



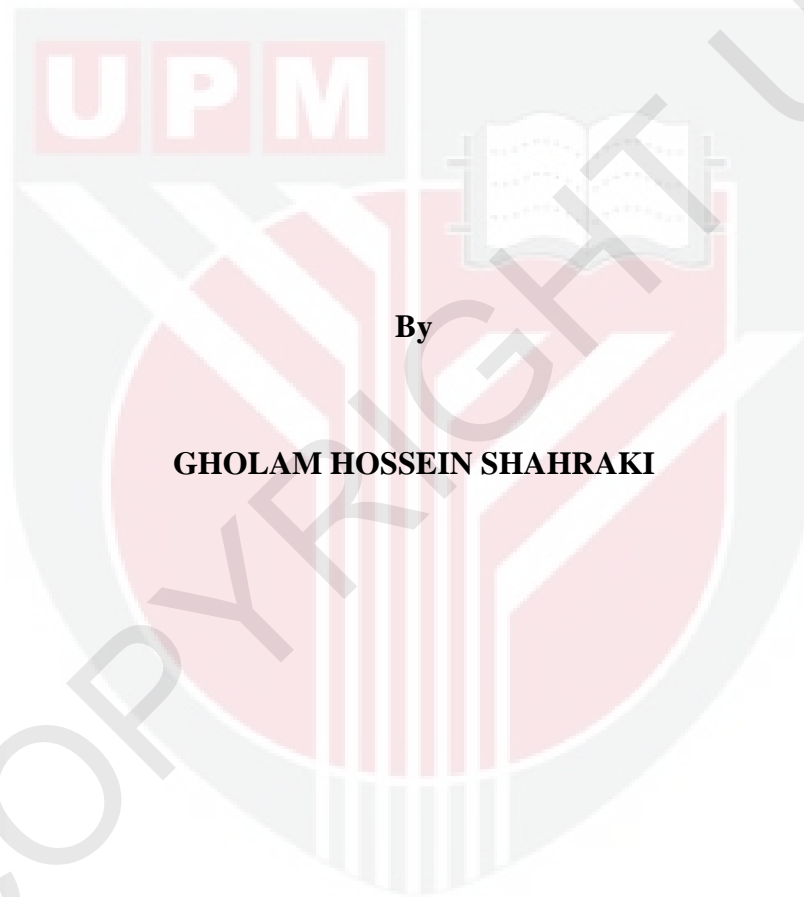
**UNIVERSITI PUTRA MALAYSIA**

**INTEGRATED PEST MANAGEMENT FOR GERMAN COCKROACH  
(*Blattella germanica* L.) IN SELECTED URBAN COMMUNITIES IN YASUJ,  
IRAN**

**GHOLAM HOSSEIN SHAHRAKI**

**FP 2011 50**

**INTEGRATED PEST MANAGEMENT FOR GERMAN COCKROACH (*Blattella germanica* L.) IN SELECTED URBAN COMMUNITIES IN YASUJ, IRAN**



**By**

**GHOLAM HOSSEIN SHAHRAKI**

**Thesis Submitted to the School of Graduate Studies, University Putra Malaysia, in  
Fulfilment of the Requirements for the Degree of Doctor of Philosophy**

**August 2011**

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

**INTEGRATED PEST MANAGEMENT FOR GERMAN COCKROACH (*Blattella germanica* L.) IN SELECTED URBAN COMMUNITIES IN YASUJ, IRAN**

By

**GHOLAM HOSSEIN SHAHRAKI**

August 2011

**Chair: Dzolkhifli b. Omar, PhD**

**Faculty: Agriculture**

A study was conducted to assess the effectiveness of IPM approach as well as cost-effective comparison of IPM and conventional control approaches against the German cockroach infestation in selected urban communities in South Western Iran. The purpose of the study was to determine the efficacy of sanitation on infestation in the residential buildings. In addition, the distribution and dispersion of cockroach species were estimated. In this study sticky traps were used to monitor cockroach populations. From a total of 675 residential, official and hospital units inspected, 44.9% were infested with cockroaches. *Blattella germanica* species was the most abundant i.e 96.7% out of 7251 trapped cockroaches. Laboratory (toxicity) evaluation of hydramethylnon 2% showed 100% mortality against trapped German cockroaches five days after treatment. Four study locations with sizable German cockroach infestation were selected for IPM intervention using Siege<sup>®</sup> gel bait (hydramethylnon 2%), vacuuming and educational programmes versus control and spray treatments were evaluated. After 15-weeks intervention period, the number of infested units (using cockroach index) improved by 97, 67 and 83% (to achieve clean level of infestation) for IPM intervention units of dormitories, house building and

hospital, respectively. The mean percentage reductions of cockroach infestation (based on cockroach trap counts) for IPM intervention were 72, 93 and 88% for dormitories, house building and hospital respectively. The reductions for study locations were significantly higher than pre-treatments and control groups. The IPM intervention method also showed 29% more effective in term of period of effectiveness compared to the spraying method using cypermethrin 10% (EC). Additionally, the IPM approach reduced the rate of insecticide application for cockroach control by 9.43 times. However, within the study period the cost for IPM treatment was almost four times higher than the cost for spray treatment. A study on the study locations showed that poor sanitation has a significantly positive impact on intensity of cockroach infestation. The effectiveness of educational programme on sanitation and knowledge of occupants were emphasized in this study. Significant effects of some unsanitary factors such as “dirty and cluttered”, “unwashed dishes left at night” and “leftover foods exposed at places” or “food debris” upon cockroach infestation were highlighted in this study. The results of this study recommended IPM methods as an alternative to manage German cockroach infestation instead of conventional spray method in an urban community.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**PENGURUSAN PEROSAK BERSEPADU LIPAS GERMAN ( *Blattella germanica* L.)  
DALAM MASYARAKAT KOTA TERPILIH DI YASUJ, IRAN**

Oleh

**GHOLAM HOSSEIN SHAHRAKI**

Ogos 2011

**Pengerusi: Dzolkhifli b. Omar, PhD**

**Fakulti: Pertanian**

Satu kajian telah dijalankan untuk menilai keberkesanan pendekatan pengurusan perosak bersepadu (IPM) serta perbandingan kos keberkesanan IPM berbanding dengan pendekatan pengawalan konvensional terhadap infestasi lipas German dalam masyarakat kota terpilih di Barat Daya Iran. Tujuan kajian ini ialah untuk menentukan keberkesanan sanitasi terhadap infestasi di bangunan yang diduduki. Selain itu, taburan dan sebaran spesies lipas telah juga dianggarkan. Dalam kajian ini, perangkap pelekat telah diguna untuk memantau populasi lipas. Daripada jumlah 675 residensi, pejabat dan unit hospital yang telah diperiksa, 44.9% didapati diinfestasi dengan lipas. Spesies *Blattella germanica* adalah yang terbanyak, yaitu 96.7% daripada 7251 lipas yang diperangkap. Penilaian makmal (toksisiti) menunjukkan hydramethylnon (2%) mengakibatkan 100% kematian terhadap lipas German lima hari selepas rawatan. Empat lokasi ujian dengan infestasi lipas German yang banyak telah dipilih untuk dirawat dengan intervensi IPM menggunakan perangkap gel Siege<sup>®</sup> (hydramethylnon, 2%). Program hampagas dan pendidikan berbanding kawalan dan rawatan semburan telah dinilai. Selepas jangka masa 15 minggu, bilangan unit yang jangkiti (guna indeks lipas) didapati

bertambah baik masing-masing sebanyak 97, 67 dan 83% (bagi mencapai aras bersih infestasi) bagi rawatan intervensi IPM di dormitori, bangunan rumah dan hospital. Purata peratus pengurangan infestasi lipas (berasaskan bilangan lipas yang diperangkap) bagi intervensi IPM ialah masing-masing 72, 93 dan 88% bagi dormitori, bangunan rumah dan hospital. Pengurangan bagi lokasi ujian didapati lebih tinggi dengan bermakna berbanding kumpulan pra-rawatan dan kawalan. Kaedah intervensi IPM juga menunjukkan 29% lebih berkesan dari segi jangka masa keberkesanan berbanding kaedah semburan dengan sipermetrin 10% (EC). Tambahan pula, kaedah IPM mengurangkan kadar aplikasi racun serangga untuk kawalan lipas sebanyak 9.43 kali ganda. Bagaimanapun, dalam lingkungan jangka masa kajian, kos rawatan IPM hampir empat kali lebih tinggi daripada kos rawatan semburan. Tinjauan ke atas lokasi ujian menunjukkan keadaan sanitasi buruk memberi impak positif yang bermakna terhadap intensiti infestasi lipas. Keberkesanan program pendidikan sanitasi dan pengetahuan kepada penghuni telah dititik beratkan dalam kajian ini. Kesan yang bermakna terhadap sesetengah faktor tidak sanitari seperti “kotor dan berserabut”, “pinggan mangkuk tidak berbasuh semalaman” dan “baki makanan terdedah berserepah” atau “serpihan makanan” bagi infestasi lipas telah ditonjolkan dalam kajian ini. Keputusan daripada kajian ini mengesyorkan kaedah IPM sebagai pilihan bagi mengurus infestasi lipas German selain daripada kaedah semburan konvensional bagi masyarakat kota.

### **ACKNOWLEDGMENTS**

I am grateful to Prof. Dr. Yusof b. Ibrahim, Prof. Dr. Dzolkhifli b. Omar, Assoc. Prof. Dr. Hafidzi b. Mohd Noor, Dr. Mohd Khadri Shahar, Assoc. Prof. Dr. Javad Rafinejad and Assoc. Prof. Dr. Faizah Abood for technical help and their guidance for the duration of this project. I thank the Vice-Chancellor of Yasuj University of Medical Sciences, Yasuj University, Azad

University and Tarbiaat Moalem University for their invaluable assistance for access to the study locations. I am grateful for the gel bait supplied by BASF (Malaysia) Sdn, Bhd. I am thankful to the students of public health (2006-2007 intakes) of the Faculty of Health Sciences at the Yasuj University of Medical Sciences for their assistance in sample collection.



I certify that a Thesis Examination Committee has met on 6 August 2011 to conduct the final examination of Gholam Hossein Shahraki on his thesis entitled “Integrated Pest Management for German Cockroach (*Blattella germanica* L.) in Selected Urban Communities in Yasuj, Iran” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Thesis Examination Committee were as follows:

**Nur Azura Binti Adam, PhD**

Faculty of Agriculture  
Universiti Putra Malaysia  
(Chairman)

**Rita Muhamad Awang, PhD**

Professor  
Faculty of Agriculture  
Universiti Putra Malaysia  
(Internal Examiner)

**Mohd Muid, PhD**

Faculty of Agriculture  
Universiti Putra Malaysia  
(Internal Examiner)

**Abu Hassan Ahmad, PhD**

Professor  
School of Biological Science  
Universiti Sains Malaysia  
(External Examiner)

---

**NORITAH OMAR**

Associate Professor and Deputy Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date: 28 October 2011



This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of **Doctor of Philosophy**. The members of the Supervisory Committee were as follows:

**Dzolkhifli b. Omar, PhD**

Professor  
Faculty of Agriculture  
Universiti Putra Malaysia  
(Chairman)

**Hafidzi Mohd Noor, PhD**

Associate Professor  
Faculty of Agriculture  
Universiti Putra Malaysia  
(Member)

**Faizah Binti Abood, PhD**

Associate Professor  
Faculty of Forestry  
Universiti Putra Malaysia  
(Member)

**Yusof b. Ibrahim, PhD**

Professor  
Faculty of Technical and Vocational Education  
Universiti Pendidikan Sultan Idris  
(Member)

**Javad Rafinejad, PhD**

Associate Professor  
Department of Medical Entomology  
School of Public Health and Institute of Public Health Research  
Tehran University of Medical Sciences  
(Member)

---

**HASANAH MOHD GHAZALI, PhD**

Professor and Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date:

## **DECLARATION**

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

---

**GHOLAM HOSSEIN SHAHRAKI**

Date: 6 August 2011

## TABLE OF CONTENTS

	Page
ABSTRACT	2
ABSTRAK	iv
ACKNOWLEDGMENTS	4i
APPROVAL	VII
DECLARATION	IX
LIST OF TABLES	Error!
Bookmark not defined.	
LIST OF FIGURES	Error!
Bookmark not defined.	
LIST OF APPENDICES	Error!
Bookmark not defined.	
LIST OF ABBREVIATIONS	Error!
Bookmark not defined.	
CHAPTER 1	ERROR!
BOOKMARK NOT DEFINED.	
1 INTRODUCTION	ERROR!
BOOKMARK NOT DEFINED.	
2 LITERATURE REVIEW	ERROR!
BOOKMARK NOT DEFINED.	
2.1 Specification of German Cockroach Subjected to Management	Error!
Bookmark not defined.	
2.1.1 Identification and Important Behavioural Characteristics	Error!
Bookmark not defined.	
2.1.2 Cockroach Infestation and Control Management in Iran	Error!
Bookmark not defined.	
2.1.3 Field Evaluation of Cockroach Population	Error!
Bookmark not defined.	
2.2 IPM and Biorational Control Approach against Cockroach	Error!
Bookmark not defined.	
2.2.1 Characteristics of IPM	Error!
Bookmark not defined.	
2.2.2 Educational Programmes for IPM	Error!
Bookmark not defined.	

2.2.3 Sanitation in IPM Approach	<b>Error!</b>
<b>Bookmark not defined.</b>	
2.2.4 Bait Application in IPM	<b>Error!</b>
<b>Bookmark not defined.</b>	
2. 3 Hydramethylnon Gel Bait	<b>Error!</b>
<b>Bookmark not defined.</b>	
2.3.1 Why Hydramethylnon (Siege Gel Bait)?	<b>Error!</b>
<b>Bookmark not defined.</b>	
2. 3.2 Characteristics of Hydramethylnon	<b>Error!</b>
<b>Bookmark not defined.</b>	
2.3.3 Efficacy of Hydramethylnon	<b>Error!</b>
<b>Bookmark not defined.</b>	
<b>3</b>	
<b>DISPERSION AND ABUNDANCE OF COCKROACH INFESTATIONS IN URBAN COMMUNITIES</b>	<b>ERROR!</b>
<b>BOOKMARK NOT DEFINED.</b>	
3.1 Introduction	<b>Error!</b>
<b>Bookmark not defined.</b>	
3.2 Materials and Methods	<b>Error!</b>
<b>Bookmark not defined.</b>	
3.2.1 Study Locations	<b>Error!</b>
<b>Bookmark not defined.</b>	
3.2.2 Evaluation and Monitoring of Cockroach Infestation in Various Location	<b>Error!</b>
<b>Bookmark not defined.</b>	
3.2.3 Survey on Cockroach Infestation in Selected Locations	<b>Error!</b>
<b>Bookmark not defined.</b>	
3.2.4 Data Analysis	<b>Error!</b>
<b>Bookmark not defined.</b>	
3.3 Results and Discussion	<b>Error!</b>
<b>Bookmark not defined.</b>	
3.3.1 Cockroach Infestation in Study Locations	<b>Error!</b>
<b>Bookmark not defined.</b>	
3.3.2 Identification of Cockroach Species, Frequency Distribution and Dispersion in the Buildings	<b>Error!</b>
<b>Bookmark not defined.</b>	
3.3.3 Infestation of Selected Heavily Infested Locations	<b>Error!</b>
<b>Bookmark not defined.</b>	
3.3.4 Factors Affecting Cockroach Infestation	47
3.3.5 Residents' Knowledge on Cockroach Infestation	<b>Error!</b>
<b>Bookmark not defined.</b>	
3.4 Conclusion	<b>Error!</b>
<b>Bookmark not defined.</b>	
<b>4</b>	
<b>COMPARATIES TOXICITIES OF HYDRAMETHYLNON, FIPRONIL AND IMIDICLOPRID GEL BAITS AGAINST</b>	

	<b>FIELD STRAIN OF GERMAN COCKROACHES</b>	<b>ERROR!</b>
	<b>BOOKMARK NOT DEFINED.</b>	
	4.1 Introduction	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	4.2 Material and Methods	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	4.3 Results and Discussion	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	4.4 Conclusion	<b>Error!</b>
	<b>Bookmark not defined.</b>	
5	<b>EFFECTIVENESS OF GEL BAIT IN AN IPM APPROACH</b>	<b>ERROR!</b>
	<b>FOR THE CONTROL OF GERMAN COCKROACH</b>	
	<b>BOOKMARK NOT DEFINED.</b>	
	5.1 Introduction	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	5.2 Materials and Methods	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	5.2.1 Study Design	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	5.2.2 Study Locations	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	5.2.3 Monitoring of Cockroach Population	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	5.2.4 Application of Hydramethylnon Gel Bait	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	5.2.5 Implementation of Educational Programmes	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	5.2.6 Implementation of Sanitation	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	5.2.7 Definitions and Data Analysis	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	5.3 Results and Discussion	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	5.3.1 History of Use of Insecticides	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	5.3.2 Effectiveness of IPM Approach on Cockroach	
	Infestation for Girls Dormitory	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	5.3.3 Effectiveness of IPM Approach on Cockroach	
	Infestation for Boys dormitory	<b>Error!</b>
	<b>Bookmark not defined.</b>	
	5.3.4 Effectiveness of IPM Approach on Cockroach	
	Infestation for House Building F	<b>Error!</b>
	<b>Bookmark not defined.</b>	

5.3.5	Effectiveness of IPM Approach on Cockroach Infestation for Hospital C <b>Bookmark not defined.</b>	<b>Error!</b>
5.3.6	Total Effects and Efficacy Comparison of IPM Approach against German Cockroach for the Four Study Locations <b>Bookmark not defined.</b>	<b>Error!</b>
5.4	Conclusion <b>Bookmark not defined.</b>	<b>Error!</b>
6	<b>COST- EFFECTIVE COMPARISON OF INTEGRATED PEST MANAGEMENT OF HYDRAMETHYLNON GEL BAIT USAGE AND CONVENTIONAL SPRAYING CONTROL MEASURE FOR GERMAN COCKROACH CONTROL IN RESIDENTIAL BUILDING BOOKMARK NOT DEFINED.</b>	<b>ERROR!</b>
6.1	Introduction <b>Bookmark not defined.</b>	<b>Error!</b>
6.2	Materials and Methods <b>Bookmark not defined.</b>	<b>Error!</b>
6.3	Results and Discussion <b>Bookmark not defined.</b>	<b>Error!</b>
6.3.1	Efficacy Comparison of IPM and Conventional Strategies <b>Bookmark not defined.</b>	<b>Error!</b>
6.3.2	Cost Comparison of IPM and Conventional Strategies <b>Bookmark not defined.</b>	<b>Error!</b>
6.4	Conclusion <b>Bookmark not defined.</b>	<b>Error!</b>
7	<b>EFFECTIVENESS OF SANITATION AGAINST GERMAN COCKROACH INFESTATION AND EFFECT OF EDUCATIONAL PROGRAMMES ON SANITATION AND KNOWLEDGE OF OCCUPANTS IN AN IPM STRATEGY BOOKMARK NOT DEFINED.</b>	<b>ERROR!</b>
7.1	Introduction <b>Bookmark not defined.</b>	<b>Error!</b>
7.2	Materials and Methods <b>Bookmark not defined.</b>	<b>Error!</b>
7.3	Results and Discussion <b>Bookmark not defined.</b>	<b>Error!</b>
7.3.1	Relationship between Sanitation and Cockroach Infestation <b>Bookmark not defined.</b>	<b>Error!</b>
7.3.2	Effectiveness of Educational Programmes on Sanitation <b>Bookmark not defined.</b>	<b>Error!</b>



**UNIVERSITI PUTRA MALAYSIA**

**INTEGRATED PEST MANAGEMENT FOR GERMAN COCKROACH  
(*Blattella germanica* L.) IN SELECTED URBAN COMMUNITIES IN YASUJ,  
IRAN**

**GHOLAM HOSSEIN SHAHRAKI**

**FP 2011 52**

7.3.3 Impact of Unsanitary Factors on Cockroach Infestation	<b>Error!</b>
<b>Bookmark not defined.</b>	
7.3.4 Evaluation of Educational Programmes for Cockroach Management on Residents	<b>Error!</b>
<b>Bookmark not defined.</b>	
7.4 Conclusion	<b>Error!</b>
<b>Bookmark not defined.</b>	
8 SUMMARY, CONCLUSION AND RECOMMENDATIONS	<b>ERROR!</b>
<b>BOOKMARK NOT DEFINED.</b>	
REFERENCES	<b>ERROR!</b>
<b>BOOKMARK NOT DEFINED.</b>	
APPENDICES	<b>ERROR!</b>
<b>BOOKMARK NOT DEFINED.</b>	
BIODATA OF STUDENT	<b>ERROR!</b>
<b>BOOKMARK NOT DEFINED.</b>	
LIST OF PUBLICATIONS	<b>ERROR!</b>
<b>BOOKMARK NOT DEFINED.</b>	

