

TABLE OF CONTENTS

TITLE	i
APPROVAL PAGE	iii
STATEMENT.....	v
ABSTRACT	vi
BIOGRAPHY	vii
PREFACE	viii
TABLE OF CONTENTS	xii
LIST OF TABLES	xiv
LIST OF FIGURE	xv
CHAPTER I INTRODUCTION.....	1
A. Background.....	1
B. Problem Statements	4
C. Research Aims	4
D. Significance	4
CHAPTER II LITERATURE REVIEW	6
A. Cocoa Plants (<i>Theobroma cacao L.</i>) Cultivation	6
B. Fungi Associated with Diseases Cocoa Plant.....	9
C. Plant Disease Inventory	20
D. Framework of Thoughts	21
E. Hypothesis	24
CHAPTER III RESEARCH METHODOLOGY	25
A. Place and Time Research	25
B. Material and Tools.....	25
C. Method.....	26
D. Research Implementation	27
E. Observation Parameter.....	30
CHAPTER IV RESULTS AND DISCUSSION	34
A. Disease Incidence and Severity	34
1. Disease Incidence and Severity of Necrotic Symptoms.....	34

2. Disease Incidence and Severity of Leaf Spot Symptoms	38
3. Disease Incidence and Severity of Chlorosis (Hypoplastic) Symptoms	40
4. Disease Incidence and Severity of Dry Rot Symptoms.....	42
B. Fungi Associated with Disease Symptomatic Cocoa Plants.....	42
1. Necrotic Symptoms	42
2. Leaf Spot Symptom	60
3. Chlorosis (Hypoplastic) Symptom	62
4. Dry Rot Symptom.....	64
5. Results of Macroscopic and Microscopic Characterization of Fungal Isolation	69
CHAPTER V CONCLUSIONS AND SUGGESTIONS.....	71
A. Conclusions	71
B. Suggestions.....	72
BIBLIOGRAPHY	73
APPENDIX	80

LIST OF TABLES

Table 4.1 Macroscopic and Microscopic Characterization of Fungal Isolation	69
--	----

LIST OF FIGURE

Figure 2.1 Colony of the Fungus <i>P.Palmifora</i>	10
Figure 2.2 Symtoms of Cocoa Pods Rot	12
Figure 2.3 Symtoms of Stem Canker Diseases in Cocoa Plant.....	14
Figure 2.4 Signs of <i>P.Palmivora</i> Stem Canker Attack	14
Figure 2.5 Mycelium of <i>Marasmius</i> sp.	16
Figure 2.6 Symtoms of Horsetail Blight on Cocoa Plant	17
Figure 2.7 Symtoms of VSD on Cocoa Plant	19
Figure 2.8 Mycelium of <i>C.theobromae</i> on PDA Medium	20
Figure 3.1 Plant Sampling Field 1	30
Figure 3.2 Plant Sampling Field 2	30
Figure 4.1 (A) Disease incidence and (B) Disease severity of necrotic symptoms	36
Figure 4.2 (A) Disease incidence and (B) Disease severity of leaf spot symptoms.....	38
Figure 4.3 (A) Disease incidence and (B) Disease severity of chlorosis (hypoplastic) symptoms	40
Figure 4.4 (A) Disease incidence and (B) Disease severity of dry rot symptoms	42
Figure 4.5 (A) Symptom on cocoa leaf; (B) Isolate F1 top surface; (C) Isolate F1 reverse surface; (D) Septate hyphae; (E) Microconidia of <i>Fusarium</i> sp.; (F) Macroconidia of <i>Fusarium</i> sp.	44
Figure 4.6 Microscopic Morphological of <i>Fusarium oxysporum</i> (A) Septate hyphae; (B) Septate macroconidium; (C) Microconidium.....	44
Figure 4.7 (A) Symptom on cocoa branch (1: brown xylem tissue; 2: necrosis leaf); (B) Isolate F2 top surface; (C) Isolate F2 reverse surface; (D) Macroconidia of <i>Fusarium</i> sp.; (E) Microconidia of <i>Fusarium</i> sp.; (F) Septate hyphae	46
Figure 4.8 Microscopic morphology of <i>Fusarium oxysporum</i> (A) Septate hyphae; (B) Septate macroconidium; (C) Microconidium.....	47
Figure 4.9 (A) Symptom on cocoa leaf (1: necrosis; 2: chlorosis); (B) Isolate PT1 top surface; (C) Isolate PT1 reverse surface; (D) Conidiogenous cells; (E) Conidia of <i>Pestalotiopsis</i> sp.; (F) Apical appendage.....	49

Figure 4.10 (A-C) Conidiogenous cell of <i>Pestalotiopsis formosana</i> ; (D-F) Conidia of <i>Pestalotiopsis formosana</i>	49
Figure 4.11 (A) Symptom on cocoa leaf (1: necrotic; 2: chlorosis) (B) Isolate PT2 top surface; (C) Isolate PT2 reverse surface; (D) Conidiogenous cells; (E) Conidia of <i>Pestalotiopsis</i> sp.; (F) Apical appendage.....	52
Figure 4.12 (A-C) Conidiogenous cell of <i>Pestalotiopsis formosana</i> ; (D-F) Conidia of <i>Pestalotiopsis formosana</i>	52
Figure 4.13 (A) Symptom on cocoa leaf; (B) Isolate P1 top surface; (C) Isolate P1 reverse surface; (D) Pycnidial conidiomata; (E) Septate hyphae.....	54
Figure 4.14 <i>Phoma</i> sp. identification; (a) Colony; (b) Mycelium; (c) Inoculation results; (d) Pycnidial conidiomata	56
Figure 4.15 (a) Symptom on cocoa leaf; (B) Isolate PP1 top surface on V8 media; (C) Isolate P1 reverse surface on V8 media; (D) Ovoid and Papillate sporangia; (E) Non papillate sporangia; (F) Terminal chlamydospore.....	57
Figure 4.16 (A) Papillate sporangia; (B) Non-semi-papillate sporangia; (C) Terminal chlamydospore; (D) Terminal chlamydospore on cotton blue (E) Ovoid sporangium; (F) Top surface colony of <i>Phytophthora</i> sp	59
Figure 4.17 (A) Symptom on cocoa leaf; (B) Isolate A2 top surface; (C) Isolate A2 reverse surface; (D) Vesicle; (E) Sterigmata; (F) Conidiophore; (G) Conidiospores; (H) Septate hyphae	59
Figure 4.18 Morphology of <i>Aspergillus fumigatus</i> ; (A) Macroscopic; (B) Microscopic	61
Figure 4.19 (A) Symptom on cocoa leaf; (B) Isolate C1 top surface; (C) Isolate C1 reverse surface; (D) Septate hyphae; (E) Conidia of <i>Colletotrichum</i> sp.; (F) Conidiophore of <i>Colletotrichum</i> sp.....	61
Figure 4.20 Conidial shapes of <i>Colletotrichum</i> sp., (A) Fusifo shape; (B) Cylindrical shape	63
Figure 4.21 (A) Symptom on cocoa leaf; (B) Isolate A1 top surface; (C) Isolate A1 reverse surface; (D & H) Conidiospores; (E) Sterigmata; (F) Vesicle; (G) Conidiophore; (H) Septate hyphae.....	64
Figure 4.22 Morphology of <i>Aspergillus niger</i> ; (A) Macroscopic; (B) Microscopic	66
Figure 4.23 (A) Dry rot symptom on cocoa pod; (B) Cocoa pod cut in half; (C) Isolate M1 top surface; (D) Isolate M1 reverse surface; (E & F) Sporangium; (G) Aseptate hypae; (H) Sporangiospores	52

Figure 4.24 (A) Macroscopic Characterization of *Mucor* sp.; (B) Microscopic characterization magnification 400x (a: spore, b: columella, c: sporangiospores)..... 54