J. Nuclear Agric. Biol., 27 (1) : 52-56 (1998)

Gamma Radiation Effects on Immature Stages of the Orange Fruit Borer, *Ecdytolopha aurantiana* (Lima)

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(Received July 7, 1997)

ABSTRACT

The main objective of this study was to determine the gamma radiation dose capable of avoiding emergency of adults of the "orange fruit borer" *Ecdytolopha aurantiana* (Lima) applied to the orange fruit after harvesting, in the packing house. The experiments were performed with infested fruits irradiated with doses of 50, 100, 150, 200, 300, 400, 500, 600, 700 and 800 Gy of gamma radiations and maintained under controlled environmental conditions into a rearing chamber between 23 and 25°C. From all irradiated insects only ten insects from 275 fruits turned into adults and even these insects came from fruits irradiated with less than 400 Gy. which has been considered the disinfestation dose for this species.

Key words : **Gamma irradiation, Radiosterilization, Food irradiation, Citrus, orange fruit borer, *Ecdytolopha aurantiana*.**

Brazil is one of the most important fruit producing countries of the world and, among the fruits produced, oranges are one of the most important crops. Export of oranges "in natura" is still small, and some insects pests are the main obstacle to increase the trading.

Among various insect pests, the "orange fruit borer" *Ecdytolopha aurantianum* (Lima), formerly known as *Gymnandrosoma aurantianum* (Lima) is perhaps, one of the most concerning species.[1] This lepidopteran is well distributed all over the country, and the characteristics of its attack to the fruits are very confusing when compared to those of the fruit flies.

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Formerly, this species was not economically important, but the concentration of the cultures within continuous orange fields without other crops beyond other wrong control methods increased the importance of this species. Faria in 1994 has prevented the export of 45 thousand boxes of grape fruits, all infested with the orange fruit borer to foreign countries.[2]

In orchards, an effective quarentenary process had to be found since there is a possible risk of introduction or establishment of exotic pest.[3] Besides the control measures to impede the spreading of infestation of fruits after harvest, the use of heat or cold and even the use of toxic chemicals are appropriate, but the first two are not adequate to oranges and the last one concerning consumer who is not willing to accept so treated fruits.

On the other hand, irradiation is a very effective method for quarantine disinfestation of fresh, dried or processed fruits, highly successful against arthropod pests and does not leave any toxic chemicals. Gamma radiation does not affect the quality of fruits or vegetables and is economically attractive and ecologically desirable.

MATERIALS AND METHODS

The research was carried out at the Center for Nuclear Energy in Agriculture of the University of Sao Paulo, Piracicaba, SP, Brazil.

The insects were irradiated into the oranges variety "Pera", which were collected almost at the ripe stage in Bebedouro, an important citrus growing region, about 300 km from Piracicaba. All fruits used in the experiments showed visible symptoms of the orange fruit borer attack. The fruits were picked out preferably from the trees and some of them were taken from the ground.

At the laboratory, eleven groups, each with 25 oranges, amounting thus to 275 fruits, were irradiated with the following gamma radiation doses from a ^{60}Co source: O (control), 50, 150, 200, 300, 400, 500, 600, 700 and 800 Gy, at a dose rate of 1.34 kGy per h.

After irradiation each fruit was individually placed into a PVC plastic bag with 0.03 mm thickness. Together with the orange, around 80 ml of sugarcane bagasse was packed, and the bags were tied with a rubber band taking care that each of it was supplied with air to assure respiration, not only to the insects, but also to maintain the freshness of the oranges. After that, the fruits were maintained into a rearing chamber whose temperature was maintained between 23° and 25°C. The relative humidity was not recorded, because the natural humidity was sufficient enough to keep adequate conditions to rear the insects. Daily observations determined the proper moment to dissect the oranges showed by the arrival of moulds, yeasts and bacterial deterioration.

After 24 days of observance, the immature forms of the insects were retrieved, and also some adults which eventually emerged. These observations were grouped into six periods of time i.e. 0-24, 25-30, 31-36, 37-42, 43-48 and 49-72 days. When the appearance of the oranges into the bags showed to be convenient, they were opened and the oranges carefully dissected. The immature forms, small or greater larvae, were introduced into a glass vial containing an artificial diet for rearing the larvae. Even when these insects were found outside the orange, in the bag among the sugarcane bagasse, these

insects were kept until they reached the adult stage. However if the insects found were in the pupal stage, these were introduced into a glass vial containing some dry sugarcane bagasse to give them the possibility to turn into adults. If the insects retrieved were adults, they were observed according to their sex and possible wing deformations, common in irradiated insects, almost combined with deformations of their reproductive organs and so mechanically sterile.

RESULTS AND DISCUSSION

In Table 1 it could be observed that from all irradiated oranges only ten adults were emerged. Three of them were males and six females, and three of them showed wing deformations. From fruits irradiated with 300 Gy of gamma radiations one single male emerged, and also this only insect showed wing deformations. The dose of 400 Gy inhibited completely the insect emergence.

Heather[3] recommended that the dose of 300 Gy would be sufficient to all lepidopterans, diptera, homoptera, thysanoptera and acarina, since that dose avoid the reproduction of these animals.

Burdit and Moffitt[4] published that the irradiation of *Cydia pomonella* could be considered as a potential quarantine treatment, since the dose of 100 Gy was capable of reducing the emergence of adults, and if these adults appeared, they were unable to reproduce. Gyulai et al[5] observed that the dose of 400 Gy was sufficient to inhibit the emergence of adults from irradiated eggs, larvae and pupae of *Plodia interpunctella*. However Arthur et al[6] found that the dose of 200 Gy induced complete sterility to the adults of the same species. Groppo[7] concluded that doses of 70, 200 and 300 Gy of gamma radiation turned lethal to eggs, larvae and pupae of *Scrobipalpuloides absoluta*. Carmo et al[8] irradiated the larval phase of *Anagasta kuehniella* with doses of 0, 50, 150, 200, 250, 300 and 350 Gy, concluding that lethal dose is of 350 Gy. Rodrigues et al[9] observed that the dose of 140 krad was totally lethal to eggs of *Sitotroga cerealella*, but doses between 300 and 320 krad did not succeed to kill immediately the insects.

Data in Table 1 shows that the dose of 300 Gy permitted the emergence of only one single adult male, and the doses of 400 Gy or beyond inhibited completely the adult emergence. These results are similar to those obtained by Groosu[10] who irradiated all life cycle phases of *Plodia interpunctella* with gamma radiations. They concluded that 250 Gy prevented the eclosion of larvae. The achieved dose to avoid adult reproduction originating from irradiated pupae was 400 and 300 Gy, respectively to males and females. The sterilizing dose was higher than 400 Gy. The present results were also according to those of Arthur et al[11], who concluded that the dose of 400 Gy on six days old pupae of *Diatraea saccharalis* induced total sterility.

Table 1. Number of larvae, pupae and adults of *E. aurantiana* irradiated with gamma radiations and retrieved during a period of 74 days after irradiation

Dose (Gy)	Small Larvae				Great Larvae				Pre-Pupae				Pupae				Adults		Total from Dose		Perforates Plastic Bag	Oranges Without Insects
	l	d	l	o	l	d	l	o	l	d	l	o	l	d	l	o	M	F	L	D		
0	2	0	1	1	5	2	2	5	0	0	0	0	0	0	3	0	0	1(n)	7	5	8	13
50	4	1	1	4	0	1	0	1	1	0	0	1	5	1	0	6	0	2(n)	12	3	6	12
100	3	0	0	3	6	0	1	5	0	0	0	0	1	5	1	5	2(n,u)	2(n,u)	14	5	7	9
150	0	0	0	0	7	2	1	8	2	1	0	3	5	5	0	10	1(n)	1(n)	16	8	8	7
200	2	0	0	2	1	5	0	6	1	1	0	2	0	3	0	3	0	0	4	9	5	13
300	1	0	0	1	4	4	0	8	1	3	0	4	1	4	0	5	0	1(u)	8	11	6	9
400	2	1	1	2	8	2	1	9	0	0	0	0	0	1	0	1	0	0	10	4	6	2
500	4	4	2	6	2	0	4	2	0	0	2	0	1	0	1	0	0	0	8	7	7	10
600	4	1	2	3	0	0	0	0	5	0	0	5	0	0	0	0	0	0	9	1	5	15
700	1	6	3	4	1	2	0	3	2	0	0	2	0	0	0	0	0	0	4	8	5	14
800	1	3	2	2	4	3	2	5	0	0	0	0	0	1	0	1	0	0	5	7	3	14
Total of Parameter	24	16	12	28	38	23	7	54	14	5	0	19	12	24	1	35	3	7	97	68	66	128

l = insects retrieved alive, d= insects retrieved dead, i = insects retrieved inside the fruits,
o = insects retrieved outside the fruits, M = adults males, F = adult females, L = living insects retrieved from the fruits, totalizing immature and adults, D = deed insects retrieved from the fruits, totalizing immatures and adults, n = insects with normal wings, u = insects with deformed wings.

As the final result of the present research it could be concluded that 400 Gy of ^{60}Co dose can be used as an efficient quarentenary tool against the attack of the orange fruit borer.

Acknowledgement

The authors express their thanks to Jose Alfredo Ferraz de Mello for his helpful work and for the final publication of the originals.

REFERENCES

1. **Lima, A.C.,** *Agronomia,* (1945) 346.
2. **Faria, J.T.,** *Comunicacao pessoal. Ministerio da Agricultura e do Abastecimento,* Sao Paulo, Brasil (1994).
3. **Heather, N.W.,** *Proc. International Symposium on management of insects pests: Nuclear and related molecular and genetic techniques,* International Atomic Energy Agency, Vienna (1993) 627.
4. **Burditt, A.K. & Moffitt, H.R.,** *Irradiation as a quarantine treatment for fruit subject to infestation by codling moth larvae. In: Radiation disinfestation of food and agricultural products, Honolulu, University of Hawaii* at Manoa, (1985) 87.
5. **Gyulai, P., Kovacs, E. & Szalma, A.,** Radappertization of agricultural and food products. *Noevenyvedelmi es Agrokemiai Allomas,* Miskolc - Hungary, (1987) 81.
6. **Arthur, V., Consolmagno, C. & Wiendl, F.M.,** *Clencia e Cultura,* (1984) 802.
7. **Groppo, A.G.,** Piracicaba, (1996) 69.
8. **Carmo, E., Roseli, D., Arthur, V. & Wiendl, F.M.,** *Lavoura Arrozeira.,* **48** (1995) 15.
9. **Rodrigues, Z.A., Rego, A.M., Oliveira, M.L. & Ferreira, D.,** Efeitos da Radiacao gama do Cobalto-60 em ovos de *Sitotroga cerealella* (Oliver, 1819) (Lepidoptera, Gelechiidae) em laboratorio. Ciencia e Cultura, Sao Paulo, Brasil, **35** (1983) 1657.
10. **Groosu, S.,** Influence of radiation gamma on the development of different stage de *Plodia interpunctella* (Hub.) (Lep. Phycitidae). *Studu si Cercetari de Biologie* 28 (1976) 145.
11. **Arthur, V., Walder, J.M.M. & Wiendl, F.M.,** *Report the Research-Coordination Meeting on Radiation Induced F1 Sterility in Lepidoptera for area Wide Control. In: Acta Agrocultural Nucleate Sinica,* 4 (1989) 57.