



# **US Phytosanitary Irradiation: Research Needs**

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Science and Technology  
Plant Protection and Quarantine  
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# Research Needs

- CPHST AQI Raleigh and Miami
- Verification Tool
- Generic Doses
- Modified Atmosphere Packaging
- Process Configuration
- Quality Studies



# CPHST AQI Raleigh and Miami

- Develop new quarantine treatments, techniques and processes
- Validate existing treatments
- Design of risk management options and systems approaches
- Development and optimization of port inspection technologies
- Support pre-clearance and domestic programs
- Interpret and provide technical support for the PPQ Treatment Manual

# Irradiation Efforts

## CPHST AQI Raleigh

- Facility, packaging and process configuration approval
- Facility certification and recertification
- PPQ policy and standard development (CFWG)
- Research proposal review and/or development
- Cooperator project management
- Irradiation database management and QA
- Field and hub staff training
- International and domestic outreach

# Irradiation Efforts

## CPHST AQI Miami

- Commodity quality
- Modified atmosphere packaging
- International and domestic outreach



## RAD SOURCE RS 1300

- One pi X-ray Emitter
- Dual radiation chambers with turn tables
- Dose rate: ~70 Gy/minute

# At the Border

When irradiated commodity arrives in the US, the Department of Homeland Security (DHS) Customs and Border Protection (CBP) conducts inspection

If a pest is intercepted, APHIS conducts the identification, and prescribes and monitors the mitigation



# What do we need?

In the event that CBP intercepts a live pest within the pest proof packaging, PPQ needs a tool to verify that an irradiation treatment has occurred.

Ideally, the verification tool would:

- Provide immediate Y/N answer
- Be inexpensive
- Be easy to use
- Not require hazardous reagents
- Have low-maintenance storage requirements
- Work for multiple insect families

# Verification Tool

CPHST has just initiated a cooperative agreement with the University of Florida to develop a diagnostic assay to verify that a phytosanitary irradiation treatment was performed using commercially available antibodies to biochemical products of irradiation stress.

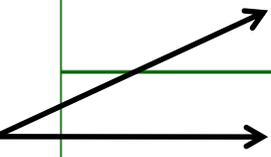


# Generic Absorbed Doses

Table 5-2-12 Pest-Specific Minimum absorbed dose (Gy)

Scientific Name	Common Name	Minimum Absorbed Dose (Gy)
<i>Cryptophlebia illepada</i>	Koa seedworm	250
<i>Cylas formicarius elegantulus</i>	Sweet potato weevil	150
<i>Cydia pomonella</i>	Codling moth	200
<i>Euscepes postfasciatus</i>	West Indian sweet potato weevil	150
<i>Grapholita molesta</i>	Oriental fruit moth	200
<i>Omphisa anastomosalis</i>	Sweet potato vine borer	150
<i>Pseudaulacaspis pentagona</i>	White peach scale	150
<i>Rhagoletis pomonella</i>	Apple maggot	60
<i>Sternochetus mangiferae</i>	Mango seed weevil	300
	All other fruit flies of the family Tephritidae which are <b>not</b> listed above	150
	Plant pests of the class Insecta <b>not</b> listed above, except pupae and adults of the order Lepidoptera	400

Generic  
Absorbed  
Doses



# Generic Absorbed Doses

## Generic Absorbed Doses Facilitate Trade

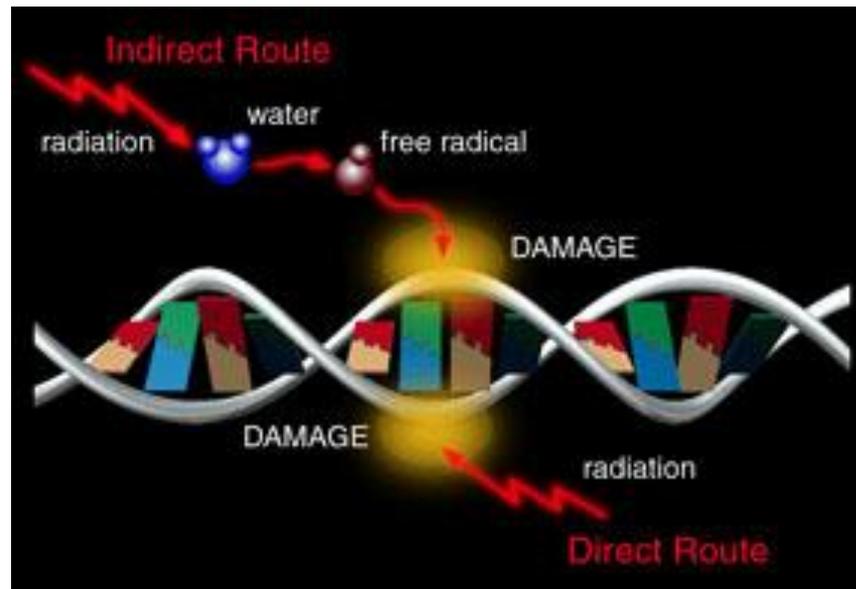
If a risk analysis of a new commodity demonstrates that no pupae or adult Lepidoptera follow a pathway, then export approval can happen without further research.



# Generic Absorbed Doses

- Development of doses for quarantine Lepidoptera (adults and pupae) not covered by the generic treatment
- Reduction of dose levels for specific pests and commodities to shorten treatment time and minimize deleterious effects
- Development of generic doses below 400 Gy for important groups of quarantine arthropods (other than fruit fly)

# Modified Atmosphere Packaging



The generation of free radicals from oxygen and water cause tissue damage.

# Modified Atmosphere Packaging

MAP is a process that alters the gas composition surrounding a commodity

- prolongs the shelf-life of perishable goods
- slows the speed of aerobic microorganisms



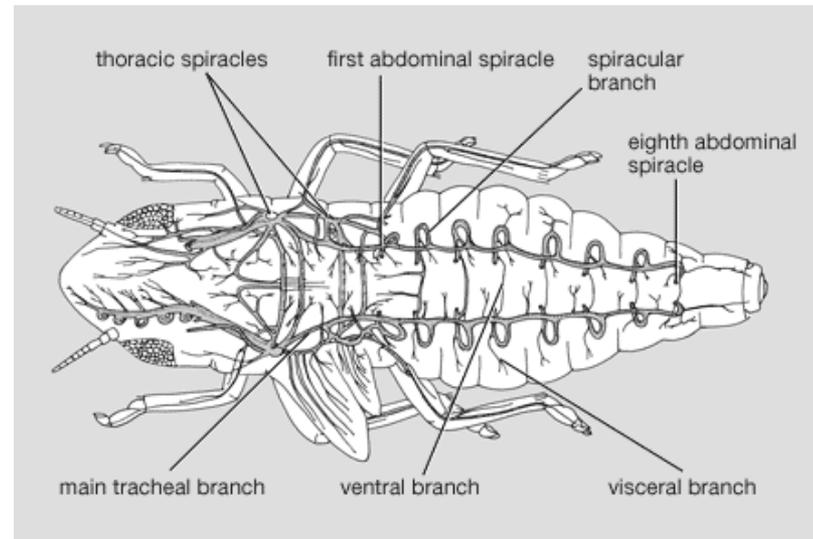
In the past few years, requests to use MAP for phytosanitary treatments have dramatically increased

# Modified Atmosphere Packaging

Most MAP creates a low  $O_2$  environment

Respiration slows, resulting in reduced  $O_2$  concentrations in the hemolymph

In hypoxic environments, higher absorbed doses may be necessary to achieve same physiological effects



# Modified Atmosphere Packaging

Commodity	Temperature	Humidity	Modified atmosphere %	
	[°C]	[%]	O <sub>2</sub>	CO <sub>2</sub>
<b><i>Fruit</i></b>				
Apricot	0-5	90	2-3	2-3
Orange	3-9	90-95	5-10	0-5
Banana	13-15	90-95	2-5	2-5
Persimmon	0-5	90-95	3-5	5-8
Cherry, sweet	0-5	90-95	3-10	10-15
Strawberry	0-5	90-95	4-10	15-20
Apple	0-5	90	1-3	1-3
Blueberry	0-5	90-95	5-10	15-20
Peach	0-5	90-95	1-2	3-5
Pear	0-5	90-95	2-3	0-1
<b><i>Vegetables</i></b>				
Asparagus	0-5	95-100	aria	5-10
Broccoli	0-5	95-100	1-2	5-10
Cauliflower	0-5	95-98	2-5	2-5
Cucumber	8-12	90-95	3-5	0
Lettuce	0-5	95-100	1-5	0
Corn, sweet	0-5	95-98	2-4	10-180
Green pepper	8-12	90-95	3-5	2-8
Tomato, partly	8-12	90-95	3-5	0-3
Spinach	0-5	95-98	7-10	5-10

**Table 8: MAP recommended conditions for fresh fruit and vegetable**



# Modified Atmosphere Packaging

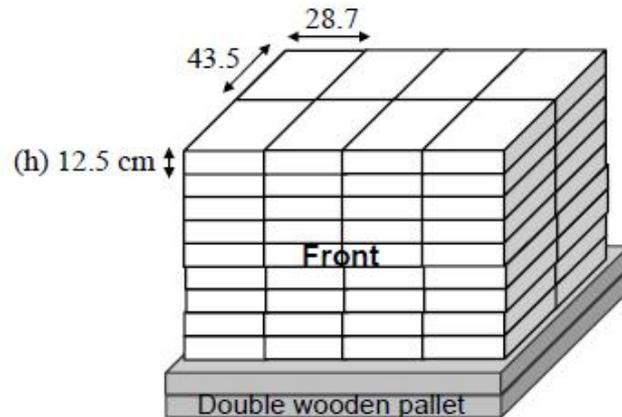
CPHST is funding University of Florida research to characterize the effects of modified atmospheres on irradiation treatments

Determine whether irradiation in modified atmospheres affects survival or fertility (Lepidopteran pests)



# Process Configurations

Packaging dimensions and orientation are critical when delivering an absorbed dose within a tight range

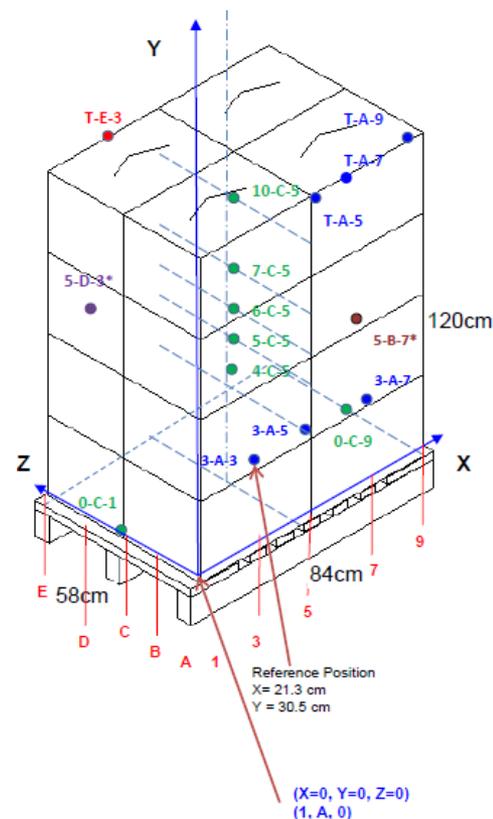


# Process Configurations

Additionally, it is important to know what the absorbed dose range will be throughout the configuration

## Dose Mapping

- Identify areas of high and low absorbed dose
- Determine  $R_f$  (reference dose)



# Predictive Modeling

When a gamma source is well-characterized, the location of  $D_{\min}$  and  $D_{\max}$  can be predicted

PPQ has reviewed and approved alternate process configuration procedures for three facilities eliminating the need for destructive, costly, and time-consuming testing



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# Final Thoughts & Questions

