STUDIES ON THE EFFECT OF GAMMA IRRADIATION ON THE DIFFERENT DEVELOPMENTAL STAGES OF KHAPRA BEETLE TROGODERMA GRANARIUM EVERTS

BY

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B. Sc. Agric., Plant Protection

Alexandria University

1972

THESIS

Submitted in Partial Fulfilment of The Requirements For The Degree of

MASTER OF SCIENCE

Plant Protection Department

Faculty of Agriculture

Ain Shams University

1979

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Title of Thesis : Studies on the effect of gamma irradiation on the different developmental stages of Khapra beetle, Trogoderma granarium Everts

Degree : M. Sc. "Entomology"

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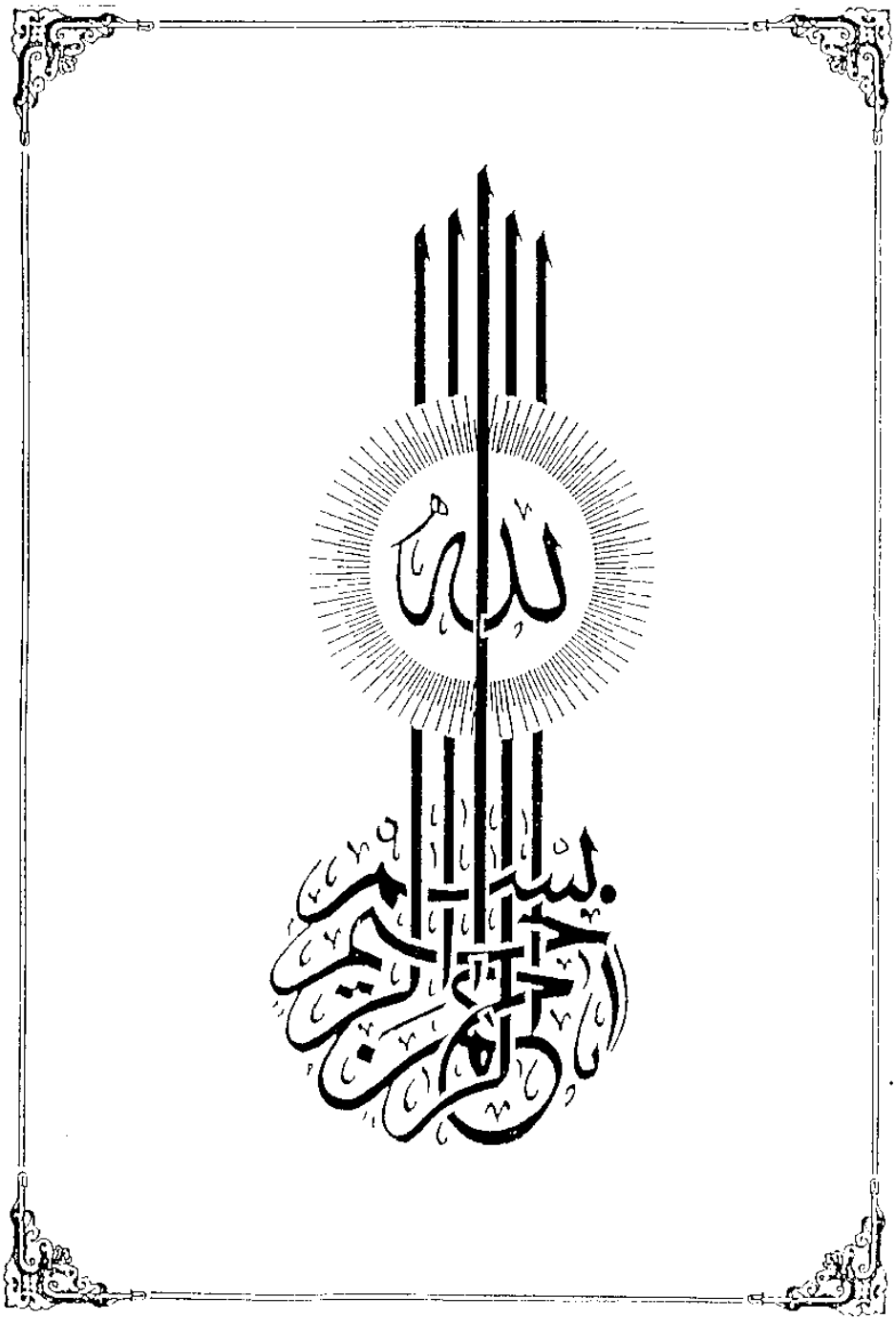
Date : 29 / 8 / 1979.



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ACKNOWLEDGMENTS

The author wishes to express his gratefully acknowledge to Prof. Dr. E.A. EL-Kady, Professor of Entomology, Plant Protection Department, Faculty of Agriculture, Ain Shams University; Dr. M.Y.Y. Ahmed, Associate Professor and Head of Entomology Research Unit, Radiobiology Dept., Nuclear Research Center, Atomic Energy Est. Cairo and Dr. M.W.F. Younes, Assistant Professor, Biology Dept. Faculty of Education EL-Menofia University for their sincere supervision, advice and encouragement throughout this work.

Appreciation is expressed to the Atomic Energy Establishment for the facilities provided.

I- INTRODUCTION

The Khapra beetle, *Trogoderma granarium* Everts, is one of the most destructive pests for stored grain and grain products. It is widespread in tropical and subtropical countries, cause serious damage in Egypt especially in Upper Egypt.

Concern that pesticide residues in foodstuffs may be hazardous, has led to the intensive investigation of nonchemical methods of pest control. One such method that appears promising and has some advantages over conventional methods of control is the application of ionizing irradiation to insects infesting grain, grain products and other foods.

The treatment with radiation takes less time than fumigation, leaves no undesirable residue, and can be as effective in controlling an insect infestation as any procedure now available.

A major problem in disinfestation of stored commodities by any method is the large number of insect species that may be present. Therefore, when irradiation is the method, an effective dose must sterilize or kill the most resistant stage present. At the same time, the lowest effective dose should be chosen because of

economic savings.

The primary objective of the present study is to investigate the effect of gamma irradiation on the different developmental stages of T. granarium. If the comparative radiosensitivity between stages can be determined, the radiation dosages required to kill or at least sterilize the most resistant stage present can be regulated.

The second purpose is to study the mating competitiveness between normal and sterile adults.

II- REVIEW OF LITERATURE

The practical approach to the radiation disinfestation of foods began more than sixty years ago with the attempt by Runner (1916) to control Lasioderma serricorne, in packaged cigars by means of X-radiation.

Considerable attention has been focused on this field after the successful eradication of the Screw worm fly, Cochliomyia hominivorax from the island of Curacao, U.S.A. (Baumhover et al 1955; Lindquist, 1955; and Knipling, 1960) by the release of flies sterilized with gamma irradiation.

Potentially, all insect species that occur in stored products can be controlled with gamma radiation by producing immediate mortality or by producing sterility of the irradiated pests. Since the dosage level required for death in all metamorphic stages within 24 h. may be 15 or more times that required to produce sterility (Cornwell and Bull, 1960), the later method appears to offer the greater promise under most conditions.

Cork (1957), studied the effect of gamma irradiation on the adult longevity of Tribolium confusum, found that the life span of flour beetles could be extended by gamma rays.

Van de Moentjine and Van den Brande (1960), found that the eggs and larvae of Ephestia kuehniella, were killed at a dose of 18 K. rad. 72% of eggs irradiated at 4.5 K. rad gave rise to adults but the adult emergence was delayed by two days. The dose 60 K. rad caused incomplete sterility of males and 20 - 40 K. rad produced 50 and 93.7% sterility, respectively. All males have shrivelled appearance and their life span was much reduced when irradiated with doses ranging from 20 to 60 K. rad.

Van den Bruel et al., (1960), found that when 1st and 2nd instar larvae of Sitophilus granarius and S. oryzae were irradiated at 1 K. rad, affected number and fertility of the resulting adults. S. granarius was more resistant at all stages of development than S. oryzae.

In studies with the Granary weevil, Sitophilus granarius and the Rice weevil, S. oryzae, Cornwell and Bull (1960), reported that the dose 300 K. rad killed adults in less than 24 hours. Lower doses of 15 and 25 K. rad gave complete control within about one week and no mortality was observed at a dose of 2 K. rad and below.

Kansu (1962), reported that the doses 6 K. rad or more reduced reproductive capacity of Trogoderma granarium when applied to 1-day- old male pupae, and 15 K. rad was

the highest dose applied which sterilized all males. Doses of up to 7.5 K. rad applied to female pupae a affected reproductive capacity. Further tests indicated that the effects become more apparent in the 2nd generation after irradiation. Following a dose of ≥10 K. rad, malformation (elytia) was observed in some adults.

Davich and Lindquist (1962), working on Anthonomus grandis, found that exposure of eggs to 600 rad did not affect hatch or subsequent development whereas 2.4 K. rad drastically reduced hatch and prevented subsequent development.

Viado and Manoto (1962), working on the tomato lady beetle, Epilachna philippinensis and the Rice weevil, Sitophilus oryzae, reported that when eggs of Epilachna sp. were treated with 10 K. rad, most of the adults that developed had abnormal legs and elytra. All the adults which emerged from this treatment were incapable of reproduction and no eggs were laid. When fifth instar larvae were irradiated with 1 K. rad, 25% of the larvae were killed, and 85.7% of the pupae reached the adult stage, but about 35% of these adults had abnormal appendages. Different developmental stages of Epilachna sp. were more susceptible to gamma rays than S. oryzae. No significant difference in susceptibility

between the sexes was noted.

Pendleburg et al (1962), reported that adults of Rhyzopertha dominica and Lasioderma serricorne were sterilized by 16 K. rad and Ephestia cautella and Plodia interpunctella were more resistant to radiation sterilization than Coleopterain insects.

Laviolette and Nardon (1963), studied the effect of gamma radiation on the fertility of Sitophilus sasakii adults. They reported that the fertility was reduced by half after a dose of 2 K. rad, some eggs were laid even after 16 K. rad and the dose 4 K. rad decreased fertility to 1/25 of normal. The significant reduction in longevity of adults irradiated with a dose of 5 K. rad in the case of males and 7 K. rad in that of females. All insects died within about 12 days after a dose of 8 K. rad and within 4 days after 100 K. rad.

Qurashi and Metin (1963), studied the effect of gamma irradiation on Callosobruchus chinensis. They found that the dose 15 K. rad gave 100% mortality in the irradiated eggs. When 8-day-old larvae were irradiated at 20 K. rad, 100% mortality was obtained. Pupal stage seemed to be less radiosensitive than eggs or larvae, and the dose 47 K. rad was required to obtain 100% mortality. The dose 42 K. rad sterilized both sexes.

Huque (1963), studied the effect of gamma irradiation on the life span of Callosobruchus maculatus, Rhizopertha dominica and Sitophilus granarius, found that a dose of 20 K. rad produced 100% mortality of Rhizopertha adults within a period of 11 days. When adults of Sitophilus sp. exposed to 10 K. rad, total mortality was attained in 7 days. The complete mortality immediately after irradiation was obtainable only with the maximum dosage of 250 K. rad. One-day-old eggs of Callosobruchus sp. exposed to 3 and 5 K. rad failed to give any emergence. While the dose 2.5 K. rad increased the life cycle to 48 days compared with 39 days for the control.

Papadopoulou (1963), working on Carpophilus hemipterous, Oryzaephilus surinamensis, Ephestia cautella and Plodia interpunctella, found that the dose 25 K. rad reduced egg hatch to 10% for Ephestia, 12% for Carpophilus, 15% for Plodia and 30% for Oryzaephilus. At a dose of 50 K. rad, latching was reduced to 2% for Ephestia, 5% for Carpophilus, 7% for Plodia and 10% for Oryzaephilus but the hatched larvae in general were not viable. The dose 100 K. rad prevented egg hatch. At the dose 50 K. rad, T_{50} varied between 5 and 6 days, depending upon the age of the larvae and the species. Pupal irradiation at 50 K. rad prevented adult emergence.

Shchegoleva (1963), reported that the dose 30 K. rad is needed for satisfactory control of dermestids attacking dried fruit, if complete mortality of all stages is a shorttime is desired.

In studies with the Mediterrnean flour morh, Ephestia kuhneilla, Bull and Wond (1963), found that newly laid eggs were more susceptible than the older. Total emergence was reduced as the dose increased in all age groups. Wing malformations occurred particularly between 1 and 12 K. rad.

Hennebery and Smith (1964), showed that the adults of the mexican bean beetle, Epilachna varivestis were sterilized by 10 or 20 K. rad of gamma irradiation. Males were more radioresistant than females. The adult longevity was reduced at doses up to 16 K. rad.

ELbadry (1965), studied the effect of gamma rays on Gnorimoschema operculella. He found that when 2-day-old eggs were exposed to 3 or 6 K. rad and 3-day-old eggs exposed to 12 K. rad, all the emerged adults were males compared with the normal sex ratio, 1 : 1, in the controls.

Vereecke and Pelerents (1965), working with Tribolium confusum, observed a marked periodic increase in the