



Types and Rates of Arbuscular Mycorrhizal Fungi Inoculation on Robusta Coffee Seedling Growth

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Outline

Introduction

Objective

Materials & Methods

Results & Discussion

Conclusion

Acknowledgement



Introduction

Arbuscular mycorrhizal fungi (AMF)

: symbiotic associations

- Mycorrhiza receives some carbohydrates and hormones from plants.
- Absorb nutrients from soil especially phosphorus and micronutrients through hyphae and mobilize into the plant for enhancing growth and yield quality.

(Clark and Zeto, 2000, Smith and Read, 2008)

Introduction



Arbuscular mycorrhizal fungi (AMF)

- Nutrient uptake and plant growth
 - increased yield, improved yield quality
- Resistance on plant disease
- Phytohormones synthesis
- Soil conservation
- Tolerance on drought, heavy metal, saline soil



(Vosátka and Albrechtová, 2009, Gianinazzi *et al.*, 2010)

Introduction



Robusta coffee (*Coffea robusta* Pierre ex Froehner L.)

High Consumption



**High Import
(Instant coffee)**

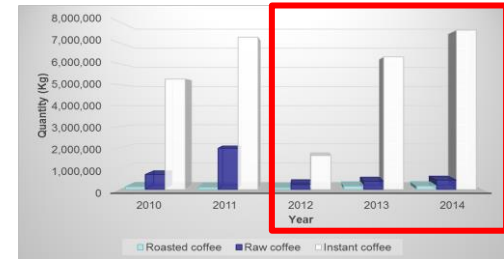


Table 1 Plantation areas in Thailand

Country	Plant area (rai)	
	2015	2016
Thailand	189,068	187,077

Source: Office of agriculture economic, 2016

Introduction



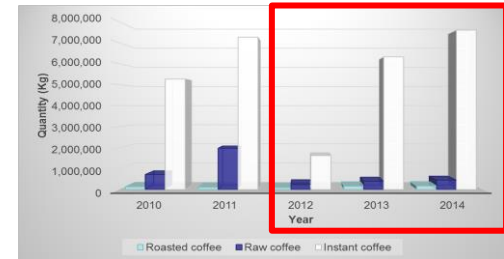
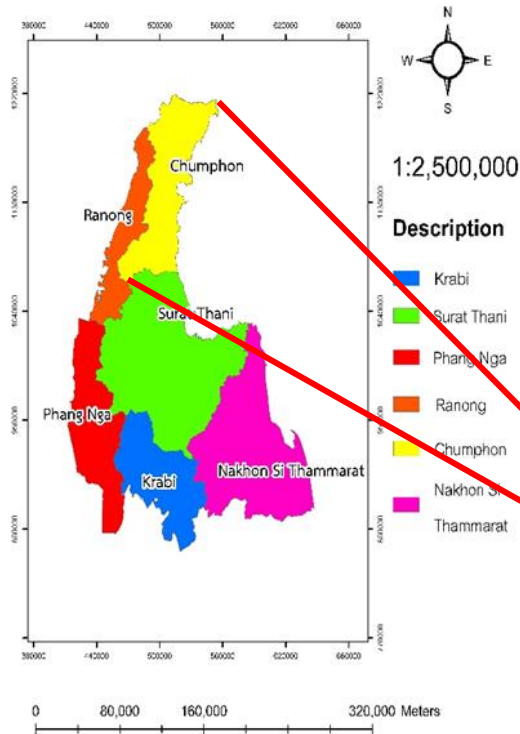
Robusta coffee (*Coffea robusta* Pierre ex Froehner L.)

High Consumption



High Import
(Instant coffee)

Plantation areas of coffee in Southern Thailand



Total areas of robusta coffee
= 128,054 rai

Introduction



Plant uptake

Hard pruning

Crop removal

Soil compaction

Leaching/Erosion

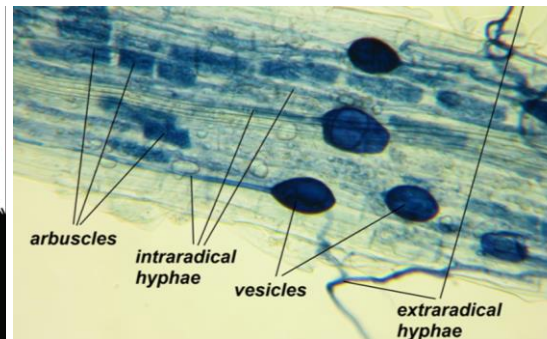
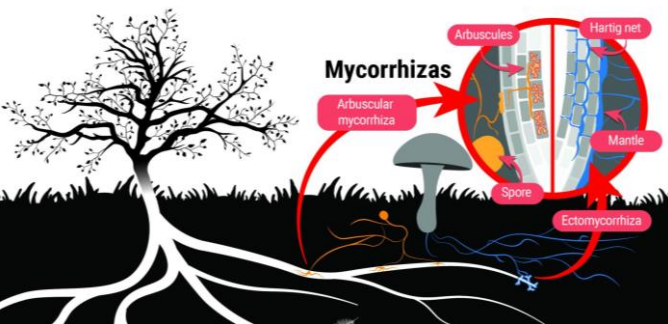
**$\text{FePO}_4 \cdot 2\text{H}_2\text{O}$,
 $\text{AlPO}_4 \cdot 2\text{H}_2\text{O}$**



(Miransari *et al.*, 2007)

Introduction

- Siquera *et al.* (1998) state that AMF can increased yield of coffee in low fertility condition.
- AMF can increased P uptake than non-inoculation (Sanchez *et al.*, 2005) and enhanced the flower formation, growth and yield of coffee (Andrade *et al.*, 2009).



Objective



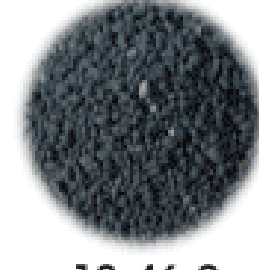
To study the types and rates of arbuscular mycorrhizal fungi inoculation on robusta coffee seedling growth



Materials



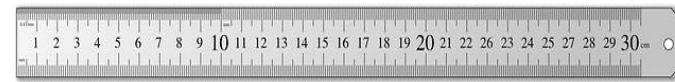
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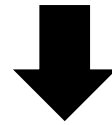
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Methods



Planning experiments



Experiment 1: Study the types of arbuscular mycorrhizal fungi inoculation on robusta coffee seedling growth

Experiment 2: Study the types and rates of arbuscular mycorrhizal fungi inoculation on robusta coffee seedling growth



Experiment 1: Study the kinds of arbuscular mycorrhizal fungi inoculation on robusta coffee seedling growth

Experiment design: Completely Randomized Design (CRD) with 9 treatments and 3 replications;

Table 1 Treatments of AMF inoculation kinds

Treatments	AMF species
1	Control (sterile soil)
2	<i>Acaulospora morrawiae</i> LU6
3	<i>Glomus aggregatum</i> TS7
4	<i>Glomus callosum</i> CH2
5	<i>Glomus callosum</i> KK5
6	<i>Glomus delhienes</i> LU3
7	<i>Glomus intraradices</i> LU3
8	<i>Glomus</i> sp. TS1
9	<i>Glomus</i> sp. 2TS5

Note: Rate of AMF inoculation at 20 g

Process (Exp.1)

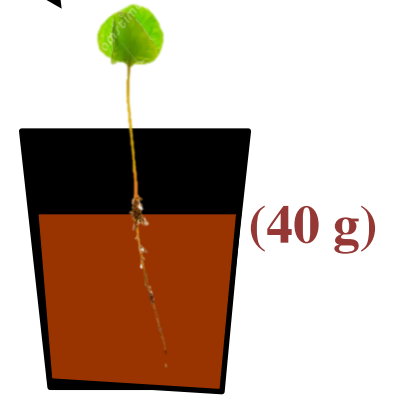
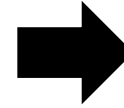


**Pak Chong series
: compost (5:1)**

**Urea, Phosphatic rock,
Potassium chloride
(200, 300, 200mg/kg)**



inoculum : growing media (1:1)



growing media (20 g)



Data collections at 2, 4 weeks after AMF inoculation (Exp.1)



- **Root colonization (%)** (Brundrett *et al.*, 1994)

$$= \frac{\text{number of infected roots}}{\text{number of observed roots}} \times 100$$

- **Plant growth:**

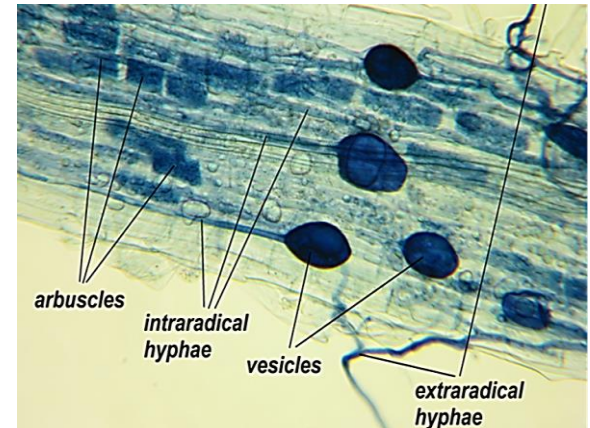
- plant height increased (cm)

$$= \text{final height} - \text{initial height}$$

- stem diameter (cm)

- **Statistical Data Analysis**

- One way analysis of variance (ANOVA) with Duncan's new multiple range test (DMRT)





Results

&

Discussion

(Experiment 1)

Results & Discussion (Exp. 1)



Table 2 Root colonization (%) of robusta coffee seedling at 2 and 4 weeks after AMF inoculation

Treatments	Root colonization (%)	
	2 weeks	4 weeks
Control	0.00 ^e	0.00 ^f
<i>Acaulospora morrawiae</i> LU6	31.25 ^a	49.77 ^{d-e}
<i>Glomus aggregatum</i> TS7	13.73 ^d	47.59 ^e
<i>Glomus callosum</i> CH2	16.67 ^c	71.43 ^b
<i>Glomus callosum</i> KK5	17.00 ^{b-c}	71.09 ^b
<i>Glomus delhienes</i> LU3	17.00 ^{b-c}	65.37 ^c
<i>Glomus intraradices</i> LU3	18.18 ^b	77.50 ^a
<i>Glomus</i> sp.TS1	28.90 ^a	50.00 ^d
<i>Glomus</i> sp.2TS5	17.67 ^{b-c}	75.39 ^{a-b}
P-value	0.00 (**)	0.00 (**)
CV.(%)	15.13	19.76

Note: Values followed by the same letter in a column are not significant at 1% level by the Duncan Multiple Range Test

Results & Discussion (Exp. 1)



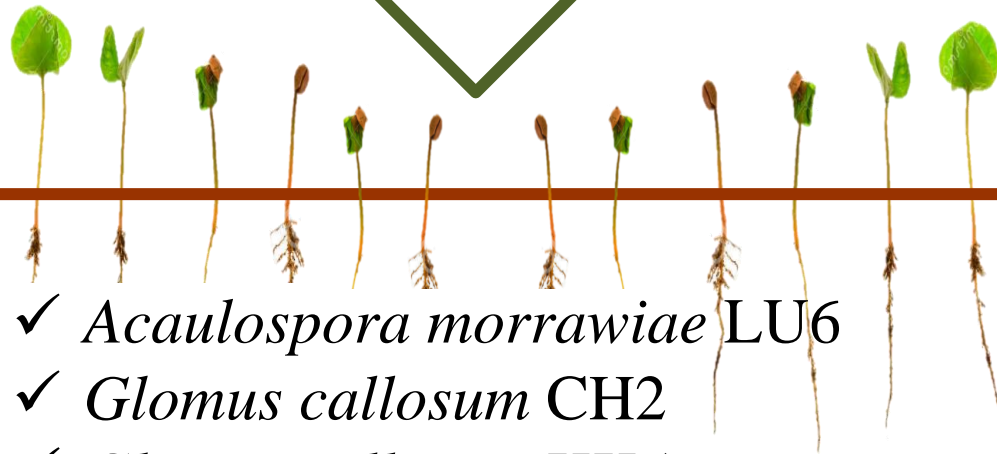
Table 3 Plant height increased and stem diameter of robusta coffee seedling at 2 and 4 weeks after AMF inoculation

Treatments	Plant height increased (cm)		Stem diameter (cm)	
	2 weeks	4 weeks	2 weeks	4 weeks
control	3.50	3.19 ^c	0.13 ^c	0.15 ^c
<i>Acaulospora morrawiae</i> LU6	5.29	5.64 ^a	0.16 ^a	0.17 ^a
<i>Glomus aggregatum</i> TS7	4.70	4.76 ^b	0.15 ^{a-b}	0.16 ^b
<i>Glomus callosum</i> CH2	5.75	5.38 ^{a-b}	0.14 ^b	0.16 ^b
<i>Glomus callosum</i> KK5	5.10	4.87 ^{a-b}	0.16 ^a	0.16 ^b
<i>Glomus delhienes</i> LU3	4.19	4.88 ^{a-b}	0.15 ^{a-b}	0.17 ^a
<i>Glomus intraradices</i> LU3	5.25	4.96 ^{a-b}	0.16 ^a	0.16 ^b
<i>Glomus</i> sp.TS1	4.78	4.87 ^{a-b}	0.15 ^{a-b}	0.16 ^b
<i>Glomus</i> sp.2TS5	4.57	5.43 ^{a-b}	0.16 ^a	0.16 ^b
P-value	0.13 (ns)	0.00 (**)	0.00 (**)	0.00 (**)
CV. (%)	19.00	10.53	13.00	9.09

Note: Values followed by the same letter in a column are not significant at 1% level by the Duncan Multiple Range Test

Conclusion

Experiment 1: Study the kinds of arbuscular mycorrhizal fungi inoculation on robusta coffee seedling growth



- ✓ *Acaulospora morrawiae* LU6
- ✓ *Glomus callosum* CH2
- ✓ *Glomus callosum* KK5
- ✓ *Glomus intraradices* LU3
- ✓ *Glomus* sp.2TS5



Experiment 2: Study the kinds and rates of arbuscular mycorrhizal fungi inoculation on robusta coffee seedling growth

Experiment design: 5×5 factorial in CRD with 4 replications;

Factor M: Mycorrhizal fungi kinds (from exp.1)

[*Acaulospora morrawiae* LU6 (M1), *Glomus callosum* CH2 (M2),
Glomus callosum KK5 (M3), *Glomus intraradices* LU3 (M4) and
Glomus sp. 2TS5 (M5)]

Factor Q: Rate of inoculation

[0g (Q1), 5g (Q2), 10g (Q3), 20g (Q4) and 40g (Q5)]

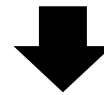
Process (Exp.2)



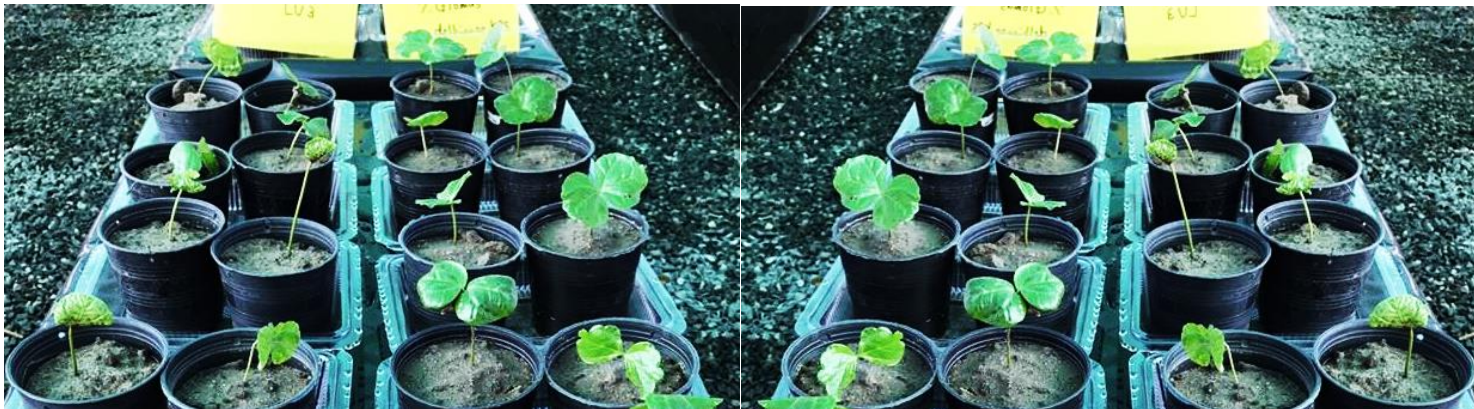
Rate of inoculation; 0g, 5g, 10g, 20g and 40g



Rate of growing material; 40g, 35g, 30g, 10g and 0g



Inoculation: growing material; 0:40, 5:35, 10:30, 30:10 and 40:0 g/g



Data collections at 2, 4 weeks after AMF inoculation (Exp.2)



- **Root colonization (%)** (Brundrett *et al.*, 1994)

$$= \frac{\text{number of infected roots}}{\text{number of observed roots}} \times 100$$

- **Plant growth:**

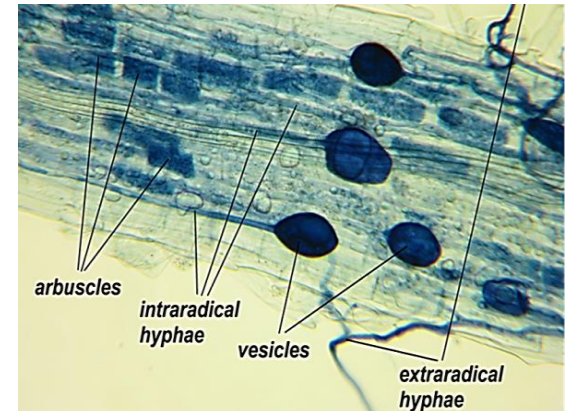
- plant height increased (cm.)

$$= \text{final height} - \text{initial height}$$

- stem diameter (cm.)

- **Statistical Data Analysis**

- One way analysis of variance (ANOVA) with Duncan's multiple range test (DMRT)





Results
&
Discussion
(Experiment 2)

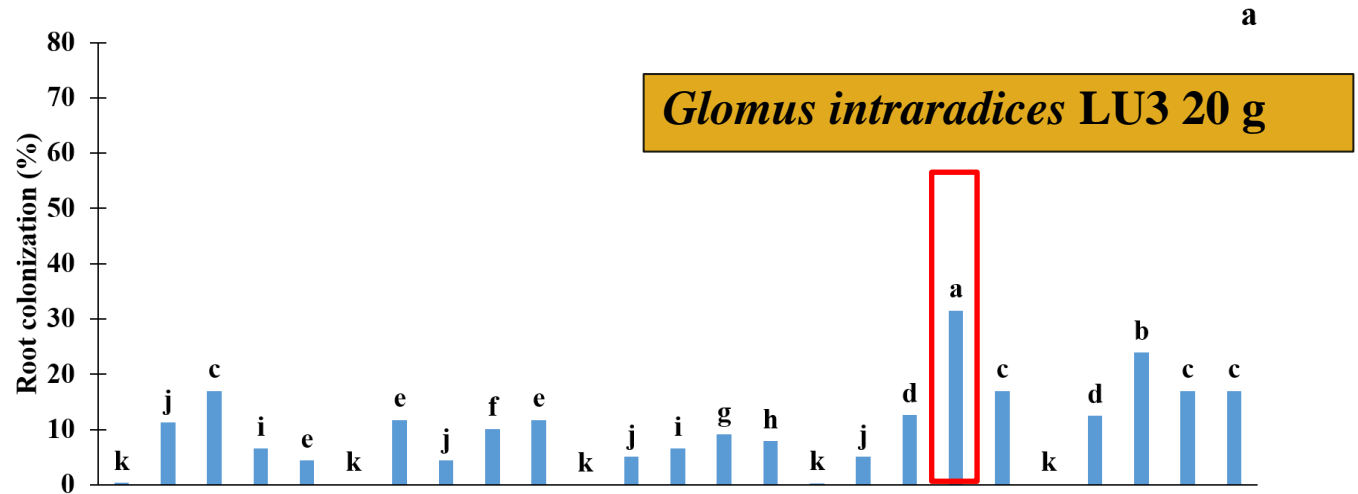
Table 4 Root colonization (%) of robusta coffee seedling at 2 and 4 weeks as affected by types and rates of AMF inoculation



Factors	Root colonization (%)	
	2 weeks	4 weeks
Mycorrhizal fungi (M)		
<i>Acaulospora morrawiae</i> LU6 (M1)	7.92 ^C	68.39 ^A
<i>Glomus callosum</i> CH2 (M2)	7.64 ^D	44.63 ^C
<i>Glomus callosum</i> KK5 (M3)	5.77 ^E	32.90 ^D
<i>Glomus intraradices</i> LU3 (M4)	13.28 ^B	30.36 ^E
<i>Glomus</i> sp.2TS5 (M5)	14.12 ^A	50.77 ^B
P-value (M)	0.00 (**)	0.00(**)
Rate of inoculation (Q)		
0g (Q1)	0.21 ^e	0.57 ^e
5g (Q2)	9.15 ^d	49.73 ^c
10g(Q3)	12.89 ^b	55.48 ^b
20g(Q4)	14.88 ^a	65.49 ^a
40g(Q5)	11.65 ^c	46.06 ^d
P-value (Q)	0.00 (**)	0.00 (**)
MxQ	0.00 (**)	0.00 (**)
CV.(%)	17.43	15.46

Note: Values followed by the same letter in a column are not significant at 1% level by the Duncan Multiple Range Test

Results & Discussion (Exp.2)



Acaulospora morrowiae LU6 10-40 g
Glomus callosum KK5 20 g
Glomus sp. 2TS5 5-20 g

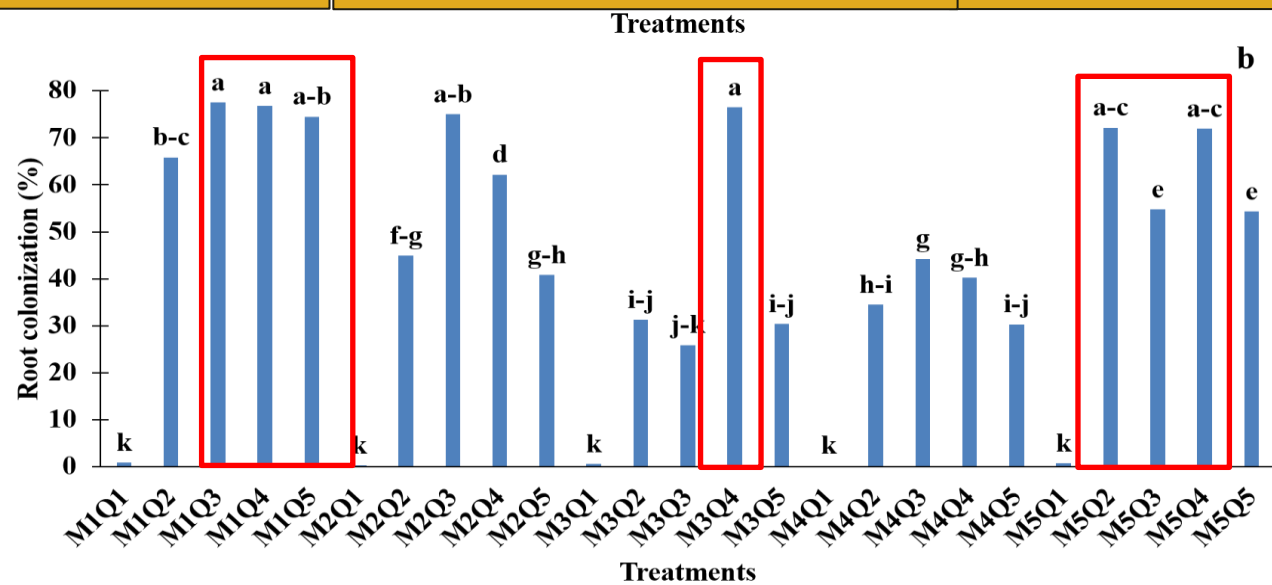


Fig. 1 Interaction between of types and rates of AMF inoculation on root colonization (%) of robusta coffee seedling at 2 weeks (a) and 4 weeks (b).

Table 5 Plant height increased (cm) of robusta coffee seedling at 2 and 4 weeks as affected by types of and rates of AMF inoculation

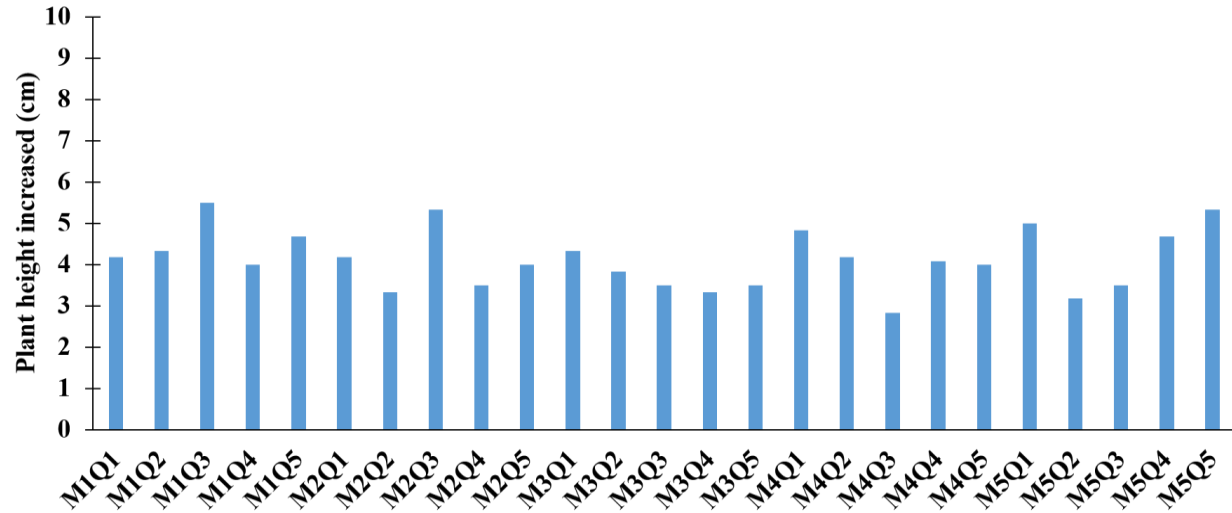


Factors	Plant height increased (cm)	
	2 weeks	4 weeks
Mycorrhizal fungi (M)		
<i>Acaulospora morrawiae</i> LU6 (M1)	4.53	5.34 ^B
<i>Glomus callosum</i> CH2 (M2)	3.97	4.69 ^B
<i>Glomus callosum</i> KK5 (M3)	3.70	7.03 ^A
<i>Glomus intraradices</i> LU3 (M4)	3.98	5.53 ^B
<i>Glomus</i> sp.2TS5 (M5)	4.33	6.60 ^A
P-value (M)	0.50 (ns)	0.00(**)
<p><i>Gl. callosum</i> KK5 and <i>Glomus</i> sp.2TS5 can grow around the plant roots, some of the hyphae can grow into the roots and protrude out of the roots lead to absorb water and nutrients in plant (Sylvia and Chellemi, 2001)</p>		
10g (Q3)	3.75	5.95
20g (Q4)	4.21	6.04 ^{a-b}
40g (Q5)	4.30	6.73 ^a
P value (Q)	0.48 (ns)	0.00 (**)
MxQ	0.76 (ns)	0.01 (**)
CV.(%)	22.34	12.24

Note: Values followed by the same letter in a column are not significant at 1% level by the Duncan Multiple Range Test

Results & Discussion (Exp.2)

a



Glomus callosum KK5 10 g

Treatments

Glomus sp. 2TS5 5-20 g

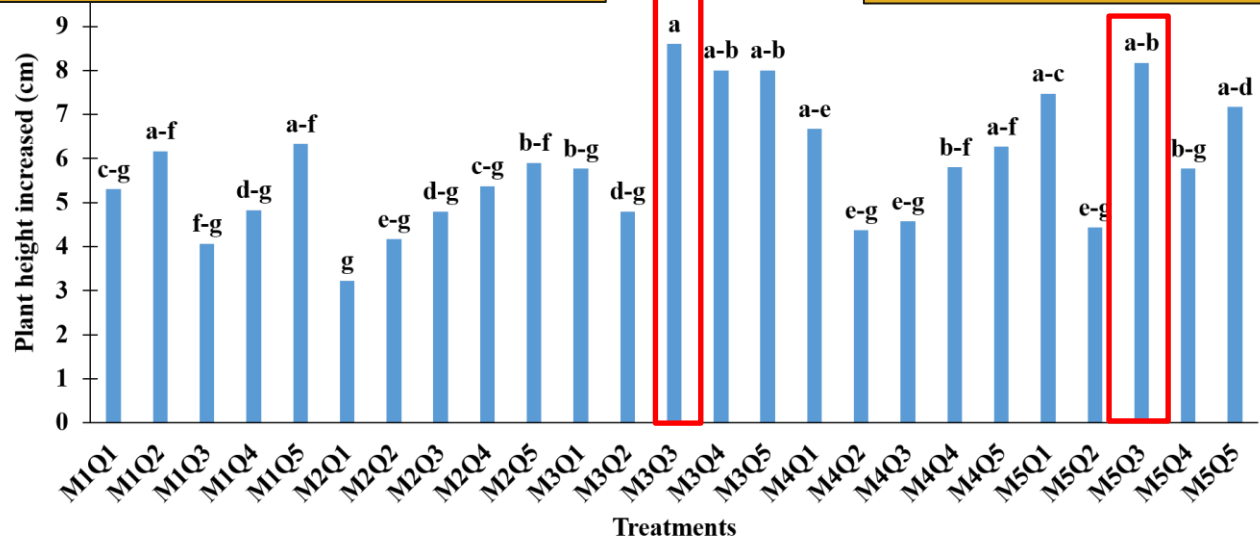


Fig. 2 Interaction between of types and rates of AMF inoculation on plant height increased (cm.) of robusta coffee seedling at 2 weeks (a) and 4 weeks (b).

Table 6 Stem diameter (cm) of robusta coffee seedling at 2 and 4 weeks as affected by types of and rates of AMF inoculation

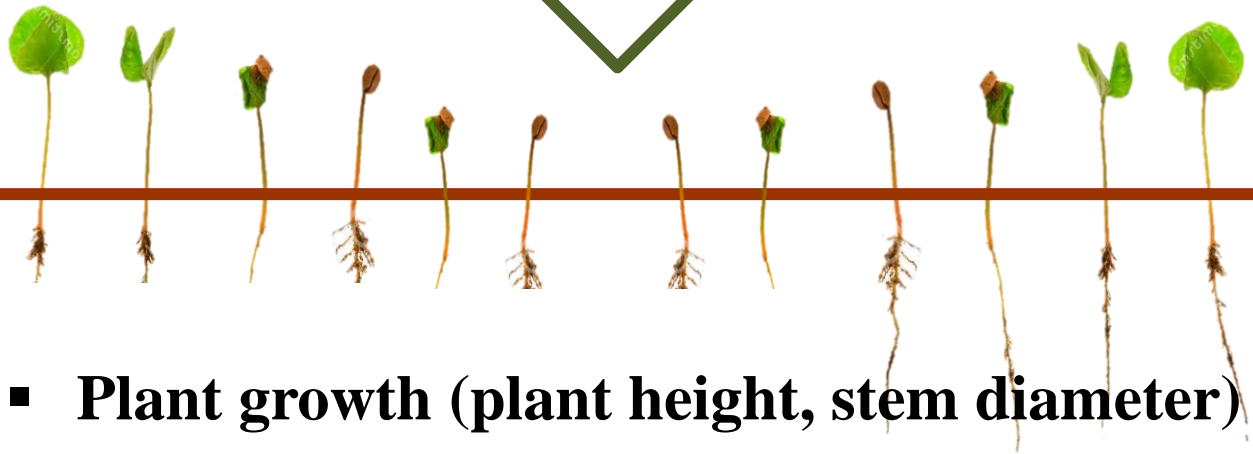


Factors	Stem diameter (cm)	
	2 weeks	4 weeks
Mycorrhizal fungi (M)		
<i>Acaulospora morrowiae</i> LU6 (M1)	0.17	1.97 ^{A-B}
<i>Glomus callosum</i> CH2 (M2)	0.15	1.84 ^{A-C}
<i>Glomus callosum</i> KK5 (M3)	0.15	1.99 ^A
<i>Glomus intraradices</i> LU3 (M4)	0.16	1.75 ^{B-C}
<i>Glomus</i> sp.2TS5 (M5)	0.15	1.73 ^C
P-value (M)	0.40 (ns)	0.00 (**)
Rate of inoculation (Q)		
0g (Q1)	0.15	1.83
5g (Q2)	0.16	1.75
10g (Q3)	0.16	1.84
20g (Q4)	0.16	1.93
40g (Q5)	0.16	1.92
P -value (Q)	0.53 (ns)	0.39 (ns)
MxQ	0.93 (ns)	0.09 (ns)
CV.(%)	18.00	18.00

Note: Values followed by the same letter in a column are not significant at 1% level by the Duncan Multiple Range Test

Conclusion

Experiment 2: Study the kinds and rates of arbuscular mycorrhizal fungi inoculation on robusta coffee seedling growth



- **Plant growth (plant height, stem diameter)**

✓ *Glomus callosum* KK5 10 g/pot

Acknowledgements



Farm owners

Ms. Naruedee Julbut



**Thank you
for
your attention**