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Treatment Manual

# Nonchemical Treatments

## *Irradiation*

## Contents



## Introduction

This chapter provides background and general information for the use of irradiation as a phytosanitary treatment of plant pests. Irradiation was first approved by APHIS in 1997 for use on papayas from Hawaii for export to the U.S. mainland, Guam, Puerto Rico, and the U.S. Virgin Islands. In 2002, irradiation was approved as a phytosanitary treatment for all admissible fresh fruits and vegetables from all countries.

## Authorities and Other Responsible Parties

- 7CFR 305.31 through 305.34
- Food and Drug Administration (FDA)

  The FDA is responsible for determining the labelling requirements for irradiated food.
- National nuclear regulatory authority of the country where the facility is located
- International Standard for Phytosanitary Measures #18 (ISPM)

  This International Standard provides technical guidance on the specific procedures for the application of ionizing radiation as a phytosanitary treatment for regulated pests or articles.

## Treatment Objectives

The objective of phytosanitary treatments is to prevent the introduction or spread of regulated pests. As a phytosanitary treatment, irradiation may reduce the risk of introduction by achieving certain responses, known as “endpoints,” in the targeted pest(s). These endpoints are:

- Inability to emerge or fly
- Inactivation or devitalization (seeds may germinate but seedlings do not grow; or tubers, bulbs or cuttings do not sprout)
- Mortality
- Sterility (inability to reproduce)

### Efficacy

Unlike the Probit 9 mortality required for many chemical and nonchemical quarantine treatments, the use of irradiation as a phytosanitary measure presents a new paradigm to PPQ. The officer inspecting the treated consignment upon arrival in the U.S. may encounter living insects. However, this is to be expected since the treatment endpoint may not necessarily be mortality.

## Treatment

There are three types of ionizing radiation:

- Electrons generated from machine sources up to 10 MeV (eBeam)
- Radioactive isotopes (gamma rays from cobalt-60 or cesium-137)
- X-rays (up to 5 MeV)

The unit of measure for absorbed dose from any type of radiation is gray (Gy).

Modified atmospheres, such as low oxygen, may reduce treatment efficacy at a prescribed dose. Do **not** treat commodities that are in an oxygen-deficient environment.

Treatment procedures should also ensure that the minimum absorbed dose (Dmin) is fully attained throughout the commodity to provide the prescribed level of efficacy. Owing to the differences in the configuration of lots being treated, higher doses than the Dmin may be received by some of the commodities to ensure that the Dmin is achieved throughout the configured commodity. All treatments must be certified by verifying Dmin with approved dosimetry systems.

The minimum absorbed dose for the most-tolerant unmitigated pest is required if more than one pest is present. Refer to ***Table 3-8-1*** on **page 3-8-4** to determine the required minimum absorbed dose. For example, if a shipment of grapes is infested with both Mediterranean fruit fly and codling moth, the commodity would be irradiated using a minimum dose of 200 Gy.

There may be additional treatment requirements specific to the pest/host complex. Refer to the treatment schedules listed in ***T105-a-1*** on **page 5-2-66** for detailed information.

*Table 3-8-1* on **page 3-8-4** summarizes the minimum required doses required for effective treatment of specific pests.:

**TABLE 3-8-1 Pest-Specific Minimum absorbed dose (Gy)**

| Scientific Name | Common Name | Minimum Absorbed Dose (Gy) |
|---|---|---|
| *Anastrepha ludens* | Mexican fruit fly | 70 |
| *Anastrepha obliqua* | West Indian fruit fly | 70 |
| *Anastrepha serpentina* | Sapote fruit fly | 100 |
| *Anastrepha suspensa* | Caribbean fruit fly | 70 |
| *Bactrocera cucurbitae* | Melon fruit fly | 150 |
| *Bactrocera dorsalis* | Oriental fruit fly | 150 |
| *Bactrocera jarvisi* | Jarvis fruit fly | 100 |
| *Bactrocera tryoni* | Queensland fruit fly | 100 |
| *Brevipalpus chilensis* | False red spider mite | 300 |
| *Ceratitis capitata* | Mediterranean fruit fly | 150 |
| *Conotrachelus nenuphar* | Plum curculio | 92 |
| *Cryptophlebia ombrodelta* | Litchi fruit moth | 250 |
| *Cryptophlebia illepida* | Koa seed worm | 250 |
| *Cylas formicarius elegantulus* | Sweet potato weevil | 150 |
| *Cydia pomonella* | Codling moth | 200 |
| *Euscepes postfasciatus* | West Indian sweet potato weevil | 150 |
| *Grapholita molesta* | Oriental fruit moth | 200 |
| *Omphisa anastomosalis* | Sweet potato vine borer | 150 |
| *Rhagoletis pomonella* | Apple maggot | 60 |
| *Sternochetus mangiferae* | Mango seed weevil | 300 |
| | All other fruit flies of the family Tephritidae which are **not** listed above | 150 |
| | Plant pests of the class Insecta **not** listed above, except pupae and adults of the order Lepidoptera | 400 |

## Dosimetry

Dosimetry is the system used by the facility to determine absorbed dose. The absorbed dose is a quantity of radiation energy (measured in Gray (Gy)) absorbed per unit of mass of the commodity.

The dosimetry system should be calibrated in accordance with international standards or appropriate national standards (e.g. Standard ISO/ASTM 51261 *Guide for Selection and Calibration of Dosimetry Systems for Radiation Processing*).

### Dose Mapping

Prior to routine treatments, the region(s) of lowest and highest dose absorbance must be mapped for each treatment configuration. Configurations may be defined by a variety of criteria which may vary by facility. Factors that affect dose mapping commonly include:

- Density and composition of the material treated
- Orientation of the product, stacking, volume and packaging
- Shape and/or size

Dose mapping of the product in each geometric packing configuration, arrangement and product density that will be used during routine treatments should be required by APHIS prior to the approval of a facility for the treatment application. Only the configurations approved by the APHIS should be used for actual treatments.

The data obtained from the dose mapping is used to determine the proper number and placement of dosimeters during routine operations.

## Facility Approval

Chapter 6-8 of this manual covers the requirements for Irradiation facility approval (***Certifying Irradiation Treatment Facilities*** on **page 6-8-1**).

## Documentation

The tracking and reporting of an irradiation treatment is critical to the integrity of the entire irradiation process. Treatment failure is linked to non-compliance, not pest detection. Consequently, an electronic database is being developed to standardize data entry, accurately and quickly produce data summaries and analysis, and allow access to a geographically diverse group of people.

Until this electronic database is fully operational, documentation requirements include the completion of the PPQ Form 203, Foreign Site Certificate of Inspection and/or Treatment.


The Irradiation Reporting and Accountability Database (IRAD) is a component of the Commodity Treatment Information System (CTIS) developed by USDA-APHIS-PPQ-CPHST Treatment Quality Assurance Unit (TQAU). Access to this web-based system will be permitted depending on the user's specific role or function in the irradiation process. TQAU will assign individual usernames and passwords.

## Terminology

**absorbed dose**—Quantity of radiation energy (in gray) absorbed per unit of mass of a specified target [ISPM No. 18]

**dose mapping**—Measurement of the absorbed dose distribution within a process load through the use of dosimeters placed at specific locations within the process load [ISPM No. 18]

**dosimeter**—A device that, when irradiated, exhibits a quantifiable change in some property of the device which can be related to absorbed dose in a given material using appropriate analytical instrumentation and techniques [ISPM No. 18]

**dosimetry**—A system used for determining absorbed dose, consisting of dosimeters, measurement instruments and their associated reference standards, and procedures for the system's use [ISPM No. 18]

**gray (Gy)**—Unit of absorbed dose where 1 Gy is equivalent to the absorption of 1 joule per kilogram (1 Gy = 1 J.kg-1) [ISPM No. 18]

**ionizing radiation**—Charged particles and electromagnetic waves that as a result of physical interaction create ions by either primary or secondary processes [ISPM No. 18]

**irradiation**—Treatment with any type of ionizing radiation [ISPM No. 18]

**minimum absorbed dose**—The localized minimum absorbed dose within the process load [ISPM No. 18] (Dmin)

**radura**—internationally recognized symbol used to indicate when a food product has been irradiated