid and non acid soil with 3 P levels with 3 P levels	92
6.7	Nodule dry weight of cowpea inoculated with spores of different AMF isolates in acid and non acid soil with 3 P levels with 3 P levels	93
6.8	Root colonization of mimosa inoculated with spores of different AMF isolates in acid and non-acid soil at 91 days after sowing	94
6.9	Shoot dry weight of mimosa inoculated with different AMF species in acid and non-acid soil at 13 weeks after sowing	95
7.1	Root colonization shoot root and total dry weight of cowpea inoculated with different inoculum types varied spore rate at 15 days after emergence	108
7.2	Nodule number, shoot P concentration and P uptake per unit root weight of cowpea inoculated with different inoculum types varied spore rate at 15 days after emergence	110
7.3	Root colonization, shoot root, and total dry weight of cowpea inoculated with different inoculum types with varied spore rate at 35 days after emergence	112

7.4	Nodule number, nodule dry weight, shoot P concentration and P uptake per unit root weight of cowpea inoculated with different inoculum types with varied spore rate at 35 days after emergence	114
7.5	Root colonization, shoot root and total dry weight of cowpea inoculated with different inoculum types with varied spore rate at 46 days after emergence	116
7.6	Nodule number, nodule dry weight, shoot P concentration and P uptake per unit root weight of cowpea inoculated with different inoculum type with varied spore rate at 46 days after emergence	118
7.7	Root colonization, shoot dry weight and root fresh weight of mimosa inoculated with AMF spores sterilized with different antiseptic at 14, 25 and 35 days	120
7.8	Root colonization, shoot root and total dry weight and nodule number per plant of cowpea and mimosa inoculated with different inoculum types at 39 days after sowing	122
7.9	Nodule dry weight, shoot P concentration, total P content and P uptake per unit root weight of cowpea and mimosa inoculated with different inoculum types at 39 days after emergence	124
7.10	Root colonization, biomass yield, nodulation, shoot P concentration and total P content of cowpea and mimosa inoculated with different AMF inoculums at 59 days after sowing	126

7.11	Nodule dry weight, shoot P concentration, total P content and P uptake perunit root weight of cowpea inoculated with different inoculum types at 59 days after emergence	128
------	--	-----

LIST OF FIGURES

Figure		Page
2.1	Distribution of acid soil in the world, with percentage of total land area with acidic soil in each continent	5
3.1	Method of soil sample collection	33
3.2	Arbuscular mycorrhiza fungi colonization in roots of 3 legumes in 4 farmer's fields at Huai Teecha	35
3.3	Arbuscular mycorrhiza fungi root colonization in 4 cowpea lines in 3 farmer fields	39
3.4	Phosphorus concentration in youngest full expanded leaf (YFEL) of 4 cowpea lines in 3 farmer's fields	40
3.5	Spore density in root zone soil of 4 cowpea lines in 3 farmer fields	41
4.1	Correlation between shoot P concentration and shoot dry weight in acid and non-acid soil	61
4.2	Correlation between shoot N concentration and shoot dry weight in acid and non-acid soil	61
5.1	Correlation between shoot P concentration and shoot dry weight	77
6.1	Spores of 2 different arbuscular mycorrhizal fungi isolated	80
6.2	Growth of mimosa inoculated with different AMF in acid and non-acid soil	96
6.3	The different of inoculation method in chapter 6 and chapter 5	100