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GAMMA IRRADIATION AS A QUARANTINE TREATMENT FOR *NEOLEUCINODES ELEGANTALIS* IN TOMATO FRUIT

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ABSTRACT

In Brazil the tomato-fruit-borer is responsible up to 45% for the loss of the production. The objective of the present report is evaluate the effects of gamma radiation (^{60}Co) on life cycle (eggs and larvae) of *Neoleucinodes elegantalis* in tomato fruits. The insects were irradiated at doses of 0 (control), 50, 100, 150, 200, 250, 300 and 400Gy, in a Gammacell 220 source at dose rate of 1.4 kGy/h. Each treatment consists of four repetitions containing 10 insects, totaling 50 insects. After irradiation, the insects were maintained under controlled conditions of 25±3° C and Relative Humidity from 65 to 75%. The evaluations were done daily, counted the number of died insects, eggs and emerged larvae. With the obtained results, we could determine the lethal and sterilizing doses for all phases of cycle life in *N. elegantalis* for a possible quarantine treatment to export tomato fruits. These results permit conclude that the dose capable to avoid further development of stage of eggs and larvae were doses of 100 and 200Gy.

1. INTRODUCTION

Neoleucinodes elegantalis (Guenée) is one of the most important pests in several tomato growing regions of Brazil [1, 2]. It was first observed in Brazil in 1922 by Costa Lima in 1922 in the Northeast Region of the country [3, 4]. Estimated losses range from 45 [1] to 90% [4, 5]. Tomato is the second most important vegetable crop in Brazil. Around 65 thousand hectare in all regions is cultivated with tomatoes, and the crop earns more than 3 million tons per year. This volume puts Brazil among the ten greatest producers of tomatoes in the world. From the production, about one third is designated for industrial purposes, and the other part goes to the common inland table market, but nevertheless both destinations require a good quality of the product.

The losses caused by insects in orchards in the State of São Paulo were at least a thousand tons per year. The worse thing is that these losses were detected only when the fruits were all ready packaged and ready for shipment to export. The biological behavior of the N. elegantalis makes it difficult its control, the female moth lays up to 160 eggs [6] preferential under the petals of green fruits (23 mm) [7]. The neonate larva enters the fruit shortly after eclosion, thus the plague is protected during the phase of the cycle where cause bigger damages, adults emerge from the pupal stage within 1 to 7 h after the beginning of scotophase, mate within 48 to 72 h of eclosion [8], and shortly thereafter begin depositing eggs, a characteristic that limits the effectiveness of insecticides and biological control agents [7, 9].

Thus, for export, great difficulties arise, because even with reasonable careful treatments during the growing season, in some locations losses reach up to 50% of production. The infested production becomes inadequate to market generating high financial losses to producers. To avoid introduction of these and other pests into importing countries, the irradiation of the finished packages could be a good deal to avoid sometimes unpredictable losses.

2. EXPERIMENTS

2.1 Samples

Insects *N. elegantalis* infesting tomatoes were collected from fruits. After collection the insects were maintained also into a rearing room regulated at the temperature of 25±3° C and relative humidity from 65 to 75%. The research on the tomato pests was carried out in the Entomology laboratory of the Nuclear Energy Center for Agriculture (CENA), in Piracicaba, State of São Paulo, Brazil.

2.2 Irradiation

Samples were irradiated at room temperature in a ^{60}Co source Gammacell 220 (A.E.C. Ltda) at dose rate of 1.4kGy/h. Harwell Amber 3042 dosimeters were used to measure the radiation dose. The eggs were irradiated with the doses of 0 (control), 50, 100, 150, 200, and 300Gy. Larvae were irradiated with the following doses: 0 (control), 50, 100, 150, 200, 300, 400 and 500 Gy.

2.3. Eggs isolation, emergency and fertility

The eggs were introduced into a cylinder of 10 cm wide and 20 cm high. Each treatment had 5 replicates with 10 eggs each, from 1 to 24 hours old. After irradiation the eggs were maintained in Petri dishes, 2.5 cm high and 11 cm in diameter, on a humid filter paper and maintained until eclosion of the eggs. Eggs were observed by a microscope during six days, to observe its emergency and thus, fertility.

2.4. Larvae isolation, emergency and fertility

Five larvae, with 10 replicates each, were used for radiation dose (treatment). After treatment each larvae was stored into a glass vial (2.5 cm in diameter and 8.5 cm high), closed with a

cotton ball. The lethal dose was obtained by counting the live larvae and adults. The larvae counting was made each 2 days for a period of 10 days.

2.5 Statistical analysis

The experimental design was completely random. Experimental data were submitted to analysis of variance and averages compared by Tukey test at 5% level of probability [10].

3. RESULTS AND DISCUSSION

With relation to the tomato pest, we can observe the results on tables 1 and 2, the number of hatched larvae of the eggs and last instar larvae. In our experimental conditions these data suggest that the response to lethal dose applied for eggs was 100Gy. For larvae the observed dose was 200Gy. The results are conforming to [11, 12, 13, 14, 15, 16], who irradiated *Sitotroga cerealella*, *Plodia interpunctella*, *Corcyra cephalonica* and *Tuta absoluta*. They are also coherent with the results obtained by [17, 18, 19, 20] , who irradiated larvae of *Diatraea saccharalis*, *Spodoptera frugiperda* .

Table 1. Number and percentage of viable eggs of *Neoleucinodes elegantalis* laid by irradiated adults with gamma radiation of ^{60}Co.

Dose (Gy)	Number of eggs	Viability of eggs	% of viability
0	50	48a	94 %
50	50	9b	18 %
100	50	0b	0 %

Numbers with different letters differ in level of 5% (Tukey)

Table 2. Total number and emergency percentage of adults of *Neoleucinodes elegantalis* irradiated with gamma radiations of Cobalt-60 as last instar larvae.

Dose (Gy)	Number of pupae	Number of adults	% of emergency
0	50	47a	94 %
50	50	35a	70 %
100	50	11b	22 %
150	50	2c	4 %
200	50	0c	0 %

Numbers with different letters differ in level of 5% (Tukey)

4. CONCLUSION

Using our experimental conditions we could conclude that the doses of 100 and 200Gy were the lethal doses to stages of eggs and larvae of the *Neoleucinodes elegantalis* specie and could be recommended as a suitable quarantine process for tomato pest.

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REFERENCES

1. Gallo, D., Nakano, O.; Silveira Neto, S.; Carvalho, R.P.L.; Batista, G.C.; Berti Filho, E.; Parra, J.R.P.; Zucchi, R.A.; Alves, S.B.; Vendramim, J.D. *Manual de entomologia agrícola*. Editora Agronômica Ceres, São Paulo, 649 p. 1988.
2. Jordão, A.L., Nakano, O. *"Ensacamento de frutos do Tomateiro visando ao controle de pragas e à redução de defensivos"*. Sci. Agric. vol.59 no.2 Piracicaba Apr./June. 2002.
3. Toledo, A.A. *Contribuição para o estudo da Neoleucinodes elegantalis (Guenée, 1854), praga do tomate*. Biológico, v.14, p.103-108, 1948.
4. Leiderman, L.; Sauer,H.F.G. *"A broca pequena do fruto do tomateiro Neoleucinodes elegantalis (Guenée, 1854")*. Biológico 19: 182-186. 1953.
5. Moreira, J.A.L.; Lara, F.M.; Churata-Masca, M.G.C. *"Resistência de cultivares de tomateiro (Lycopersicon esculentum Mill) à "broca-pequena-dos-frutos," Neoleucinodes elegantalis (Guenée, 1854) (Lepidoptera: Pyralidae)"*. Ci. Cult. 37: 618-623. 1985.
6. Marcano, R. *"Ciclo biológico del perforador del fruto del tomate Neoleucinodes elegantalis (Guenée) (Lepidoptera: Pyralidae), usando berenjena (Solanum melongena) como alimento"*. Boletin de Entomologia Venezolana, v.6, p.135-141, 1991.
7. Blackmer, J.L.; Eiras, A.E.; Souza, C.L.M. *"Oviposition preference of Neoleucinodes elegantalis (Guenée) (Lepidoptera: Crambidae). and rates of parasitism by Trichogramma pretiosum (Riley) (Hymenoptera: Trichogrammatidae) on Lycopersicon esculentun in São José de Ubá"*. Brazil. Neotrop. Entomol. 30: 89-95. 2001.
8. Eiras, A.E. *"Calling behaviour and evaluation of sex pheromone glands extract of Neoleucinodes elegantalis Guenée (Lepidoptera: Crambidae)"*. Anais da Sociedade Entomológica do Brasil, v.29, p.453-460, 2000.
9. Siqueira, H.A.A.; Guedes, R.N.C.; Picanço, M.C. *Insecticide resistance in populations of Tuta absoluta (Lepidoptera: Gelichiidae)*. Agric. For. Entomol. 2: 147-153. 2000.
10. Sas Institute. Sas/Stat user´s guide 8.0. Cary, 1998.
11. Arthur, V. *"Efeitos Esterilizantes e Letais das Radiações Gama nas Diferentes Fases do Ciclo Evolutivo de Sitotroga cerealella (Oliv.) em Arroz e Milho"*, Tese de Doutorado – ESALQ/ USP – Piracicaba, SP, 77pp. 1985.
12. Arthur, V. *"Influência da Radiação na Longevidade de Lagartas de Plodia interpunctella (Hbn, 1913) (Lep. Pyralidae) em Dieta Artificial"*, *En. Nuclear & Agric.* Piracicaba, SP, vol. 9, no 1, 28-35, 1988.
13. Arthur, V. *"Uma Visão Crítica do Uso de Radiações Ionizantes como Processo Quarentenário para Moscas-das-Frutas"*, Tese Livre-Docente, Cena/ Usp, Piracicaba, SP, 53 pp. 1998.
14. Duarte-Aguilar, J. A.; Arthur, V., *"Effects of Gamma Radiation on Pupae, Adults and First Generation of Corcyra cephalonica (Stainton)"*. *Jour. Nuclear Agric. Biol*. Vol 23, , no 2, 136-139, 1994

15. Groppo, A. G., *"Efeitos da radiação gama nas diferentes fases do ciclo evolutivo da traça do Tomateiro Tuta absoluta Meyrick, 1917 (Lep. Gelechiidae)"*. Tese Doutorado, Piracicaba, CENA/USP, 69 pp, 1996.
16. Tamborlin, M. J. "Efeitos das Radiações Gama nas Diferentes Fases do Ciclo Evolutivo de *Plodia interpunctella* (Hbn, 1813) (Lep. Pyralidae) em Dieta Artificial", Diss. Mestrado, Esc. Sup. Agric. Luiz de Queiroz, ESALQ/ USP, Piracicaba, 91 pp.,1988.
17. Duarte-Aguilar, J. A.; Arthur, V. "Effect of Sub-Sterilizing Doses of Gamma Radiations on Pupae, Adults, and First Generation of *Corcyra cephalonica* (Stainton)" , *Jour. Nuclear Agric. Biol.* Vol 27, no 2, 132-138, 1998.
18. Arthur, V.; Walder, J.M.M; Wiendl, F.M. "Sugar Cane Borer Control Through F-1 Sterilization", *Acta Agric. Nucleatae Sinica*, vol. 4, 57-63, 1990.
19. Arthur, V.; Wiendl, F.M ; Duarte-Aguilar, J.A; Wiendl, J.A. "Effect of Gamma Irradiation on Pupal Stage of the Fall Armyworm Parent and F-1 Generations Reproduction", *Acta Agric. Nucleatae Sinica*, vol. 8, 14-18, 1994
20. Arthur, V.; Wiendl, F. M.; Duarte-Aguilar, J.A., "Effect of Gamma Irradiation on Pupal Stage of the Sugar Cane Borer *Diatraea saccharalis* (Fabr.) Parent, F-1, and F-2 Generations", *Journ. Nuclear Agriculture* Biol. Vol. 26, no 3, 166-169, 1997.