



Ain Shams University  
Faculty of Science  
Entomology Department

**Assessment of the potential of *Beauveria*  
*bassiana* and diatomaceous earth as alternatives  
to chemical insecticides for the control of  
*Rhyzopertha dominica* (F.) (Coleoptera:  
Bostrychidae) on wheat**

By

**Abeer Omar Baiumy Abotaleb**

B.Sc. Entomology, Faculty of Science, Cairo University (1992)

M. Sc. Entomology, Ain Shams University (2013)

A Thesis

Submitted to the Faculty of Science, Ain Shams University,

For the Award of the Ph. D. Degree (Entomology)

**2016**



Assessment of the potential of *Beauveria bassiana* and diatomaceous earth as alternatives to chemical insecticides for the control of *Rhyzopertha dominica* (F.) (Coleoptera: Bostrychidae) on wheat

A thesis

Submitted to the Faculty of Science, Ain Shams University,  
For the Award of the Ph. D. Degree (Entomology)

By

**Abeer Omar Baiumy Abotaleb**

B.Sc. Entomology, Faculty of Science, Cairo University, (1992)  
M. Sc. Entomology, Ain Shams University (2013)

**Under the Supervision of**

**Prof. Dr. Bahira Mahmoud ELSawaf**

Professor Emeritus of Entomology, Department of Entomology,  
Faculty of Science, Ain Shams University.

**Prof. Dr. Ragaa Kotb Abdel Gaber Hamed**

Professor Emeritus of Entomology, Department of Entomology,  
Faculty of Science, Ain Shams University.

**Prof. Dr. Salwa Mostafa Sayed Ahmed**

Professor Emeritus, Department of stored product- Plant Protection  
Research Institute, Agriculture Research Center.

**Prof. Dr. Abd Elmawgoud Abdalla Asran**

Professor Emeritus, Department of Harmful Animal, Plant Protection  
Research Institute, Agriculture Research Center.



## **APPROVAL SHEET**

**Name of the Student:** Abeer Omar Baiumy Abotaleb

**Title of Thesis:** Assessment of the potential of *Beauveria bassiana* and diatomaceous earth as alternatives to chemical insecticides for the control of *Rhyzopertha dominica* (F.) (Coleoptera: Bostrychidae) on wheat

**Degree:** Ph. D. (Entomology)

### **Under the Supervision of**

**Prof. Dr. Bahira Mahmoud ELSawaf** .....

Professor Emeritus of Entomology, Department of Entomology,  
Faculty of Science, Ain Shams University.

**Prof. Dr. Ragaa Kotb Abdel Gaber Hamed** .....

Professor Emeritus of Entomology, Department of Entomology,  
Faculty of Science, Ain Shams University.

**Prof. Dr. Salwa Mostafa Sayed Ahmed** .....

Professor Emeritus , Department of stored product- Plant Protection  
Research Institute, Agriculture Research Center.

**Prof. Dr. Abd Elmawgoud Abdalla Asran.** .....

Professor Emeritus, Department of Harmful Animal, Plant Protection  
Research Institute, Agriculture Research Center.

### **Approved by:-**

**Prof. Dr. Hussein Samir Abdel Rahman Salama.** .....

Professor Emeritus-National Research Center- Cairo.

**Prof. Dr. Ali Ahmad Younos.** .....

Professor of Entomology, Department of Entomology,  
Faculty of Science, Cairo University.

**Prof. Dr. Bahira Mahmoud ELSawaf.** .....

Professor Emeritus of Entomology, Department of Entomology,  
Faculty of Science, Ain Shams University.

**Prof. Dr. Ragaa Kotb Abdel Gaber Hamed.** .....

Professor Emeritus of Entomology, Department of Entomology,  
Faculty of Science, Ain Shams University.

**Date:**                 /         / 2016



## **ACKNOWLEDGMENT**

First of all, I would like to express my deepest thanks to the Almighty “ALLAH” who gave me the patience, power; knowledge and helped me to carry out this study.

Words cannot express my deep appreciation to Prof. Dr. Bahira Mahmoud ELSawaf Professor of Entomology, Faculty of Science, Ain Shams University, for careful supervision, valuable suggestions, encouragement, sincere guidance, useful advice throughout the investigation period and correction of the manuscript.

My special and deep thanks to Prof. Dr. Salwa Mostafa Sayed Ahmed Professor of Economic Entomology, Plant Protection Research Institute, Agriculture Research Center, for her careful supervision, valuable suggestions, encouragement, sincere guidance, useful advice throughout the investigation period, offering help and encouragement.

I express my sincere thanks and deep appreciation to Prof. Dr. Abd Elmawgod Abdalla Asran Professor of Harmful Animals Research Section - Plant Protection Research Institute, Agriculture Research Center, for his supervision, helpful advice and, valuable assistance.

I wish to express my deepest thanks and gratitude to Prof. Dr. Ragaa Kotb Abdel Gaber Hamed Professor of Entomology, Faculty of Science, Ain Shams University, for her valuable supervision, lending time and sincere guidance, throughout this work.

In addition, I feel greatly indebted to Prof. Dr. Mohamed Abou Seta Head Researcher of Economic Entomology, Plant Protection Research Institute, Agricultural Research Center, for his help in the statistical analysis of data.

Thanks are also extended to all staff members, and researchers at the Entomology Department, Faculty of science, Ain Shams University for their cooperation, performing duties exceptionally well and providing advice. And all

staff members, researchers at the stored product pests section, Plant Protection Research Institute.

Last but not least, my deep cordial thanks and gratitude extending to my family mother, brothers, sisters, and my daughters, for their great sacrifices during the achievement of this dissertation and along my life, they will ever be my eternal source of pride, strength, happiness, pure love and everything good in this world. I will never forget my father who set an example for me, I wish my God forgive him and rest him in peace.



## **ABSTRACT**

The wheat crop is the most important strategic crops in Egypt, because of its economic importance, directly related to the human diet in Egypt, the aim of this study is to find an environmental safe means to protect wheat from stored grain pests. Laboratory bioassays were conducted to assess the insecticidal efficacy of the two formulations of entomopathogenic fungus, *Beauveria bassiana* (Botani-Gard and Biosect), and two formulations of diatomaceous earth (DE) (Insecolo and Foodgrade), used alone or in combination, against the lesser grain borer, *Rhyzopertha dominica* adults on wheat grains. The results showed that, Dose and time dependent mortality was observed for all tested powders. Fungal formulations in DE provided better protection against the lesser grain borer by giving significantly better kill compared to control. The results showed a significant decrease in the number of emerged adults due to LC<sub>50</sub> of tested powders-treated eggs. While, at LC<sub>95</sub>, for all tested powders adults emergence was completely suppressed. All tested mixtures were able to prevent adult emergence completely, except the mixtures that consist of the LC<sub>25</sub> of both tested materials. Residual activity of all materials and their mixtures gradually decrease with increasing storage periods up to 12 weeks for all treatments. No deleterious effect on the germination and the water absorption of wheat grains treated with the tested powders and their mixtures was noticed. The most promising fungus, Biosect was selected for in depth study. The results showed no side effects on the biochemical properties (total proteins, total carbohydrates, fat, starch, crude fiber, ash content and metabolic energy) of wheat grain after treatment with Biosect at the initial time and after storage. Biosect powder did not affect the baking quality of bread which was scored "good" for all acceptability parameters at initial and after 12 weeks storage. No adverse effect in the

biochemical parameters of liver (albumin, ALT, AST, total cholesterol and total proteins) and kidney (creatinine and urea) functions of the albino rats, with prolongation of the period post treatment when compared with those of the control group.

**Keywords:** lesser grain borer, *Rhyzopertha dominica*, entomopathogenic fungus, *Beauveria bassiana*, diatomaceous earth, , toxicity, wheat grains, baking quality, albino rats.

# CONTENTS

	Page
<b>I. INTRODUCTION.....</b>	1
<b>II. REVIEW OF LITERATURE .....</b>	5
1. Insecticidal efficacy of some biopesticide against stored grain insects.....	5
2. Insecticidal efficacy of combination of some bi- opesticide against stored grain insects.....	9
3. The efficacy of some biopesticide alone or in com- bination: on the biology and progeny production of stored grain insects.....	12
4. Residual efficacy of some biopesticides alone or in combination against stored grain insects.....	15
5. The efficacy of some biopesticides on the quality analysis of wheat grains.....	18
6. The efficacy of some biopesticides on the biochem ical constituents of wheat grains.....	20
7. The efficacy of some biopesticides on albino rats....	21
<b>III. MATERIALS AND METHODS.....</b>	24
<b>1. Tested grains.....</b>	24
<b>2. Insect culture.....</b>	24
<b>3. Tested materials.....</b>	27
3.1. Fungus formulation of <i>Beauveria bassiana</i> ....	27
3.2. Diatomaceous earth (DE).....	27
<b>4. Toxicological studies.....</b>	29
4.1. Insecticidal efficiency of <i>B. bassiana</i> and DE and their combinations on <i>R. dominica</i> adults	29
4.2. Joint toxic action studies.....	31
4.3. Effect of <i>B. bassiana</i> and DE and their com- binations on eggs of <i>R. dominica</i> .....	32
4.4. Residual efficacy of <i>B. bassiana</i> and DE and their combinations on wheat grains at differ- ent storage periods.....	33

<b>5. Studies on wheat grains <i>Triticum aestivum</i></b>	34
5.1. Effect of <i>B. bassiana</i> and DE and their combinations on germination and growth parameters of wheat grains	34
5.1.1. Germination parameters	35
5.1.1.1. Final germination percentage (FG)	35
5.1.1.2. Germination energy percentage (GE)	35
5.1.1.3. Significance of viability (SV)	35
5.1.2. Growth parameters	36
5.1.2.1. Root and shoot length	36
5.1.2.2. Vigor index (VI)	36
5.2. Effect of <i>B. bassiana</i> and DE and their combinations on water absorption of wheat grains	36
5.3. Effect of LC <sub>95</sub> of <i>B. bassiana</i> (b) on some biochemical constituents of wheat grains	37
5.3.1. Estimation of total protein content (P)	37
5.3.2. Estimation of total sugars (ST)	38
5.3.3. Estimation of fat content	39
5.3.4. Estimation of starch content	39
5.3.5. Estimation of crude fibers content principle	40
5.3.6. Estimation of ash content	41
5.3.7. Calculation of energy metabolism (E)	42
5.4. Effect of LC <sub>95</sub> of <i>B. bassiana</i> (b) on baking quality of bread	42
5.4.1. Physical measurements	43
5.4.2. Sensory evaluation of bread	43
<b>6. Effect of LC<sub>95</sub> of <i>B. bassiana</i> (b) on albino rats, <i>Rattus norvegicus</i>)</b>	43
6.1. Experimental animals	44
6.2. Experimental design	44
6.3. Serum preparation	45
6.4. Blood biochemical determinations	45

6.5.	Ethical consideration.....	45
7.	<b>Statistical analysis</b> .....	46
<b>IV. RESULTS</b>	.....	47
1.	<b>Toxicological studies</b> .....	47
1.1.	Toxicological evaluation of <i>B. bassiana</i> and DE on <i>R. dominica</i> adults.....	47
1.2.	Insecticidal efficiency of <i>B. bassiana</i> and DE combinations against <i>R. dominica</i> adults.....	52
1.3.	Co-toxicity factors (CF) estimation.....	55
1.4.	Effect of <i>B. bassiana</i> and DE on eggs of <i>R. dominica</i> .....	61
1.5	Effect of <i>B. bassiana</i> and DE combinations on eggs of <i>R. dominica</i> .....	63
1.6	Residual activity of <i>B. bassiana</i> and DE.....	65
1.6.1.	Residual activity of <i>B. bassiana</i> and DE... ..	65
1.6.2.	Residual activity of <i>B. bassiana</i> and DE combinations.....	66
2.	<b>Studies on wheat grains <i>Triticum aestivum</i></b> .....	69
2.1.	Effect of <i>B. bassiana</i> and DE on germination parameters of wheat grains.....	69
2.1.1.	Effect of <i>B. bassiana</i> and DE on growth parameters of wheat grains.....	73
2.1.2.	Effect of <i>B. bassiana</i> and DE combinations on germination parameters of wheat grains.....	75
2.1.3.	Effect of <i>B. bassiana</i> and DE combinations on growth parameters of wheat grains.....	77
2.2.	Effect of <i>B. bassiana</i> and DE on water absorption of wheat grains.....	79
2.2.1.	Effect of <i>B. bassiana</i> and DE combinations on water absorption of wheat grains.....	82
2.3.	Effect of LC <sub>95</sub> of <i>B. bassiana</i> (b) on some biochemical constituents of wheat grains.....	84

2.4.	Effect of LC <sub>95</sub> of <i>B. bassiana</i> (b) on baking quality of bread.....	86
2.4.1.	Physical measurements.....	86
2.4.2.	Sensory/acceptability evaluation of bread.....	87
3.	Effect of LC <sub>95</sub> <i>B. bassiana</i> (b) on liver and kidney functions of albino rats, <i>Rattus norvegicus</i> .....	90
3.1.	Blood biochemical determinations.....	90
<b>V.</b>	<b>DISCUSSION</b> .....	93
1.	Toxicological studies.....	93
2.	Studies on wheat grains <i>Triticum aestivum</i> .....	102
3.	Effect of LC <sub>95</sub> of Biosect powder on albino rats, <i>Rattus norvegicus</i> .....	110
<b>VI.</b>	<b>SUMMARY</b> .....	116
<b>VII.</b>	<b>REFERENCES</b> .....	120
<b>ARABIC SUMMARY</b>		

## LIST OF TABLES

Table		Page
1	Materials and corresponding concentrations used.....	31
2	Mortality of <i>R. dominica</i> adults exposed for 3-day, 1-week and 2- weeks to various concentrations of <i>B. bassiana</i> and DE – treated wheat.....	49
3	Probit analyses of dose-mortality data of <i>R. dominica</i> exposed for 3-days to various concentrations of <i>B. bassiana</i> and DE powders –treated wheat.....	51
4	Mortality of <i>R. dominica</i> adults exposed for 3-days to various concentrations of <i>B. bassiana</i> (a) plus <i>B. bassiana</i> (b) and DE (a, b) on wheat grains.....	54
5	Mortality of <i>R. dominica</i> adults exposed for 3-days, 1-week and 2-weeks to various concentrations of <i>B. banssiana</i> (a and b) and DE (a, b) –treated wheat.....	58
6	Mortality of <i>R. dominica</i> adults exposed for 3-days, 1-week and 2-weeks to various concentrations of <i>B. bassiana</i> (a) plus <i>B. bassiana</i> (b) and DE (a, b) –treated wheat.....	59
7	The joint action and co-toxicity factor of various concentrations of <i>B. bassiana</i> (a) with <i>B. bassiana</i> (b) and DE (a, b) against <i>R. dominica</i> adults 3-days post treatment....	60
8	Extended effects of LC <sub>50</sub> and LC <sub>95</sub> of <i>B. bassiana</i> and DE on the eggs of <i>R. dominica</i> exposed to treated wheat grains.....	62