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INTERACTION OF STARVATION AND GAMMA RADIATION ON THE FECUNDITY OF *TRIBOLIUM CASTANEUM* (HERBST) (COLEOPTERA: TENEBRIONIDAE)

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Starved and unstarved beetles of *Tribolium castaneum* (Herbst) were irradiated with low doses of gamma radiation viz:- 4, 6, 8, 12 krad and their fecundity was studied up to 8 days under controlled laboratory conditions. It was recorded that fecundity decreased immediately following irradiation, but the subsequent recovery was dose dependent. The rate of oviposition increased with an increased period of starvation. Pre-irradiation starved beetles were less fecunditive than the post-irradiation ones. Irradiated individuals, though, laid eggs, but none of the eggs hatched at 8 and 12 krad.

INTRODUCTION

The ionizing radiation is known to cause sexual sterility, a finding utilised in insect control. Gamma radiation appears to be a potential alternative to chemicals for insect control in stored products [1,2]. However, the cost of irradiation is higher than those of treating them by currently used chemical control methods.

Starvation exerts stress on the physiology of the insects which ultimately affects their feeding activity and reproductive potential. Relatively little is known about this aspect of insect behaviour especially in the red flour beetle, *Tribolium castaneum.* Present studies were designed to observe additive, complementary and antagonistic effects of both radiation and starvation, singly as well as in combination, on the fecundity of *T. castaneum.*

MATERIALS AND METHODS

The culture of *T. castaneum* was maintained on whole wheat flour with 5 % yeast at 27±1° and 60±5 % R.H. with 12:12 light-dark cycle. Pupae of uniform age were taken from the stock culture and sexed 2 days before emergence according to Ho [3]. The two sexes were held separately in paired glass petri dishes with small quantity of wheat flour. Adults were sorted 24 hours after eclosion and confined as such. For experimentation, the insects were grouped in six batches, by assigning single batch to each treatment including control. Each treatment was replicated four times. The five sets of experiment comprised of starvation, radiation, radiation and starvation, pre-irradiation starvation and post-irradiation starvation.

For starvation, insects of each sex at the age of 9 days were confined in glass petri dishes and starved for 1 – 8 days. For 8-day starvation treatment the insects were deprived of food on the first day while for the rest of the treatments they were starved on subsequent days. At the completion of starvation a single pair of insects was released in small glass vial containing 60-meshed wheat flour with 5 % yeast and plugged with cotton wool. The pair was allowed to oviposit for 1 day and then transferred daily to fresh food vial up to 8 days. The contents of the vial were sieved through 60-mesh sieve and the eggs held were counted.

For single radiation, 9-day-old insects of each sex were irradiated in glass petri dishes separately in cobalt-60 gamma irradiator with a dose rate of 98.6 krad/hr. The doses given were 4, 6, 8 and 12 krad, respectively. After irradiation, the insects were confined for oviposition in the manner described above. Egg viability was determined through larval hatch counts.

For the combined treatment of irradiation and starvation, the insects were irradiated with 4, 6, 8 and 12 krad doses in the same gamma source, and then starved for 1–8 days in the manner described above.

In the fourth and fifth set of experiment, i.e., pre- and post-irradiation starvation, the beetles were starved for one

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and two days either before or after irradiation and then experimented accordingly.

During the entire period of study all the insects were kept at 27±1° and 60±5 % R.H. with 12:12 light-dark cycle. The data recorded were compiled and subjected to statistical analysis for the mean values in the form of graphical representation.

RESULTS AND DISCUSSION

1. *Effect of Irradiation.* The effect of irradiation on the fecundity of *T. castaneum* (Fig. 1) shows that the rate of oviposition decreased immediately following irradiation and it was at the minimum level in all the four doses. However, the effect was dose dependent and the insects recovered gradually. Fecundity was lowest in 12 krad, followed by 8, 6 and 4 krad, respectively. The speed of recovery was also dose dependent, as insects irradiated with lower doses recovered earlier than those treated with higher ones. The doses of 4,6 and 8 krad exhibited effect up to 1 day, whereas at 12 krad it lasted for about two days. After two days the increase in recovery was significant in 4 and 6 krad as compared to 8 and 12 krad.

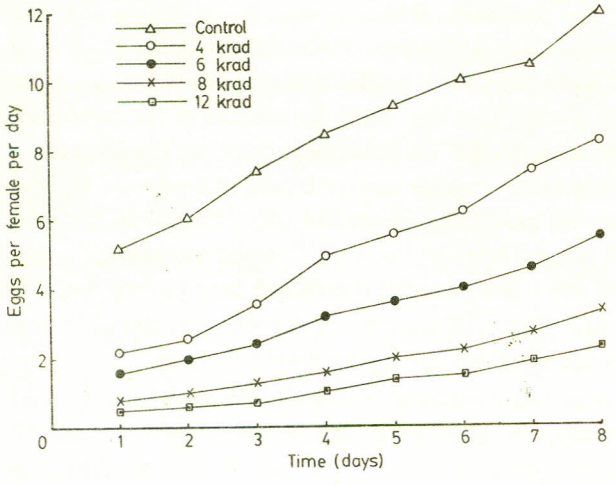

Fig. 1. The effect of four doses of gamma radiation on the fecundity of *T. castaneum* up to 8 days after irradiation.

2. *Single Starvation and Post-irradiation Starvation.* When beetles were starved up to 8 days, the rate of oviposition increased correspondingly with the increased period of starvation (Fig. 2) and it reached up to the maximum number of 10.87 eggs at 8 days. In case of insects starved after irradiation, the rate of fecundity was, however, lower than the control (single starvation). Minimum number of eggs were laid in 12 krad followed by 8, 6 and 4 krad, respectively. The rate and speed of recovery was also dose dependent in all the treatments.

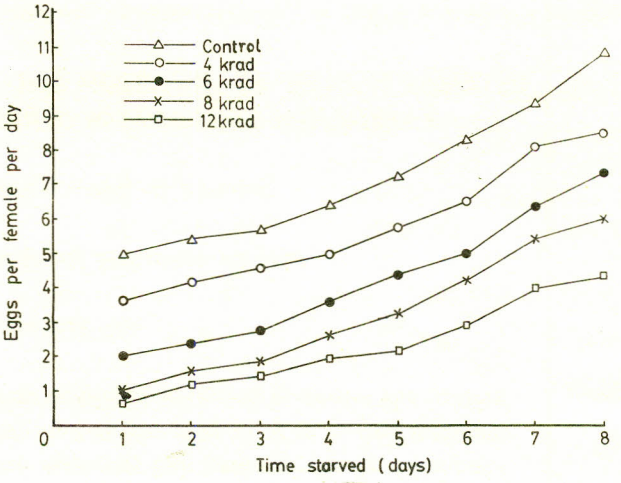

Fig. 2. The effect of different periods of starvation on the fecundity of *T. castaneum* after irradiation.

3. *Pre- and Post-irradiation Starvation.* The fecundity of *T. castaneum* when starved for one and two days before or after irradiation (Fig. 3) indicates that 2-day starved post-irradiation insects laid a maximum number of 4.69 eggs at 4 krad followed by 1-day treatment. Fecundity decreased with an increased dose of irradiation which reached to the minimum level at 12 krad. The rate of egg laying in 2-day and 1-day starved pre-irradiation treatment was comparatively lower than the post-irradiation starved insects at all the dose levels. However, in the unstarved irradiated beetles, fecundity was significantly lower than the starved irradiated ones. It indicates that post-irradiation starvation resulted in increased fecundity than the pre-irradiation starvation and at the same time starvation overcame the radiation syndrome and resumed fecundity. It also reflects that reproductivity of the insect was directly influenced both by radiation and starvation depending on the dose exposure and length of starvation period.

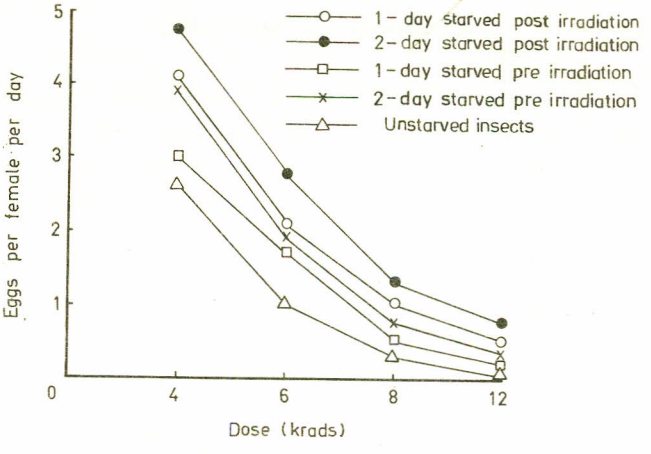

Fig. 3. The fecundity of *T. castaneum* starved for 1 and 2 days before or after irradiation.

Present findings reflect that even at lower doses of radiation, starvation can subside radiation effect which in other words increased feeding activity and resulted in greater fecundity than the single radiation. However, in single radiation the irradiated individuals laid eggs, but none of the eggs hatched at 8 and 12 krad. These findings are in close conformity with already published results [4].

The present results also indicate that post-irradiation starvation treatment insects were comparatively more fecunditive than the single radiation and pre-irradiation starvation. It may be due to the reason that in post-irradiation starvation the insects might have recovered from radiation effect during starvation period while in pre-irradiation starvation, the effect of radiation was more pronounced because it not only checked recovery, but also exerted double stress at the vulnerable point.

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