

ECOLOGICAL STUDIES ON SUBTERRENEAN TERMITE AND CONTROL AT ISMAILIA GOVERNORATE (EGYPT)

Submitted By

Amal Thabit Thabit Hussien

B.Sc. of Agricultural Sciences (Plant Protection), Faculty of Agriculture,
Cairo University, 2004

M. Sc. in Agricultural Sciences (Economic Entomology), Faculty of Agriculture,
Cairo University, 2012

A Thesis Submitted in Partial Fulfillment
Of
The Requirement for the Doctor of Philosophy Degree
In
Environmental Sciences

Department of Environmental Agricultural Sciences
Institute of Environmental Studies and Research
Ain Shams University

2019

APPROVAL SHEET
**ECOLOGICAL STUDIES ON SUBTERRENEAN TERMITE
AND CONTROL AT ASMAILIA GOVERNORATE (EGYPT)**

Submitted By

Amal Thabit Thabit Hussien

B.Sc. of Agricultural Sciences (Plant Protection), Faculty of Agriculture,

Cairo University, 2004

M. Sc. in Agricultural Sciences (Economic Entomology), Faculty of Agriculture,

Cairo University, 2012

A Thesis Submitted in Partial Fulfillment

Of

The Requirement for the Doctor of Philosophy Degree

In

Environmental Sciences

Department of Environmental Agricultural Sciences

This Thesis Towards a Doctor of Philosophy Degree in

Environmental Science has been Approved by:

Name

Signature

1-Prof. Dr Ezzat Farag El-Khayat

Prof. of Economic Entomology

Faculty of Agriculture (Moshtohr)

Banha University

2-Prof. Dr. Yousef Az-Eldin Yousef

Prof. of Economic Entomology-Department of Economic Entomology

Faculty of Agriculture

Ain Shams University

3-Prof. Dr. Hassan Mohamed Ahmed

Head of Department of Wood Borers and Termite Unit

Institute of Plant Protection

4-Prof. Dr. Mohamed Salem Abdel-Wahed

Emeritus Prof. of Economic Entomology-Department of Economic

Entomology

Faculty of Agriculture

Ain Shams University

ECOLOGICAL STUDIES ON SUBTERRENEAN TERMITE AND CONTROL AT ASMAILIA GOVERNORATE (EGYPT)

Submitted By

Amal Thabit Thabit Hussien

B.Sc. of Agricultural Sciences (Plant Protection), Faculty of Agriculture,
Cairo University, 2004

M. Sc. in Agricultural Sciences (Economic Entomology), Faculty of Agriculture,
Cairo University, 2012

**A Thesis Submitted in Partial Fulfillment
Of**

**The Requirement for the Doctor of Philosophy Degree
In**

Environmental Sciences

Department of Environmental Agricultural Sciences

Under The Supervision of:

1-Prof. Dr. Mohamed Salem Abdel-Wahed

Emeritus Prof. of Economic Entomology-Department of Economic
Entomology

Faculty of Agriculture

Ain Shams University

2-Prof. Dr. Hassan Mohamed Ahmed

Head of Department of Wood Borers and Terming Unit

Institute of Plant Protection

Agricultural Research Center (A.R.C.)

2019

ACKNOWLEDGMENT

*First of all, my prayerful gratitude should be submitted to the merciful **ALLAH** whose help I always seek and without his willing I will achieve nothing.*

*I would like to express my sincere grateful to my advisor **Prof. Dr. Mohamed Salem Abdel-Wahed**, Professor of Economic Entomology, plant protection Department, Faculty of Agriculture, Ain Shams University, for the continuous support, mentoring throughout my Ph.D., the positive reinforcement, his provided valuable insight, patience, immense knowledge, His guidance helped me in all the time of research and his effort in critical reading of the main script and helpful guidance. I am extremely grateful.*

*I would like to express my gratitude appreciation and respect to **Prof. Dr. Hassan Mohamed Ahmed Ali**, Professor of Economic Entomology, Wood Borers and Termites Department, Plant Protection Research Institute, for his helpful through this work, advice, and encouragement in carrying out this work. I am really grateful.*

*Also, thanks to all staff members and technical assistants of plant protection, Wood Borers and Termites, Specially, **Prof. Dr. Mohamed Kmal Abdel-Lattef** for helping me.*

*Also, thanks to **Prof. Dr. Shaaban Mohamed Abdel-Rasoul**, Professor at Department of Lime and Sandy Soil, Agricultural Research Center, for his helpful through this work.*

*Also, thanks to **Prof. Dr. Mohamed Abo-Sata**, Head of Research, Plant Protection Research Institute. And **Prof. Dr. Sawsan M. Abdel-Megeed**. Associate prof. of Economic Entomology plant protection Department, Ain Shams University, for helping me in Statistical analysis.*

*Also, thanks to Dr. Mohamed Kamel, Lecturer,
Basic Science Department, Institute of Environmental
Studies & Research*

ABSTRACT

All experimental of the study were conducted at Ismailia Governorate, Al-Qassasien location and laboratory of wood borers and termites department, Plant Protection Research Institute, these studies was aimed to survey and identifying the common subterranean termites species and their distribution at Ismailia Governorate, moreover, through the light on some ecological aspects of the most widespread subterranean termite species, Also, effect of some weather factors on different activities of the most common species; *Anacanthotermis ochraceus*, and finely, evaluation the efficiency of some Chemical insecticides, IGRs, Bio-pesticide and Co-formulated mixture under field conditions, the results obtained could be summarized as following: Two species of subterranean termites were found at Ismailia Governorate, the first and most widely distributed namely *A. ochraceus* (Burm.), while the second and less distributed namely *Psammotermes hypostoma* (Desneux). Data revealed that the harvester subterranean termite *A. ochraceus* (Burm.) had two peaks of activity annually in both two years of study. The first and the highest one took place between January and April while the second was relatively small size, took placed between August and October. The results obtained demonstrated that both of rain and relative humidity has a positive significant effect on subterranean termite *A. ochraceus* activity while the other tested factors (wind speed, solar radiation and mean temperature) has a highly significant negative effect in both two years of study. Data demonstrated that the different castes represented by 67.1, 32.7 ,0.18 and 0.0% for worker, nymphs, soldier and alates respectively, in the first year (2015/2016) and 72.9, 26.65, 0.226 and 0.15% for worker, nymphs, soldier and alates respectively, in the second year (2016/2017). Data revealed that the maximum of surface activity of subterranean termite occurred during the

moderate weather prevailing in November and early Spring (the maximum caught in the traps) while the minimum caught of the traps occurred in the hot months. The same trend of food consumption was observed in the same months, and finely the activity of soil translocation, which well-known fact that it is one of the most activity of subterranean termites, in this respect, data revealed that the highest rate of translocated soil occurred in April, reached 15.8 folds as food consumption, while the lowest occurred in February representing 2.41 folds as food consumption. Foraging activity of *A. ochraceus* in relation to changing of some soil physical and chemical properties were studied, the following results were obtained; an increased in the clay fraction, soil water stable aggregates, soluble salts and organic matter content tend to increase in materials of infested tunnels, infested traps, infested soil as compared to natural soil. Regarding soluble cations and anions, results showed that the distribution pattern of cations was found in the descending order of $Mg^{2+} > Ca^{2+} > Na^{+} > K^{+}$ for the natural and traps soil while it changed to $Ca^{2+} > Mg^{2+} > Na^{+} > K^{+}$ for the infested soil, for the tunnel soil it changed to $Na^{+} > Ca^{2+} > Mg^{2+} > K^{+}$. A wide range of insecticides belonging to Phenylpyrazoles group, organic phosphors (OP) (Chlorpyrifos), insect growth regulators (IGRs), Bio-pesticides and Co-formulated mixture group were evaluated under field conditions, using three concentration (half recommended, recommended and fold recommended). Results obtained revealed that the recommended and half recommended concentrations are sufficient to achieve a good results, and not need to use excessive concentration.

Keywords: Subterranean termite, *A. ochraceus*, foraging activity, caste composition, weather factors, control, soil properties

CONTENTS

Page

*Also, thanks to all staff members of **Institute of Environmental Studies& Research**, for supporting me. I am really thankful.*

Sincere thanks for everyone helped me in this work.

Finally I am indebted forever to Family at home for their greet help, support and continuous encouragement.

LIST OF TABLES	V
LIST OF FIGURES	IX
LIST OF ABBREVIATION	XIII
I.INTRODUCTION.	1
II.REVIEW OF LITERATURE.	3
A.Survey studies.	3
B.Studies on <i>Anacanthotermes ochraceus</i>	7
B.1. Ecological Studies.	7
B.1.1.Traps.	7
B.1.2. Foraging activity.	8
C.Effect of weather factors.	12
D.Foraging activity of <i>A. ochraceus</i> and its relation with changing of physical and chemical properties of the soil.	21
D.1. Organic matter content.	25
E. Control studies on subterranean termite <i>A. ochraceus</i> .	26
III. MATERIALS AND METHODS.	35
A. Survey studies.	35
B. Ecological studies.	36
B.1. Traps.	36
and Population activity. B.2.Foraging	36
B.3.Relationship between population activity, the behavior of <i>A. ochraceus</i> and weather factors.	37
C. Foraging activity of <i>A. ochraceus</i> and its relation with changing of some physical and chemical soil properties.	37
D. Control Studies of <i>A. ochraceus</i> .	38
D.1. Field evaluation of the tested compounds.	38
D.2. insecticide used.	40

D.2.1. Chemical insecticides groups.	40
D.2.2. Bio-insecticides groups.	41
D.2.3. Insect growth regulators groups.	44
IV. RESULTS AND DISCUSSIONS.	51
A. Survey studies.	51
B. Ecological studies.	55
B.1. Foraging and population activity.	55
B.2. Effect of some weather factors on subterranean termite, <i>A. ochraceus</i> activity.	59
B.3. Relationship between weather factors and both of food consumption and constructed soil induced by <i>A. ochraceus</i> activity.	67
B.4. Caste composition.	69
B.5. Infestation traps.	73
B.5.1. Traps with individual termite.	73
B.5.2. Traps with food consumption.	74
B.5.3. Traps with construction soil.	74
C. Food consumption and constructed soil induced by subterranean termite <i>A. ochraceus</i> infestation.	78
C.1. Weight of food consumption.	78
C.2. Weight of constructed soil.	79
C.3. The relation between the weight of food consumption and behavior of <i>A. ochraceus</i> towards constructed soil.	83
D. The relationship between behavior of <i>A. ochraceus</i> and some soil physio-chemical changes accompanied its foraging activity.	89
D.1. Physical properties of the studied soil materials.	89
D.1.1. Particle size distribution.	89
D.1.2. Soil water stable aggregates.	89
D.2. Chemical properties of the soil materials.	90

D.2.1.Soluble salt and ions.	90
D.2.2.Organic matter content.	91
E. Control study.	99
E.1.Treated insecticide with Recommended concentration.	100
E.2.Treated insecticide with Half recommended concentration	101
E.3.Treated insecticide with Fold recommended concentration	102
V.SUMMARY.	111
VI.REFERENCES.	119
VII.ARABIC SUMMARY.	

No.	<u>LIST OF TABLE</u>	Pag N.
1.	The tested insecticides and corresponding tested doses as concentration% or ppm.	46
2.	Some chosen locations for studies surveying at	

	Ismailia Governorate.	52
3.	Foraging activity and caste composition of harvester subterranean termite, <i>A. ochraceus</i> from December 2015 to November 2016 at Ismailia Governorate.	56
4.	Foraging activity and caste composition of harvester subterranean termite, <i>A. ochraceus</i> from December 2015 to November 2016 at Ismailia Governorate.	57
5.	Correlation between some weather factors and population and attracted traps of subterranean termite, <i>A. ochraceus</i> activity at Al-Qassasin district, Ismailia Governorate during two successive seasons.	61
6.	Correlation between some weather factors and both of food consumption and constructed soil induced by subterranean termite, <i>A. ochraceus</i> activity at Al-Qassasin district, Ismailia Governorate during two successive seasons.	68
7.	Number of infested traps (traps with insects, with consumed parts and with translocated soil) by <i>A. ochraceus</i> during (2015/2016) in Ismailia Governorate.	76
8.	Number of infested traps (traps with insects, with consumed parts and with translocated soil) by subterranean termite <i>A. ochraceus</i> during (2016/ 2017) in Ismailia Governorate	77
9.	Rate of food consumption and constructed soil induced by subterranean termite, <i>A. ochraceus</i> infestation during (2015/ 2016) in Ismailia Governorate.	81
10.	Rate of food consumption and constructed soil induced by subterranean termite, <i>A. ochraceus</i>	82

infestation during (2016/ 2017) in Ismailia Governorate.

11. Relationship between weight of food consumption and constructed soil during 2015-2016 at Ismailia Governorate. 85
12. Relationship between weight of food consumption and constructed soil during 2016-2017 at Ismailia Governorate. 86
13. Correlation between Constricted soil and Attracted traps, Food consumption and some weather factor (Rain, Wind speed, R.H., S.Rad and Mean Temp.) during 2015-2016at Ismailia governorate(Al-Qassasin location) 88
14. Correlation between Constricted soil and Attracted traps, Food consumption and some weather factor (Rain, Wind speed, R.H., S.Rad and Mean Temp.) during 2016-2017at Ismailia governorate(Al-Qassasin location). 88
15. Some physical properties as affected by foraging activity of subterranean termite, *A. ochraceus* at Ismailia Governorate (Al- Qassasin). 90
16. Effect of foraging activity of subterranean termite, *A. ochraceus* on particle size distribution at Ismailia Governorate (Al- Qassasin). 93
17. Some chemical properties as affected by foraging activity of subterranean termite, *A. ochraceus* at Ismailia Governorate (Al- Qassasin). 94
18. Average number of castes of subterranean termite, *A. ochraceus* caught in traps treated by recommended concentration of the tested insecticides and corresponding food consumption and constructed soil as compared to untreated traps 106

- (Al-Qassasin district, Ismailia Governorate).
19. Average number of castes of subterranean termite, *A. ochraceus* caught in traps treated by half recommended concentration of the tested insecticides and corresponding food consumption and constructed soil as compared to untreated traps (Al-Qassasin district, Ismailia Governorate). **107**
 20. Average number of castes of subterranean termite, *A. ochraceus* caught in traps treated by fold recommended concentration of the tested insecticides and corresponding food consumption and constructed soil as compared to untreated traps (Al-Qassasin district, Ismailia Governorate) **108**
 21. Effect of different doses of Twelve insecticide (Recommended concentration, Fold recommended concentration and Half recommended concentration) on *A. ochraceus* by attractive traps. **109**

No.	<u>LIST OF FIGURES</u>	Page N.
1.	P.V.C traps which used in Experimental studies.	47
2.	Soil infested (Experimental area) with subterranean termite, <i>A. ochraceus</i> and putted in P.V.C. traps in Ismailia Governorate (Al- Qassasin district).	48
3.	Delineation and distribution treated traps with tested insecticides in studied area.	49

4.	Distribution of <i>Anacanthotermes ochraceus</i> within the study location at Ismailia Governorate.	53
5.	Correlation between altitude and numbers of individuals within the study localities.	54
6.	Fluctuation in the population density of subterranean termite, <i>A. ochraceus</i> at Al- Qassasin location, Ismailia Governorate.	58
7.	Relationship between Population fluctuations of <i>A. ochraceus</i> and MeanTemp. factor during two season.	62
8.	Relationship between population fluctuations of <i>A. ochraceus</i> and RH factor during two season.	63
9.	Relationship between population fluctuations of <i>A. ochraceus</i> and Rain factor during two season.	64
10.	Relationship between population fluctuations of <i>A. ochraceus</i> and Wind factor during two season.	65
11.	Relationship between population fluctuation of <i>A. ochraceus</i> and Solar Radiation factor during two season.	66
12.	Cast composition % of <i>A. ochraceus</i> (Burm.) in 2015-2016 at Ismailia Governorate.	72
13.	Cast composition % of <i>A. ochraceus</i> (Burm.) in 2016-2017 at Ismailia Governorate.	72
14.	Weight of food consumption and constructed soil induced by <i>A. ochraceus</i> activity during 2015-2016.	87
15.	Weight of food consumption and constructed soil induced by <i>A. ochraceus</i> activity during 2016-2017.	87
16.	Particle size distribution as affected by <i>A. ochraceus</i> activity.	92