The Effect Of Gamma Radiation On The

Lesser Cotton Leaf Worm _Laphygma exigua_ Hb.

By

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B.Sc. (University of Cairo) 1963

Thesis

Submitted to the Faculty of Agriculture

Ain Shams University
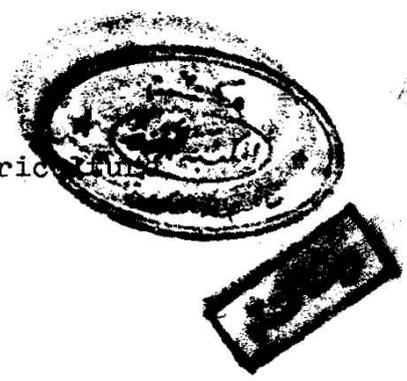
For the Degree of

MASTER OF SCIENCE

2878

595-1 1968

This Thesis for M.Sc. Degree

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Date ..27.3..1969

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ACKNOWLEDGEMENTS

I. INTRODUCTION

The lesser cotton leaf worm <u>Laphygma</u> <u>exigua</u> Hb. is one of the major pests causing damage to field and vegetable crops especially in Upper Egypt. The severe infestations of cotton plants, in the last few years showed that this pest can attack the cotton plants from seedling stage until harvesting time, especially in Minia and Assiut Provinces.

It is a noctoid moth of the family <u>Agrotidae</u>. The larva is the injurious stage feeding for about two weeks on any part of the vegetative growth of the plant.

Bodenheimer (1951) recorded 25 plants belonging to 16 families as host plants to the lesser cotton leaf worm in the Middle East. He mentioned that other herbs and weeds are very commonly attacked.

In Egypt it has been recorded in the last few years to attack maize in Minia and Assiut, and at present is considered as a major pest in the New Valley.

Considerable research has been concerned with irradiation to prevent reproduction or to produce lethal effects on stored-product insects (Davey, 1919; Hassett & Jenkins, 1952; Cornwell et al., 1957; Jefferies & Cornwell, 1958; Carney, 1959; Cornwell & Bull, 1960; and Dennis, 1961).

Similar work has been done on insects affecting man (Potts, 1957 & 1958; Terzian & Stahler, 1958; Cole et al., 1959; and Davis et al., 1959).

Also, there have been studies to determine dosages required to prevent eggs from hatching, to kill larvae or arrest their development or cause them to produce sterile adults and to sterilize adults (Vasilyan, 1961; Proverbs and Newton, 1962; Husseiny, 1963; and Balock et al., 1963). Ways of utilizing this autocidal principle of insect control were summarized by Knipling (1960).

The success of the sterile male method for eradicating the screw worm, Callitroga hominivorax Cqrl. has suggested the possibilities of utilizing sexual sterile insects for controlling or eradicating their species, such as tsetse flies, sheep blow flies, fruit flies, mosquitoes, the flour mill moth, and other insects.

The primary objective of the present study is to investigate the effect of gamma radiation on the different developmental stages of Laphygma exigua. The second purpose is to study the mating competitiveness between normal and sterilized males.

Such results might provide us with the basic informations concerning the application of the sterile moths for eradication of this pest.

larvae were observed migrating in large numbers across roads.
The larval stage lasted for 16 to 18 days, and the total life
cycle averaged 25-28 days. The adults live 2-2.5 weeks, while
the preoviposition period is 1-3 days, and the oviposition
period lasts for 10-15 days. The total number of eggs laid by
a female ranged from 500 to 1700.

Wilson (1933 & 1935) recorded that the incubation period
of the lesser cotton leaf worm ranged from 3 to 10 days. Each
of the five larval instars requires about 2 days, average larval
period is 11.5 to 13.2. At 61.5°F. the larval period is 37.6
days. The pupal stage lasts in soil for 6-8 days. Pre-
oviposition period is 2-3 days, while oviposition period is
4-5 days. Average number of eggs laid by a female was 600 eggs.
Total life cycle averages 24 days.

Willcocks & Bahgat (1937) in Egypt stated that the larvae
had five ecdyces, the first instars were gregarious, fed to-
gether, spun a good deal of loose silken webs. The duration
of this instar is from 36 to 48 hours, and the second instar
takes the same period. The third instar lasts for 24 to 36
hours, and the fourth and fifth instars last for 36-48 hours.
Pupal stage lasts about 46 days in winter. The whole life cycle
needs about 30 to 40 days. Females laid eggs in clusters
(20-70 eggs each) and the incubation period is 2-3 days in
summer.

Patel (1946) reported that the egg, larval and pupal stages lasted 2, 13-16 and 5-7 days, and males and females survived for averages of 8.1 and 11.8 days respectively. Preoviposition period is 2-8 days, while the oviposition period is 2-11 days. The female lays an average of 461 eggs, with a maximum of 1278 eggs.

Bodenheimer (1951) indicated that the development of the total life cycle of Laphygma lasts 20.3, 27.8, 44.0 and 105.0 days at 30°C., 25°C, 20°C. and 15°C. respectively.

Kozhanchikov (1955) stated that Laphygma exigua develops uninterruptedly at all times of the year under tropical and sub-tropical conditions but hibernates in temperate regions, though there is no true diapause. It has been recorded as hibernating in the adult stage and in the egg and pupal stages, and investigations in Soviet Central Asia have shown that hibernation of the larvae is possible.

Atkins (1960) reported that the female moth of L. exigua deposited 83 eggs per mass. The larvae had five instars. The first stage larvae remain together feeding gregariously, and might remain together till the third instar. The average length of different stages on citrus at 80°F. and 40-55% R.H. was, egg 4.4 days, larvae 21.3 days, pupae 8.7 days, adults 8 days (females 7 days and males 9 days). The average of life cycle was 36.4 days.

El-Sawaf et al. (1959), during a study on the biology of
Spodoptera exigua Hbn. in Alexandria, recorded that the durations
of egg, larval, and pupal stages were 2-7, 12.4-20.4 and 6.3-8.6
days at 30°C. and 23°C. respectively. In winter conditions at
19°C. the duration of the larval stage varied between 41 and 60
days and the pupal stage between 19 and 36 days. Preoviposition
period averaged 1.5 days at 26°C. and 86% R.H., and the ovi-
position period was 4.5 days. Many mated females lived for few
days. The whole life cycle varied from 36.6 days at 25°C. and
69% R.H. to 26.3 days at 30°C. and 66% R.H. At 19°C. during
winter the duration of the whole life cycle ranged from 74 to
104 days. Females laid eggs in masses of about 33 eggs each;
and each female deposited 10 masses. Number of eggs in each
mass ranged from 4 to 233 eggs at 26.6°C. and 69% R.H. The
maximum number of daily eggs was about 555 eggs. The average
total number of eggs laid by a single female was 590 eggs.

Butler (1966) reared individuals of beat army worm,
Spodoptera exigua Hübner on lima bean-agar in temperature
cabinets, and reported that the regression equations are: for the
number of days for the egg stage, $\hat{y} = -0.3472 + 0.0083\,x$; from
the first instar larvae to the prepupal stage, $\hat{y} = -0.0921 + 0.00203\,x$; to the pupal stage, $\hat{y} = -0.1032 + 0.00214\,x$; and to
the adult stage, $\hat{y} = -0.0716 + 0.00147\,x$, where $\hat{y}$ is the reci-
procal and x is the temperature (F°.). The rate of development
was the same at constant as at fluctuating temperatures. The

regression equation for the number of days to the death coil from the hatching of S. exigua is $\hat{y} = -0.1385 + 0.00283\,x$, and to the adult stage is $\hat{y} = -0.0841 + 0.00164\,x$.

B. Biological Effects of Radiation

The present review reports, briefly, the influence of radioisotopes and ionizing radiations on many biological aspects of different insects. Special emphasis was made to their role in the induction of sterility in various species of insects and their applications to the control of insect populations.

1. Early studies on the biological effects of radiation

The effect of ionizing radiations on living cells of higher plants and animals were evidenced by various alternations in the constitution and behaviour of cellular materials, which was observed by the pioneer workers in the early years of the 20th Century.

The first detailed investigation on the effects of ionizing radiation began with the discovery of Muller (1928a,b) that mutations could be induced in Drosophila melanogaster Meig. by X-ray treatments. Geneticists accepted this discovery and found that X-rays could be used as a useful tool for increasing the mutation rates in various species of insects as well as in different organisms ranging from viruses to higher plants and laboratory mice. Muller (1940) concluded that a given number

of ionizations produced the same number of gross structural changes in <u>Drosophila</u> spermatozoa regardless of (a) wavelength from 50 Kv X-rays to gamma rays; (b) continuous dose or fractionation over a 3-week period; (c) fertilization immediately or one month after treatment; (d) radiation intensity, from 0.05 to 250 r/minute; and (e) temperature from 5° to 37°C. Hence, in spermatozoa undergoing irradiation "primary" effect of individual ionizations accumulated independently until fertilization, and their final total number determined the number of structural changes produced.

2. Recent studies on the biological effects of radiation

a- Effect of irradiation on immature stages

The effects of irradiation on growth are dependent on dosages; low dosages cause little effects, at intermediate ones there appears to be enhancement in some cases and retardation in others. At high dosages, growth may be retarded for a period producing larger individuals. Such a phenomenon could be explained as due to retardation of pupation and therefore increased length of larval development.

Balock <u>et al.</u> (1956) studied the effects of gamma rays on the oriental fruit fly <u>Dacus dorsalis</u> Hendel. and reported that 6-hour-old eggs were killed by approximately 4000 r; 24-hour-old eggs in which embryonic development was about 50 per

Pelerents and Brande (1961) studied the effect of gamma
rays on eggs of _Anagasta_ (_Ephestia_) _kuehniella_ Zell. and they
reported that doses of 9000 and 14,000 rad caused significant
reductions in the hatching of eggs 6 and 4-day old respectively.
Doses of 1000 and 2500 rad stimulated the hatching of eggs
2-d-old, but 4000 r reduced it. A dose of 20,000 rad reduced
the hatching of eggs 6 and 4-d-old to 24.2 and 0% respectively,
and one of 6000 rad prevented all 2-d-old eggs from hatching.
Doses of 1000-2500 rad increased adult emergence from surviving
6-d-old, doses greater than 2500 rad reduced that from 4-d-old
eggs, and one of 2000 rad reduced that from 2-d-old eggs.
Adults from eggs treated when 2-d-old with 3000 rad or more
laid few or no eggs.

Dixon (1962) studied the effects of X-irradiation on
Cochliomyia hominivorax Coquerel and exposed pupae aged 1, 29,
52, 76, and 87 hours to equal multiple and single doses of ir-
radiation varying from 600 to 7800 r. Newly emerged eggs were
exposed for 1, 2, 3, and 4 minutes at 531 r per minute. Five-
hour-old eggs were exposed in minute intervals from 1 to 15
minutes at 539 r per minute. Unfertilized ova and sperms were
exposed to 531, 600 and 1062 r by irradiation of 8-day-old
flies. He reported that, in general, multiple irradiation was
more harmful to pupae than an equal single dose. Unfertilized
eggs seemed more susceptible to irradiation than newly laid eggs.
Five-hour-old eggs appeared less susceptible than unfertilized
or newly laid eggs.

Proverbs and Newcon (1962a) found that irradiation of
eggs, mature larvae, or young pupae of Carpocapsa pomonella L.
with gamma radiation induced dominant lethality in a high per-
centage of the sperm, but caused prohibitively high mortality
and frequently reduced mating.

Sidorova (1962) made a preliminary survey on the effects
of gamma radiation on the cut worm, Laphygma exigua Hb. and
found that irradiation of larvae, in the third instar, with
10,000 and 50,000 r Co-60 caused 40% mortality in the first 7
days. High dosages of 100,000-250,000 r killed 100 per cent
of the larvae. No unfavourable effects were found when larvae
fed on the irradiated cotton leaves (10,000 and 50,000 r),
except that their respiratory rates were reduced.

Balock et al. (1963) determined the irradiation effects
on the development of eggs, larvae and pupae of the oriental
fruit fly (Dacus dorsalis Hendel.), the melon fly (Dacus
cucurbitae Coquillett), and the Mediterranean fruit fly
(Ceratitis capitata Wiedmann). They arrived to the conclusion
that increasing dosages were required to prevent hatch as eggs
become more mature except that eggs of one-third developed were
more sensitive than younger ones. The LD_{95} for hatch of newly
laid eggs was about 1300 r and for nearly mature eggs, it
ranged from 86,000 to 125,000 r. Pupation was reduced by 95
per cent when eggs were exposed to 13,000 r and 1-day-old larvae