2017 International Nuclear Atlantic Conference - INAC 2017
Belo Horizonte, MG, Brazil, October 22-27, 2017
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR – ABEN

Agência Brasileira do ISBN
ISBN 978-85-99141-07-6

GAMMA RADIATION FOR ALL PHASES OF LIFE CYCLE OF COTTON BOLLWORM *Helicoverpa armigera* AIMING AT ITS CONTROL

Gianni Q. Haddad[1], André R. Machi[2,1], Valter Arthur[1,2]

[1] Centro de Energia Nuclear na Agricultura, CENA/USP, Laboratório de Radiobiologia e Ambiente, Av. Centenário, 303, Bairro São Dimas, CEP: 13400-970 – Piracicaba – SP – Brasil., Emil: ghaddad2001@yahoo.com.br ; arthur@cena.usp.br

[2] Instituto de Pesquisas Energéticas e Nucleares, IPEN/CNEN – SP - Av. Professor Lineu Prestes 224205508-000 São Paulo, SP, Brasil. rica_machi@hotmail.com

ABSTRACT

Since the 1950s, scientists have used ionizing radiation to sterilize insects, which are released in nature to mate, but without any progeny. Known as the sterile insect technique (SIT), this insect control method traditionally uses ionizing radiations to sterilize insects, being a technique that does not generate residue, and can act in synergy with the other techniques within integrated pest management. For several years, Brazil has been fighting against the increase of pests, introducing new tactics and techniques within IPM programs, to overcome the resistance of chemical products, such as: reducing residues of pesticides. For some important crops of our country, we have a wide spectrum of pests occurring from beginning to end of the harvest, one of them is the cotton crop and among the key pests of this crop, we have some extremely important caterpillars among them *Helicoverpa armigera*. Due to this the objective this study was establishes doses of gamma radiation to sterilizing of the phases of : eggs, larvae, pupae and adults of *H. armigera* aiming their control. The experiment was carried out with application of gamma radiation from a Cobalt-60 source. The treatments consisted of doses of gamma radiation varying of according with the insect phase, being this variation of: 0 (control) to 400 Gy. The experiments with pupae and adult phases showed satisfactory results in the sterilization of *H. armigera* for use in autocide control programs. The sterilize dose to adult and pupae phase were 400 Gy and 100 Gy respectively, being the best doses for the application of the sterile insect technique to this pest in cotton.

Keywords: Radiation, Autocide, Control, Cotton, Bollworm

1. INTRODUCTION

Some species of lepidoptera are responsible for the greatest damage caused to Food and fibrous cultures worldwide [1, 2]. For this reason they are targeting significant amounts of Insecticides, impairing the integrated control of pests and consequently the environment. The economic impact of these pests and their current control techniques include loss of income, reduced access to the market, and increased cost. An important new pest, recorded in Brazil, is the *Helicoverpa armigera* or old world caterpillar, which is also an extremely

polyphagous species whose larvae have been recorded in more than 60 species of wild and cultivated plants. About 67 host families, including Asteraceae, Fabeaceae, Malvaceae, Poaceae and Solanaceae [3, 4]. Moreover, it disperses easily, since the adults are natural migrants and have a long range movement, being able to reach 1,000 km of distance and having a high fecundity, reaching to oviposit 1,500 eggs per female [5].
Because of all their biological and physiological aspects that favor their resistance to chemical control, farmers in Brazil are beginning to adhere more easily to alternative controls and integrated pest management. As for example, use of cultivars that reduce the population of the pest; Determination of planting season and restriction of subsequent crops; Use of biological control; Use of bait traps and other methods of physical control, sanitary emptiness, adoption of refuge areas at planting, crop rotation, destruction of volunteer plants and cultural remains.
Despite all the current information and resources on techniques and tactics for sustainable management in agriculture, it is still alarming the amount of pesticides, which are continually launched on the market and given that Lepidoptera species are among the most harmful food and fiber pests in the world, management often comes to be unwise with large amounts of crop sprays with often insecticides persistent.
Considering the increasing occurrence of resistance to these insecticides, and the negative impacts on the environment and ecosystems, the need for control tactics that are not only effective but also less polluting to the environment are becoming more and more present. The sterile insect technique (SIT) offers great potential as additional control tactics for integration with other control methods in the management of the entire integrated pest area [6].

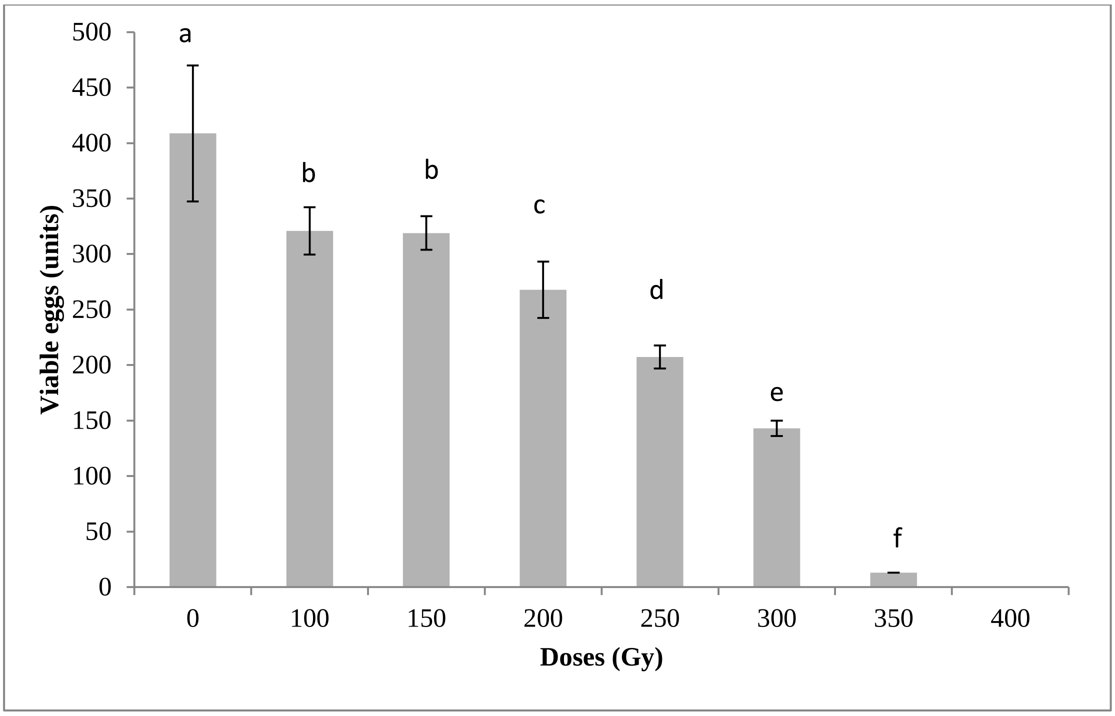
2. MATERIAL AND METHODS

The experiment was developed at the Department of Entomology and Acarology in School of Agriculture "Luiz de Queiroz" (ESALQ-USP), the insects were Irradiated at the Center for Nuclear Energy in Agriculture (CENA), both in the municipality of Piracicaba - SP, located at 22 ° 43'12 "S and 47 ° 38'54" W, with 580 m of altitude.
The initial creation of *H. armigera* was established by Laboratory of Insect Biology, were kept on artificial diet based on beans and germ of wheat, following the recommendations of [7] and developed in room conditioned at 25 ± 1ºC, relative humidity of 70 ± 10% and photophase of 12h.
The first step was to test the doses with a pre-selection where several (Doses) concentrations at each stage of the insect.
In the preliminary experiment to identify the appropriate dose interval, larvae and pupae from 5 to 6 days of age received 50, 100, 150, 200, 300, 400, 500. At dose of 200 Gy and above, all larvae and pupae died. Therefore, six doses below 200 Gy.
For adults, we followed the same procedure and in this case at the dosage of 500 Gy all died, so doses below 500 Gy were selected for this specie. Then, in order to estimate an optimal dose, the correlations between the fertility and competitiveness, crosses of males irradiated with normal females. Tests were also carried out to study the radiobiological effects in the evolutionary cycle of the specie (egg, larva, pupa and adult).

3. RESULTS

From the results shown in Figure 1 and Table 1, when only males were irradiated with increasing doses of gamma radiation and crossed with virgin females of the same generation, we can observe at the dose of 350 Gy there was a reduction in the number of eggs. At the dose of 400 Gy, all the eggs laid by the females were not viable.
Dose to male sterility, being these results according to those of [8, 9, 10, 11] who obtained doses for some lepidopteran species.

Figure 1. **Viability of eggs from crosses between irradiated males and normal females of *Helicoverpa armigera.***



Equal letters in the same column do not differ statistically at the 5% significance level in the Tukey test.

Table 2. Mean of viable eggs from males (adults) irradiated with normal females of *Helicoverpa armigera* with different doses of gamma radiation.

Doses (Gy)	Mean of viable eggs
0 (Nm x Nf)	408.73 a ± 61.32
100 (Im x Nf)	251.58 b ± 21.32
150 (Im x Nf)	319 b ± 15.10
200 (Im x Nf)	267.73 c ± 25.38
250 (Im x Nf)	207.4 d ± 11.22
300 (Im x Nf)	143 e ± 10.34
350 (Im x Nf)	13.06 f ± 6.87
400 (Im x Nf)	0

Equal letters in the same column do not differ statistically at the 5% significance level in the Tukey test.
Nm= normal males, Im = irradiated males, Nf = normal females.

4. CONCLUSIONS

The sterilize dose to adult and pupae phase of *Helicoverpa armigera* were 400 Gy and 100 Gy respectively, being the best doses for the application of the sterile insect technique to this pest in cotton

REFERENCES

1. PETERS, T. M. *Insects and human society*. New York: Van Nostrand Reinhold, 254 p., 1988.
2. BLOEM, K. A.; BLOEM, S.; CARPENTER, J. E. Impact of moth suppression/eradication programmers using the sterile insect technique or inherited sterility. In: DYCK, V. A.; HENDRICHS, J.; ROBINSON, A. S. (Ed.). *Sterile Insect Technique. Principles and practice in area wide integrated pest management*. Dordrecht: Springer, 2005. p. 677-700.
3. FITT, G. P. The agroecology of *Heliothis species* in relation to agroecosystems. *Annual Review of Entomology*, Palo Alto, v. 34, p. 17-52, 1989.
4. POGUE, M. G. A new synonym of *Helicoverpa zea* (Boddie) and differentiation of adult males of *H. zea* and *H. armigera* (Hübner) (Lepidoptera: Noctuidae: Heliothinae). *Annals of the Entomological Society of America*, College Park, v. 97, n. 6, p. 1222-1226, 2004.
5. PEDGLEY, D. E. Windborne migration of *Heliothis armigera* (Hübner) (Lepidoptera: Noctuidae) to the British Isles. *Entomologist's Gazette*, Wallingford, v. 36, n. 1, p. 15-20, 1985.
6. VREYSEN, M. J. B.; KLASSEN, W.; CARPENTER, J. E. Overview of technological advances toward greater efficiency and efficacy in sterile insect-inherited sterility programs against moth pests. *Florida Entomologist*, Gainesville, v. 99, p. 1-12, 2016.

7. PARRA, J. R. P. Consumo e utilização de alimentos por insetos. In: PANIZZI, A. R.; PARRA, J. R. P. (Ed.). *Ecologia nutricional de insetos e suas implicações no manejo de pragas.* São Paulo: Manole, 1991. cap. 2, p. 9-65.
8. ARTHUR, V. *Efeitos esterilizantes e letais das radiações gama nas diferentes fases do ciclo evolutivo de Sitotroga cerealella (Oliver, 1819) (Lepidóptera: Gelechiidae) em arroz e milho*. 1985. 77 p. Tese (Doutorado) - Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, Piracicaba,1985.
9. MACHI, A. R.; ARTHUR, V. Oxygen atmosphere potentiates radiation effects on *Brevipalpus yothersi* (Trombidiformes: Tenuipalpidae), *Florida Entomologist*, v.99, special 2, p. 18-23, 2016.
10. PIERO, E. A. *Determinação das doses letais e esterilizantes de radiação gama para todas as fases do ciclo evolutivo de Ecdytolopha aurantiana (Lima, 1927) (Lepidóptera : Tortricidae) bicho-furão-dos-citros, visando o seu controle*. Piracicaba: Centro de Energia Nuclear na Agricultura, Universidade de São Paulo, 2016. Dissertação de Mestrado no Centro de Energia Nuclear na Agricultura
11. CARPENTER, J. E.; BLOEM, S.; MAREC, F. Inherited sterility in insects. In: DYCK, V. A.;HENDRICHS, J.; ROBINSON, A. S. (Ed.). *Sterile Insect Technique. Principles and practice in area wide integrated pest management*. Dordrecht: Springer, 2005. p. 115-146.