

Postharvest Quarantine Treatments for Insect Control



The goal of phytosanitary regulations

- To prevent entry and establishment of exotic or non-indigenous organisms that pose a risk to plant life or health
- Entry or establishment must be prevented
- Systems approach may employ independent mitigation measure targeting both entry and establishment

APHIS

Animal & Plant Health Inspection Service

- A branch of the USDA
- Responsible for regulating the import/export and movement within the US of commodities that are subject to quarantine restrictions

APHIS/PPQ oversees:

Importation of:

- Craft Industries
- Endangered Plant Species (CITES)
- **Fruits and Vegetables**
- Plants and Products Covered by the Lacey Act
- Plants and Seeds for Planting
- Regulated Garbage
- Wood Packaging Materials

Coordination of products to be exported from USA

Key Program Components

- Inspection
- Treatment Oversight
- Safeguarding
- Documentation

Development of Phytosanitary Regulations

- Assessment of Risk
- Systems Approach
- Treatment Schedules

What is a "Systems Approach"?

- "[A] defined set of phytosanitary procedures, at least two of which have an independent effect in mitigating pest risk associated with the movement of commodities." (Plant Protection Act)
- "The integration of different pest risk management measures, at least two of which act independently, and which cumulatively achieve the desired level of phytosanitary protection." (UN, FAO 2001)

Steps in the development of "System Approach" Strategies

Step 1

Pest Harm Identification **RISK**
Impact Analysis; Quarantine Pest Identification and Pest Risk Assessment

Step 2

Selection of Risk Mitigation Measures **RISK**
Selection of Enforcement Instruments

Step 3

Review, Evaluation and Adjustment

Strategies used in a Systems Approach

- Pest Free Zones
- Non-host Status
 - Harvest maturity
 - GA sprays - susceptibility to infestations
- Inspection/certification
- Physical Commodity Treatments

Packaging




Containment




Inspection and Certification



Physical commodity treatments





APHIS Treatment Manual

The Desired Level of Control

With the exception of Irradiation the goal of any phytosanitary treatment is to achieve **Probit 9** Control

Probit 9:
Treatment should result in 99.9968% mortality of target pest

3 survivors per 100,000 treated

Treatment Schedules for Fruits and Vegetables

- *Methyl Bromide Fumigation*
- *Water Treatment*
- *High Temperature Forced Air*
- *Pest Specific/Host Variable*
- *Irradiation*
- *Vapor Heat*
- *Cold Treatment*
- *Fumigation + Refrigeration*
- *Cold Treatment + Fumigation*
- *Quick Freeze*

T101 - Methyl Bromide Fumigation

What is fumigation?

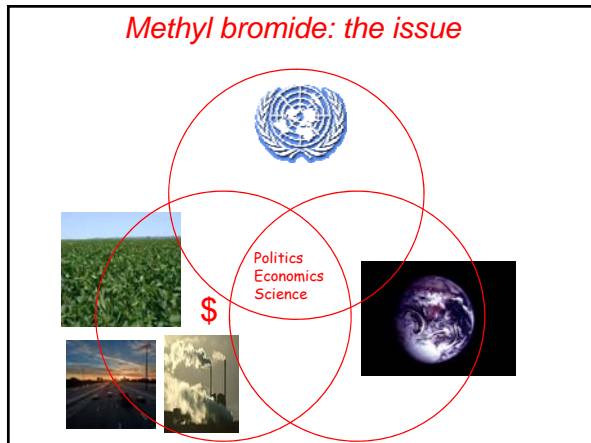
Fumigation is the act of releasing and dispersing a toxic chemical so it reaches the target organism in a gaseous state.

Chemicals applied as aerosols, smokes, mists, and fogs are suspensions of particulate matter in air and are not fumigants.

Methyl Bromide

- Widely used - primary quarantine fumigant
- General Biocide - Very effective
- Inexpensive
- Easy to use

Methyl bromide: the issue



Current Ways to Use Methyl Bromide

- As a "Quarantine" treatment for commodities being imported/exported from foreign countries or inter-state within the U.S.
- As a condition of "Pre-shipment" - treated within 21 days of shipment.
- As granted by the Parties to the Montreal Protocol under the "Critical Use Exemption" (CUE) provisions of the Montreal Protocol - done on a yearly basis.

Methyl Bromide fumigation treatment dependent on:

- Host
- Pest
- Temperature
- Duration
- Aeration time

Selected commodities approved for Methyl Bromide Fumigation (T101)

grape	chestnut	leafy veg.
avocado	macadamia	okra
citrus	almond	asparagus
stone fruit	walnut	corn
pome fruit	cut flowers	root crops
	ornamentals	beans/lentils

Schedule varies with target pest

T101-s-1

Cherry

Pest: *Rhagoletis indifferens* (Western cherry fruit fly) and *Cydia pomonella* (codling moth)

Treatment: **T101-s-1** MB at NAP—chamber only

Temperature	Dosage Rate (lb./1,000 ft ³)	Exposure Period
70 °F or above	2 lbs	2 hrs
60-69 °F	2.5 lbs	2 hrs
50-59 °F	3 lbs	2 hrs
40-49 °F	4 lbs	2 hrs

Note the temperature x dosage relationship

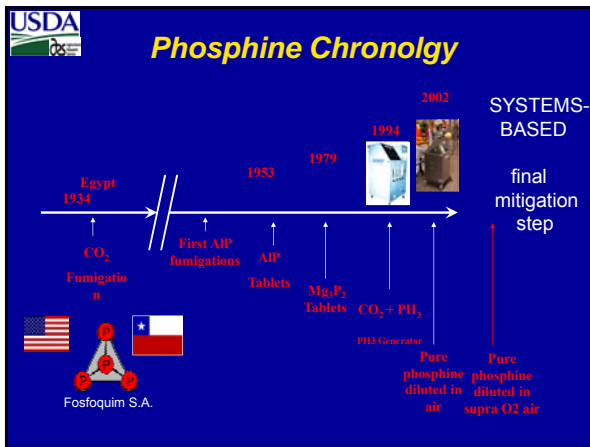
Source: APHIS Treatment Manual



USDA

Fumigants

- Methyl Bromide – CH₃Br
- Phosphine (Cytec®) – PH₃
- Sulfuryl Fluoride (Dow®) – SO₂F₂
- Ethyl Formate
- Carbonyl Sulfide – COS
- Ozone – O₃
- Ethanedinitrile
- Hydrogen cyanide
- Ammonia





PH3 Applications: MB chambers, CA rooms



02-18-2005

Physical Treatments

Water Treatments (T102)

Heat

- Hot Water Immersion (T102)
- Vapor Heat (T106)
- Forced Hot Air (T103)

Cold Treatment (T107)

Irradiation (T105)

Water Treatments (T102) Non-heated

Soapy Water and Wax

Cherimoya, Limes,
Passionfruit from Chile
Chilean false spider mite of
grapes



Warm Soapy Water and brushing

Durian and other large
fruits such as breadfruit
for external feeders



Heat Treatments

Generally based on maintaining the plant material at a specific temperature for a specified time; designed to kill plant pests without destroying or appreciably devaluing the infested commodity

Fruit Heat Tolerance

Goal:

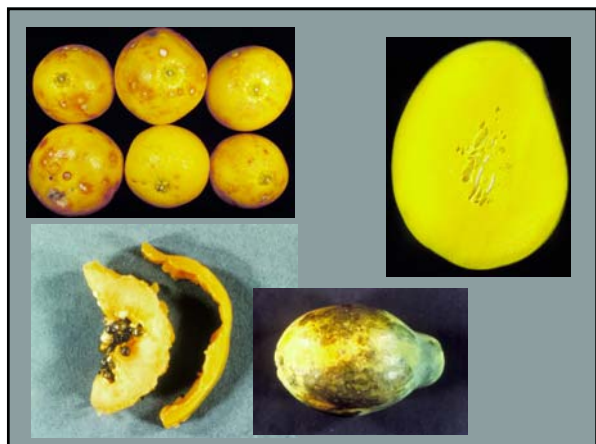
Heat fruit fast without damaging quality yet controlling target pest

Considerations:

Heating Method
Treatment Temperature

What is the fastest way to heat a commodity?

Heating	Efficiency
Water immersion	*****
Forced Vapor (wet surface)	*****
Forced Moist Air (surface dry)	***



Hot Water Treatments

Principle
 Uses heated water to raise the temperature of the commodity to the required temperature for a specified period of time.
 Primarily used for fruit fly hosts

Schedules
 The time-temp relationship varies with commodity and the pest.
 Typically, pulp temp is raised to between 115 - 118F (46.1 - 47.8C) for a specified period of time

Water Treatments (T102) Heated

Hot Water Immersion
 49C (120.2F) for 20"
 Litchi/Longan from HI - MFF, OFF
 Limes for mealybugs

Hot Water Dip
 Mango for MFF and MexFF;
 Anastrepha spp.

All require product to be submersed at least 4" below water surface.

High Temperature Forced Air (T103)

Principle

Really a modification of Vapor Heat
Maintain dew point temp of chamber 2C cooler than fruit surface temp to avoid condensation.
Based solely upon center pulp temperature of the fruit.
Primarily used for fruit fly hosts

Schedules

The time-temp relationship varies with commodity and the pest.
Can have rapid or slow ramping
Fruit should be sized
Typically, pulp temp is raised to 44-48C (111.2-118F) then held for a specified dwell time
Cooling after treatment - Forced air or hydrocooling

Example of High Temperature Forced Air

T103-c-1

Mango from Mexico

Pest: *Anastrepha ludens* (Mexican fruit fly), *Anastrepha obliqua* (West Indian fruit fly), and *Anastrepha serpentina* (black fruit fly)

Treatment: T103-c-1 High temperature forced air

Heat Up Time:	N/A
Heat Up Recording Interval:	2 minutes
Minimum Air Temperature:	50.0 °C/122.0 °F
Minimum Pulp Temperature at End of Heat Up:	48.0 °C/118.0 °F
Dwell Time:	2 minutes
Dwell Recording Interval:	2 minutes
Cooling Method:	Forced air or Hydrocooling
Size Restrictions:	Fruit weight must not exceed 1 1/2 lbs. (700 grams)

Source: APHIS Treatment Manual

Cold Treatment (T107)

- Treatments vary: -1 to 8 C for days to months
- Tropical and subtropical pests are easier to kill
- Many commodities are chilling sensitive and will not tolerate treatment

- Preconditioning fruit
 - May increase tolerance
 - Conditioning temperature varies; difficult to predict
 - Conditioning period appears to be time and temperature linked

Can commodities be conditioned to tolerate cold treatment?

Can you successfully cold-treat avocado?

The fruit will respond positively to intermediate low temperature conditioning

Work published by Hofman et al (2003) PBT and Woolf et al (2003) PBT demonstrated that following several days at 6-8C will provide protection against peel damage during subsequent low temperature storage.

Success of conditioning is dependent on temperature (don't want softening) and duration.

Temperature Range: 5-10C
Duration: 3-5 days



Examples of Cold Treatment

T107-a

Ceratitis capitata
and *C. rosa*
(Med FF, Natal FF)

Apple, Apricot¹⁰, Avocado, Blueberry, Cape Gooseberry, Cherry, Ethrog, Grape, Grapefruit, Kiwi, Lemon, Loquat, Litchi (Lychee), Nectarine, Orange, Ortanique, Peach, Pear, Persimmon, Plum⁸, Plumcot, Pomegranate, Pummelo, Quince, Sand Pear, Tangerine (includes Clementine)

Pest: *Ceratitis capitata* (Mediterranean fruit fly) and *Ceratitis rosa* (Natal fruit fly)

Treatment: T107-a Cold treatment

Temperature	Exposure Period
34°F (1.11°C) or below	14 days
35°F (1.67°C) or below	16 days
36°F (2.22°C) or below	18 days

T107-b

Anastrepha ludens
(Mex. FF)

Apple, Apricot¹², Cherry, Ethrog, Grapefruit, Litchi, Longan, Orange, Peach, Persimmon, Plum¹¹, Pomegranate, Tangerine (includes Clementine), White Zapote

Pest: *Anastrepha ludens* (Mexican fruit fly)

Treatment: T107-b Cold treatment

Temperature	Exposure Period
33°F (0.56°C) or below	18 days
34°F (1.11°C) or below	20 days
35°F (1.67°C) or below	22 days

Combination Treatments

- MB fumigation plus refrigeration
- Refrigeration plus MB fumigation

- Schedules Varies
- Limited number of commodities approved

Controlled Atmosphere Temperature Treatment Systems CATTs

- Approved for inclusion in APHIS Treatment Manual - January 2008
- Currently approved for commodities destined for EXPORT from USA
- USE currently suspended



IRRADIATION (T105)



A methyl bromide alternative that may work for some commodities

USDA-APHIS facilitating the use of Irradiation (TASC meeting, 2012)

Treatment must be conducted at approved facilities.

Dose mapping required for each commodity and/or size. Different configurations, packaging and/or mixed commodities should also be mapped.

Standards

- Intl. Plant Protection Convention (ISPM 18) established guidelines
- ISPM Technical Panel on Phytosanitary Treatments: development of intl. recognized treatments
- ASTM International: ASTM F1355 - 06: Std. guide for Irradiation as treatment

Regulations

- 10/23/2002: Establishment of requirements for irradiation (Closely followed ISPM 18)
- 1/27/2006: Est. **generic doses** for all insects (400 Gy) and for fruit flies (150 Gy)
- 2007 - present
 - Approved for importation from several countries
 - Establish pest specific doses

Examples of minimum required dose by **Pest**

Regulations: Required Doses (Gy)	
Generic Dose: All fruit flies of the family Tephritidae	150
Generic Dose: All insects except adults and pupae of the order Lepidoptera	400
Rhagoletis pomonella	60
Anastrepha ludens, Anastrepha obliqua, Anastrepha suspensa	70
Conotrachelus nemophar	92
Anastrepha serpentina, Bactrocera jarvisi, Bactrocera tryoni, Ceratitis capitata, Copitarsia declora	100
Bactrocera cucurbitae, Aspidiotus destructor, Bactrocera dorsalis, Cylas formicarius, Eusecepes postfasciatus, Omphisa anastomosalis, Pseudaulacaspis pentagona	150
Cydia pomonella, Grapholita molesta	200
Cryptophlebia ombrodelta, Cryptophlebia illopidia	250
Brevipalpus chilensis, Sternochetus mangiferae	300

Examples of allowed Product

Regulations: Eligible Commodities	
Ghana	Eggplant, Okra, Pepper
Hawaii	Abiu, Atemoya, Banana, Breadfruit, Capsicum spp., Carambola, Cucurbita spp., Dragon fruit, Eggplant, Jackfruit, Litchi, Longan, Mango, Mangosteen, Melon, Moringa pods (Drumstick), Papaya, Pineapple, Rambutan, Sapodilla, Sweet Potato, Tomato, banana, star fruit, curry leaves
India	Mango
Malaysia	Rambutan
Mexico	Carambola, Clementino, Grapofruit, Guava, Mango, Chilo Marzano, Sweet Lime, Sweet Orange, Tangelo
Pakistan	Mango
South Africa	Grapes, Stone Fruit, Pears, Persimmons
Thailand	Litchi, Longan, Mango, Mangosteen, Pineapple, Rambutan, Dragon Fruit
Viet Nam	Dragon fruit, Rambutan

Product may be treated at various points

- Preclearance: treated in country of origin
- Port of entry: treatment in US, restricted locations
- Internal Quarantine: movement within US
- Export: US products for export

Considerations pertaining to irradiation

- Many hosts are injured at <1000 Gy
- Sterilization dose vs. lethal dose
- Dosimetry
- Not a substitute for good handling
- Cost/Logistics
- Social Issues

Approaches for the future

- **Chemically-Based Alternatives**
 - New Fumigants/New Techniques
 - Volatile Identification/Mating Disruption
 - Emissions Control
- **Non-Chemical/Physical Alternatives**
 - Irradiation
 - Heat/Cold
 - Physical Control - Compression/Vacuum
 - RF Energy

Resource Information

Available in pdf downloadable format at www.aphis.usda.gov/import_export/plants/manuals/



➤ APHIS Treatment Manual and updates

- Fruit and Vegetables Manual

- Cut Flowers and Greenery

- Export Program Manual



FAVIR Database

Fruits and Vegetables Import Requirements (FAVIR)

This online reference allows easy access to regulations and information pertaining to the importation of fruits and vegetables into the United States, its territories, and possessions.

<https://epermits.aphis.usda.gov/manual/index.cfm?CFID=1704134&CFTOKEN=2a58b629840420a5-F5952858-9BBA-F0A6-A7CCD990C7504EA9&ACTION=pubHome>
