

EFFECTS OF GAMMA RADIATION ON LARVAE OF *Spodoptera frugiperda* (SMITH, 1797) (LEPIDOPTERA: NOCTUIDAE) FALL ARMYWORM

Valter Arthur¹, Paula B. Arthur¹, Suely S. H. Franco^{1,2}, Lucia C. A. S. Silva¹,
André R. Machi², José G. Franco¹, Márcia N. C. Harder^{1,3}

¹Centro de Energia Nuclear na Agricultura, CENA/USP, Universidade de São Paulo, Av. Centenário, 303, Piracicaba, SP, Brasil, CEP: 13400-970, E-mail: arthur@cena.usp.br

²Instituto de Pesquisas Energéticas e Nucleares (IPEN / CNEN - SP)
Universidade de São Paulo
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP, Brasil
gilmitta@uol.com.br

³Curso Superior de Tecnologia em Bicombustíveis, FATEC, Piracicaba –SP
Rua Diácono Jair de Oliveira, s/n, Santa Rosa, Piracicaba, SP, Brasil, CEP:13414-141 E-mail:
mnharder@terra.com.

ABSTRACT

One of the most harmful insects the corn culture is the *Spodoptera frugiperda* (J.E. Smith, 1797) (Lepidoptera: Noctuidae), known commonly as fall armyworm, it is would originate of the tropical and subtropical areas of the American continent; its economical importance is due polyphagism, attacking countless grassy, such as corn, sorghum, wheat, barley, rice and pastures. One of the methods more used in the moment is the chemical control that during several applications the insect can turn resistant, then news researches has been made to the control of the insects. Due what was exposed the objective of the research was evaluated the effects of gamma radiation on larvae of *S. frugiperda*. Insects were rear in artificial diet. Each treatment had 5 repetitions with 20 larvae with 15-20 days of age in the total of 100 larvae per treatment. The larvae were irradiated with doses of gamma radiation of: 0 (control), 50, 100, 200 and 300 Gy, in source of Cobalt-60, type Gammacell-220, at dose rate of 0,508 kGy/hour. After irradiation the insects were keep in room with climatic conditions of 25±5°C and 70±5% R.H. Were evaluated the emergence of adults. The results showed that the dose of 300 Gy was the lethal dose to larvae irradiated, and 200 Gy the sterilizing dose to adults.

Key words: Gamma radiation, larvae phase, control, fall armyworm

1.INTRODUCTION

The corn culture is attacked by several insects pests that contribute to lower the productivity of the corn. One of the methods more used now, is the chemical control in

which the insects acquire resistance, due this researches has been development to new alternative methods of control of insects.

One of the harmful insects the corn culture is the *Spodoptera frugiperda* (J. E. Smith, 1797) (Lepidoptera: Noctuidae), known commonly as fall armyworm, it is originate of the tropical and subtropical areas of the American continent; their economical importance is due its polyphagism, attacking countless grassy, such as corn, sorghum, wheat, barley, rice and pastures.

Some authors, such as: [1, 2, 3] observed that the damages caused by this insect is very significant in corn and can be of until 35% of damage.

One of the alternative methods of control of insects is the use of radiations ionizing, and the pioneer in the use of this method was [4] that obtained good results when it used X-ray to control *Lasioderma serricorne* (L.) in the attack to the tobacco.

In the decade of 1950, a great progress was verified in this research area, as the irradiation of Diptera *Cochliomyia hominivorax* (Coq.) in Curacao. Currently this control method too is used in others countries as the Brazil [4,5].

According with [7,8] this technique if does necessary the massal rearing of insects, in artificial diets, due this, the objective of the work was the irradiated larvae of *S. frugiperda* to phytosanitary treatment.

2. MATERIAL AND METHODS

The experiment was made in the laboratory of Radiobiology and Environment of the Center of Nuclear Energy in the Agriculture - CENA/USP, Piracicaba, SP., Brazil. Insects of specie *S. frugiperda* were captured in the larvae phase in corn culture in 1994, in the municipal district of Piracicaba, then these insects were rear in artificial diet, composed basically of bean: beer yeast and wheat germ, modified, and prepared according to the procedures described by [9].

The diet was put in tubes of 8,0 cm of height by 2,5 cm of diameter and covered with sterilized hydrophilic cotton, later it received the diet in amount corresponding to a third of the test tube, in each tube a larvae was inoculated recently emerged and maintained at room acclimatized with temperature of $25\pm 2^{\circ}\text{C}$ and relative humidity of $70\pm 5\%$, photoperiod of 14 hours of light for 10 hours of darkness. The larvae obtained with 15-20 days of age, they were irradiated with doses of gamma radiation: 0 (control), 50, 100, 200 and 300 Gy. To irradiation was utilized a source of Cobalt-60 type Gammacell-220, with a dose rate of 0.508 kGy/hour. Each treatment consisted of 5 repetitions with 20 larvae for repetition.

After the irradiation was evaluated the number of pupae and emerged adults. The data were submitted the variance analysis and the averages compared by the test of Tukey in level of 5% of probability.

3. RESULTS AND DISCUSSION

In the Table 1 we can observe the medium values of the number of pupae and of adults emerged inside of each treatment of *S. frugiperda* of larvae irradiated with 15-20 days of age, with doses of gamma radiation of Cobalt-60.

Table 1. Mean number of pupae, adults and eggs of *Spodoptera frugiperda* emerged after irradiation of larvae with doses of gamma radiation.

Dose (kGy)	Nº Larvae irradiated	Number Pupae	Nº Emerged adults	% Emergency Adults	% Hatchability eggs
0	20	18.0 ^a	17.0 ^a	85	90
50	20	16.0 ^{ab}	15.0 ^{ab}	81	80
100	20	13.0 ^{abc}	6.0 ^c	39	50
200	20	5.0 ^e	2.0 ^{cd}	10	0
300	20	0.0 ^d	0.0 ^d	0	0

*Means followed by the same letter do not differ by Tukey test at 5%

In the Table 1 we can observe that the pupae and adults of larvae irradiated with dose of 50 Gy practically they didn't present significant differences in relation the treatment control, already with larger doses the effects of the radiation were more drastic reducing the emergency of insects significantly, those results is in agreement with the of [17]. The lethal dose to inhibit the transformation of the larvae in pupae and adults was obtained with the dose of 300 Gy.

We can observed that had adults emergency in the dose gamma radiation of 200 Gy, but they were sterile, Because the gamma irradiation induced a dominant lethal mutation in the insects that taking the sterilization in females and males, results similar were obtained by [10,11,12] when irradiated *Sitotroga cerealella*, *Diatraea saccharalis* and *Tuta absoluta* and to [13,14,15,16] when irradiated *Spodoptera frugiperda*. Based in these results, we can affirm categorically that the dose of 200 Gy was the sterilizing to adults and 300 Gy the lethal dose, that can be used to irradiate larvae of *S. frugiperda* to phytosanitary treatment of this insect pest [17].

4. REFERENCES

1. R.P.L. Carvalho. "Danos, flutuação da população e comportamento de *Spodoptera frugiperda* (J. Smith, 1797) e susceptibilidade de diferentes genótipos de milho, em condições de campo". Piracicaba, [Tese (Doutorado) - Escola Superior de Agricultura Luiz de Queiroz USP]. 170p. (1970).

2. I. Cruz & F.T. Turppin. "Efeito da *Spodoptera frugiperda* em diferentes estádios de crescimento da cultura de milho". *Pesquisa Agropecuária Brasileira*, **17**:335-359, (1982).
3. J.E. Carpenter, J.R. Young, E.F. Knipling, A.N. Sparks. "Fall armyworm (Lep., Noctuidae) inheritance of gamma induced deleterious effects and potential for pest control". *Journal of Economic Entomology*, **76**:378-382, (1983).
4. G.A. Runner. "Effect of roentgen ray on the tobacco cigarette and results of experiment with new roentgen tube". *Journal of Agricultural Research*, **66**:383-388, (1916).
5. V. Arthur. "Controle de insetos-praga por radiações ionizantes". *Biológico*, **59**:77-79, (1997).
6. M. Singh & J.N. Liler. "Effect of gamma rays on the lethality and reproductive potencial of lesser grain borer adults". *Journal of Economic Entomology* **65**:656-659, (1972).
7. M. Kogan, "Criação de insetos: bases nutricionais e aplicadas em programas de manejo de pragas. In: *Congresso Brasileiro de Entomologia*, 6., 1980, Campinas. Anais. Campinas: Fundação Cargil, p.45-75 (1980).
8. P.A. Singh. "General purpose laboratory diet mixture for rearing insects". *Journal of Insect Science*, **4**:357-362, (1983).
9. J.R.P. Parra. *Biologia dos insetos*. ESALQ, Piracicaba & Brazil (1979).
10. V. Arthur. "Utilização da radiação gama no controle de *Sitotroga cerealella* em milho". In: *Conferência Brasileira de Pós-Colheita*, I., 1999, Porto Alegre Anais. Passo Fundo: p.282-287. (1999).
11. V. Arthur, F.M. Wiendl, J.A. Duarte Aguilar. "Effect of gamma irradiation on pupal stage of sugarcane borer *Diatraea saccharalis* (Fabr.) parent and F-1 and F-2 generations". *Journal of Nuclear Agriculture and Biology*, **26**:166-169, (1997).
12. V. Arthur, A. G. Groppo, J. Tesariolineto, "Dose esterilizante de radiação gama do Cobalto-60 para adultos de *Tuta absoluta* (Meyrich) (Lepidoptera: elechiidae)". *Revista de Agricultura*, (Prelo) (2002).
13. V. Arthur, J.A.D. Aguilar, P.B. Arthur. "Esterilização de adultos de *Spodoptera frugiperda* a partir de pupas irradiadas". *Arquivos do Instituto Biológico*, **69**:75-77, (2002).
14. J.W. Snow, J.R. Young, W.J. Lewis, R.L. Jones. "Sterilization of adult fall armyworms by gamma irradiation and its effect on competitiveness". *Journal of Economic Entomology*, **65**:1431-1433, (1972).
15. J.E. Carpenter, J.R. Young, A.N. Sparks. "Fall armyworm (Lep., Nuctuidae): comparison of inherited deleterious effects in progeny from irradiated males and females". *Journal of Economic Entomology*, **79**:46-49, (1986).
15. A.F.M. Wakid & J.M. Hayo. "Inherited sterility in progeny of irradiated male cotton leafworm, *Spodoptera fugiperda*". *Journal of Applied Entomology*, **73**:331-335, (1972)
16. J.E. Carpenter, J.R. Young, A.N. Sparks. "Fall armyworm (Lep., Nuctuidae), comparison of inherited deleterious effects in progeny from irradiated parents". *Journal of Economic Entomology*, **80**:883-886, (1987).
17. C.J. Hallman, V. Arthur, C.M. Blackburn, A.G. Parker. "The case for a generic phytosanitary irradiation dose 200 Gy for eggs and larvae". *Radiation Physics and Chemistry*, **89**:70-75, (2013).