INTERACTIVE EFFECTS OF RADIATION AND TEMPERATURE ON MORTALITY OF TWO STORED PRODUCT INSECTS

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This paper reports on the various studies conducted on some pests of wheat in Egypt with the ultimate goal of utilizing gamma radiation for commodity treatments under different temperatures.

Interaction of radiation and temperature with time required to kill rice weevil, *Sitophilus oryzae* and lesser grain borer, *Rhizopertha dominica* was examined. The time taken to kill 100 % of the population of each species depends on the dose of gamma radiation and temperature. Effects were similar with each species the higher the dose of gamma radiation the higher the mortality of adult insects. On the other hand, mortality of insects reared at 20°C and 40°C was higher than mortality at 30°C.

Interaction of radiation and temperature is a viable alternative to chemical fumigation for controlling some insect infestations in food storage.

INTRODUCTION

Temperature and humidity are two important physical factors that affect the growth and development of insects. The modifying effects of temperature on various kinds of radiation has attracted considerable interest. **Okasha** *et al.* (1970) showed that exposure of *Rhodnius genus* adults to sublethal high temperatures not only hyphenate inhibits reproduction during the exposure period but also exert harmful effects on their activity when they were returned to normal temperature conditions. However, **Cogburn** (1967) found that short exposure to sublethal dosages hyphenate of infrared radiation at 44°C did not inhibit reproduction of surviving rice weevils *Sitophilus oryzae* (L.) ; lesser grain borer *Rhizopertha dominica* (F.) or Angoumois grain moth, *Sitotroga cerealella* (Oliver).

The aim of this work is to study the survival of *S. oryzae* and *R. dominica* under different of temperatures after exposure to gamma radiation.

MATERIALS AND METHODS

General breeding of *R. dominica* and *S. oryzae* was carried out in the laboratory at 30 ± 2°C and 70 % R.H. in glass jars each containing wheat grains as medium. In each test 500 mg of wheat were infested with 50 newly emerged adults of each species separately. The samples were irradiated by gamma ray doses of 25, 50 and 100 krad. Each treatment was repeated 3 times. After irradiation, samples were kept at 20, 30 and 40°C and investigated every 15 days until achievement of 100 % mortality for irradiated samples.

RESULTS AND DISCUSSION

Temperature has been recognized as an important regulator of biological processes for a long time. It is not surprising that temperature regulation has been used as a means of controlling pests in stored food.

In every sample 3 bags of wheat grains were infested by 50 newly emerged adults of *S. oryzae* or *R. dominica* separately. Samples were stored after irradiation at temperatures of 20, 30 and 40°C. The results of the combined effect of temperature and irradiation are seen in tables 1 and 2. At low temperature, the vital functions of the insects were retarded by combining irradiation with low temperature. In the period examined, there was significant differences found between the results of samples stored at 20°C and 30°C (ambient temperature).

The heat may act either through an effect on the whole organism (for example, through increasing metabolism), or alternatively its influence may be at the molecular level (for example, through effects on protein nucleic acids or other cell constituents (**Baldwin** and **Narraway**, 1957). Tables 1 and 2 shows the results of a combined treatment ; heat at 40°C and irradiation doses of 25, 50 and 100 krad. It was found that the life of adult insects was decreased with heat treatment, the greatest effect can be achieved by combining radiation (100 krad) and heat treatment (40°C).

Generally, the higher the dose of gamma radiation the higher the mortality of insects and the combined effects were more pronounced when samples were stored after irradiation at 40°C. For example, survival of *R. dominica* adults acclimatised for 15 days at 20°C was 36 adults after exposure to gamma rays with 25 krad, but survival was 25 adults of those kept for 15 days at 40°C after exposure to gamma rays with the same dose (25 krad).

Table 1 : Survival of *S. oryzae* adults on irradiated food at different time intervals under various temperatures

Temp. (°C)	Dose (krad)	Mean no. of living adults at different time intervals in days				
		15	30	45	60	Mean
	Cont.	50,0	48,3	80,7	92,3	67,8
	25	40,7	18,3	5,7	0,0	16,2
20	50	22,0	13,3	2,3	0,0	9,4
	100	3,3	0,0	0,0	0,0	0,4
Mean		29,0	20,0	22,2	23,1	23,6
	Cont.	50,0	57,3	52,3	862,7	373,3
	25	45,0	25,0	15,7	0,0	21,4
30	50	32,0	6,7	6,3	0,0	11,3
	100	11,7	2,3	0,0	0,0	3,5
Mean		34,7	22,8	136,3	215,7	102,4
	Cont.	44,0	77,3	593,0	896,7	402,8
	25	33,7	19,0	15,7	2,7	17,8
40	50	12,7	11,0	1,7	0,0	6,4
	100	0,0	0,0	0,0	0,0	0,0
Mean		22,6	26,8	125,6	224,9	106,7
Mean of	Cont.	48,0	61,0	399,0	617,2	281,3
doses	25	39,8	20,8	12,4	0,9	18,5
over all	50	22,2	10,3	3,4	0,0	9,0
temp.	100	5,0	0,8	0,0	0,0	1,5
Mean		28,8	23,2	103,7	154,5	77,6

L.S.D. 0,05 (Temp.) = 6,1
L.S.D. 0,05 (Time and Dose) = 7,0
L.S.D. 0,05 (Temp. x Time)
= 12
(Temp. x Dose)
L.S.D. 0,05 (Time x dose) = 14,0
L.S.D. 0,05 (Temp. x Time x Dose) = 24,29

500 mg of wheat grains were infested by 50 newly emerged adults of *S. oryzae* in each treatment.

Table 2 : Survival of *R. dominica* adults on irradiated food at different time intervals in days

Temp. (°C)	Dose (krad)	Mean no. of living adults at different time intervals in days				
		15	30	45	60	Mean
	Cont.	45,7	45,0	77,7	90,0	64,6
	25	38,3	21,3	0,0	0,0	14,9
20	50	18,6	0,0	0,0	0,0	4,5
	100	0,0	0,0	0,0	0,0	0,0
Mean		25,5	16,6	19,4	22,5	21,0
	Cont.	46,3	53,3	475,3	709,7	321,2
	25	39,0	31,3	1,3	0,0	17,9
30	50	14,0	2,3	0,0	0,0	4,1
	100	0,0	0,0	0,0	0,0	0,0
Mean		24,8	21,7	119,2	177,4	85,8
	Cont.	50,0	65,7	830,0	956,3	475,5
	25	28,0	18,7	5,3	0,0	13,0
40	50	19,3	4,3	0,0	0,0	5,9
	100	0,0	0,0	0,0	0,0	0,0
Mean		24,3	22,2	208,8	239,1	123,6
Mean of doses over all temp.	Cont.	47,3	54,7	461,0	585,3	287,1
	25	35,1	23,8	2,2	0,0	15,3
	50	17,1	2,2	0,0	0,0	4,8
	100	0,0	0,0	0,0	0,0	0,0
Mean		24,9	20,2	115,8	146,3	76,8

L.S.D. 0,05 (Temp.) = 10,0
L.S.D. 0,05 (Time and Dose) = 11,5
L.S.D. 0,05 (Temp. x Time)
= 20,0
(Temp. x Dose)
L.S.D. 0,05 (Time x Dose) = 23,0
L.S.D. 0,05 (Temp. x Time x Dose) = 40

500 mg of wheat grains were infested by 50 newly emerged adults of *R. dominica* in each treatment.

Temperature has for a long time been used to kill insects or at least reduce their damage in grain and grain products. Our results show that there are effects which can be achieved by combining radiation and heat treatment. **Cornwell** (1966) postulated that the life span of weevils was significantly reduced by a combined heat and irradiation treatment. **Kovacs** and **Kiss** (1983) found that the greatest effect of mortality of weevils can be achieved by combining radiation and heat treatment (40°C, 30 minutes), which decreased life span considerably. These results are in good agreement with our results.

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LES EFFETS INTERACTIFS DES RADIATIONS ET DE LA TEMPERATURE SUR LA MORTALITE DE DEUX INSECTES DES PRODUITS STOCKES

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RESUME

Cet exposé concerne des études variées entreprises sur certains déprédateurs du blé en Egypte, dans le but d'utiliser les rayons gamma dans le traitement des produits à différentes températures.

On a étudié l'interaction entre les radiations et la température, et le temps nécessaire pour tuer le charançon du riz, *Sitophilus oryzae* et le petit capucin du grain, *Rhyzopertha dominica*. La durée létale nécessaire pour tuer 100 % de la population de chaque espèce dépend de la dose de rayons gamma et du degré de température. Les effets ont été semblables pour chaque espèce, une dose d'irradiation élevée engendrant un taux de mortalité élevé d'insectes adultes. D'autre part, la mortalité des insectes élevés au-dessous de 20° C et 40° C a été supérieure à celle des insectes élevés au -dessous de 30° C.

L'interaction entre la température et radiations et une alternative valable à la fumigation pour éliminer certaines infestations des stocks. La température et l'humidité sont deux facteurs physiques importants affectant la croissance et le développement des insectes.