

TABLE OF CONTENTS

	Page
TABLE OF CONTENTS	i
LIST OF TABLES	ii
LIST OF FIGURES	vii
INTRODUCTION	1
OBJECTIVES	4
LITERATURE REVIEW	6
MATERIALS AND METHODS	20
RESULTS AND DISCUSSION	47
CONCLUSION AND RECOMMENDATION	109
LITERATURE CITED	113
APPENDIX	140

LIST OF TABLES

Table	Page
1 <i>Hinf</i> I, <i>Ban</i> I and <i>Taq</i> I digested fragment sizes (bp) of PCR products amplified from 18S rDNA of <i>G. aggregatum</i> with MH2 and MH4 primers.	48
2 Restriction fragment lengths (bp) of PCR products amplified from 18S rDNA of <i>S. fulgida</i> by MH2 and MH4 primers.	49
3 Correlation coefficients (r) among root colonization (RC) and spore intensity (SI) of AM fungi and shoot dry matter (DM) of maize plants.	60
4 Shoot dry weight (SDW) and N, P and K efficiencies of the maize cultivars obtained without AM fungal inoculation. Values are the means of three replicates with standard errors of the means in brackets.	77

Appendix Table

1 Tasseling age (days) of maize as affected by AM fungal species, N rates and P rates (Experiment 2).	141
2 Shoot dry matter (g pot ⁻¹) of maize as affected by AM fungal species, N rates and P rates (Experiment 2).	142
3 Root colonization (%) of <i>A. spinosa</i> as affected by different rates of N and P fertilizers (Experiment 2).	143
4 Root colonization (%) of <i>G. aggregatum</i> as affected by different rates of N and P fertilizers (Experiment 2).	143
5 Spore intensity (sp g ⁻¹ soil) of <i>A. spinosa</i> as affected by different rates of N and P fertilizers (Experiment 2).	144

LIST OF TABLES (Continued)

Appendix Table	Page
6 Spore intensity (sp g ⁻¹ soil) of <i>G. aggregatum</i> as affected by different rates of N and P fertilizers (Experiment 2).	144
7 Height (cm) of maize at 30 DAP as affected by maize cultivar and AM fungal treatments (Experiment 3).	145
8 Height (cm) of maize at 45 DAP as affected by maize cultivar and AM fungal treatments (Experiment 3).	145
9 Height (cm) of maize at 62 DAP as affected by maize cultivar and AM fungal treatments (Experiment 3).	146
10 Tasseling age (days) of maize as affected by maize cultivar and AM fungal treatments (Experiment 3).	146
11 Silking age (days) of maize as affected by maize cultivar and AM fungal treatments (Experiment 3).	147
12 Shoot dry weight (g pot ⁻¹) of maize as affected by maize cultivar and AM fungal treatments (Experiment 3).	147
13 N uptake (mg N pot ⁻¹) in shoot of maize as affected by maize cultivar and AM fungal treatments (Experiment 3).	148
14 P uptake (mg P pot ⁻¹) in shoot of maize as affected by maize cultivar and AM fungal treatments (Experiment 3).	148
15 K uptake (mg K pot ⁻¹) in shoot of maize as affected by maize cultivar and AM fungal treatments (Experiment 3).	149
16 Spore intensity (spores 100 g ⁻¹ soil) of the inoculated AM fungal treatments in soil after harvest (Experiment 3).	149
17 Shoot dry weight (kg ha ⁻¹) of maize as affected by AM fungal inoculation in the field of each cropping in 96L, 97E, 98D, 98L, 99D, 99L, 00E, 00L, 01E and 01L (Experiment 4).	150

LIST OF TABLES (Continued)

Appendix Table	Page
18 Grain yield (kg ha^{-1}) of maize as affected by AM fungal inoculation in the field of each cropping in 96L, 97E, 98D, 98L, 99D, 99L, 00E, 00L, 01E and 01L (Experiment 4).	151
19 N uptake (kg N ha^{-1}) of maize as affected by AM fungal inoculation in the field of each cropping in 98D, 98L, 99D, 99L, 00L, 01E and 01L (Experiment 4).	152
20 P uptake (kg P ha^{-1}) of maize as affected by AM fungal inoculation in the field of each cropping in 98D, 98L, 99D, 99L, 00L, 01E and 01L (Experiment 4).	153
21 K uptake (kg K ha^{-1}) of maize as affected by AM fungal inoculation in the field of each cropping in 98D, 98L, 99D, 99L, 00L, 01E and 01L (Experiment 4).	154
22 Abundance (%) of <i>G. aggregatum</i> spore in soil collected from the field of each treatment of each cropping in 99D, 99L, 00L, 01E and 01L (Experiment 4).	155
23 Abundance (%) of <i>A. spinosa</i> spore in soil collected from the field of each treatment of cropping in 99D (Experiment 4).	155
24 Shoot dry weight (kg ha^{-1}) of maize as affected by AM fungal inoculation in the field of each cropping in 99D, 99L, 00E, 00L and 01E (Experiment 5).	156
25 Grain yield (kg ha^{-1}) of maize as affected by AM fungal inoculation in the field of each cropping in 99D, 99L, 00E, 00L and 01E (Experiment 5).	157
26 N uptake (kg N ha^{-1}) of maize as affected by AM fungal inoculation in the field of each cropping in 99D, 99L, 00L and 01E (Experiment 5).	158

LIST OF TABLES (Continued)

Appendix Table	Page
27 P uptake (kg P ha^{-1}) of maize as affected by AM fungal inoculation in the field of each cropping in 99D, 99L, 00L and 01E (Experiment 5).	159
28 K uptake (kg K ha^{-1}) of maize as affected by AM fungal inoculation in the field of each cropping in 99D, 99L, 00L and 01E (Experiment 5).	160
29 Abundance (%) of <i>G. aggregatum</i> spore in soil collected from the field of each treatment of each cropping in 99D, 99L, 00L and 01E (Experiment 5).	160
30 Shoot dry weight (g plant^{-1}) of maize as affected by AM fungal inoculation in the pot of cropping in 99D (Experiment 5).	161
31 N uptake (mg N plant^{-1}) of maize as affected by AM fungal inoculation in the pot of cropping in 99D (Experiment 5).	161
32 P uptake (mg P plant^{-1}) of maize as affected by AM fungal inoculation in the pot of cropping in 99D (Experiment 5).	161
33 K uptake (mg K plant^{-1}) of maize as affected by AM fungal inoculation in the pot of cropping in 99D (Experiment 5).	161
34 Abundance of <i>G. aggregatum</i> spore (%) in soils collected from the pot after harvest of the specified cropping seasons as affected by inoculation with different AM fungi (Experiment 5).	162
35 Shoot dry weight (kg ha^{-1}) of maize as affected by AM fungi in the first repetitive inoculation cropping (Experiment 6).	162
36 Grain yield (kg ha^{-1}) of maize as affect by inoculated AM fungi in the first repetitive inoculation cropping (Experiment 6).	162
37 N uptake (kg N ha^{-1}) of maize as affected by AM fungi in the first repetitive inoculation cropping (Experiment 6).	162

LIST OF TABLES (Continued)

Appendix Table	Page
38 P uptake (kg P ha ⁻¹) of maize as affected by AM fungi in the first repetitive inoculation cropping (Experiment 6).	163
39 K uptake (kg K ha ⁻¹) of maize as affected by AM fungi in the first repetitive inoculation cropping (Experiment 6).	163
40 Total spores (spores 100 g ⁻¹ soil) of each treatment in the first repetitive inoculation cropping (Experiment 6).	163
41 Number of <i>G. aggregatum</i> spore (spores 100 g ⁻¹ soil) of each treatment in the first repetitive inoculation cropping (Experiment 6).	163
42 Grain yield (kg ha ⁻¹) of maize as affect by inoculated AM fungi in the second repetitive inoculation cropping (Experiment 6).	163
43 Shoot dry weight (kg ha ⁻¹) of maize as affected by AM fungi in the second repetitive inoculation cropping (Experiment 6).	164
44 N uptake (kg N ha ⁻¹) of maize as affected by AM fungi in the second repetitive inoculation cropping (Experiment 6).	164
45 P uptake (kg P ha ⁻¹) of maize as affected by AM fungi in the second repetitive inoculation cropping (Experiment 6).	164
46 K uptake (kg K ha ⁻¹) of maize as affected by AM fungi in the second repetitive inoculation cropping (Experiment 6).	164
47 Total spores (spores 100 g ⁻¹ soil) of each treatment in the second repetitive inoculation cropping (Experiment 6).	164
48 Number of <i>S. fulgida</i> spore (spores 100 g ⁻¹ soil) of each treatment in the second repetitive inoculation cropping (Experiment 6).	165
49 Number of <i>G. aggregatum</i> spore (spores 100 g ⁻¹ soil) of each treatment in the second repetitive inoculation cropping (Experiment 6).	165

LIST OF FIGURES

Figure		Page
1	Sporocarp of <i>Glomus aggregatum</i> .	21
2	Two morphotypes of <i>Scutellospora fulgida</i> spores presented with (a) or without (b) bulbous suspensor.	21
3	Cropping seasons in which sequential cropping were done (Experimet 4)	32
4	Cropping seasons in which sequential cropping were done (Experimet 5)	37
5	Cropping seasons in which the first and the second repetitive application of the treatment were applied (Experimet 6)	42
6	1.4 Kb PCR products of 18S rDNA of <i>Glomus aggregatum</i> derived from spores (1-6) and colonized roots (7-10).	47
7	RFLP patterns of PCR products amplified from 18S rDNA of <i>Glomus aggregatum</i> derived from spores and colonized roots with MH2 and MH4 primers. <i>Hinf</i> I (lane 1 and 4), <i>Ban</i> I (lane 2 and 5) and <i>Taq</i> I (lane 3 and 6).	48
8	1.4 Kb PCR products of 18S rDNA of <i>Scutellospora fulgida</i> derived from spores without bulbous suspensor (a) and with bulbous suspensor (b).	50
9	RFLP patterns derived from <i>Ban</i> I (lane 1, 3 and 5), <i>Hinf</i> I (lane 2, 4 and 6) and <i>Taq</i> I (lane 7 to 12) digestion of the 18S rDNA region of <i>Scutellospora fulgida</i> spore with (+) and without (-) bulbous suspensor.	50
10	RFLP patterns derived from <i>Hinf</i> I, <i>Ban</i> I and <i>Taq</i> I digestion of the 18S rDNA region of <i>Scutellospora fulgida</i> clones.	51
11	Three spore wall layers of crushed spores presented with (a) or without (b) bulbous suspensor.	51

LIST OF FIGURES (Continued)

Figure		Page
12	Squashed spore of <i>Scutellospora fulgida</i> stained with Melzer's reagent.	52
13	Effects of AM fungal species and N rates, AM fungal species and P rates on tasseling age (TA) of maize.	53
14	Effects of AM fungal species and N rates, AM fungal species and P rates on shoot dry matter (DM) of maize.	54
15	Effects of different rates of N and P fertilizers on root colonization (RC) of <i>A. spinosa</i> and <i>G. aggregatum</i> .	57
16	Effects of different rates of N and P fertilizers on spore intensity (SI) of <i>A. spinosa</i> and <i>G. aggregatum</i> .	59
17	Relations among root colonization (RC) and spore intensity (SI) of <i>A. spinosa</i> and <i>G. aggregatum</i> .	60
18	Height (a) and increase in height, as compared with that of NI, (b) of maize at 30 DAP as affected by maize cultivar and AM fungal species.	63
19	Height (a) and increase in height, as compared with that of NI, (b) of maize at 45 DAP as affected by maize cultivar and AM fungal species.	64
20	Height (a) and increase in height, as compared with that of NI, (b) of maize at 62 DAP as affected by maize cultivar and AM fungal species.	65
21	Tasseling age (a) and decrease in tasseling age, as compared with that of NI, (b) of maize as affected by maize cultivar and AM fungal species.	67
22	Silking age (a) and decrease in silking age, as compared with that of NI, (b) of maize as affected by maize cultivar and AM fungal species.	68

LIST OF FIGURES (Continued)

Figure		Page
23	Shoot dry weight (a) and increase in shoot dry weight, as compared with that of NI, (b) of maize as affected by maize cultivar and AM fungal species.	69
24	N uptake in shoot (a) and increase in N uptake in shoot, as compared with that of NI, (b) of maize as affected by maize cultivar and AM fungal species.	71
25	P uptake in shoot (a) and increase in P uptake in shoot, as compared with that of NI, (b) of maize as affected by maize cultivar and AM fungal species.	72
26	K uptake in shoot (a) and increase in K uptake in shoot, as compared with that of NI, (b) of maize as affected by maize cultivar and AM fungal species.	74
27	Spore intensity of the inoculated AM fungal species in soil after harvest.	75
28	Relationship between shoot dry weight (SDW) of non-AM fungus inoculated plants (NI) and their responses in SDW to the two AM fungal species.	78
29	Relationship between N efficiency of non-AM fungus inoculated plants (NI) and their responses in SDW to the two AM fungal species.	78
30	Relationship between spore intensity and responses in N uptake of the two AM fungal species.	79
31	Relationship between P efficiency of non-AM fungus inoculated plants (NI) and their responses in SDW to the two AM fungal species.	80

LIST OF FIGURES (Continued)

Figure		Page
32	Relationship between K efficiency of non-AM fungus inoculated plants (NI) and their responses in SDW to the two AM fungal species.	81
33	Grain yields of maize grown in the ten successive cropping seasons as affected by AM fungal inoculation applied in the first cropping (96L cropping season).	84
34	Shoot dry weight of maize grown in the ten successive cropping seasons as affected by AM fungal inoculation applied in the first cropping.	85
35	N uptake of maize grown in seven of the the ten successive cropping seasons as affected by AM fungal inoculation applied in the first cropping.	85
36	P uptake of maize grown in seven of the the ten successive cropping seasons as affected by AM fungal inoculation applied in the first cropping.	86
37	K uptake of maize grown in seven of the the ten successive cropping seasons as affected by AM fungal inoculation applied in the first cropping.	86
38	Time course of relative grain yields of maize grown observed in the ten successive cropping as affected by AM fungal inoculation applied in the first cropping.	87
39	Time course of relative shoot dry weight of maize grown observed in the ten successive cropping as affected by AM fungal inoculation applied in the first cropping.	88
40	Time course of relative N uptake of maize grown observed in seven successive cropping as affected by AM fungal inoculation applied in the first cropping.	88

LIST OF FIGURES (Continued)

Figure		Page
41	Abundance of <i>G. aggregatum</i> in the soils after harvest of the specified cropping seasons as affected by inoculation with different AM fungi in the first cropping season.	90
42	Abundance of <i>A. spinosa</i> in the soils after harvest of the specified cropping seasons as affected by inoculation with different AM fungi in the first cropping season	90
43	Grain yield of maize grown in the five successive cropping seasons as affected by AM fungal inoculation applied in the first cropping (99D cropping season).	92
44	Shoot dry weight of maize grown in the five successive cropping seasons as affected by AM fungal inoculation applied in the first cropping.	93
45	N uptake of maize grown in the four successive cropping seasons as affected by AM fungal inoculation applied in the first cropping.	94
46	P uptake of maize grown in the four successive cropping seasons as affected by AM fungal inoculation applied in the first cropping.	94
47	K uptake of maize grown in the four successive cropping seasons as affected by AM fungal inoculation applied in the first cropping.	95
48	Time courses of relative shoot dry weight of maize grown in five successive cropping as affected by AM fungal inoculation applied in the first cropping.	95
49	Time course of relative N uptake of maize grown in four successive cropping as affected by AM fungal inoculation applied in the first cropping.	96

LIST OF FIGURES (Continued)

Figure		Page
50	Time course of relative P uptake of maize grown in four successive cropping as affected by AM fungal inoculation applied in the first cropping.	96
51	Abundance of <i>G. aggregatum</i> spores in soils after harvest of the specified cropping seasons as affected by inoculation with different AM fungi in the first cropping season.	98
52	Shoot dry weight of maize as affected by AM fungal inoculation in the pot experiment.	99
53	N uptake of maize as affected by AM fungal inoculation in the pot experiment.	99
54	P uptake of maize as affected by AM fungal inoculation in the pot experiment.	100
55	K uptake of maize as affected by AM fungal inoculation in the pot experiment.	100
56	Abundance of <i>G. aggregatum</i> spore in soils collected from the pot after harvest of the specified cropping seasons as affected by inoculation with different AM fungi.	101
57	Relative grain yields of maize as affected by repetitive AM fungal inoculation applied in the two following cropping seasons (01L and 02E) compared to that of the previous cropping season (01E).	103
58	Relative shoot dry weight of maize as affected by repetitive AM fungal inoculation applied in the two following cropping seasons compared to that of the previous cropping season.	104
59	Relative N uptake of maize as affected by repetitive AM fungal inoculation applied in the two following cropping seasons compared to that of the previous cropping season.	105

LIST OF FIGURES (Continued)

Figure		Page
60	Relative P uptake of maize as affected by repetitive AM fungal inoculation applied in the two following cropping seasons compared to that of the previous cropping season.	106
61	Relative K uptake of maize as affected by repetitive AM fungal inoculation applied in the two following cropping seasons compared to that of the previous cropping season.	106
62	Abundance of <i>G. aggregatum</i> spore in soil after harvest as affected by repetitive AM fungal inoculation applied in the two following cropping seasons compared to that of the previous cropping season.	107
63	Abundance of <i>S. fulgida</i> spore in soil after harvest as affected by repetitive AM fungal inoculation applied in the two following cropping seasons compared to that of the previous cropping season.	107