## TABLE OF CONTENTS

	Page
Acknowledgement	III
Abstract in English	IV
Abstract in Thai	VI
Table of contents	VIII
List of table	X
List of illustrations	XII
Chapter 1 Introduction	1
Chapter 2 Literature Review	3
2.1 Aphid in Thailand	3
2.2 Lipahis erysimi (Kaltenbach)	45
2.3 Plants with botanical insecticide property for control	5
aphids	4
2.4 Pesticidal properties of derris plant	6
2.5 Derris propagation and root production	8
2.6 Physical and chemical properties of rotenone	10
2.7.The rotenone extraction	11
2.8 Toxicological effect of rotenone	13
2.9 Bioassay	15
2.10 Mode of action of rotenone	16
2.11 Formulation	16
Chapter 3 Derris Plant Species Identification and Rotenone	18
Root Quantity as Determined by Isozyme Pattern	
Method and the Plant Morphological Characteristics	versity
3.1 Introduction	18
3.2 Material and methods	19
3.3 Result and discussion.	22
3.4 Conclusion	31

	Chapter 4 Ascertainment of Rotenone Content in Accordance with	32
	Derris Plant Ages Cultivated in Various Container Types	
	and Sizes Versus the Field Condition	
	4.1 Introduction	32
	4.2 Material and methods	32
	4.3 Result and discussion	33
	4.4 Conclusion.	38
	Chapter 5 Modification Techniques for Rotenone Extraction	44
	5.1 Introduction	44
	5.2 Material and methods	44
	5.3 Result and discussion.	46
	5.4 Conclusion	51
	Chapter 6 Determination of Rotenone Degradation for Sprayed	52
	Residues in Selected Environment	
	6.1 Introduction	52
	6.2 Material and methods	52
	6.3 Result and discussion.	53
	6.4 Conclusion	55
	Chapter 7 The Longevity Extension and Efficacy of the Derris Formulated	60
	Product for Controlling the Cabbage Aphid	
	7.1 Introduction	60
	7.2 Material and methods	60
	7.3 Result and discussion.	63
	7.4 Conclusion	68
	Chapter 8 General Discussion and Conclusion	71
	8.1 General discussion	71 /Arsity
A	8.2 Conclusion	74
	8.3 Recommendations for field application and storage	75
	8.4 Suggestion for future experiment	75
	References	77
	Appendix	85
	Curriculum vitae	99

## LIST OF TABLES

Table	Page
3.1 Rf values of young and mature leaves of derris cultivar and local	23
varieties as determined by POX, EST, and ACP isozyme patterns	
3.2 Amount of Rotenone content (%) per 1 gram dry weight of	25
mature leaf, shoot, stem and various root diameter of 2-year-old	
derris varieties grown in the same environment factor at LARTC	
(4 replications)	6
3.3 Morphological characters of derris local variety (D. elliptica) and	27
derris cultivar variety (D. malaccensis)	
4.1 Percentages of rotenone quantities detected from 6-, 9-, and 12-	34
month derris root according to treatments	
4.2 Fresh and dry weights (gram per plant) collected from 6-, 9-, and	37
12-month derris root by treatments	4
4.3 Total fresh and dry weights (gram per plant) observed from 6-,	38
9-, and 12-month derris plants in relation to treatments	· //
5.1 Means rotenone concentrations detected from solutions of derris	47
fresh root, derris root powder, and derris root precipitate	
extracted by 2 different treatments in 4 replications	
5.2 Rotenone concentrations and absorbance determined by varying	50
concentrations of derris fresh root solutions extracted with	
modified water extraction	?
5.3 Rotenone content of evaporate and non evaporate of derris	51
extracted by varying volume of 95% ethanol treatments	
6.1 Rotenone contains in solutions and on Petri dishes by	istersity
treatments before and after sprayed at 0, 6, 12, 24 and 30	4 V O O
hours, for indoor and outdoor conditions with regression	V C U
equations of rotenone degradations.	
6.2 Percent rotenone degrade after sprayed on petri dish at 6, 12, 24	58

and 30 hours, outdoor and indoor condition

6.3 Percent rotenone degrade and rotenone concentration of all	58
treatment before and after sprayed on cabbage at 0, 6 and 12 hours	
7.1 Rotenone content in each formulation of derris root extracts when	64
kept for 4 months at room temperature	
7.2 Rotenone content and LC <sub>50</sub> values by treatments	65
7.3 Average numbers of aphids for pre- and post-treatment applications	67
and percentages of aphid decrease conducted at 18, 27, and 33	
days after transplanted	0
7.4 Fresh weight, width and length of cabbages at harvest period and	68
Fv/Fm values of cabbage leaf chlorophyll after treatment	
applications	7967 7967

## ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่ Copyright<sup>©</sup> by Chiang Mai University All rights reserved

## LIST OF ILLUSSTRATIONS

Figure	Page
2.1 Lipaphis erysimi Kaltenbach with row of slightly darker shiny	4
bars on body (Banziger, 1977)	
3.1 Peroxidase isozyme cymogram patern of mature leaf (right) and	23
young leaf (left) column 1-5 were of cultivar variety, column 6-	
10 were of local variety	
3.2 Esterase isozyme zymogram patern of mature leaf (right) and	24
young leaf (left) column 1-5 were of cultivar variety, column 6-	
10 were of local variety	
3.3 Acid phosphatase isozyme zymogramand patern of mature leaf	24
(right) and young leaf (left) column 1-5 were of cultivar variety,	505
column 6-10 were of local variety	200
3.4 Morphological Characteristics of <i>D. malacensis</i> Flower (1cm)	28
3.5 Morphological Characteristics of <i>D. elliptica</i> Flower (1cm)	29
3.6 Flower cluster of D. elliptica on stem	30
3.7 Flower cluster of <i>D. malaccensis</i> (Right) and <i>D. elliptica</i> (Left)	30
3.8 Compound leave of <i>D. malaccensis</i> (Left) and <i>D. elliptica</i> (Right)	30
3.9 Young leave of <i>Derris malaccensis</i> Prain. (Right) and	30
Derris elliptica Bent.(Left) Figure	
3.10 Higher rotenone content in solution of derris cultivar (right)	30
and local varieties (Left)	9
3.11 More than 12 months old of cultivar derris root	30
3.12 HPLC machine (Shimadzu LC 14AD)	31
4.1 Derris fibrous root (left) and branch root (right)	34ersity
4.2 Bar chart of rotenone quantity percentages observed from 6-, 9-,	35
and 12-month derris root according to treatments	veo
4.3 Bar chart of dry weights of 6-, 9-, and 12- month derris roots	37
according to treatments	
4.4 Bar chart of total dry weights collected from 6-, 9-, and 12-	38
month derris plants in accordance with treatments	

4.5 Types and sizes of planting containers 10"x 20", 13"x 26" plastic	39
bags and 15"x 15" plastic pot	
4.6 Derris plants developed in 10"x 20" plastic bags	40
4.7 Twelve months old of derris root removal from 10" x 20" plastic	40
bag 218136	
4.8 Derris plants developed in 13"x 26" plastic bags	40
4.9 Twelve months old of derris root removal from 13" x 26" plastic	41
bag	1/1
4.10 Derris plants developed in 15"x 15" plastic pots	41
4.11 Twelve months derris root system removal from 15" x 15"	41
plastic pot	
4.12 Derris plants cultivated in the field	42
4.13 Twelve months derris root system removal from the field	42
4.14 Derris plants developed in 40 x 80 cm circular cement	42
containers	4
4.15 Eighteen-month derris root system removal from in 40 x 80 cm	43
circular cement container	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \
5.1 Percent rotenone content and weight of derris root precipitate	47
from derris resh root 10 gm/water 100 ml	
5.2 Water derris extract (A), ethanol + water derris extract (B), derris root	48
precipitate (C)	
5.3 Derris crystals in forms and sizes detected in modified water	49
extraction solutions	7
5.4 Linear regressions of rotenone concentration and absorbance for	49
derris fresh root by modified water extraction	
6.1 Rotenone degradation by treatments for indoor condition	156ersity
6.2 Rotenone degradation by treatments for outdoor condition	56
6.3  A = Derris fresh root extract  (20gm/L)	59
B = Derris dry root extract (10gm/L)	
C = Non evaporate ethanol derris root powder extract (1%)	
D = Evaporate ethanol derris root powder extract (1%)	

$6.4 \text{ A} = \text{Topical tower sprayer (5 ml, } 40 \text{ lb/inch}^2\text{)}$	
B = Derris extract sprayed on dry plates (Petri dishes)	59
6.5 Field application of derris extract solution (L/m²)	59
7.1 Life cycle of Lipaphis erysimi Kaltenbach and instar of aphid for	61
bioassay 8081818	
7.2 Soil planting bed preparations	62
7.3 Ten-day old cabbage seedlings	62
7.4 Pearson square for adjusted rotenone concentration	63
(Wagner and Stanton, 2006)	3
7.5 Percent rotenone content in derris product at 4 months after	64
storage at room temperature	
7.6 Cabbage aphids on the leaves of Chinese cabbage	65
7.7 Bioassay of Cabbage aphids on Chinese cabbage leaves	65
7.8 Cabbage aphids on Chinese cabbage leaves when sprayed with	66
Topical tower sprayer	4
7.9 Topical tower sprayer	66
7.10 Numbers of aphids on cabbage for pre- and post-treatment	67
applications at 18, 27, 33 days after transplanted	
7.11 Preparation of cabbage seedling	69
7.12 Thirty three days old of cabbage	69
7.13 Forty days old of cabbage	69
7.14 Aphid on leaf of cabbage	70
7.15 Stunt caused by aphid	70
7.16 Ready-to-harvest cabbage (40 days old) of harvesting ready and	70
harvesting	
7.17 Cabbage fresh weighting	176ersity
7.18 Width and height of cabbage	70
7.19 Fluorescent chlorophyll apparatus and sensor on cabbage leaf	70