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QUARANTINE TREATMENT BY GAMMA RADIATION FOR DIFFERENT DEVELOPMENT STAGES OF *Callosobruchus maculatus* IN BEAN *Vigna sinensis*

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ABSTRACT

The loss of stored grain caused by insects generates a problem of economic order of importance, due to concern about the increased supply of food for the world population is expanding. Associated with this fact, there is the problem of nutritional deficiency due to lack of protein, especially for the less privileged populations. The use of ionizing radiation in grains and products stored without a doubt can solve the problem of the losses in these products, since it does not induce resistance to insects and leaves no toxic residue in the products, and is considered an effective and safe method. The aim of the experiment was to determine the effect of ionizing radiation from cobalt-60 as a quarantine treatment for the different stages of development of *Callosobruchus maculatus* (Fabr., 1972) (Coleóptera, Chysomilidae) in bean *Vigna sinensis*. The experiment was conducted in the laboratory of Radiobiology and Environment CENA / USP., Piracicaba, SP, Brazil. Bean samples infested with eggs, larvae, pre-pupae and pupae *C. maculatus*, the experiment consisted of 4 replicates for each stage of the insect's life cycle, and each repetition consisted of 20 individuals (eggs, larvae, pre-pupae and pupae), a total of 200 subjects per treatment which were irradiated with doses of 0 (control), 25, 50, 75 and 100 Gy, a source of cobalt-60, Gammabeam-650 type, in a rate dose of 1.3 kGy / h. The experiment was conducted in a room with a relative of 25 ± 2 ° C temperature and humidity of 70 ± 5%. After 35 days of irradiation process were carried out evaluations of the number of insects emerged in each repetition within the treatments. From the results obtained it was concluded that the dose lethal to eggs and larvae was 25 Gy, while for pre-pupae was 50 Gy, to pupae 100 Gy was not sufficient to control the adult emergence.

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].

2. LITERATURE REVIEW

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].

Studied the effects of gamma radiation in *Callosobruchus subinnotatus* (Pic) found that eggs, larvae, pupae and adults can be satisfactorily controlled with doses of 2.5 to 3; 3; 5; 20 Kr, respectively [10].

Studied the effects of gamma radiation at various stages of the life cycle of *Callosobruchus chinensis* (L.), found that pre-larvae and pupae were 100% eliminated when exposed to a dose of 16 krad, while the pupae were fully killed while under dose of 32 krad [11].

That there was total mortality of eggs *Callosobruchus maculatus* embryos under dose of 2.2 krad and total mortality of the larvae with 3 krad, while for total pupal mortality occurred at dose 22 8 krad [12].

Reported by [13] that doses of 80 to 100 Gy of gamma irradiation on *Tribolium confusum* resulted in higher adult mortality. Results of [14] found that in *T. castaneum*, doses ranging from 20 to 50 Gy was a decline in fertility adults.

Research on this subject has been increasingly pronounced, thus, in order to clarify the advantages of this method and the benefits it provides in raising food for the population, and in recent years has been given greater attention by governments and private companies. 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]. The aim of the experiment was the quarantine treatment by gamma radiation for the different stages of development *Callosobruchus maculatus* in bean *Vigna sinensis*.

3. MATERIAL AND METHODS

Bean samples were infected with eggs, larvae, pre-pupae and pupae *Callosobruchus maculatus*, the experiment consisted of 4 replicates for each stage of the insect's life cycle, and each repetition consisted of 20 individuals (eggs, larvae, pre-pupae and pupae), a total of 200 subjects per treatment which were irradiated with doses of 0 (control), 25, 50, 75 and 100 Gy, a source of cobalt-60, Gammabeam-650 type, in a rate dose of 1.3 kGy / h. The experiment was conducted in a room with a relative of 25 ± 2 ° C temperature and humidity of 70 ± 5%. After 35 days the irradiation process were performed evaluations using the method of counting the number of insects emerged in each replicate within treatments. The experimental statistical design was completely randomized in a 5x1 scheme (5 treatments and 1 sampling time and 4 repetitions). The results of evaluations of the tests were subjected to analysis of variance by F test, and the comparison of averages by 5% Tukey test, using the statistical system [15].

4. **RESULTS**

By results of the Table 1 we can observe that when the eggs were irradiated at a dose of 25 Gy was sufficient to control the population of emergence of adults of *Callosobruchus maculatus*. These results are in agreement with those found by [16] that by irradiating *Callosobruchus maculatus* in various stages of development, found that the most sensitive stage was the egg, where 50% and 100% mortality were induced with irradiation of 10 and 30 Gy, respectively. They also reported that a full sterilization of adults was obtained with a dose of 100 Gy and for males and females. Also found that eggs three days *Callosobruchus maculatus*, a dose of 10 Gy caused death in 50% of the eggs, while a dose of 30 Gy caused a total kill of eggs [16].

Callosobruchus chinensis the radiosensitivity is not directly proportional to the age of the eggs.[11] However [17] irradiated eggs *Acarus siro* five different ages and dose 3 Gy, the results showed variations in mortality and hatching of the larvae, and eggs 3 days in the more sensitive age, they attributed the results to a higher rate of physiological activity and insect morphological change. When eggs *C. subinnotatus*, aged 1 day were exposed to doses of 3 and 5 kR, no emergency has been found, however, larvae died 12 days of days after exposure of 5, 10, 15, 20 kR [18].

Table 1. Mean number of eggs irradiated with gamma radiation from cobalt-60 and adult *Callosobruchus maculatus* emerged.

Dose/Gy	Eggs irradiados	Adults emerged
0	20	32 a
25	20	1b
50	20	0b
75	20	0b
100	20	0b

Mean with same letters do not differ statistically by Tukey test at 5%

Table 2. Mean number of larvae irradiated with gamma radiation from cobalt-60 and adult *Callosobruchus maculatus* emerged.

Dose/Gy	Larvae irradiated	Adults emerged
0	20	45a
25	20	0b
50	20	0b
75	20	0b
100	20	0b

Mean with same letters do not differ statistically by Tukey test at 5%

Table 3. Mean number of pre-pupae irradiated with gamma radiation from cobalt-60 and adult *Callosobruchus maculatus* emerged.

Dose/Gy	Pré-pupae irradiadas	Adults emerged
0	20	40a
25	20	5b
50	20	0b
75	20	0b
100	20	0b

Mean with same letters do not differ statistically by Tukey test at 5%

Table 4. Mean number of pupae irradiated with gamma radiation from cobalt-60 and adult *Callosobruchus maculatus* emerged.

Dose/Gy	Pupae irradiated	Adults emerged
0	20	40a
25	20	45a
50	20	38a
75	20	25b
100	20	12c

Mean with same letters do not differ statistically by Tukey test at 5%

The effects of gamma radiation in the stages of egg and larva, there is a similarity in these stages where in after the dose of 25 Gy did not occur and no little adult emergence, respectively. These results are in agreement with [19] which determined the radiosensitivity of various stages in the life cycle of *Callosobruchus chinensis* (L) found that larvae dose that caused 100% mortality was of 20 Gy.

Larvae irradiated with 14 days, a dose of 60 Gy was able to completely eliminate the larvae. They also observed that pupae 27 days after oviposition do not result in emergence of adults at a dose of 20 krad [17].

As for the pupae stage the total control was not achieved even with the highest dose of 100 Gy, thus showing a greater radiosensitivity this phase in relation with the phase of egg, larvae and pupae. Being these results according to [20] studied when the radiosensitivity of *Callosobruchus chinensis*, and determined as the dose of 300 krad. to cause 100% mortality for pupation.

5. CONCLUSIONS

Dose of 25 Gy was sufficient to control the emergence of *Callosobruchus maculatus* adults when applied in stages of eggs and larvae;

Pupae stage was more resistant, not being fully controlled with the doses used.
Doses greater than 100 Gy should be used for the quarantine treatment of *C. maculatus* on beans of *Vigna* cultivars.

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