2009 International Nuclear Atlantic Conference - INAC 2009
Rio de Janeiro,RJ, Brazil, September27 to October 2, 2009
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR - ABEN
***ISBN:* 978-85-99141-03-8**

GAMMA IRRADIATION AS A QUARANTINE TREATMENT AGAINST EGGS OF CITRUS BLACK FLY (*Aleurocanthus woglumi* Ashby)

Anna Lucia C. H. Villavicencio[1]; Michel M. Araújo[1]; Gustavo B. Fanaro [1]; Helbert H. S. F. Costa[1]; Priscila P. V. Silva[1]; Valter Arthur[2] and José Tadeu Faria[3]

[1] Instituto de Pesquisas Energéticas e Nucleares (IPEN/CNEN-SP)
Av. Prof. Lineu Prestes, 2242
05508-000 São Paulo, SP, Brazil
villavic@ipen.br

[2] CENA – Centro de Energia Nuclear na Agricultura, USP
Laboratorio de Radibiologia e Ambiente
Piracicaba, SP, Brazil
arthur@cena.usp.br

[3] MAPA – Ministério da Agricultura Pecuária e Abastecimento
São Paulo, SP, Brazil
dt-sp@agricultura.gov.br

ABSTRACT

The citrus black fruit fly (*Aleurocanthus woglumi* Ashby) is an important pest of citrus originated in Southeast Asia and its first record in the new world was in Jamaica in 1913. In Brazil, it was detected in 2001 in the state of Pará and more recently it was detected in São Paulo in 2008. This pest that attacks over 300 species of plants, but its main host are citrus. It is an A2 quarantine pest, because it is not spread throughout the country. The objective of this study was to test doses of 0 (control), 25, 50, 75, 100, 125, 150, 175 and 200Gy of gamma irradiation for disinfection of eggs of the citrus black fruit fly in leaves of citrus plants. Treatment consisted of 5 replicates with 60 eggs each. Evaluations were performed in the following periods: 1, 3, 5, 7 and 10 days after irradiation. Under the conditions assayed, it could be concluded that a dose of 200Gy caused 100% mortality of *Aleurocanthus woglumi* Ashby eggs and could be recommended as a successful quarantine processing against infested plants.

1. INTRODUCTION

The citrus black fly *Aleurocanthus woglumi* Ashby is an important pest of citrus originated in Southeast Asia [1] and its first record in the new world was in Jamaica in 1913, spreading to Cuba in 1916 and Mexico in 1935 [2]. It was recorded in Florida in 1934 [3]. In South America, it was detected in 1965 in Venezuela [4]. The citrus black fly was eradicated in Florida in 1937 and Texas in 1956. After that the pest had new outbreaks recorded in 1971 in Texas and Florida in 1976 [5], established in central and southern region of Florida state [6], besides Hawaii [7]. The citrus black fly was first found in Brazil in July 2001 in the State of Pará [8] and then in Maranhão in 2003 [9], in Amazonas in 2004 [10] and in Amapá in 2006 [11]. In the state of Sao Paulo, it was recorded in March 2008 in lemon crops.

The black fruit fly is a sucking insect (Hemiptera: Aleyrodidae). The newly emerged adult has a light yellow head, pale legs and red-brown eyes, and after 24 hours, is

covered by a thin layer of powder that gives to its body a bluish color almost black. The sex is easily differentiated by size, because males measure 0.9mm in length while females measure 1.3mm [13]. The life cycle varies with climatic conditions so, from 27ºC to 32ºC, the duration of the phases are: egg - 9 and 13 days, 1st instar - 7 and 9 days, 2nd instar - 5 and 7 days; 3 instar - 6 and 9 days, pupa - 25 and 36 days. At adult emergence, an opening similar to a "T" appears in the front of the pupa and becomes visible about an hour before the outbreak of adults [14].

Although the citrus species are primary hosts of *A. woglumi*, it is a pest of polyphagous feeding habits that can infest more than 300 plant species, including among them, mango, grapes, citrus, cashew, avocado, guava, apple, fig, banana, papaya, pear, pomegranate, quince, coffee, roses and other [6]. It can also infest other ornamental plants and weeds, easily transported to other regions [12].

Direct damage is caused because of continuous sucking nutrients from leaves and the consequent depletion of the plants by nymphs and adults [12]. The indirect damages are caused by the elimination of sugary secretion on the leaves, inducing the occurrence of saprophytic fungi that forms sooty mould, which greatly reduces light incidence reducing photosynthesis [15].

The citrus black fly of citrus is a quarantine pest present in Brazil (A2), that is, it is not widespread in the country and is under official control [16] that is why it should be avoided transporting infested plants to other regions of the country unaffected. Citrus fruits transportation is authorized, as long as they had been processed and washed and free of leaves [17]. In São Paulo, citrus areas are located near sites producers of ornamental plants, which are distributed throughout Brazil and also abroad. In order to facilitate the safe transport of ornamental plants with leaves that could host the insect, from areas affected to free citrus black fly zones, it is necessary to seek alternative treatments to combat the insect. These treatments should not leave undesirable residues on treated products as well as not pollute the environment. Therefore the use of gamma radiation on ornamental plants from the area infested with the citrus black fly, may be a viable and safe treatment. This study aims to test various ^{60}Co doses on citrus black fly eggs to determine an effective radiation dose.

2. MATERIAL AND METHODS

2.1 Samples

Naturally infected *Valencia* orange leaves with citrus black fly eggs, were collected from a ranch at Artur Nogueira municipality, in the state of São Paulo. The orchard established in 1988, contains 2600 trees which were not treated with spraying chemicals over the past 60 days. The leaves were placed into plastic bags and transported in the same day to the Irradiated Food Laboratory at IPEN (Nuclear and Energy Research Institute) in São Paulo. In order to treat only eggs freshly oviposited, were selected only those leaves that showed the latest ovipositions. Into a Petri dish containing a moistened filter paper, was placed a leaf with 60 citrus black fly eggs, previously counted and identified in each leaf. For each treatment were prepared five Petri dishes and each sample was identified with its respective radiation dose.

2.2 Irradiation Treatment

Immediately after samples preparation, they were irradiated at room temperature (around 25ºC) in a ^{60}Co source (Gammacell 220) at IPEN/CNEN-SP. Dose rate was 2.11kGy/h. Applied doses were: 0 (control), 25, 50, 75, 100, 125, 150, 175 and 200Gy. Harwell Amber 3042 dosimeters were used for the measurement of radiation dose.

2.3 Assessment of Mortality

After irradiation the plates were brought back to the laboratory and kept at room temperature (25ºC). Assessment of mortality was evaluated by the first-instar nymphs eclosion, at intervals of 1, 3, 5, 7 and 10 days after irradiation. All the ecloded nymphs were counted and the data were recorded cumulatively.

2.4 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 [18].

3. RESULTS AND DISCUSSION

The results in Table 1 indicated that gamma radiation processing showed effective to inhibit *Aleurocanthus woglumi* eggs eclosion. Control samples reached a viability of 79.66%, decreasing to 0% with a radiation dose of 200Gy. All treatments differed from the control treatment. The treatment that received a radiation dose of 200Gy caused a 100% mortality of eggs. Such data is in agreement with those obtained by [19] and [20] who obtained 100% of mortality of *Ceratitis capitata* eggs with a radiation dose of 200Gy. These results also agree with [21] that irradiated eggs of *Dacus cucubitae* and *Dacus dorsalis* with 150Gy, obtaining any adult. These results are promising and are in accordance with International Atomic Energy Agency [22], who stated that gamma radiation doses lower than 1000Gy can be used as a quarantine treatment for plants infested with pests and doses from 150 to 260Gy can prevent the emergence of adults of *Ceratitis capitata*. However, if the judgment of mortality would be replaced by the judgment of viable adults for reproduction, 30Gy could be effectively used.

Table 1. Number and percentage of viable eggs of *Aleurocanthus woglumi* irradiated with gamma radiation of ^{60}Co.

Dose (Gy)	Eggs Numbers	Eggs viability	% of viabity	Mean
0	300	239	79,66	47,80[a]
25	300	141	47,00	27,60[b]
50	300	105	35,00	21,60[bc]
75	300	108	36,00	21,00[bc]
100	300	100	33,33	20,00[bc]
125	300	93	31,00	18,60[bc]
150	300	65	21,66	13,00[c]
175	300	13	4,33	2,60[d]
200	300	0	0	0

Values followed by different letters have a significative difference by Tukey test (P<0.05).

4. CONCLUSION

Under the conditions assayed, it could be concluded that a radiation dose of 200Gy caused a 100% mortality of eggs of *Aleurocanthus woglumi* Ashby and could be recommended as a quarantine process for plants infested with eggs of this insect.

ACKNOWLEGMENTS

We thank to CNPq, FAPESP, CNEN and IPEN/CNEN-SP for financial support and to CENA, MAPA - CDA/Secretaria da Agricultura do Estado de São Paulo for its collaboration.

REFERENCES

1. H. F. Dietz, J. Zetek, " The blackfly of citrus and other subtropical plants". *USDA Bulletin*, **885**, pp.1-55 (1920).
2. H. D. Smith, H. L. Maltby, E. J. Jimenez, "Biological control of the citrus blackfly in Mexico", *USDA-ARS, Technical Bulletin*, **1311,** pp.1-30 (1964).
3. W. Newell, A.C. Brown, "Eradication of the citrus blackfly in Key West, Fla", *Journal Economic Entomology*, **32**, pp.680-682 (1939).
4. N. Angeles, R. Oakley, J. O. Osorio, "Presencia en Venezuela de *Aleurocanthus woglumi* Ashby (Aleyrodidae: Homoptera) mosca prieta de los cítricos", *Agronomia Tropical*, **18**(4), pp.487-488 (1968).
5. W. G. Hart, A. Selhime, D. P. Harlan, S. J. Ingle, R. M. Sanches, R. H. Rode, C. A. Garcia, J. Caballero, R. L. Garcia, "The introduction and establishment of parasites of citrus blackfly, *Aleurocanthus woglumi* in Florida (Hem.: Aleyrodidae)", *Entomofhaga*, **23**(4), pp.361-366 (1978).

6. R. Nguyen, A. B. Hamon, "Citrus Blackfly, *Aleurocanthus woglumi* Ashby (Homoptera: Aleyrodidae)", Gainesville Florida Department of Agriculture & Consumer Service – Division of Plant Industry, 1993, (Circular nº 360).
7. R. A. Heu, W. T. Nagamine, "Citrus blackfly", State of Hawaii – Department of Agriculture, 2001, (New Pest Advisory nº 99-03).
8. Ministério da Agricultura, Pecuária e Abastecimento (Brasília), M. R. V. Oliveira, C. C. A. Silva, D. Navia, *Mosca negra dos citros Aleurocanthus woglumi: alerta quarentenário*, (2001).
9. R. N. S. Lemos, G. S. Silva, J. R. G. Araújo, E. F. Chagas, A. A. Moreira, A. T. M. Soares, "Ocorrência de *Aleurocanthus woglumi* Ashby (Hemiptera: Aleyrodidae) no Maranhão", *Neotrop Entomol,* **35**, pp.558-559 (2006).
10. M. R. Pena, N. M. Silva, pp. 16-18, "Sugadora negra", *Revista cultivar: hortaliças e frutas*, Pelotas, 7 (2007).
11. A. L. Jordão, R. A. Silva, *Guia de pragas agrícolas para o manejo integrado no estado do Amapá*, Editora Holos, Ribeirão Preto, Brasil (2006).
12. Agência Paulista de Tecnologia dos Agronegócios, Instituto Biológico, A. Raga, V. A. 12. Costa, *Mosca Negra dos Citros*, Documento Técnico 001, Abril de 2008, pp.1-9 (2008).
13. R. Nguyen, A. B. Hamon, T. H. Fasulo, "Citrus Blackfly *Aleurocanthus woglumi* Ashby (Insecta: Homoptera: Aleyrodidae)" http://creatures.ifas.ufl.edu/citrus/citrus_blackfly.htm. (2003)
14. N. B. Martinéz, "Biologia de la mosca prieta de los cítricos *Aleurocanthus woglumi* Ashby (Homoptera:Aleyrodidae) en el campo", *Agronomia Tropical*, **31**, pp.211-218 (1982).
15. EMBRAPA, M. R. V. Oliveira, C. C. A. Silva, D. Navia, *Praga Quarentenária A1: A mosca negra dos citros, Aleurocanthus woglumi Ashby (Hemíptera:Aleyrodidae)*, Comunicado Técnico 40 (1999).
16. Ministério da Agricultura, Pecuária e Abastecimento, "IN 52 (Instrução Normativa 52)", www.extranet.agricultura.gov.br/sislegis-consulta/18212 (Dezembro de 2007).
17. Ministério da Agricultura Pecuária e Abastecimento, "IN 23 (Instrução Normativa 23)", www.extranet.agricultura.gov.br/sislegis-consulta/18857 (29 de abril de 2008).
18. SAS Institute, *SAS/Stat user's guide 8.0*, Cary (1998).
19. J. T. Faria, *Radiação gama como um processo quarentenário para Ceratitis capitata (Wied., 1824) e Anastrepha fraterculus (Wied., 1830) (Diptera: Tephritidae) em mamão papaya (Carica papaya L.) cultivar sunrise solo*, (1989), Dissertação de Mestrado, ESALQ/USP, Piracicabal/SP.
20. J. M. M. Walder, S. R. Vicino, L. A. Lopes, *Efeito letal da radiação gama em ovos de larvas de Ceratitis capitata (Wied., 1824 (Diptera: Tephritidae)*, In: Congresso Brasileiro de Entomologia, 12, pp.503, Belo Horizonte, Resumos, Sociedade Entomológica do Brasil, (1989).
21. P. Thomas, G. W. Rahalkar, "Desinfestation of fruit flies in mango by gamma irradiation", *Current Science*, Bangalore, 44(21), pp.775-776 (1975).
22. International Atomic Energy Agency, Vienna. (1985). Use of irradiation as a quarantine treatment of agricultural commodities; Technical document, Vienna, 1985. 66 p.