Qatar Univ. Sci. J. (1993), 13(2): 285 - 287

# THE REPRODUCING CAPACITY OF GAMMA IRRADIATED ADULTS OF *TROGODERMA VERSICOLOR* (CREUTZ)

By

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# الكفاءة التناسلية لخنفساء تروجود يرما فيرسيكولور المعالجة بأشعة جامـــــا

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عند تشعيع الطور الكامل ( الذكور والاناث ) حديث الخروج لخنفساء تروجوديرما فيرسيكولور بأشعة جاما وجد أن الذكور تتطلب جرعات للتأثير عليها أكبر مما تتطلبه الاناث . وتقل المقدرة التناسلية كلما زادت الجرعة الاشعاعية المستخدمة .

ولقد وجد أن الجرعة ٢١٠ جراي كانت كافية لتعقيم الذكور تعقيماً كاملاً ، بينما كانت الجرعة ٨٠ جراي هي المطلوبة لاحداث نفس التأثير بالنسبة للاناث .

وقد كان عدد البيض الناتج من الاناث العادية والمتزاوجة مع ذكور مشعة أكثر من البيض الناتج من اناث مشعة بنفس الجرعات المستخدمة من ٢٠ إلى ٢١٠ جراي . وقد مالت نسبة الذكور في النسل الناتج من آباء كانت الذكور فيها مشعة إلى الزيادة بشكل غير معنوي ، كما أن الذكور الناتجة من نسل الآباء الذكور المشعة أقل في الخصوبة من الاناث الناتجة من نفس النسل ، وعند تزاوج ذكور واناث هذا النسل الناتج كان النقص في الخصوبة أكثر وضوحاً .

وفي الجيل الأول أظهر نسل الذكور الناتج من آباء ذكور مشعة مستويات من العقم أكثر من الآباء .

*Key Words:* Radiation effect, reproducing capacity.

## ABSTRACT

Male and female, *Trogoderma versicolor* (Creutz.) were irradiated by gamma radiation as newly emerged adults (12-24 hrs. after emergence). Males required higher doses than females to be sterilized and the reproductive inability increased with increasing dose. Doses of 210 and 80 Gray were sufficient to induce almost complete sterility for males and females, respectively. Egg production per female was highest in crosses involving irradiated males as compared with eggs produced from irradiated females at any dose level (from 20 to 210 Gray). The distortion of sex ratio produced from a treated male parent was slightly in favour of males. Male progeny of treated $P_1$ males showed a greater reduction in fertility than female progeny, but this fertility was lowest in progeny of cross $F_1$ male x $F_1$ female. Male progeny produced from irradiated males exhibited levels of sterility more than their irradiated male parents.

## INTRODUCTION

*Trogoderma versicolor* (Creutz.) is one of the economically important members of the 85 world species of the Dermestid beetles of the genus Trogoderma. It was recorded in Egypt in 1925 by Willcocks. This pest is one of the most numerous stored product insects in granaries, flour mills and store-houses. It causes serious damage to stored cereals, dried milk products, maize, biscuit, chocolate ... etc.

In recent years much effort has been devoted to develop nonchemical methods of controlling insect in grain and grain products. Gamma radiation can complement or replace existing methods of chemical treatments, moreover, a dose of 0.5 KGy will disinfest all stored food products from coleopteran and lepidopteran pests, leaves no residues in treated food and does not alter physical, chemical, organoleptic and technological properties of the treated products (Ahmed, 1990).

Research on irradiation of grain is being directed primarily to the practical objective of controlling infestation by killing insects or by inhibiting their reproduction and thus preventing storage loses and extending storage life (Qureshi *et al., 1970).*

The FAO and the IAFA have technical assistance projects with several developing countries that support research leading to practical application of food irradiation processing.

The study reported here was conducted to determine the doses of gamma irradiation necessary to induce complete sterility in newly emerged adults of males and females *T. versicolor* (Creutz.). in addition to the effect on longevity, sex ratio and reproductive potential of $F_1$ progeny of the irradiated male parent.

## MATERIALS AND METHODS

The test adults *T. versicolor* (Creutz.) in this study were taken from the laboratory colony, which were maintained for several generations. All experiments were carried our at 32 ± 2°C and 65 - 70% R.H. (Hadaway, 1956). Groups of virgin adult males and females (12-24 hr-old) were gamma irradiated to doses of 20, 50, 80, 110, 140, 170 and 210 Gray from a Cobalt-60 Unit (Model 220) installed at the Nuclear Physics Division of the Nuclear Research Center, Atomic Energy Authority at a dose rate of 0.01 Gray/min. Corrections for delay were conducted every month, using the fricke ferrous sulfate dosimeter (half life = 5.3 years). Immediately after irradiation, five pairs of newly emerged adults were placed in small plastic tubes on finely sifted whole wheat as an oviposition site. The number of eggs laid and their hatchability was recorded until all the females died to determine the sterility of the male and female. Beetles were sexed at the pupal stage to prevent uncontrolled mating. The following crossing scheme was used to determine the reproductive potential in the first generation of descendants of irradiated parental males: N♂ x N♀, $F_1$♂ x N♀, N♂ x $F_1$♀, and $F_1$♂ x $F_1$♀. Each experiment was replicated three times. All data were subjected to analysis of variance.

## RESULTS AND DISCUSSION

The data presented in Table (1) clearly show that gamma irradiation of newly emerged males decreased the number of eggs laid per females. This effect increased with increase of dose. Egg production as a percentage of control was 91.21, 88.01, 87.80 and 77.93, when females mated with males treated with doses of 20, 50, 80 and 110 Gray, respectively. There was no significant difference, as determined by the F-test, in comparison to that of unirradiated control males. The lowest number of eggs occurred among females mated with males irradiated to 210 Gray.

Egg hatch was adversely affected as a result of male treatment. A dose of 210 Gray was sufficient to induce almost complete sterility. The noticeable reduction in percent egg hatch observed from the dose of 110 Gray or over.

**Table 1**

Effect of gamma irradiation on the reproduction of male *Trogoderma versicolor* (Creutz.) (adults treated as 12-24 hr-old after emergence).

| Dose (Gray) | Crosses (♂ x N♀) | Eggs/Females (% of control) | Egg hatch (% of control) | Male Longevity (days) ± S.E. |
|---|---|---|---|---|
| Control | N x N | 100.00 | 100.00 | 11.4±0.33 |
| 20 | T x N | 91.21 | 77.14 | 11.1±0.71 |
| 50 | T x N | 88.01 | 74.66 | 10.4±0.83 |
| 80 | T x N | 87.80 | 71.47 | 10.4±0.37 |
| 110 | T x N | 77.93 | 61.75 | 9.5±0.67 |
| 140 | T x N | 54.63 | 16.50 | 9.2±0.91 |
| 170 | T x N | 47.61 | 4.09 | 9.3±0.08 |
| 210 | T x N | 35.07 | 0.0 | 8.1±0.17 |

N = Normal T = Treated

The analysis of variance yielded an insignificant F-value for the longevity of irradiated male which was not affected at doses up to 110 Gray. However, males irradiated with 140, 170 or 120 Gray had a significantly shorter longevity (about 20-28%).

Similar results were obtained by other workers (Lapis *et al.*, 1978) with *Lasioderma serricorne,* Ahmed *et al.*, (1979) with *Trogoderma granarium* and El-Kady (1985) with *Bruchus rufimanus* and *Bruchidius incarnatus* who concluded that some eggs were laid even after the sterilizing dosage and the survival time of irradiated adults decreased with increasing radiation dose.

Table (2) presents the results for irradiated females paired with unirradiated males. Egg production per females was greatly decreased at each dose level from 20 to 80 Gray. A significant reduction in the fecundity occurred at dose of 50 Gray and above.

The hatchability of eggs laid by irradiated females was drastically reduced at each radiation dose used. The reduction in egg hatch continued as the dose was increased. For example, the percent egg hatch after a dose of 50 Gray was 18.08%. A dose of 80 Gray was sufficient to induce complete sterility of *T. versicolor* females.

**Table 2**

Effect of gamma irradiation on reproduction of female *Trogoderma versicolor* (Creutz.) (adults treated as 12-24 hr-old after emergence).

| Dose (Gray) | Crosses (♂ x N♀) | Eggs/Females (% of control) | Egg hatch (% of control) | Male Longevity (days) ± S.E. |
|---|---|---|---|---|
| Control | N x N | 100.00 | 100.00 | 9.9±0.48 |
| 20 | N x T | 66.51 | 51.22 | 8.7±0.19 |
| 50 | N x T | 49.11 | 18.08 | 8.3±0.70 |
| 80 | N x T | 27.49 | 0.0 | 7.7±0.88 |

N = Normal T = Treated

In regard to the longevity of irradiated females, no detectable differences were observed at all radiation doses used from 20 to 80 Gray and the untreated control.

The percentage of pupation and adult emergence from irradiated parental males was negatively correlated with the dose of irradiation (Table 3). It was found that irradiation of $P_1$ males with 50 Gray or above significantly affected the rate of pupation and adult emergence, but 20 Gray allowed 66.5% adult emergence.

**Table 3**

Effect of gamma irradiation on pupation, emergence and sex ratio in, $F_1$ progeny of *Trogoderma versicolor* (Creutz.) produced from treated male parents (as 12-24 hr-old).

| Dose (Gray) | Initial No. of eggs used | % pupation | % Emergence | % Males |
|---|---|---|---|---|
| Control | 300 | 92.6 | 88.2 | 47.8 |
| 20 | 300 | 70.7 | 66.5 | 49.1 |
| 50 | 300 | 59.3* | 41.1* | 51.3 |
| 80 | 300 | 44.3** | 27.7** | 50.9 |
| 110 | 300 | 29.6** | 14.8** | 50.1 |
| 140 | 300 | 9.5** | 4.2** | 52.6 |

* Significant at 5% level as determined by F-test.
**Significant at 1% level as determined by F-test.

The sex ratio of adults from irradiated male parents was in favour of males for all doses that caused a decrease in the percentage of adult emergence, i.e., the increase in the percentage of males was related to the decrease in the total percentage of adult emergence (Table 3).

The reasons for this distortion in sex ratio are not yet apparent (Proshold and Bartell, 1970).

Table (4) shows that, irradiation of $P_1$ male adults to substerilizing doses ranging from 20 to 100 Gray caused some inherited sterility matings in the $F_1$ generation. The $F_1$ female progeny of males irradiated to 20, 50, 80 and 110 Gray showed almost no reduction in oviposition from that of the unirradiated control, but normal females mated with with $F_1$ males of the same percentage had slightly reduced eggs per female. The egg reduction was greater in $F_1$♂ crossed with $F_1$♀ than the other crosses. Generally, egg production per female was not significantly influenced by the radiation treatment.

**Table 4**

Effect of gamma irradiation on reproduction of $F_1$ *Trogoderma versicolor* (Creutz.) (male parents treated as 12-24 hr-old).

| Dose (Gray) | Eggs/female (% of control) | Egg hatch (% of control) |
|---|---|---|
| | $F_1$ male x N female | |
| Control | 100.00 | 100.00 |
| 20 | 90.22 | 75.51 |
| 50 | 87.53 | 74.22 |
| 80 | 82.11 | 72.93 |
| 110 | 76.56 | 60.98 |
| | N male x $F_1$ female | |
| Control | 100.00 | 100.00 |
| 20 | 99.41 | 98.47 |
| 50 | 97.45 | 88.66 |
| 80 | 97.71 | 92.95 |
| 110 | 93.66 | 90.87 |
| | $F_1$ male x $F_1$ female | |
| Control | 100.00 | 100.00 |
| 20 | 88.12 | 71.65 |
| 50 | 80.23 | 71.65 |
| 80 | 78.84 | 68.63 |
| 110 | 73.69 | 57.44 |

The fertility of $P_1$ males was greater than that of their male progeny (Table 4), but, female progeny had a higher fertility than the irradiated $P_1$ males. Male progeny were more sterile than female progeny. When $F_1$ males paired with $F_1$ females, the percentage of sterility was higher (43% of control at 110 Gray and 32% of control at 80 Gray) than when either sex was paired with normal opposites.

Exposure of virgin males, *Anthonomus grandis* to 100 Gray resulted in transient sterility whereas 150 Gray produced permanent sterility (Davich and Lindiquist, 1962). The phenomenon of partial recovery from induced sterility in a number of insect species, may influence the permanence of sterility in successive matings (Liggins and Singh, 1971, and Brower, 1980).

Finally, a dose of 210 Gray can effectively sterilize and control *Trogoderma versicolor* in all stored food products.

A low dose of 1 KGy has been recommended by the international bodies for disinfestation of food (Ahmed, 1990).

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