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Received on: 10/11/2018
Accepted on: 07/04/2019
Published online: 25/04/2019

Effect of Gamma Radiation on *Callosobruchus maculatus (F.)* (Coleoptera: Bruchidae) and Seed Germination

Abstract: The grain legumes are the second most important economic crops attacked by many of storage pests, one of these pests is Cowpea seed beetle (Callosobruchus maculatus). Gamma radiation appears to be a potential alternative to chemicals control in stored products. Therefore, this research aims to study the effect of gamma radiation (0.03, 0.06, 0.09, 0.12, 0.15, 0.18 and 0.21 (kGy) on eggs, larvae, pupae and seed germination. The results of this study showed that the irradiated eggs did not hatch. While the last larval stage was very sensitive to all doses of gamma rays, no adults emerged from larvae were exposed to 0.03 (kGy) or higher doses. In addition, the highest death percentages of pupae were 88% at 0.21(kGy). Finally, the results showed the same doses used in this study did not affect the rate of seed germination compared to control. This technique would help to improve using for other agriculture pests.

Keywords: Gamma Radiation, *Callosobruchus maculates*, larval stage, Coleoptera

How to cite this article: S. Abd, S.A. Kathier and E.A. Mahmmod, "Effect of Gamma Radiation on Callosobruchus maculatus (F.) (Coleoptera: Bruchidae) and Seed Germination," *Engineering and Technology Journal*, Vol. 37, Part C, No. 1, pp. 90-92, 2019.

1. Introduction

Grain legumes are the second most important group of crops worldwide. Globally, 840 million people are undernourished mainly on account of inadequate intake of proteins, vitamins and minerals in their diets, pulses are excellent sources of proteins (20-40%), carbohydrates (50-60%) and are fairly good sources of thiamin, niacin, calcium and iron [1]. One of the major constraints in production is insect pests, which inflict severe losses in both the field and storage. Cowpea seed beetle (Callosobruchus maculatus) is a major pest that causes serious damage [2,3]. There are various methods for control of the cowpea weevils and other storage pests including, insecticides which are widely used to protect stored commodities from insect infestations and contamination but their use lead to problem of undesirable [4,5]. Ionizing radiation used successfully to control insect species and may prove effective in controlling many others. Gamma radiation appears to be a potential alternative to chemicals for insect control in stored products, One of the modern techniques in controlling stored food pests is the use of nuclear technology [6,7,8]. Therefore, this work aims to study the effect of gamma radiation on these pests at some stages and the effect of radiation on seed germination.

2. Materials and Methods

I. Stock culture

All experimental procedures were carried out at Entomology Laboratory, University of Baghdad and under the same environmental conditions. Beans were collected from various stores, and were brought to the Laboratory; grains were kept in jars and covered with muslin cloth at 29±1^{0}C and relative humidity 60±5. The culture was observed regularly for the presence of *Callosobruchus maculatus* [9].

II. Irradiation of egg, larval, and pupal stages:

The beans had larvae of same age were isolated and collected from the culture. The one day old eggs, nine day old larvae, and four day old pupae were exposed to 0.03, 0.06, 0.09, 0.12, 0.15, 0.18 and 0.21 (kGy). 220-GammaCell, a radiation source of CO^{60}. The development of all stages were recorded after gamma ray treatments. The experiment was designed in Complete Randomized Design with three replications and twenty-five for each.

III. Seed germination

50 seeds of beans in three replications were exposed to gamma rays (cobalt-60 source) at doses 0.03, 0.06, 0.09, 0.12, 0.15, 0.18 and 0.21 (kGy). Also the healthy seeds were exposed to these doses and subjected to germination test.

https://doi.org/10.30684/etj.37.1C.14
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IV. Statistical analysis

Experimental results were analyzed by Complete Randomized Design. Duncan- test was used to separate means when significant overall differences occurred at 5%.

3. Results and Discussion

Table 1 shows that eggs did not hatch at all doses, which means that gamma radiation has influence on the embryo development. Eggs of *Callosobruchus maculates* are very sensitive and killed when exposed to gamma radiation, especially when the one - day old eggs [10]. Table 2 shows that larval stage has different radiosensitive to gamma radiation. The dose 0.15 (kGy) gave 100 killing, because the larvae stop feeding due to the breakdown of lining of the digestive system [11]. The percentage of normal pupae from irradiated larvae decreased from 93% in control to 3% at treatment with 0.12 (kGy), the percentage of abnormal pupa increased from zero in control group to 7% at dose 0.21 (kGy), and showed reduction percentage of normal adults from 87% in control to 0% at dose (0.03kGy). These results are consistent with the results of Al-Badry and Ahmed [12] where it was found that a dose of 3 (kGy) lead to the death of all the larvae of the *Callosobruchus maculates* before theyreach to adults. Treated *Callosobruchus maculates* with dose (20 kGy) induces semi-sterility [13]. Table 3 shows that the mortality of pupa was increased significantly with increasing dose radiation. However, the pupa stage was less sensitive than larval stage. Significant differences were found among tested doses compare to control in percent pupal mortality [14].

Table 1. Effect of radiation doses on egg hatching of *Callosobruchus maculates*

Radiation Dose (kGy)	Egg hatching %
0	83.5 a
0.03	0 b
0.06	0 b
0.09	0 b
0.12	0 b
0.15	0 b
0.18	0 b
0.21	0 b

Similar letters within the columns indicate no significant differences between the different doses at 5%

Table 2. Effect of radiation doses on the mortality rate of the last larval stage of *Callosobruchus maculates*

Radiation Dose (kGy)	Mortality larva %	Abnormal pupa %	Normal pupa %	Abnormal adults %	Normal adults %
0	70 d	0 c	93 a	0 b	87a
0.03	78 c	40 b	18 b	7 a	0 b
0.06	84 bc	10 a	6 c	0 b	0 b
0.09	89 b	9 a	2 c	0 b	0 b
0.12	90 b	7 a	3 c	0 b	0 b
0.15	100 a	-	-	-	-
0.18	100 a	-	-	-	-
0.21	100 a	-	-	-	-

Similar letters within the columns indicate no significant differences between the different doses at 5%.

Table 3. Effect of radiation doses on the mortality rate of the pupal stage of *Callosobruchus maculates*

Radiation Dose (kGy)	Mortality pupa %	Abnormal adults %	Normal adults %
0	17.4 e	0 c	82.6 a
0.03	22.6 de	0 c	77.3 ab
0.06	27.7 d	4 b	68.3 b
0.09	56 c	4 b	40 c
0.12	49.3 c	10.7 a	40 c
0.15	72 b	8 a	20 d
0.18	80 ab	6.7 ab	13.3 d
0.21	88 a	8 a	4 e

Similar letters within the columns indicate no significant differences between the different doses at 5%

Table 4 shows no significant differences in seed germination rate after irradiated with a different doses of gamma rays compared to control. However, only the seeds of Barley (*Hordeum vulgare*) treated with 0.4 kGy had a significant lower germination rate than the other three treatments (control, 0,1 and 0.2 kGy).

Table 4. Effect of radiation doses in the germination of beans seeds

Radiation dose	Germination rate

0	63 +5.05	a
0.03	70.5+ 5.09	a
0.06	56+ 3.26	a
0.09	62+ 6.93	a
0.12	62+ 5.16	a
0.15	56+ 3.27	a
0.18	60+ 4.60	a
0.21	62+ 5.16	a

Similar letters within the columns indicate no significant differences between the different doses at 5%

4. Conclusions

Eggs of *Callosobruchus maculates* are very sensitive when exposed to gamma radiation, while the larval stage has different radiosensitive and not effect in seed germination rate after irradiated with a different doses of gamma rays .

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