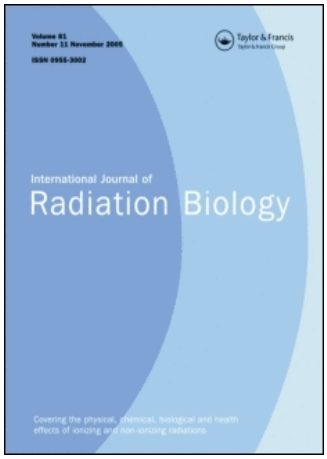

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Effects of gamma radiation on potato epilachnid, *Henosepilachna vigintioctopunctata* (F), (Coleoptera, Coccinellidae) Part 1. Radiosensitivity of different developmental stages

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1. Introduction

The potato epilachnid, *Henosepilachna vigintioctopunctata* (F) is a serious pest of solanaceous crops. Both larval and adult stages of this insect are destructive, since they feed on the leaves of the host. There are some reports concerning the effects of radiation on related species of *Epilachna*. Viado and Manoto (1963) have reported the pupal stage to be more radioresistant than larval and adult stages of *Epilachna phillipinensis*. However, Henneberry *et al.* (1964) have shown that the adults of *Epilachna varivestis* are more radioresistant than the larvae and pupae. The present investigation deals with the effects of gamma radiation on the different stages of development of *Henosepilachna vigintioctopunctata*. These studies were undertaken in order to determine the most suitable stage and proper dose for sterilizing techniques for this insect.

2. Materials and methods

Adults of potato epilachnid beetle *H. vigintioctopunctata* (F) (order Coleoptera, family coccinellidae) were collected from the Karsog area of Himachal Pradesh (India) during the month of April from heavily infested potato fields. Adults were kept in plastic jars in a B.O.D. incubator set at 30 ± 1°C, with photophase of 17L : 7D and R.H. of about 70 per cent. They were fed on fresh potato leaves. Females laid eggs on the surfaces of leaves in clusters. Eggs were collected and allowed to hatch. The progeny of adults which had spent several generations in the laboratory was used in this experiment.

Three-day-old eggs, 4th instar grubs, 1 and 3 to 4-day-old pupae and 3 to 5-day-old adults were irradiated by a ^{60}Co source (dose rate 0·52 Gy per s) at radiation doses of 0 (control), 10, 30, 50 and 70 Gy. The specimens for irradiation were placed in plastic jars. Each treatment consisted of 5 replicates each containing 100 insects.

Observations were made on the hatchability of irradiated eggs, development of larvae eclosing from irradiated eggs, the percentage of larvae attaining the adult stage, and hatchability of the eggs laid by the adults. In the irradiated grubs, pupation, adult emergence, adult survival for 16 days and abnormalities if any due to irradiation were observed. Similar observations were made on irradiated 1-day-old and 4-day-old pupae. Irradiated 3- to 5-day-old adult insects were observed for their survival for 14 days.

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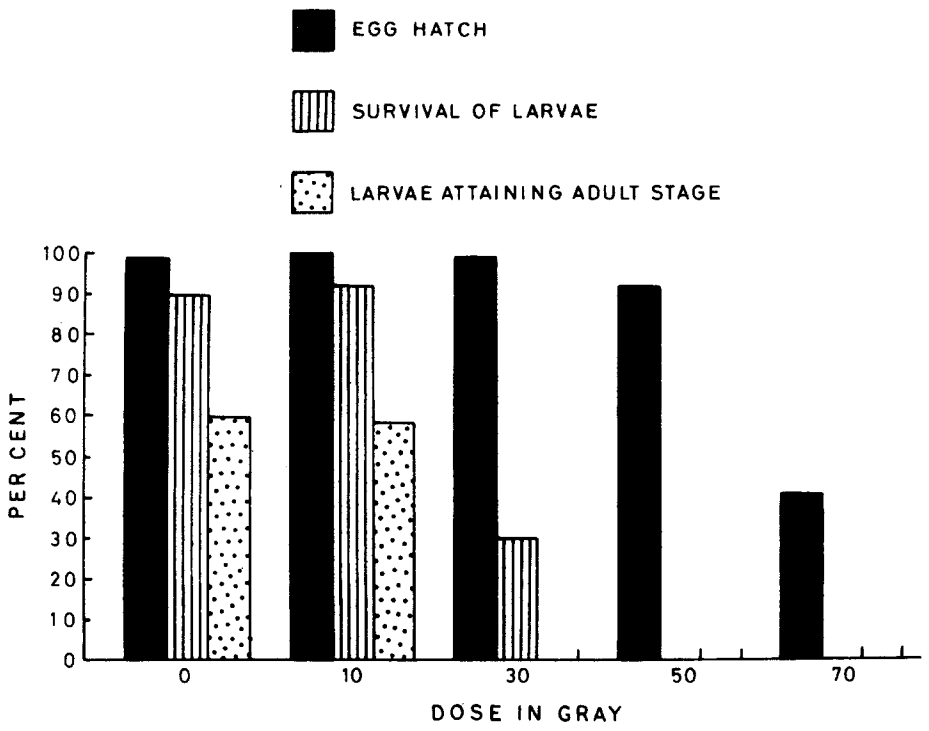

Figure 1. Histogram showing effect of gamma radiation on 3-day-old eggs of *H. vigintiocto-punctata*.

3. Results and discussion

3.1. *Irradiation of eggs*

Egg hatch was not affected by radiation doses of 10 and 30 Gy. However, it was reduced to 92·1 and 41·1 per cent in eggs irradiated with 50 and 70 Gy respectively (figure 1). Thus the percentage of egg hatch was a dose-dependent variable. The survival of grubs after hatching from irradiated eggs was 92·9, 31, 0 and 0 per cent in the 10, 30, 50 and 70 Gy treatments respectively, 7 days post-irradiation. In controls the survival of grubs was 90·6 per cent. This shows that the lethal effect, which remained latent at the time of egg hatch, became visible during later development. None of the grubs surviving 7 days after irradiation of eggs with 30 Gy could attain the imaginal stage. Adults emerging from 10 Gy irradiated eggs were normal and laid 91 per cent fertile eggs.

In *Epilachna phillippinensis* (Viado and Manoto 1963), normal adults having an egg fertility of 95 per cent emerged after 10 Gy irradiation of eggs, but after 50, 100 and 200 Gy, the emerging adults were abnormal. In the present study, normal adults having 91 per cent fertility did emerge after 10 Gy irradiation and there was no adult emergence at doses higher than 10 Gy. Brower (1975 a and b) has reported that development of adults from eggs was prevented when eggs of *Sitophagus hololeptiodes* and *Tribolium destructor* were irradiated with 50 Gy or higher doses.

3.2. *Irradiation of grubs*

After 10 Gy irradiation of fully fed fourth instar grubs, the percentage pupation, adult emergence and fertility of eggs laid were comparable with the control, yet many

Figure 2. Adults of *H. vigintioctopunctata* emerging from the 4th instar grub irradiated with 10 Gy. Note the reduced size and abnormal wings showing the extent of malformation.

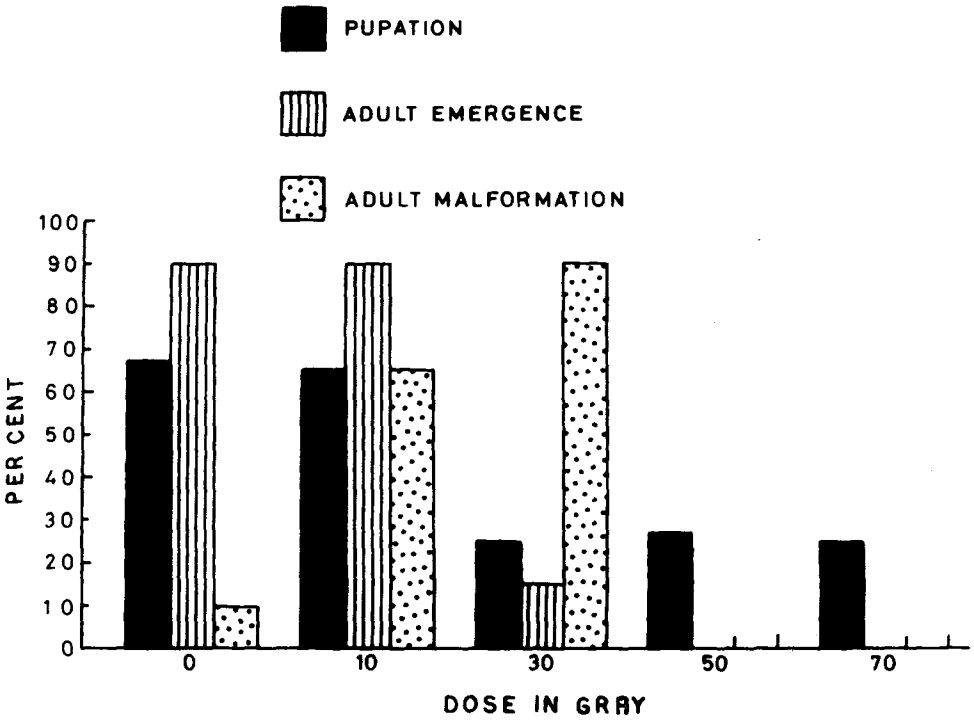

Figure 3. Histogram showing effect of gamma radiation on 4th instar grubs of *H. vigintioctopunctata*.

imagines showed malformations (figure 2). The frequency of malformation was 9·1 and 66·2 per cent respectively in the controls and the 10 Gy irradiated group (figure 3). At higher doses, the effects were more deleterious. The pupation of grubs irradiated with 30, 50 and 70 Gy was 24·3, 27·0 and 25·1 per cent respectively. In controls, pupation was 67·1 per cent. Adult emergence from the pupae was 90·5, 89·3 and 14·4 per cent in control, 10 Gy and 30 Gy irradiated insects. After 50 and 70 Gy irradiation, there was no adult emergence.

Radiation damage to grubs became visible within two days of irradiation. Affected grubs shrivel up and turn blackish instead of the natural greenish yellow. At higher doses (30, 50 and 70 Gy), the larval period was prolonged. Few grubs survived for 7 to 10 days when all the control grubs had pupated. Such grubs did not pupate.

Larvae of *Epilachna varivestis* have also been reported to be sensitive to gamma radiation (Henneberry *et al.* 1964). When the larvae were exposed to 40 Gy and higher doses, there was no survival. In *H. vigintioctopunctata* too, we did not find adult emergence above 30 Gy irradiation. Adults emerging from the larvae of *E. philippinensis* (Viado and Manoto 1963) irradiated with 10 Gy had abnormal wings and legs and there was no adult emergence at doses above 10 Gy. In the present study, there was no adult emergence at 50 and 70 Gy while after 10 and 30 Gy, abnormal adults emerged.

3.3. *Irradiation of pupae*

When 1-day-old pupae were irradiated, morphological deformities existed in 41·8 and 95·2 per cent imagines after 10 and 30 Gy irradiation (figure 4). At higher doses, normal adults did not emerge. All the emerging adults after 50 and 70 Gy were malformed. Irradiation of 3- to 4-day-old pupae did not produce morphological abnormalities at any dose level. However, post-irradiation survival of emerging adults was the same in both 1 and 3 to 4-day-old pupal irradiation (figures 5 and 6). There was no survival of adults irradiated with 50 and 70 Gy at 16 days after irradiation. The radiosensitivity of immature pupae is revealed only in terms of higher adult malformation than after irradiation of mature pupae. Adults emerging from the pupae after 10 Gy irradiation (both immature i.e. 1 day old and mature i.e. 3 to 4 days old) laid fertile eggs.

In *E. philippinensis*, when pupae were irradiated with 50 Gy, emerging adults still laid 40 per cent fertile eggs (Viado and Manoto 1963). However, in *H. vigintioctopunctata* adults emerging after irradiation with 30 Gy and above were sterile.

3.4. *Adult irradiation*

3- to 5-day-old adults after 10 Gy irradiation did not show any effect of irradiation. Eggs laid by these beetles were 91 per cent fertile. However, at higher doses,

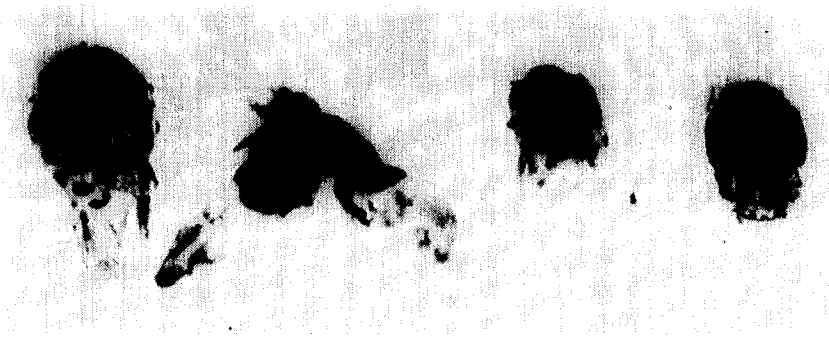

Figure 4. Malformed adults of *H. vigintioctopunctata* emerging from pupae irradiated at one day of age with 10–30 Gy.

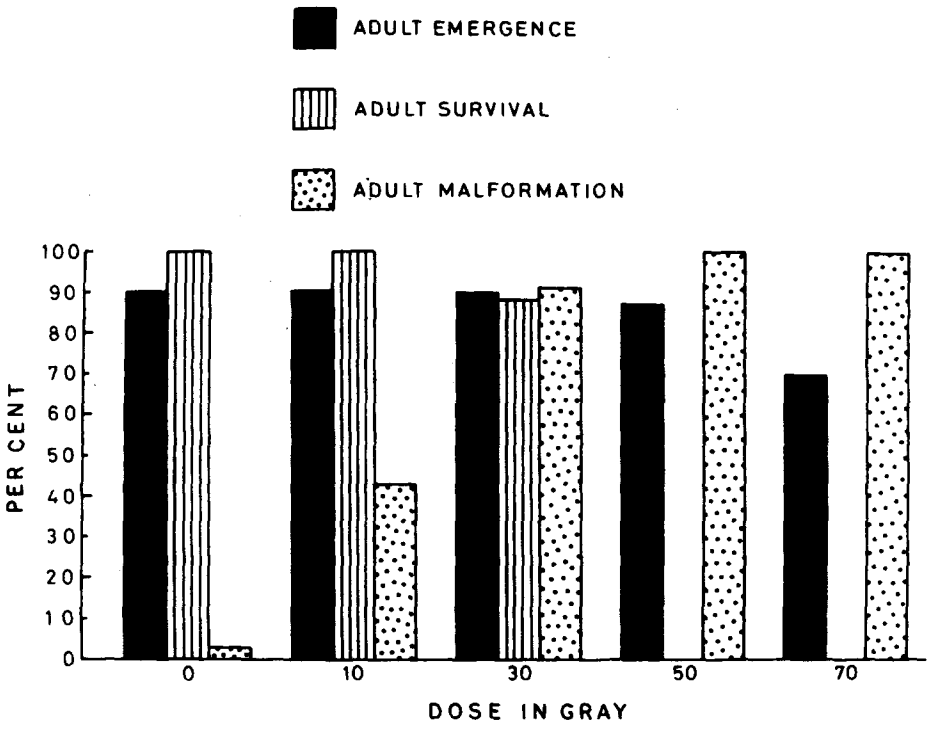

Figure 5. Histogram showing effect of gamma radiation on one-day-old pupae of *H. vigintioctopunctata*. Survival 16 days after irradiation.

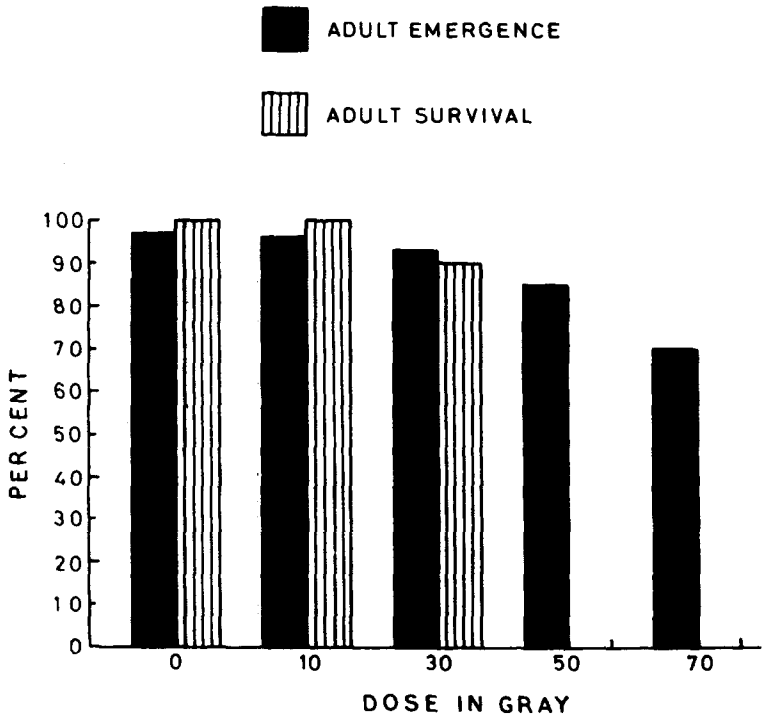

Figure 6. Histogram showing effect of gamma radiation on 3- to 4-day-old pupae of *H. vigintioctopunctata*. Survival 16 days after irradiation.

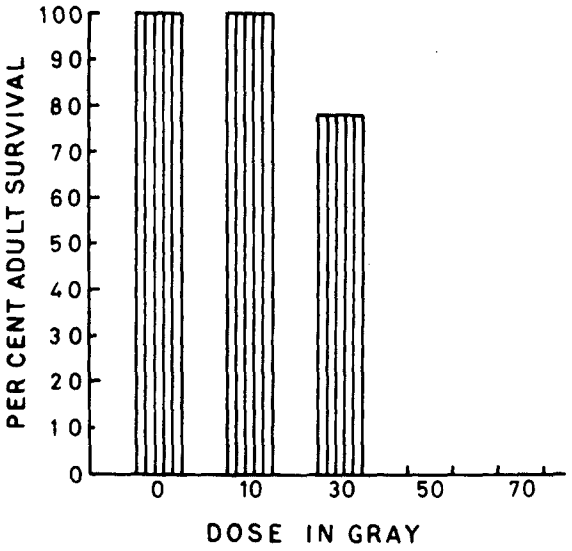

Figure 7. Histogram showing effect of gamma radiation on 3- to 5-day-old adults of *H. vigintioctopunctata*. Survival 14 days after irradiation.

radiation damage was apparent. Irradiation of adults with 30, 50 and 70 Gy resulted in 75·4, 0 and 0 survival at 14 days (figure 7).

After 30 Gy irradiation, adults were sterile. Radiation damage to the beetles at higher doses of 50 and 70 Gy was visible within 1 to 2 days of irradiation. Anorexia was caused at these doses and the beetles started showing a dislike to the food, which is a typical consequence of irradiation as described by Grosch (1956). There was no morphological defect in the irradiated insects. Adults of *E. philippinensis* were also not affected by 10 Gy, but at higher doses i.e. 50, 100 and 200 Gy, they still laid 72, 60 and 30 per cent fertile eggs respectively (Viado and Manoto 1963).

It is evident from the present study that after 30 Gy irradiation of eggs, grubs, pupae and adults, the resulting adults were sterile. The larval stage appears to be most radiosensitive as suggested by lower larval survival and adult malformations. Mature pupae were quite radioresistant and there was no malformation of adults such as found after irradiation of immature pupae. Moreover, this stage is very easy to handle during irradiation. These results indicate that for sterile insect techniques either mature pupae or adults are the ideal stages for irradiation of *H. vigintioctopunctata* with minimum somatic damage. Many other workers have also reported that immature stages of insects were sensitive to irradiation (Chung *et al.* 1971, Cogburn *et al.* 1966).

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