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STERILIZING OF Alphitobius diaperinus (PANZER, 1797) (COLEOPTERA: TENEBRIONIDAE) IRRADIATED IN PUPA STAGE

[2,1]Paula Bergamin Arthur, [2]Anna Lúcia C.H., Villavicencio, [1,2]André Ricardo Machi, [2]Rodrigo Sebastião Rossi Leandro, [1,2]Valter Arthur

[1]Center For Nuclear Energy in Agriculture (CENA/USP), Department of Radiobiology and Environment, University of São Paulo, Box: 13416 – 000, Piracicaba – SP. Brazil.[2] Institute of Energy and Nuclear Research (IPEN), Department of Radiation Technology Center, University of São Paulo. Box: 05508-000, São Paulo – SP, Brazil.

ABSTRACT

Worldwide the loss of stored grain is a problem of economic order of importance, in view of the concern of the increased supply of food for a world population increasingly expanding. Associated with this fact, there is the problem of nutritional deficiency due to lack of protein, especially for the less privileged populations in the resources of a country. This lack could be met by adequate supply of grain produced, requiring for it, a system that provides optimum grain storage conditions in securing the quality until the time of consumption. The use of radiation in stored grain can solve the problem of the losses in these products, as it does not induce resistance of insects and leaves no toxic residue to the consumer, and is considered an effective and safe method. The aim of the experiment was to determine the sterilizing dose of ionizing radiation from cobalt-60 to *Alphitobius diaperinus* (Panzer, 1797)(Coleoptera: Tenebrionidae) in peanuts irradiated in pupa stage. The experiment was conducted in the laboratory of Radiobiology and Environment of the Center for Nuclear Energy in Agriculture - CENA / USP., Piracicaba, SP, Brazil. Peanuts samples infested with pupae of *A. diaperinus* were utilized in the experiment that consisted of 8 treatments with 5 repetitions. Each repetition consisted of 20 pupae a total of 100 individuals per treatment. Were irradiated with doses of 0 (control), 25, 50, 75, 100, 125, 150 and 175 Gy, in a source of cobalt-60, Gammacell-220 type, with a rate dose of 381Gy / h. The experiment was conducted in a room with temperatures of 25 ± 5 ° C and relative humidity of 70 ± 5%. After of irradiation process was evaluated of the number of emerged adult insects in each repetition in the treatments. The results show that the sterilizing dose in F_1 generation was 125 Gy and the pupa lethal dose 150 Gy. The dose of 150 Gy of gamma radiation can be used as phytosanitary treatment to control of immature stages of *A. diaperinus* infested peanuts.

1. INTRODUCTION

Worldwide the loss of stored grain is a problem of economic order of importance, in view of the concern of the increased supply of food for a world population increasingly expanding. Associated with this fact, there is the problem of nutritional deficiency due to lack of protein, especially for the less privileged populations in the resources of a country. This lack could be met by adequate supply of grain produced, requiring for it, a system that provides optimum grain storage conditions in securing the quality until the time of consumption. The use of radiation in stored grain can solve the problem of the losses in these products, as it does not induce resistance of insects and leaves no toxic residue to the consumer, and is considered an effective and safe method [1, 2].

The first use of ionizing radiation on insects was performed by [3] when irradiated *Sitophilus oryzae* with X-ray, but did not get satisfactory results. Promising results were obtained only by [4] that used X-rays to control *Lasioderma serricorne*, tobacco plague stored.

From 1950 there was a major breakthrough in this type of research. Some factors such as the discovery of resistance to certain pests to chemicals, biological imbalance and toxicological problems caused by these products, contributed to this advance. Irradiation of the stored products can solve these types of problems, since it does not induce the emergence of resistance nor residues [5, 6, 7].

Some control measures are adopted to solve the damage and losses caused by insects such as good storage practices, monitoring of pests and chemical treatment, this in turn end up causing some damage, besides the resistance of insects to the active ingredients used in composition of chemicals, and because of these problems, there is a need for more effective methods of control at low cost. Irradiation by numerous factors has been presented as the best solution to control pests [6, 2, 8, 9].

The disinfestation of grain consists of a physical control method, inhibiting reproduction of insects or even killing him. However, for such control is of prime importance to know the lethal doses of ionizing radiation for the different stages of the life cycle of the pest, as the radiosensitivity varies according to several factors, including the stage of development [1, 2].

Postharvest phytosanitary irradiation is growing in commercial application and offers some advantages compared with other treatments for the control of quarantine pests on exported commodities. Irradiation takes less time than fumigation and leaves no undesirable residues, while being at least as effective as any other existing method insect and mite control. Also, while the development of resistance to insecticides and acaricides is a growing problem, resistance to irradiation has never arisen in arthropods [10, 11].

The use of methyl bromide as a fumigant to protect commodities is being phased out; indeed the 1997 Montreal Protocol Agreement stipulated that methyl bromide usage would be completely phased out by 2005 in developed countries and by 2015 in developing countries, (UNEP 2009). Nevertheless, certain uses of methyl bromide are exempt from phase-out, and these include the strictly regulated quarantine and preshipment applications [12].

Irradiated adults *Lasioderma.serricorne*, *Plodia interpuctella, Sitophilus zeamais and Sitophilus oryzae,* in four commercial brands of feed used to feed small animals. The samples were irradiated with doses of: 0 (control) 0.5; 1.0 and 2.0 kGy. He concluded that the dose of

0.5 kGy was enough to induce the sterilization and consequently the disinfestation of all rations studied [6].

Stated that food irradiation for food borne disease prevention and pest commodity disinfestation is increasing in several countries. The objective of this review is to analyze the literature and current use of irradiation to control the pests of stored products and suggest research to optimize its potential. Doses to avoid pest reproduction of stored products [9].

Irradiated all phases of the evolutionary cycle of *Trogoderma granarium* with doses of 50 to 200 Gy of gamma radiation. He concluded that a dose of 100 Gy was sufficient to control the insects and that this dose of radiation could be applied for quarantine treatment [10].

But studied on the effects of gamma radiation with this specie of insect *A. diaperinus* no work was found in the literature review. Due to this the aim of the experiment was determine the sterilizing dose to *A. diaperinus* irradiated in pupa stage by gamma radiation in peanuts at their control.

2. MATERIAL AND METHODS

The experiments were performed in the Laboratory of Radiobiology and Environment, Center for Nuclear Energy in Agriculture (CENA / USP), Piracicaba city, Sao Paulo, Brazil. The insect colony was obtained from cultures that had been maintained in the laboratory for more than 1 yr. were utilized peanuts *Arachis hypogaea* cv. IAC 8112 samples in flasks with capacity of 200 mL infected with adults of *Alphitobius diaperinus*. The experiment consisted of 8 treatments, each treatment had 5 repetitions and each consisted of 20 individual's pupae, a total of 100 individuals per treatment. Were irradiated with doses of 0 (control), 25, 50, 75, 100, 125, 150 and 175 Gy, in a source of Cobalt-60, Gammacell-220 type, at a rate dose of 381 Gy/h. (Atomic Energy of Canada, Ottawa, Ontario, Canada) located in CENA / USP.

The intended doses for the irradiated samples were 25 - 175 Gy. Gammachrome dosimeters with range dose of 0.1–3 kGy were used, and they were read with a Genesy 20 spectrophotometer. Dose certifications were made by the Institute for Energy and Nuclear Research – IPEN. The traceability of dose measurements was maintained by comparison with the international service assurance dose offered by the International Atomic Energy Agency, Vienna, Austria. The 200 mL flasks were centralized inside the irradiator in order not to disrupt the uniformity of the radiation. Six dosimeters were positioned as follows: 1 on top of the flask, 1 at the bottom, and 4 equally-spaced at lateral positions. The uncertainty in each flask was ± 1.6%. The variation of measured doses was of ± 1.5% in the Gammacell-220 source.

The experiment was conducted in a room with a relative of 25 ± 5 ° C temperatures , humidity of 70 ± 5% and a 14:10 h L:D photoperiod. After 50 days of the irradiation process were performed evaluations using the method of counting of the number emerged insects in P and F_1 generations in the treatments. The experimental statistical design was completely randomized in an 8x5x1 scheme (8 treatments and 1 sampling time and 5 repetitions). The results of evaluations of the tests were subjected to variance analysis by F test, and the comparison of averages by 5% Tukey test, using the statistical system SAS (2002).

3. RESULTS AND DISCUSSION

Table 1 shows the average number of adults emerged in the P and F_1 generations from adults of generation *A. diaperinus* irradiated in phase pupae with increasing doses of Cobalt-60 gamma radiation of: 0 (control); 25; 50; 75; 100; 125; 150 and 175 Gy in peanuts. From the results of this Table, we can observe that to all the treatments presented significant statistical differences and that the effects of the gamma radiation in the pupae were directly proportional to the increase of the doses of radiation. Radiation doses of 50 Gy to 100 Gy caused a significant reduction in the development of the irradiated pupae, which was above 60% when compared to the control treatment, but these doses were not sufficient to cause total sterility in adults. The sterility of irradiated generation P adults was only obtained with the dose of 125 Gy, where there was no emergence of adults in the F1 generation. These results are in agreement with the results obtained by [6, 9,14,], and with the other results of the articles cited in the review of literature to insects of the same order as the mealworm.

In relation to the phytosanitary treatment to pupa of *A. diaperinus* in peanuts, a dose of 125 Gy should be applied, consequently the emergence of adults from paternal generation irradiated. This dose was sterilizing in induced dult insects, and as we know a sterile population is an extinct population. In accordance with the International Standards for Phytosanitary Measures ISPM No. 18, which states that for beetles of stored products of Coleopteran order to sterilize adult in active reproduction requires doses of 50-400 Gy.

According to our results, irradiation of *A. diaperinus* the sterility of generation P adults was only obtained with the dose of 125 Gy, where there was no emergence of adults in the F_1 generation. The lethal dose to pupae was 150 Gy where there was no adult emergency in the F_1 generation. Based on criterion of 100% of mortality the dose of 150 Gy can also be considered a viable candidate for phytosanitary irradiation of *A. diaperinus* infested peanuts.

Table 1. Mean number of adults (± SE) of *Alphitobius diaperinus* emerged in the P and F_1 generations of pupa in peanuts irradiated with doses of 0 (control), 25, 50, 75, 100, 125, 150 and 175 Gy, with gamma radiation of Cobalt-60 .

Doses/Gy	Mean number of irradiated pupae	Mean number of emerged adults in P generation	Mean number of emerged adults in F_1 generation
0	20	19.4±2.0a	147.0±3.0a
25	20	13.7±1.5b	97.1±1.0b
50	20	10.2±1.3c	21.4±1.5c
75	20	7.2±1.0d	11.9±1.7d
100	20	3.5±1,7e	3.2±0.7e
125	20	1.3±0.7f	0.0±0.0f
150	20	0.0±0.0g	0.0±0.0f
175	20	0±0,7g	0±0,0f

*Means followed by the same letter do not differ by Tukey's test at 5%.

4. CONCLUSION

The dose of gamma radiation of 125 Gy was sterilizing to adults emerged and lethal dose 150 Gy being considered a viable candidate for phytosanitary irradiation of *A. diaperinus* infested peanuts.

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