

EFFECTS OF GAMMA RADIATION ON THE MATING ACTIVITY OF THE MEDITERRANEAN FRUIT FLY *Ceratitis capitata* Weid

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Key words : Gamma radiation, Mating activities, Medfly.

ABSTRACT

Full grown pupae of the Mediterranean fruit fly, *Ceratitis capitata* Weid were exposed to three doses of gamma radiation, 50 70 and 90 gray. The effects of irradiation on the fly mating activity were studied. There was no significant effect of the two low doses (50 & 70 gray) on the ability of the irradiated males to mate with irradiated females. However, at 90 gray, the mating of the irradiated males were significantly less than normal males. The mating ability of the irradiated males with normal females was decreased with increasing the dose. Irradiated males seemed to have ability to mate with irradiated females than to mate with normal females. The mating frequency of the irradiated males was decreased when caged with normal females, and the majority of males mated 3 times. On the other hand, the mating frequency of the irradiated males was increased when caged with irradiated females, and the majority mated 4 times. There was a slight decrease in the ability of the irradiated males to inseminate normal females at all doses tested.

INTRODUCTION

Following the successful elimination of the screw-worm fly, *Cochliomyia hominivorax* (Cocquerel) from many parts of the United States of America, large scale field applications of the Sterile Insect Technique (SIT) to control fruit fly species were achieved in many countries. Recently, large programmes for controlling the Mediterranean fruit fly, *Ceratitis capitata*, were applied successfully in Mexico and currently in Egypt.

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A primary requirement of the sterile insect technique for population suppression or eradication is that released sterilized flies must successfully mate with the wild population. To be successful, the released flies and the wild flies must be compatible, mating frequency and ability to inseminate in the released flies must be high and the times of mating of released and wild flies must be synchronized (Hooper, 1977).

In the present study, mating ability, mating frequency and the ability of the irradiated male to transfer sperms to the female were studied.

MATERIALS AND METHODS

The Mediterranean fruit fly was successfully reared and maintained in the Entomology Laboratories of the Radiobiology Department, Nuclear Research Centre, Atomic Energy Authority, Cairo, Egypt for more than 15 years. The rearing technique of both larvae and adults was described by Wakid (1975). Gamma cell unit (^{60}Co) was used as a radiation source. The dose rate ranged between 8–14 rad/second, throughout the present work.

Laboratory reared irradiated males (irradiated as pupae 1–2 days before eclosion). Each sex was then placed in a separate plastic cage and provided with water and food (a mixture of one part yeast hydrolyzate and three parts sucrose). They were then kept under regular laboratory conditions ($25 \pm 2^\circ\text{C}$, 70% R.H. and continuous illumination) for four days.

One irradiated male was placed with 5 normal females (or irradiated) in an experimental plastic cage for mating. Immediate mating of the male with one female was observed. Each mating pair (in the different replicates) was then transferred while in copula using small tube to another cage to complete the mating period. After separation of the sexes, the male was placed in the next day with five virgin females in a cage for mating. Again when the male was observed in copula with a female, the same procedure was repeated with 5 new virgin females until no mating was observed. Thus, the number of matings by an irradiated male was recorded. Five replicates were done for each of the doses 50, 70 and 90 gray. A control group of normal males and normal females was made.

To assess the ability of the irradiated male to inseminate virgin females the following technique was used. Irradiated males (in the pupal stage) and normal

females were sexed after eclosion. They were then placed in groups of equal numbers of males and females (10 individuals) in ventilated plastic cages and provided with the usual food and water. They were kept under regular laboratory conditions previously mentioned. When complete matings were observed in the groups, the females of each group were dissected and their spermathecae checked for the presence of active sperm. The females were anaesthetized with chloroform, placed in a drop of Insect Ringer Solution on a microscope slide and their genitalia exposed by pulling the tip of the abdomen with fine forceps. The spermathecae which are brown-black in appearance, were crushed and checked for sperms. The data describe the effect of different doses of gamma radiation (50, 70 and 90 gray) applied to the male on its ability to inseminate virgin normal females, compared with the unirradiated male.

To assess the ability of the irradiated males to mate with normal or irradiated females, twenty five normal or irradiated females were isolated after eclosion till the beginning of the experiments (5 days) and then mixed with 25 previously isolated 5-day-old males irradiated in the pupal stage in a plastic cage (14.5 X 11.5 cm) containing food and water supply as usual and kept in the normal laboratory conditions. The cage was checked regularly at 15-minutes intervals for 4 hours and the numbers of mating pairs recorded. Doses of 50, 70 and 90 gray were used beside a control (unirradiated group), 4 replicates were done.

RESULTS AND DISCUSSION

1. Mating Ability

The results obtained in this experiment on the mating of the male flies irradiated with 3 doses of gamma radiation (Fig. 1) showed that there was no significant effect of the two low doses (50 and 70 gray) on the ability of the male flies to mate with irradiated females where 79.7 and 85% of the flies were found in copula in the first 4 hours, compared with 82% in the untreated population. However, at 90 gray only 64% of the irradiated males were found in copula with irradiated females. This difference was statistically significant, it means that high doses of gamma radiation did affect the mating activity of the males represented in their less ability to mate with irradiated females.

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As to the mating ability of the irradiated males to mate with untreated females, there was a gradual decline with increasing the dose. While 82% of the normal males were found in copula with normal females, only 71.4%, 56.9% and 42.1% of the irradiated males mated with normal females. This means that irradiated males seemed to have more ability to mate with irradiated females than to mate with normal females. Similar results were recorded by other workers on fruit fly *Dacus cucumis*, (Hooper, 1977) and on the Medfly *C. capitata*, (Holbrook and Fujimoto, 1970).

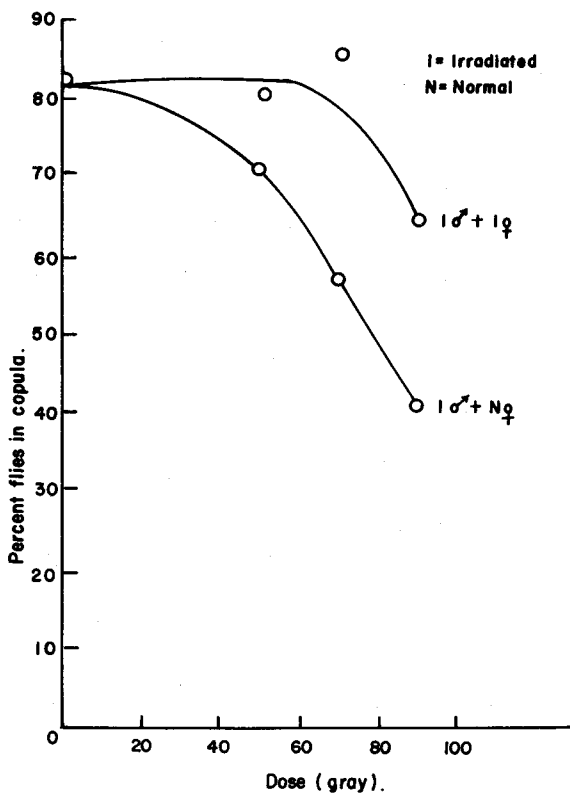


Fig. 1 : Effect of gamma radiation on the mating ability of *Ceratitidis capitata*

2. Mating Frequency

Fig. 2 and 3 illustrate the effect of gamma radiation on the mating frequency of the irradiated males when caged with normal or irradiated females. From the data obtained it is clear that gamma radiation seemed to decreased the mating

frequency of the male when caged with normal females. Thus, 40% of the males irradiated at 50 gray mated 3 times and 20% mated 4 times with normal females. This frequency of mating decreased at higher doses; as 20% and 25% males irradiated at 70 and 90 gray, respectively, mated 3 times, but none mated 4 times with normal females. In the control experiment, 50% of normal males mated 3 times and 25% mated 4 times with normal females.

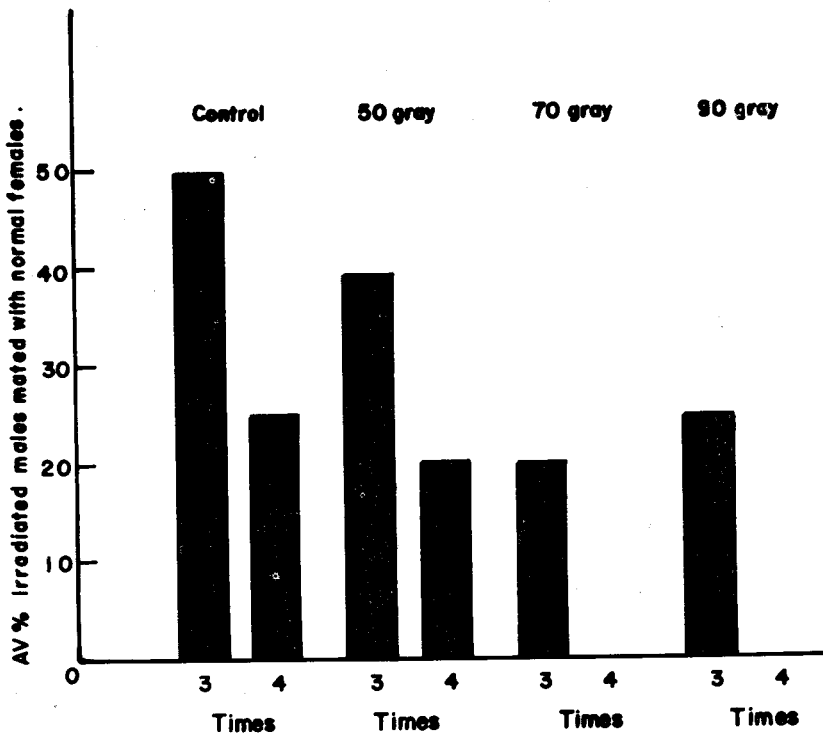


Fig. 2 : Effect of gamma radiation on the mating frequency of the male when caged with normal females

On the other hand, when irradiated males were caged with irradiated females their mating frequency seemed to be increased. While only 75% of the normal mated 3-4 times at 50, 70 and 90 gray, respectively. Moreover, the majority of irradiated males mated four times with irradiated females. This means that the mating frequency of the irradiated males was more when they were caged with irradiated females than when they were caged with normal

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females, a phenomenon that was observed when the mating ability was studied (Experiment I), as it was observed that irradiated males had more ability to mate with irradiated females than to mate with normal females.

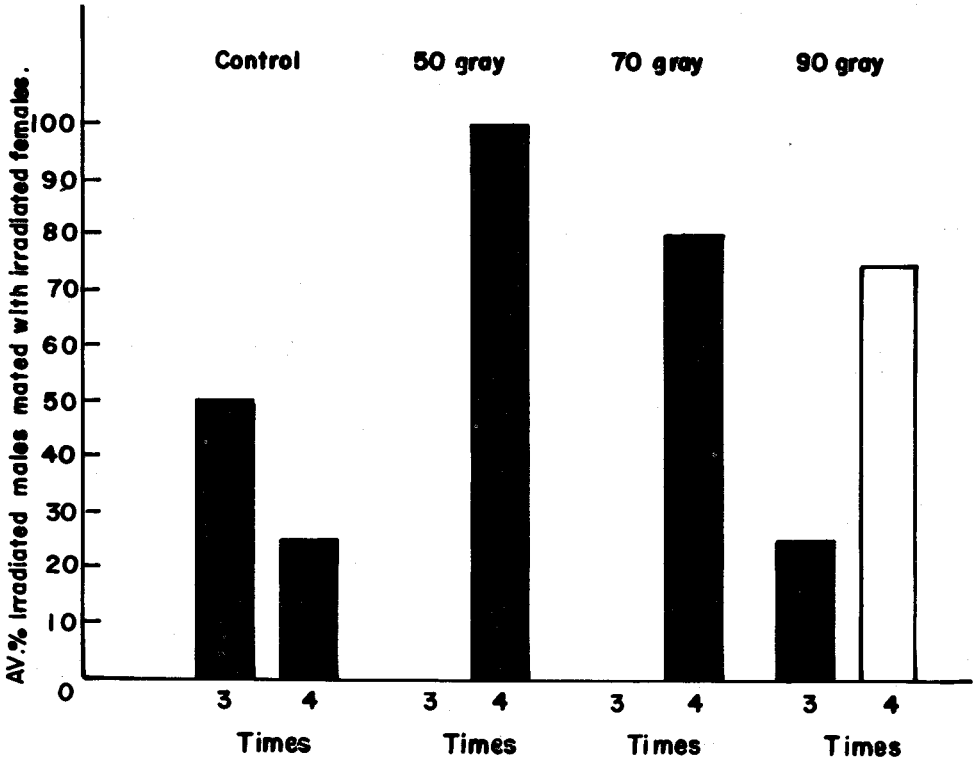


Fig. 3 : Effect of gamma radiation on the mating frequency of the male when caged with irradiated females

3. The Ability of the Irradiated Male to inseminate Normal Females

From the data obtained (Fig. 4) a slight but insignificant effect was observed on the ability of the males to inseminate normal females at all doses tested. While 97.3% of the females were inseminated by normal males, only 85.0, 86.6 and 87.5% of the normal females were inseminated by irradiated males at 50, 70 and 90 gray, respectively.

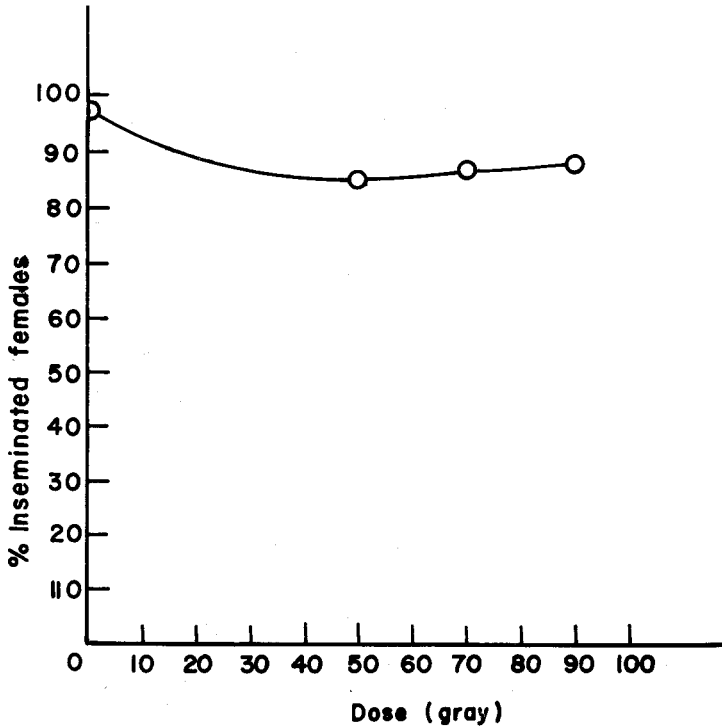


Fig. 4 : Effect of gamma radiation on the mating ability of the males to inseminate normal females of *Ceratitidis capitata* Weid

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تأثير أشعة جاما على النشاط التزاوجي لذبابة فاكهة البحر الأبيض المتوسط

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عرضت العذارى كاملة النضج لذبابة فاكهة البحر الأبيض المتوسط لثلاث جرعات من أشعة جاما ٥٠ ، ٧٠ ، ٩٠ جرای ثم تمت دراسة النشاط التزاوجي للذباب الناتج . لم يلاحظ تأثير معنوي على قابلية الذكور المشععة لتلقيح الإناث المشععة عن قابلية الذكور غير المشععة ولكن كذلك لوحظ نقص قابلية الذكور المشععة للتزاوج مع الإناث غير المشععة عند زيادة الجرعة الإشعاعية . وعموماً فإن قابلية الذكور المشععة للتزاوج مع الإناث المشععة كانت أكبر من قابليتها للتزاوج مع الإناث غير المشععة عند الجرعتين ٥٠ ، ٧٠ جرای أما عند جرعة ٩٠ جرای فقد إزدادت قليلا عنه في الجرعتين السابقتين . أما عدد مرات تزاوج الذكور المشععة مع الإناث المشععة فقد زادت عند جميع الجرعات كما كان هناك نقصاً بسيطاً في مقدرة الذكور المشععة على توصيل الحيوانات المنوية للإناث غير المشععة عند جميع المستويات الإشعاعية المستخدمة .