

**LETHAL EFFECT OF GAMMA RADIATION ON
SOME POST HARVEST INSECTS OF CERTAIN
FRUIT AND VEGETABLE CROPS**

By

RAGAA SAYED ABDALLA

B.Sc. Agric. Sc. (Pesticides), Cairo University, 1984

M.Sc. Agric. Sc. (Pesticides), Ain Shams University, 2004

**A thesis submitted in partial fulfillment
of
the requirements for the degree of**

DOCTOR OF PHILOSOPHY

**in
Agricultural Science
(Pesticides)**

**Department of Plant Protection
Faculty of Agriculture
Ain Shams University**

2011

Approval Sheet

**LETHAL EFFECT OF GAMMA RADIATION ON
SOME POST HARVEST INSECTS OF CERTAIN
FRUIT AND VEGETABLE CROPS**

By

RAGAA SAYED ABDALLA

B.Sc. Agric. Sc. (Pesticides), Cairo University, 1984

M.Sc. Agric. Sc. (Pesticides), Ain Shams University, 2004

This thesis for Ph.D. degree has been approved by:

Dr. Amina Mohamed Abd El-Rahman

Prof. of Insect Control, Faculty of Science, Cairo University

Dr. Zidan Hendy Abd El-Hameed

Prof. Emeritus of Pesticides, Faculty of Agriculture, Ain Shams
University

Dr. Sayed Mohamed Abd El-Latif Dahroug

Prof. Emeritus of Pesticides, Faculty of Agriculture, Ain Shams
University

Dr. Amged Mohamed Kamel Sobieha

Prof. Emeritus of Pesticides, Faculty of Agriculture, Ain Shams
University

Date of Examination: 4 /7/ 2011

LETHAL EFFECT OF GAMMA RADIATION ON SOME POST HARVEST INSECTS OF CERTAIN FRUIT AND VEGETABLE CROPS

By

RAGAA SAYED ABDALLA

B.Sc. Agric. Sc. (Pesticides), Cairo University, 1984

M.Sc. Agric. Sc. (Pesticides), Ain Shams University, 2004

Under the supervision of:

Dr. Amged Mohamed Kamel Sobieha

Prof. Emeritus of Pesticides, Department of Plant Protection, Faculty
Agriculture, Ain Shams University (Principal Supervisor).

Dr. Sayed Mohamed Abd El-Latif Dahroug

Prof. Emeritus of Pesticides, Department of Plant Protection, Faculty
of Agriculture, Ain Shams University

Dr. Salwa Abdo Rizk

Prof. of Entomology, Department of Natural Products, National
Center for Radiation Research and Technology

**التأثير القاتل لاشعة جاما علي حشرات ما بعد الحصاد
لمحاصيل فاكهة و خضر معينة**

رسالة مقدمة من

رجاء سيد عبد الله

بكالوريوس علوم زراعية (مبيدات الآفات) ، جامعة القاهرة ، 1984
ماجستير علوم زراعية (مبيدات الآفات) ، جامعة عين شمس ، 2004

للحصول على
درجة دكتور فلسفة في العلوم الزراعية
(مبيدات الآفات)

قسم وقاية النبات
كلية الزراعة
جامعة عين شمس

2011

صفحة الموافقة على الرسالة

**التاثير القاتل لاشعة جاما علي حشرات ما بعد الحصاد
لمحاصيل فاكهة و خضر معينة**

رسالة مقدمة من

رجاء سيد عبد الله

بكالوريوس علوم زراعية (مبيدات الآفات)، جامعة القاهرة ، 1984
ماجستير علوم زراعية (مبيدات الآفات)، جامعة عين شمس ، 2004

للحصول على

**درجة دكتورفلسفة في العلوم الزراعية
(مبيدات الآفات)**

وقد تمت مناقشة الرسالة والموافقة عليها

اللجنة:

..... د. أمينة محمد عبد الرحمن

أستاذ مكافحة الحشرات، كلية العلوم، جامعة القاهرة

..... د. زيدان هندی عبد الحميد

أستاذ كيمياء وسمية المبيدات المتفرغ ، كلية الزراعة ، جامعة عين شمس

..... د. سيد محمد عبد اللطيف دحروج

أستاذ المبيدات المتفرغ، كلية الزراعة ، جامعة عين شمس

..... د. أمجد محمد كامل صبيحة

أستاذ كيمياء وسمية المبيدات المتفرغ كلية الزراعة ، جامعة عين شمس

تاريخ المناقشة: / / 2011

جامعة عين شمس
كلية الزراعة

رسالة دكتوراه

اسم الطالب : رجاء سيد عبد الله
عنوان الرسالة : التأثير القاتل لاشعة جاما علي حشرات ما بعد الحصاد لمحاصيل
فاكهة و خضر معينة
اسم الدرجة : دكتور فلسفة فى العلوم الزراعية (مبيدات الآفات)

لجنة الإشراف:

د. أمجد محمد كامل صبيحة
أستاذ كيمياء وسمية المبيدات المتفرغ ، قسم وقاية النبات ، كلية الزراعة ، جامعة عين شمس
(المشرف الرئيسى)

د. سيد محمد عبد اللطيف دحروج
أستاذ المبيدات المتفرغ، قسم وقاية النبات ، كلية الزراعة ، جامعة عين شمس

د. سلوى عبده رزق
أستاذ الحشرات ، قسم المنتجات الطبيعية ، هيئة الطاقة الذرية

تاريخ التسجيل 2005/9/5

الدراسات العليا

أجيزت الرسالة بتاريخ

2011/ /

موافقة مجلس الجامعة

2011/ /

ختم الإجازة

موافقة مجلس الكلية

2011/ /

ABSTRACT

RAGAA Sayed Abdalla: Lethal Effect of Gamma Radiation on some Post Harvest Insects on Certain Fruits and Vegetable Crops. Unpublished Ph.D. Thesis, Department of Plant Protection, Faculty of Agriculture, Ain Shams University, 2011.

The objective of the present study is to investigate the lethal dose level of gamma radiation applied against different stages of Mediterranean fruit fly, peach fly and potato tuber moth, determine the efficiency of gamma irradiation as post harvest treatment to eradicate the insect infestation of guava, peach fruit and potato tubers the effective lethal dose, of gamma irradiation required to applied on infested guava and peach fruits as well as potato tubers to stop the insect survive before cooling storage. Also the effects of applying lethal dose on the physical and chemical properties of the treated fruits and vegetables were investigated.

Based on LD₅₀ and LD₉₀, the egg stage proved to be more radiosensitive followed by pupal and larvae stages of the tested flies and moth's. Also, all stages of potato tuber moth proved more radio tolerant than both of Mediterranean and peach fruit flies. While peach fruit fly stages showed the same or more radio tolerant

The dose levels of 1.6 and 2 KGy could be considered as the fatal gamma irradiation dose for all Mediterranean fruit fly and peach fly stages, respectively. The dose of 2.8 KGy was the fatal dose for all potato tuber moth stages when irradiated directly.

The effective dose of gamma radiation required to disinfest guava and peach fruits artificially infested with the eggs and larvae of fruits flies were 2 and 2.5 KGy for guava and peach respectively. Also, a dose of 2.8 KGy was suggested to inhibit the development and survival of potato tuber moth. The effect of suggested gamma irradiation to applied on guava and peach fruits as well as potato

tubers properties during 21, 28 and 90 days of cooling storage was summarized, comparing with unirradiated stored crops, as following decrease in the percentage of discarded fruits and potato tubers. Data indicated significant increase in fruit firmness, insignificant effect on potato tubers, insignificant increase in total soluble solids of fruits, significant decrease in L-ascorbic acid in fruits and significant increase in potato tubers, significant decrease in respiration rate in fruits and insignificant in potato tubers, significant decrease in total phenols in fruits and insignificant in potato tubers, insignificant decrease in total sugar in peach fruit and significant increase in potato tubers, insignificant increase in moisture rate of potato tubers, insignificant increase in total starch of potato tubers, insignificant increase in carotenoids content of guava fruits, significant decrease in total anthocyanin in peel and significant increase in pulp of peach fruits and 100% inhibition in sprouting of potato tubers.

As conclusion, the obtained results indicated that gamma irradiation could be of fruits and potato vegetable recommended as an alternative method to chemical fumigants as post harvest treatment to achieve insect disinfestations and tuber sprouting inhibition and reduce the food losses. Accordingly, this technology improve hygienic quality and safety of food and could be used as an effective quarantine treatment. The suggested applied gamma irradiation dose levels were 2 to 2.8 KGy, while the safe limits recommended by joint FAO/WHO codex Alimentarius Commission (1984) was 10KGy for irradiated foods

Key words: Gamma irradiation, fatal effects *Ceratitis capitata*, *Bactrocera zonata*, *Phthorimaea opculella*, disinfestation, fruits, potato tubers, post harvest.

ACKNOWLEDGEMENT

First I Thank Allah for helping me to finish this work

The author wishes to express her full appreciation and profound gratitude to Prof. Dr. Amged Mohamed Kamel Sobeiha, Plant Protection Dept., Faculty of Agriculture, Ain Shams University for suggesting the problem, his guidance active supervision, advice during the achievement of this research work, his guidance in writing and revision of manuscript and continuous encouragement during this work.

The author wishes to express deep appreciation to Prof. Dr. Sayed Mohamed Abd El-Latif Dahroug, Department of Plant protection, Faculty of Agriculture, Ain Shams University, helpful assistance. Advice and revision of the manuscript. Deep thanks is also due to Prof. Dr. Salwa Abdo Rizk, Natural Product Department, N.C.R.R.T. for valuable advices, guidance and reading the manuscript.

I would like to thanks Prof. Dr. Gehad Mohamed Aly, Natural Product Department, N.C.R.R.T. for his guidance and reading the manuscript.

Great thanks due to Dr. Samah Nasr, Ministry of Agricultural, Dokki, Giza for her assistance helpful and continuous encouragement during this work.

Special thanks are also expressed to Prof. Dr. Ahmed Mohamed Zaki Mosallam, Department of horticultural Pests, Plant Protection Research institute Agriculture Research Center for his assistance helpful and continuous encouragement during. this work

The author is greatly honored to express her thanks to Prof. Dr. Hedayat Allah Mahmoud Salem, Head of Biotechnology Division (N.C.R.R.T.) for offering all possible facilities through the course of the present work.

Great thanks is due to Prof. Dr. Eman Mahmoud Haiba, Head of Natural Product Department N.C.R.R.T. for co-operation and continuous encouragement.

I would like to thank my sister Dr. Magda Sayed Abdalla, Assistant Prof. of Entomology, Biological Application Department, Nuclear Research Center, Atomic Energy for her assistance helpful and continuous encouragement during this work.

Finally ,deep and warm thanks are due to all my family members specially my parents my husband, my sisters, my brothers and my sons for their encouragement, patience and moral support..

CONTENTS

	Page
LIST OF TABLES	vi
LIST OF FIGURES	xi
I. INTRODUCTION	1
II. REVIEW OF LITERATURE	3
1. The effect of gamma irradiation on the different developmental stages of insects	3
1.1. Egg stage	3
1.2. Larval stage	5
1.3. Pupal stage	6
2. Disinfestations of fruits and vegetable by using gamma radiation	8
3. Effect of gamma radiation on physical and chemical properties of irradiated fruits	12
4. Effect of gamma radiation on physical and chemical properties of irradiated vegetables.....	16
III. MATERIAL AND METHODS	
1. Rearing technique of investigated insects	21
1.1. Fruit flies	21
1.1.1. Egg production	21
1.1.2. Adult production	22
1.2. Potato tuber moth.....	22
2. Irradiation technique.....	23
2.1. Gamma radiation source.....	23
2.1.1. Irradiation of insect stages	23
2.1.2. Irradiation of fruits and tubers.....	24
3. Irradiation treatments and evaluation of its effect on investigated flies and moth stages	25
3.1. Mediterranean fruit fly, <i>Ceratitidis capitata</i>	25
3.1.1. Egg stage.....	25

	Page
3.1.2. Larval stage.....	25
3.1.3. Pupal stage.....	25
3.2. Peach fruit fly, <i>Bactrocera zonata</i>	26
3.2.1. Egg stage.....	26
3.2.2. Larva stage.....	26
3.2.3. Pupal stage.....	26
3.3. Potato tuber moth, <i>phthorimaea operculella</i>	27
3.3.1. Egg stage.....	27
3.3.2. Larval stage.....	27
3.3.3. Pupal stage.....	27
3.4. Gamma radiation dose-mortality response relationship	27
4. Efficiency of gamma radiation to disinfestation of storage crops from different stages of fruit flies (<i>C. capitata</i> & <i>B.zonata</i>) and <i>P. operculella</i>	28
5. Study the effect of gamma radiation on physical and chemical properties for fruits and tubers.....	28
5.1. Storage and sample technique of fruit and vegetable	28
5.2. Evaluation technique of investigated crop properties	29
5.2.1. Discarded fruits percentage.....	29
5.2.2. Weight losses percentage.....	29
5.2.3. Firmness.....	29
5.2.4. Sprouting percentage.....	29
5.2.5. Total soluble solids.....	30
5.2.6. Total acidity.....	30
5.2.7. L. ascorbic acid content.....	30
5.2.8. Respiration rate.....	30
5.2.9. Moisture rate.....	30
5.2.10. Total sugar content.....	31
5.2.11. Total phenol.....	31
5.2.12. Total anthocyanine.....	31
5.2.13. total carotenoids.....	31

	Page
5.2.14. Total starch contents.....	31
6. Statistical analysis.....	31
IV. RESULT AND DUSCUSSION	
1. The lethal effect of gamma irradiation on fruit flies and potato tuber moth.....	32
1.1. The lethal effect of gamma irradiation on the different developmental stages of Mediterranean fruit fly, <i>Ceratitidis capitata</i>	32
1.1.1. Effect on egg stage.....	32
1.1.2. Effect on larval stage.....	35
1.1.3. Effect on pupal stage.....	36
1.1.4. Relative susceptibility of different stages of <i>Ceratitidis</i> <i>capitata</i> to gamma irradiation.....	39
1.2. The lethal effect of gamma irradiation on the different developmental stages of peach fruit fly <i>Bactrocera</i> <i>zonata</i>	40
1.2.1. Effect on egg stage.....	40
1.2.2. Effect on larval stage.....	43
1.2.3. Effect on pupal stage.....	45
1.2.4. Relative susceptibility of different stages of <i>Bactrocera zonata</i> to gamma irradiation.....	47
1.3. The lethal effect of gamma irradiation on the different developmental stages of potato tuber moth, <i>Phthorimaea</i> <i>operculella</i>	48
1.3.1. Effect on egg stage.....	48
1.3.2. Effect on larval stage.....	50
1.3.3. Effect on pupal stage.....	51
1.3.4. Relative susceptibility of different stages of <i>Phthorimaea operculella</i> to gamma irradiation.....	53
1.4. Relative radiosensitivity of fruit flies and potato tuber moth stages.....	54

	Page
2. Efficiency of gamma irradiation as post harvest treatment for inhibition of development and survival of fruit flies and potato tuber moth infestation in storage crops.....	56
2.1. Effect on development of fruit flies infestation.....	56
2.2. Effect on development of potato tuber moth	57
3. Effect of gamma irradiation on certain physical and chemical properties of fruits and vegetable.....	59
3.1. The effect on guava fruits.....	59
3.1.1. Discarded fruits.....	59
3.1.2. Weight losses of fruits.....	61
3.1.3. Fruit firmness.....	62
3.1.4. Total soluble solids.....	64
3.1.5. Total acidity.....	65
3.1.6. L-ascorbic acid content.....	67
3.1.7. Respiration rate.....	68
3.1.8. Total phenols content.....	69
3.1.9. Total carotenoid.....	70
3.2. The effect on peach fruits.....	73
3.2.1. Discarded fruits.....	73
3.2.2. Weight losses of fruits.....	74
3.2.3. Fruit firmness.....	75
3.2.4. Total soluble solids.....	77
3.2.5. Total acidity.....	78
3.2.6. Respiration rate.....	79
3.2.7. Total sugar contents.....	80
3.2.8. Total phenols contents.....	81
3.2.9. Total anthocyanin in fruits peel and pulp.....	83
3.3. The effect on potato tubers.....	85
3.3.1. Decline and Discarded tubers.....	85
3.3.2. Weight losses.....	86
3.3.3. Tubers firmness.....	87

	Page
3.3.4. Sprouting percentage.....	88
3.3.5. Total soluble solids.....	90
3.3.6. L-ascorbic acid.....	91
3.3.7. Tuber respiration rate.....	93
3.3.8. Moisture rate.....	94
3.3.9. Total sugars content.....	95
3.3.10. Total phenols.....	96
3.3.11. Total starch contents	97
V. SUMMARY	
VI. REFERENCES.....	
ARABIC SUMMARY	