



EFFECT OF GAMMA RAYS ON NUCLEIC ACIDS CONTENT
(RNA & DNA) OF THE COTTON LEAFWORM
SPODOPTERA LITTORALIS (BOISD)

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ABSTRACT

Full grown pupae of the cotton leafworm *Spodoptera littoralis* (Boisd). were exposed to substerilizing doses of 100, 200 or 300 Gy of gamma radiation. The changes in nucleic acids content (RNA & DNA) of irradiated pupae, after 24 hours from irradiation, and also in 3 days old adults resulting from irradiated pupae were investigated.

The total nucleic acids content in either pupae or adults was progressively reduced as the dose was increased. The reduction of both RNA & DNA in females was greater than in males. DNA was more radiosensitive than RNA. The destructive action of irradiation on nucleic acids was more pronounced in adult stage. Irradiation increased the RNA/DNA ratio than control at all treatments except for female pupae

at 200 Gy.

INTRODUCTION

Lepidopterous species which have been evaluated for the effects of irradiation require relatively high doses (300 - 600 Gy) of radiation to induce sterility. Mating competitiveness and longevity are adversely affected by sterilizing doses, but competitive moths will result when doses are substerilizing North⁽¹⁾. Moreover, 'individuals' treated at substerilizing doses produce offsprings which are nearly or completely sterile^(2,3).

Among all lepidopterous species, the cotton leafworm *S. Littoralis* is the most important pest of cotton in Egypt. Some efforts have been carried out to introduce the sterile male technique in the control of the cotton leafworm. First filial generation of this insect resulting from adult males treated with substerilizing doses of gamma radiation exhibited various degrees of sterility. Sallam and Ibrahim⁽⁴⁾ reported that the cotton leafworm males irradiated by low doses of 100 or 150 Gy were fully competitive and the same trend was true among F₁ males.

The application of classical cytogenic and modern molecular biology techniques offers considerable promise in improving sterile insect technique and for developing methods of autocidal control. However, these newer techniques are unlikely to realize their full potential if they are not developed hand-in-hand with the more traditional techniques of physiology, biochemistry, behaviour and ecology.

The aim of this research is to study the changes in the nucleic acids content of the cotton leafworm induced by irradiation in the hoping to utilize such data in genetic approaches to insect control.

MATERIAL AND METHODS

The mass culture of the cotton leafworm used in this study has been maintained in the laboratory of Radiobiology Department, NRC, Atomic Energy Authority at Inshas. Larvae were fed on fresh castor oil plant leaves. Both male and female mature pupae (48 hours before emergence) were irradiated using a gamma cell (^{60}Co - source) that had a dose rate of approximately 4.18 Gy/min. The irradiation doses used were 100, 200 or 300 Gy. The experimental conditions throughout the study were 25-32 °C and 60-70% R.H.

Nucleic acids were determined for either male or female pupae 24 hour after irradiation and in 3 days old adults. Nucleic acids (RNA & DNA) were extracted according to the method described by Ogar and Rosen⁽⁵⁾, with an essential suggested modification to use cold ethanol ether (3 : 1) instead of boiled mixture at the step of lipids removal to prevent extraction of carbohydrates which can interfere with RNA determination and to prevent hydrolysis.

The concentration of RNA and DNA were calculated as micro mole ribo or desoxynucleic acids per gram fresh weight. Three replicates were performed for each treatment.

RESULTS AND DISCUSSION

The changes in the RNA and DNA content of the irradiated male or female pupae 24 hour after irradiation and also the changes in 3 days old male or female adults produced from irradiated full grown pupae were investigated.

Table (1) shows the effect of 100, 200 and 300 Gy on the nucleic acids content in irradiated samples as compared to control. The ratio between RNA to DNA was calculated for each treatment, and the relative variation of RNA/DNA in

Table (1): Nucleic acids content of the pupae and adults of *Spodoptera littoralis* (Boisd) irradiated as full grown pupae with gamma rays.

Doses (Gy)		RNA						DNA					
		Pupae			Adults			Pupae			Adults		
		Male	Female	Mean	Male	Female	Mean	Male	Female	Mean	Male	Female	Mean
100	U.mole/g wet body	10.550	12.501	11.525	7.738	11.683	9.710	2.889	2.668	2.778	2.677	2.847	2.762
	Reduction than control (%)	1.457	13.145	7.301	8.932	17.434	13.182	8.634	15.031	11.832	12.801	22.929	17.865
200	U.mole/g wet body	9.662	10.922	10.292	6.653	10.626	8.639	2.824	2.605	2.714	2.325	2.577	2.451
	Reduction than control (%)	9.75	24.115	16.932	21.702	24.904	23.303	10.689	17.038	13.863	24.267	30.238	27.252
300	U.mole/g wet body	9.464	10.086	9.775	6.497	9.546	8.021	2.260	2.137	2.198	2.157	2.213	2.185
	Reduction than control (%)	11.601	29.924	20.762	23.538	32.537	28.037	28.526	31.942	30.234	29.739	40.092	34.911
0	U.mole/g Wet body	10.706	14.393	12.549	8.497	14.150	11.323	3.162	3.140	3.151	3.070	3.694	3.382

irradiated sample compared with unirradiated one was tabulated in Table (2).

The obtained data indicated that irradiation of pupae decreased the amount of both RNA and DNA for pupae and adults. The magnitude of effect varied according to the applied dose, sex, stage and type of nucleic acids estimated.

In general, the effect was gradually increased with increasing the gamma dose. The amounts of RNA and DNA were gradually decreased by increasing the irradiation dose 100 Gy to 300 Gy.

Data revealed that, sex has a role in the radiosensitivity of nucleic acids, where RNA and DNA in pupal and adult females proved to be more radiosensitive than in males.

Data presented in Table (2) showed that, irradiation in general increased the RNA/DNA ratio than that of the control with both investigated insect stages and for the two sexes, except for female pupae at 200 Gy, which showed a slight decrease than the control. The rate of RNA/DNA increase of irradiated treatments than control varied according to the applied dose, insect stage and sex. The highest rate of increase was recorded at 300 Gy for both pupal and adult stage and also, for either males or females. However, male pupae recorded the highest rate of RNA/DNA.

From the foregoing data, it could be seen that irradiation damaged the nucleic acid molecules in the pupal stage which developed to the adult stage. In this connection, Passonneau⁽⁶⁾ deduced that irradiation could be shown to produced degradation and inhibition of nucleic acids synthesis in *Melanoplus differentialis* eggs. The finding of greater radiosensitivity of DNA than RNA was in agreement with those of Ord and Stocken⁽⁷⁾; and Copper and Alpen⁽⁸⁾ who

Table (2): The ratio of RNA to DNA in pupae and adults of *Spodoptera littoralis* (Boisd) irradiated as full grown pupae with gamma rays.

Dose (Gy)	Pupae				Adults			
	Males		Females		Males		females	
	Ratio of RNA/DNA	Rate of ratio different than control (%)	Ratio of RNA/DNA	Rate of ratio different than control (%)	Ratio of RNA/DNA	Rate of ratio different than control (%)	Ratio of RNA/DNA	Rate of ratio different than control (%)
100	3.651	+ 7.85	4.685	+ 2.22	2.890	+ 4.44	4.103	+ 7.12
200	3.421	+ 1.06	4.192	- 8.53	2.861	+ 3.39	4.123	+ 7.57
300	4.301	+ 27.06	4.719	+ 2.96	3.012	+ 8.85	4.312	+ 12.58
0	3.385	----	4.583	----	2.767	----	3.830	----

concluded that DNA synthesis had been suppressed by irradiation frequently in animal tissues than RNA. The rate of nucleic acids reduction did not correlate with the rate of increasing dose. This phenomenon was observed with each of pupal or adult stages and also for both sexes. The highest rate of RNA reduction was observed by raising the applied dose from 100 to 200 Gy, while the highest rate of DNA reduction was recorded by raising the radiation dose from 200 to 300 Gy.

The previous obtained data revealed that DNA was more radiosensitive than RNA under the present experimental conditions. The data also showed that the response of each nucleic acid may differ according to applied radiation dose. Taking insect stage in consideration, it could be concluded from data in Table (1) that both RNA and DNA nucleic acids were highly reduced in adults than pupal stages. The mean percentages reduction in RNA was 7.301, 16.932 and 20.762 for pupal stage and 13.182, 23.303 and 28.037 for adult stage with 100, 200 and 300 Gy, respectively. While the mean percentages reduction in DNA were 11.832, 13.863 and 30.234 for pupal stage and 17.865, 27.252 and 34.911 for adult stage with 100, 200 and 300 Gy, respectively. The previous finding indicated that the destructive action of radiation on nucleic acids was irreversable and transferable from treated stage to the following stage. The insect do not have capacity to reconstruct the damaged acid which progressively increased in the following stage.

Altman and Mukherjee⁽⁹⁾ found that the damage of DNA in salivary glands of late third instar larvae of *Drosophila melanogaster* was done by 300 Gy ⁶⁰Co-irradiation.

The difference in the response of each nucleic acid was due to applied radiation dose was also found by Lassota⁽¹⁰⁾ who reported that irradiation of *Bombyx mori* eggs with 50 Gy delayed the synthesis of DNA, while 200 Gy delayed the

synthesis of DNA and damaged the synthesis of RNA. Meanwhile 2000 Gy stopped the synthesis of DNA and induced the break down of RNA.

The higher radiosensitivity of females rather than males did not agree with finding of Abd El-Salam⁽¹¹⁾ who mention that the inhibition of RNA was more less in irradiated males of *Ephestia kuehniella* pupae than in females, while the reduction of DNA was more pronounced in males than in females at 200 Gy gamma radiation.

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