

Sterilization of a Libyan Strain of the Mediterranean Fruit Fly (*Ceratitis capitata* Wied.) by Gamma Radiation Part II: Effect on Sexual Competitiveness of Males.

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ABSTRACT

The success of Sterile Male Technique for the control of Medfly depends on the viability of released adults. Therefore the effect of radiation on the percentage of adult emergence, flight ability, longevity, sexual ratio, egg hatch percentage, and sexual competitiveness of irradiated males should be studied.

The objective of this work was to study the effect of different radiation doses on the sexual competitiveness of the irradiated males. Competitiveness value was determined for different gamma ray doses (8, 9, 10, 11, 12 and 13) Krad at different ratios of irradiated males: non-irradiated males: non-irradiated females (1:1, 3:1, 5:1, 7:1 and 9:1).

Results showed that the sexual competitiveness increased as the ratio of irradiated to non-irradiated males increased; while it decreased with the increase of radiation dose.

INTRODUCTION

The Mediterranean Fruit Fly (Medfly) is considered as a major pest of fruits in the Mediterranean Basin. It attacks citrus, peaches, apricots, figs, dates and other hosts in Libya. The losses due to medfly infestation of fruits and the cost of control are currently estimated to reach at least up to 7.5 million US\$ annually (8).

The use of insecticides for the control of agricultural pests causes some problems, such as environmental pollution, insecticide resistant and biological disequilibrium. These problems have led to the development of selective pest control methods. One of these methods is the use of Sterile Insect Technique (SIT). The success of this technique depends on the vigor of the released flies. Calkins et al. (1) reported that flies with poor mobility will not be able to locate host plants or mating areas after release.

The type of radiation used to produce sexual sterility is not specific for the reproductive system. Its effect on the other biological characteristics (adult emergence percentage, flight ability, longevity, sex-ratio, egg hatch percentage and sexual competitiveness of the irradiated males) must be evaluated to produce not only sterile males, but healthy and sexually aggressive males.

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In this work, the effect of different gamma radiation doses on the sexual competitiveness of Medfly males were studied at different ratios of irradiated to non-irradiated males for the local population designated by the name "Al-Qudas".

MATERIALS AND METHODS

Medfly (*Ceratitis capitata* Wied.) pupae, which have been collected from Al-Qudas farm in Tripoli were reared in the laboratory for 40 generations. Larvae of this culture were reared on a diet based on wheat bran (Sibersdorf diet) (7).

Sterilization of flies was carried out by irradiating pupae (one day before adult eclosion) using a Cobalt-60 irradiator at Tajoura Nuclear Research Center, Libya. Equal amounts of pupae (100 ml each) were placed in glass vials and irradiated with 8, 9, 10, 11, 12 and 13 Krad. Adults were kept in screened cages, fed on Sibersdorf diet and provided with water.

To evaluate sexual competitiveness of males, ratios of 0:1:1 (sterility), 1:0:1 (control), 1:1:1, 3:1:1, 5:1:1, 7:1:1 and 9:1:1 were used for each dose and replicated 3 times, i.e for 1:1:1 ratio, 5 irradiated males, 5 normal males and 5 normal females were placed in a screened cage (15 cm in diameter) one day after adult emergence. The eggs were collected daily on a black wet cloth. Egg hatch percentage was determined twice a week for three weeks. The mean percent of egg hatch was calculated for each replicate, then the mean percent for each treatment was determined. The competitiveness value (CV) for the irradiated males was calculated according to Fried's (3) parameters as follows:

$$CV = \frac{HN - HC}{HC - HS} \times \frac{N}{S}$$

Where,

CV = competitiveness value.

HN = mean percent of egg hatch in presence of normal males only.

HC = mean percent of egg hatch in presence of normal and irradiated males.

HS = mean percent of egg hatch in presence of irradiated males only.

N = number of normal males.

S = number of irradiated males.

RESULT AND DISCUSSION

The data obtained for the effect of gamma radiation on egg hatch percent of Medfly females in presence of irradiated males with different doses and at different ratios of irradiated males to non-irradiated males is summarized in Table (1). Clearly the level of sterility increased with the increase of radiation dose at the absence of non-irradiated males, but at the presence of non-irradiated males the sterility decreased with the increase of radiation dose at the same ratio of irradiated to non-irradiated males. The sterility also increased by the increase of the ratio of the irradiated males to non-irradiated males at the same dose.

Table 1 – Egg hatch percent of Medfly females in presence of irradiated males with 0, 8, 9, 10, 11, 12 and 13 Krad and at 0:1:1, 1:0:1, 1:1:1, 3:1:1, 5:1:1, 7:1:1 and 9:1:1 ratios (irradiated males: non-irradiated males: non-irradiated females).

Dose (Krad)	Egg hatch	percent at different ratios of Irrad.			males:	nor.males:	nor. females
		1:0:1	1:1:1	3:1:1	5:1:1	7:1:1	9:1:1
0	82.48	–	–	–	–	–	–
8	–	4.26	66.33	44.39	32.57	23.67	15.79
9	–	2.55	66.82	46.38	34.44	26.29	16.33
10	–	1.52	68.19	46.86	35.67	27.69	16.65
11	–	0.77	68.82	49.29	37.61	28.12	16.62
12	–	0.69	70.04	52.93	39.49	29.96	20.37
13	–	0.55	71.22	54.17	40.74	30.77	22.73

From the calculated competitiveness value (CV) of the irradiated Medfly males presented in Table (2), it can be observed that the CV decreasing with the increase of radiation dose. For instance, the competitiveness values of males irradiated with 8, 9, 10, 11, 12 and 13 Krad at ratio of 9:1 (irradiated: non-irradiated males) were equal to 0.65, 0.54, 0.49, 0.46, 0.35 and 0.30, respectively. Similar observation were reported by Zumreoglu et al. (10); though, the competitiveness values of male pupae irradiated with 9, 10 and 11 Krad one day before adult eclosion at 3:1 ratio were equal to 0.16, 0.12 and 0.08, respectively. Steiner and Christenson (9) reported that the CV of the irradiated males is inversely proportional to dosage. They indicated that although the degree of egg sterility is proportional to the ratio of irradiated to the non-irradiated males, the actual sterility at any given ratio is always less than the theoretical sterility. The results reported by Hooper (4) indicate that competitiveness decreased with increased doses. This factor counteracted the increased degree of sterility induced by increased dose, so that doses of 5-11 Krad led to similar reduction in egg hatch.

Table 2 – The competitiveness values of Medfly males irradiated with 8, 9, 10, 11, 12 and 13 Krad and at ratios of 1:1:1, 3:1:1, 5:1:1, 7:1:1 and 9:1:1 (irradiated males; non-irradiated males; non irradiated females).

Dose (Krad)	Competitiveness Value				
	1:1:1	3:1:1	5:1:1	7:1:1	9:1:1
8	0.27	0.31	0.36	0.44	0.65
9	0.25	0.28	0.30	0.34	0.54
10	0.22	0.26	0.28	0.30	0.49
11	0.21	0.23	0.24	0.29	0.46
12	0.18	0.18	0.22	0.26	0.35
13	0.17	0.18	0.21	0.25	0.30

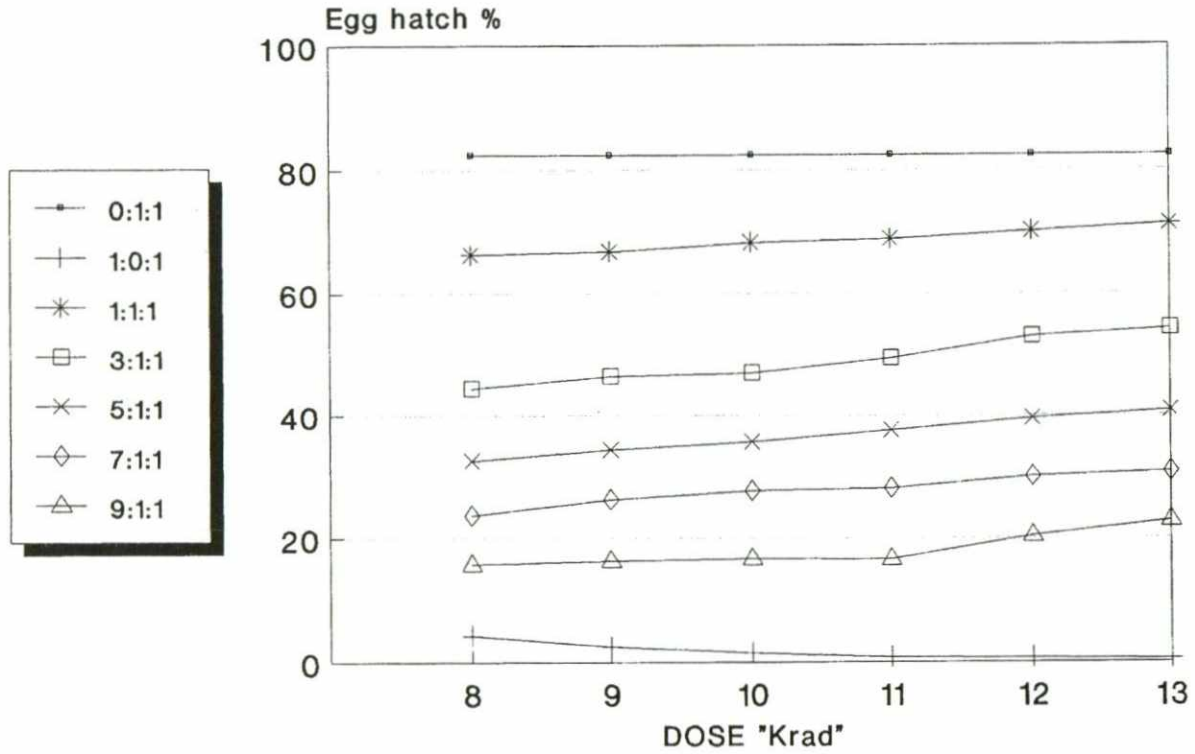


Figure 1: Egg hatch percent of Medfly females in presence of irradiated males with different radiation doses & different ratios

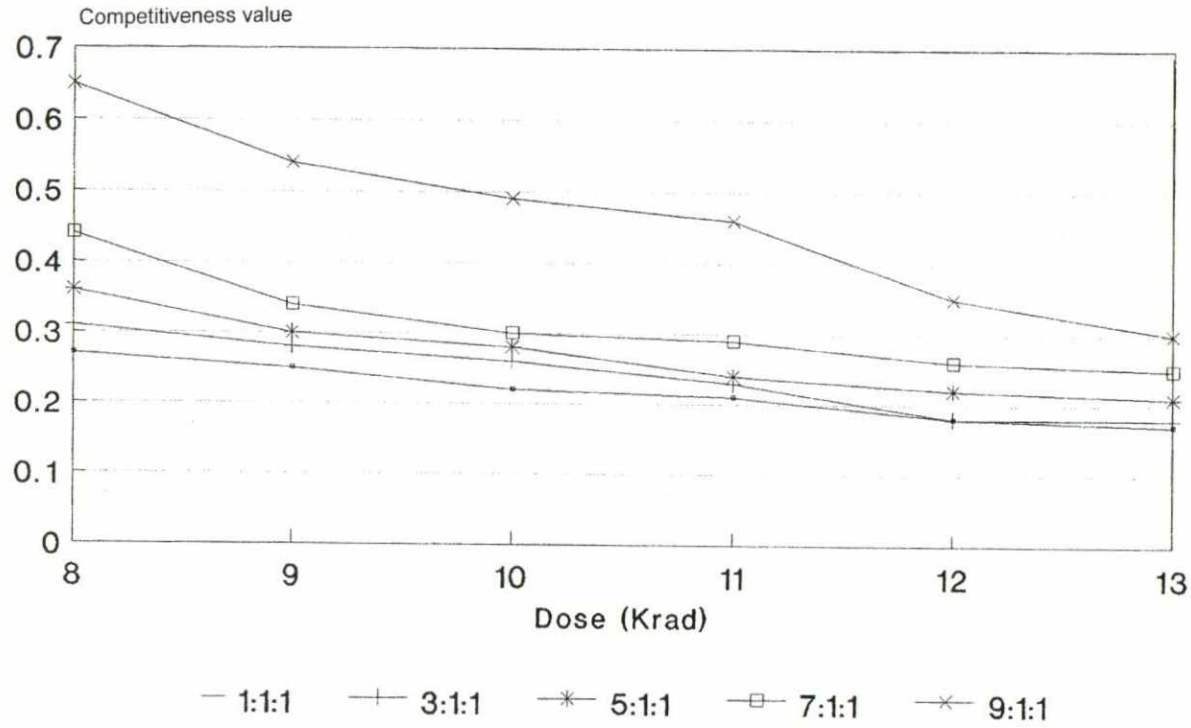


Figure 2: Sexual competitiveness values of Medfly males irradiated with different doses & in different ratios compared with non-irradiated

Table (2) also shows that for a given radiation dose, the sexual competitiveness of the irradiated males is increasing with higher ratio of irradiated males to non-irradiated males. The results show that the competitiveness value (CV) of males irradiated with 10 Krad is equal to 0.22 for a 1:1 ratio; and equal to 0.49 for 9:1 ratio. Earlier results reported by Katiyar and Valerio (6) indicate that within the range of 2:1 to 9:1 (irradiated: non-irradiated males) the competitiveness of 10 Krad treated males was about 50% with respect to that of untreated males. It was also reported by Katiyar and Ramirez (5) and Feron (2) that over flooding ratios of 40:1 and up to 64:1, respectively are required to obtain an egg hatch of less than 5%.

From the discussed results, it can be concluded that, although the level of sterility of the irradiated males increased with increasing radiation dose, the sexual competitiveness decreased with higher doses and increased with the increase of the treated to untreated male ratio for a given radiation dose.

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تعقيم سلالة ليبية من ذبابة فاكهة البحر المتوسط (*Ceratitis capitata* Wied.) بواسطة أشعة جاما. جزء 2: التأثير على التنافسية الجنسية للذكور

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المستخلص

يعتمد نجاح تقنية الذكور في مكافحة ذبابة البحر المتوسط على حيوية الذكور المحررة، ولذلك فإنه يجب دراسة تأثير التشعيع على: النسبة المئوية لظهور الحشرات البالغة، والمقدرة على الطيران، والبقائية (التعمير)، والنسبة الجنسية، ونسبة البيض الفاقس، والتنافسية الجنسية للذكور المشععة.

إن الهدف من هذا البحث هو دراسة تأثير الجرعات المختلفة من الإشعاع على التنافسية الجنسية للذكور المشععة. لقد حددت «قيمة التنافسية» لجرعات مختلفة من أشعة جاما هي 8، 9، 10، 11، 12، 13 كيلوراد عند نسب متباينة من ذكور مشععة: ذكور غير مشععة: إناث غير مشععة كالتالي: 1:1، 1:3، 1:5، 1:7، 1:9.

أظهرت النتائج المتحصل عليها أن التنافسية الجنسية ازدادت بزيادة نسبة الذكور المشععة إلى غير المشععة؛ بينما تناقصت مع الزيادة في جرعة الإشعاع.