Irradiation as a Phytosanitary Treatment:
a Global Solution
Contents

- A bit of history
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Earlyest suggestion of irradiation as a phytosanitary treatment?

Kiyoshi Koidsumi

Quantitative studies on the lethal action of X-rays upon certain insects


In the Island of Formosa, a large number of fruits and vegetables such as Citrus, Mango, Bamboo-shoot, Cucumber, Melon, Luffa etc. are damaged in a considerable degree by many species of fruit fly, Dacus. These larvae hatching from eggs laid on these plants damage them very considerably. The killing of any stages of these insects which are parasitic to these plants, as they are contained in plants themselves or in a package to be exported, has a very important significance in the exportation of the plants.

It was the purpose of the author to destroy them within fruits or vegetables or packages which contained insects by means of X-ray radiation, and it was developed that a certain intensity of rays killed such naked insects as were not covered with any objects during any stages of development. I first determined the purely scientific relation of the rays to the death of the naked insects. This article will deal with the obtained results, of interest from a scientific point of view.
Milestones

1980:
Joint WHO-FAO-IAEA Expert Committee on the Safety of Irradiated Food:

*Irradiated food pose no toxicological, microbiological or nutritional hazard*

1986:
US FDA approves irradiation up to 1 kGy for preservation and disinfestation of fresh fruits and vegetables

1990s:
First regular commercial shipments of irradiated fruit from Hawaii

2002:
USDA APHIS establishes regulations providing for use of irradiation as a phytosanitary treatment for imported fruit and vegetables
Development of international standards

**International Plant Protection Convention (IPPC)**

Multilateral treaty under the Food and Agriculture Organization (FAO)

- **ISPM 18 (2003):** Guidelines for the use of irradiation as a phytosanitary measure
  
  Technical guidance on procedures for the application of ionizing radiation as a phytosanitary treatment for regulated pests or articles

- **ISPM 28 (2007):** Phytosanitary Treatments for Regulated Pests
  
  Requirements for submission and evaluation of the efficacy data for a proposed phytosanitary treatment

Annexes: treatments adopted by the Commission on Phytosanitary Measures (CPM).
Development of international standards

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<th>Annexes ISPM 28</th>
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<td>Irradiation treatment for Anastrepha ludens</td>
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<td>07 (2009)</td>
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<td>14 (2011)</td>
<td>Irradiation treatment for Ceratitis capitata</td>
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Development of international standards

Most recent approval of irradiation treatment by the TPPM (week March 16, 2015)

3 mealy bugs: *Dysmicoccus neobrevipes, Planococcus lilacinus and Planococcus minor* (*Pseudococcidae*)

Minimum dose: 231 Gy

Possible implication subject to APHIS approval:

Dragon fruit from Vietnam could be irradiated at 231 Gy minimum instead of the current 400 Gy because the only pests on the Pest Risk Analysis were these three mealybugs and three fruit flies that require only the 150 Gy generic dose for Tephritidae.
Development of international standards

Approval of Irradiation Facilities

- Endorsed in 2013 by the Asia and Pacific Plant Protection Commission (APPPC)
- Submitted to the IPPC

http://www.fao.org/docrep/019/i3707e/i3707e.pdf
Specifics of irradiation vs. other phytosanitary treatments

• Irradiation does not necessarily result in immediate mortality of target pests.

• Possible effects of irradiation for phytosanitary purpose:

  1. Sterility: target pest alive and may develop to maturity but unable to fly

  2. Inability to emerge or fly: successful development is disrupted. Target pest alive but unable to develop to full maturity (emergence, flight)

  3. Inactivity or devitalization (seeds may germinate but seedlings do not grow)

  4. Mortality: target pest is killed, immediately or after a delay

• Products that have been properly irradiated and satisfy quarantine requirements may still contain live pests.

• Ensuring that the treatment has been properly applied is essential.
Advantages of phytosanitary irradiation

• A non-chemical process, effective and quick

• Applicable to a broad range of products with no or marginal loss of
  • sensory qualities
  • nutritional qualities

• Possibility to use *one fits all* minimum doses (generic doses)

• Tolerance (maximum dose applicable) depends on
  • Species
  • Variety
  • Maturity at time of irradiation
  • Combination with other treatments

• Extends shelf-life in some cases

• Simultaneous inactivation of parasites
Trade of produce irradiated for phytosanitary purpose

Global volume 2013 ~ 20,000 tons
Technologies used for phytosanitary irradiation

Gamma irradiation
Electron accelerators
X-Ray machines

Credit: IBA
X Ray irradiation facility used for phytosanitary treatments

- USA
  - Hawaii Pride – since 2000
    Surebeam system – Linac 5 MeV
Electron beam irradiation facilities used for phytosanitary treatments

- **Asia-Pacific**
  - Vietnam
    - SonSon Corporation

- **Americas**
  - USA
    - National Center for EB Research, College Station, Texas
    - Sadex  Sioux City, Iowa
Gamma irradiation facilities used for phytosanitary treatment (1/2)

- **Asia-Pacific**
  - **Australia**  Steritech, Queensland – Multipurpose
  - **India**  Krushak, Lasalgaon, Maharastra – Food only
  - **Thailand**  Thai Irradiation Centre, Bangkok - Multipurpose
    Synergy Health, Chonburi - Multipurpose
  - **Vietnam**  Anphu, Ho Chi Minh City - Multipurpose

*Credit: Steritech*
Gamma irradiation facilities used for phytosanitary treatment (2/2)

- Africa
  - South Africa
    - HEPRO, Cape Town – Multipurpose

- Americas
  - USA
    - Gateway, Gulfport, Mississipi
    - Pa’ ina, Hawaii – since 2013
  - Mexico
    - Benebion, Guadalajara
    - Sterigenics, Mexico City - Multipurpose

Credit: Graystar
Phytosanitary irradiation has been tested since 2008

In 2015 an EB facility in Pingxiang, Guanxi will treat fruit imported from Vietnam
Project of phytosanitary irradiation facility in China

2 accelerators 7.5 kW – 10 MeV

Irradiation from top + bottom
Project of phytosanitary irradiation facility in China

Planned irradiation capacity: 100,000 tons / year

2 x 7 feeding lines
Point of irradiation

Country of origin vs. Country of destination

Minimum phytosanitary risk

Technical factors
- Availability of an approved irradiation facility
- Dimensions of packages that can be irradiated
- Time available between harvest and irradiation

Cost factors
- Logistics cost
- Inspection cost
- Irradiation cost
Contribution of the Joint FAO-IAEA Division

- Dissemination of information on phytosanitary applications
  - Technical report to be published in 2015 *Good Practice in Food Irradiation*
  - E-learning course to go live in April 2015.

Both will be available in Spanish

- Training and workshops

*Next one: 5-7 October 2015, Mexico City for Caribbean and Latin America*
Contribution of the Joint FAO-IAEA Division

- Participation to the development of international standards
- Several Coordinated Research Projects on Phytosanitary Irradiation.

Latest (2009-2014):

*The Development of Generic Irradiation Doses for Quarantine Treatments*

- 15 participating countries
- 38 species studied of which 13 fully completed using very large numbers of insects in confirmatory tests required to validate treatment efficacy.
- Will lead to propose some generic doses including one of 250 Gy for all mealybugs on all hosts (second most important pest group according to Pest Risk Analyses)
- Results to be published in a special issue of *the Florida Entomologist*


- Initiatives to facilitate the use of EB and X-ray machines.
Experimental facilities

GammaCell using cobalt-60

X Ray irradiator
New technologies being studied for phytosanitary irradiation

Low energy X ray

Dose distribution in a carton of papaya

180 keV - 4.5kW – 10 cm/min conveyor speed

DUR: 1.4

Credit: USDA-ARS Hawaii and Comet
New technologies being studied for phytosanitary irradiation

Low energy EB

Credit: Applied Energy Devices
Marketing irradiated food products

Irradiated products do sell

USA

France

New Zealand

China

Peru

Thailand

Consumers’ acceptance less of an issue than retailers’ acceptance