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LETHAL DOSE DETERMINATION OF COBALT-60 FOR ADULT *Tribolium castaneum* (Coleoptera: Tenebrionidae) and *Cryptolestes ferrugineus* (Coleoptera: Laemophloeidae).

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ABSTRACT

The insect infestation is a major problem in the grain storage. The pesticides are most widely used method for desinfestation and prevention. Treatment with gamma irradiation may increase the product shelf life without encountering formation of waste can be used in packaged foods and ready for commercialization, representing an important alternative to the use of pesticides. This study aimed to determine the immediate lethal dose of gamma radiation for adults of *Tribolium castaneum* and *Cryptolestes ferrugineus*. The study was conducted in the Instituto Biológico and the radiations held at the Instituto de Pesquisas Energéticas e Nucleares - IPEN/CNEN, São Paulo city, using a multipurpose irradiator Cobalt-60 with 3.31 dose rate and 3.23 kGy in months of November/2014 and January/2015. Each experimental unit consisted of 20 adult insects, confined in a 10 mL polyethylene container. The experimental plots in number 10 per dose were subjected to increasing doses of gamma radiation: 0; 0.5; 0.75; 1.0; 1.25; 1.50; 1.75; 2.00; 2:50 and 3.00 kGy. Mortality was assessed within two to four hours after irradiation. The data were submitted to Probit analysis, using the POLO PLUS program. The LD90 to control 90% (LD90) to control adult *Cryptolestes ferrugineus* and *Tribolium castaneum* were 2.73 and 2.91 kGy, respectively.

1. INTRODUCTION

Global losses in stored products, due to the attack of insect pests in post-harvest are estimated annually by 15 % and high costs are involved for the protection of grains against these infestations, which in Brazil can amount to 10 % of all the production (MOREIRA et al., 2005).

The infestation by insects is the main problem of cereals production, storage and marketing. The most widely used control method consists of spraying of highly toxic pesticides because of the low cost (EL NAGGAR et al., 2011). However, due to the deleterious effects of these substances on human health and the environment, some of these products were banned in the 1980, while others tend to be banned (FAO/OMS, 2014).

C. ferrugineus is a secundary pest and relacioned whith infestation of primary pest as Rhyzopertha dominica e Sitophilus spp. Adults are agile measure 1.5 – 2 mm. They have body flattened reddish-brown. They are capable of destroying cracked and cracked grains, penetrating and feeding germ. Females lay their eggs, about 200 in damaged grain or bulk substrate. Infests stored products such as cereals and oilseeds (PACHECO & PAULA, 1995; RESS, 2007).

T. castaneum is a cosmopolitan secondary pest, infesting broken grains, flour, bran, animal feed, occasionally found in pasta and chocolates. The adults are approximately 4 mm and the body is flattened. The color is reddish-brown. The larvae are the elateriform type, with yellowish white color. Pupae can be found in loose substrate. Adults have longevity of up to 2 years (CAMPOS & ZORZENON, 2006; LORINI, 2001).

Some pesticides are not able to penetrate uniformly in the grain mass, enabling the survival of some individuals. Rossi et al. (2010), points out that the control of insects that infest stored products using the fumigation of synthetic insecticides may lead to the emergence of resistant populations and Wang et al. (2006) point out that also the extensive use of synthetic fumigants for this purpose is the cause of serious concerns about its effects on the environment, however, alternative techniques must be environmentally safe and clean. The treatment with gamma radiation may increase the product's shelf life without sludge formation occurs, and this method can be used in foods already packaged and ready for marketing (SILVA et al., 2004). This study aimed to determine the immediate lethal dose of gamma radiation for adults of *T. castaneum* and *C. ferrugineus*.

2. MATERIAL AND METHODS

The study was conducted in the Arthropods Laboratory of Biological Institute IB/SP and the radiations held at the Institute of Energy and Nuclear Research - IPEN/CNEN using a multipurpose irradiator Co^{60} with 3.31 dose rate and 3.23 kGy in months of November / 2014 and January / 2015. Population of *T. castaneum* and *C. ferrugineus* were reared in wheat bran and cornmeal respectively, maintained in conditioned room 27 ± 2 °C with relative humidity (R.H.) of 60 ± 10%. To determine the lethal doses of gamma radiation, newly emerged adult was used with 3 to 7 days old. Were used ten replicates of 20 insects, confined in a polyethylene container (10 mL), for each dose. The experimental plots were subjected to increasing doses of gamma radiation : 0; 0.5 ; 0.75; 1.0 ; 1.25; 1.50; 1.75; 2.00; 2:50 and 3.00 kGy. Doses were obtained according to the exposure time of insect. Mortality was evaluated within two to four hours after radiation. The data were submitted to Probit analysis (FINNEY, 1971), using the POLO PLUS program (LEORA SOFTWARE, 2003).

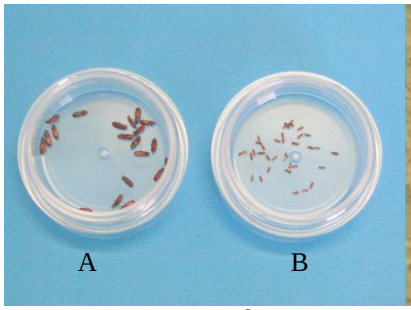

Figure 1. Samples,
A - *T. casteneum*
B - *C. ferrugineus.*
REIS, F. C.

Figure 2. *Tribolium castaneum.*
POTENZA, M. R.

Figure 3. *Cryptolestes ferrugineus.*
Potenza, M. R..

3. RESULTS AND DISCUSSION

Bioassays irradiation disinfestation *C. ferrugineus* and *T. castaneum* adults, average lethal doses were observed (LD_{50}) and 2.38 kGy 1.89 kGy, respectively (Table 1).

The gamma radiation doses required to kill 90% (LD_{90}) of insects in a period of 4 hours were, respectively, 2.73 kGy and 2.91 kGy for *C. ferrugineus* and *T. castaneum*.

The results corroborate those of Ayvaz et al. (2002) and Silva and Arthur (2004), who employed doses between 2 and 5 kGy to control various pests of stored grains, including *S. oryzae, R. dominica, T. castaneum and T. confusum*.

For *T. castaneum*, the lethal dose observed were superior to those obtained by Fontes (1994), who employed dose of 1.5 kGy to control the pest.

According Nouaddin and Abbas (2011), the dose of 700 Gy (or 0.70 kGy) would be enough for the control of *T. castaneum* on stored products. The authors found that for treatment of pupae (five days of age), dosage required to prevent the emergence of adults was 0.7 kGy.

Table 1. Estimate of LD_{50} (kGy), LD_{90} (kGy), Limits (%), Slope and e Standard Error (S.E.), chi-square ($\chi 2$) Degrees of Freedom (D.F.) of *Tribolium castaneum* and *Cryptolestes ferrugineus.*

Species	*n*	LD_{50} (kGy) (95%)	LD_{90} (kGy) (95%)	Slope ± SE	χ^2	G.L.
Tribolium castaneum	600	1.890 (1.638 - 3.001)	2.909 (2.217 - 5.415)	6.841 ± 0.674	5.32	4
Cryptolestes ferrugineus	700	2.387 (2.279 - 2.472)	2.731 (2.621 – 2.943)	2.904 ± 0.738	1.71	4

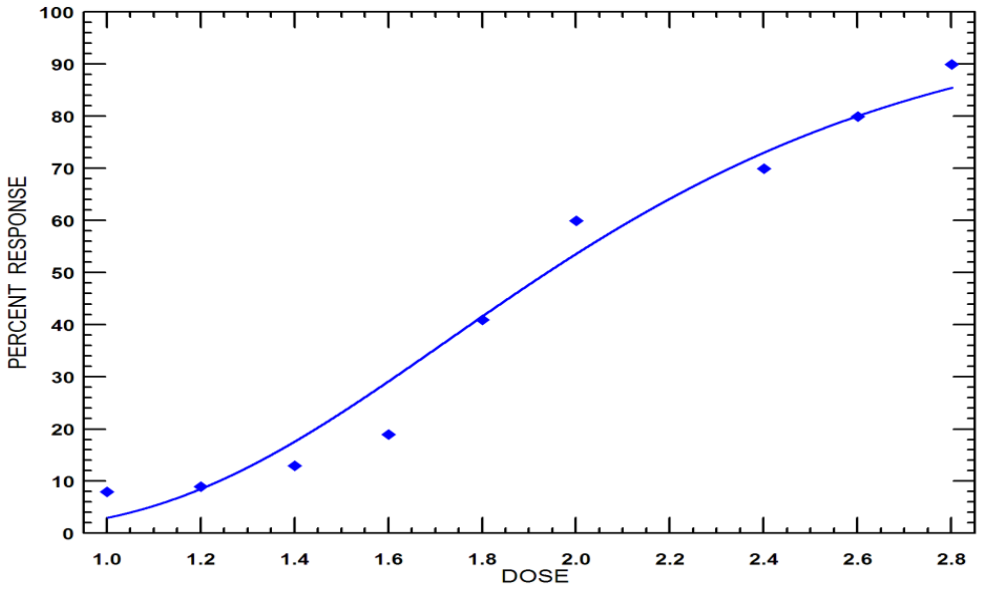

Figure 4. Percent response of *Tribolium castaneum.*

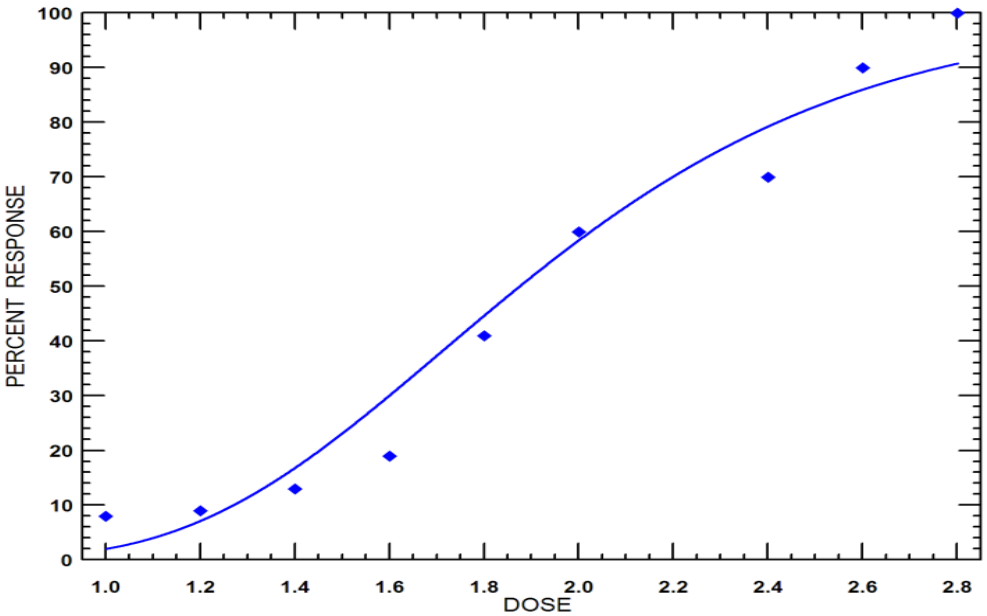

Figure 5. Percent response of *Cryptolestes ferrugineus*.

3. CONCLUSIONS

The dose of gamma radiation of 2.91 kGy is sufficient to kill 90 % (LD_{90}) of *Cryptolestes ferrugineus* and adult *Tribolium castaneum*.

The use of gamma radiation is an important strategy for the control of stored grain pests, being a promising alternative to replace the use of synthetic insecticides to control these pests.

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