

RAP PUBLICATION 2004/23

**REGIONAL STANDARDS  
FOR PHYTOSANITARY MEASURES**

***GUIDELINES FOR THE DEVELOPMENT OF  
HEAT DISINFESTATION TREATMENTS  
OF FRUIT FLY HOST COMMODITIES***

**APPPC RSPM No. 1**



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The Asia and Pacific Plant Protection Commission (APPPC)  
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS  
REGIONAL OFFICE FOR ASIA AND THE PACIFIC  
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## *Endorsement*

Regional standards for phytosanitary measures are developed and adopted by the Asia and Pacific Plant Protection Commission as part of the plant protection programme of the Commission's contracting parties. This programme makes available to contracting and other interested parties regional standards for phytosanitary measures to support regional harmonization, with the aim to facilitate trade and avoid the use of unjustifiable measures as barriers to trade.

This standard was endorsed by the twenty-third session of the Asia and Pacific Plant Protection Commission in August 2003.



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### ***Endorsement***

This Asia and Pacific Plant Protection Commission (APPPC) Regional Standard for Phytosanitary Measures was endorsed by the twenty-third session of the APPPC held from 4 to 8 August 2003 in Kuala Lumpur, Malaysia.

### ***Review***

APPPC Regional Standards for Phytosanitary Measures are subject to periodic review. The next review date for this standard is 2009. The standard may be reviewed earlier if the APPPC decides this is necessary.

### ***Distribution***

APPPC Regional Standards for Phytosanitary Measures are distributed by the Executive Secretariat of the APPPC to all APPPC members, the Administrative Heads of Regional Plant Protection Organizations and the FAO International Plant Protection Convention (IPPC) Secretariat. This standard is available on the APPPC webpage found within the International Phytosanitary Portal: <http://www.ippc.int/En/rppo/jsp>

# INTRODUCTION

## SCOPE

These guidelines describe methods for identifying and developing appropriate heat disinfestation treatments against quarantine fruit flies in host commodities traded by APPPC member countries.

## REFERENCES

ACIAR 1996. *Guidelines for the development of quarantine disinfestation heat treatments for fresh horticultural produce for fruit flies* (Australian Centre for International Agricultural Research Project No. 9051, 1996).

*Agreement on the application of sanitary and phytosanitary measures, 1994.* World Trade Organization, Geneva.

*Glossary of phytosanitary terms, 2002.* ISPM No. 5, FAO, Rome.

*Guidelines for pest risk analysis, 1996.* ISPM No. 2, FAO, Rome.

*Pest risk analysis for quarantine pest including analysis of environmental risk, 2003.* ISPM No. 11 Rev. 1, FAO, Rome.

*Requirements for the establishment of pest free areas, 1996.* ISPM No. 4, FAO, Rome.

*The use of integrated measures in a systems approach for pest risk management, 2002.* ISPM No. 14, FAO, Rome.

## DEFINITIONS AND ABBREVIATIONS<sup>1</sup>

APPPC*	Asia and Pacific Plant Protection Commission
area	An officially defined country, part of a country or all or parts of several countries (FAO, 1990; revised FAO, 1995; CEPM, 1999; based on the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures)

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<sup>1</sup> The references listed in square brackets refer to the definition or revision of the terms found in ISPM No. 5 *Glossary of phytosanitary terms*.

commodity	A type of plant, plant product or other article being moved for trade or other purpose (FAO, 1990; revised ICPM, 2001)
Disinfestations*	Application of a phytosanitary treatment to kill a pest or pests in a commodity
eclosion*	Metamorphosis to the adult from the egg, pupa, cocoon, puparium or last nymphal instar (for some insect)
endangered area	An area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss (FAO, 1995)
entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO, 1995)
equivalence	The situation of phytosanitary measures which are not identical but have the same effect (FAO, 1995; revised CEPM, 1999; based on the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures)
establishment	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 1990; revised FAO, 1995; IPPC, 1997; formerly established)
fecundity*	The potential reproductive capacity of an organism or population; the number of eggs an animal produces during each reproductive cycle
heat disinfestation*	Application of a heat treatment to kill a pest or pests infesting a commodity
heat treatment	The process in which a commodity is heated until it reaches a minimum temperature for a minimum period of time according to an



	officially recognized technical specification (ISPM No. 15, 2002)
host range	Species of plants capable, under natural conditions, of sustaining a specific pest (FAO, 1990)
instar*	The period or stage between moults, numbered to designate the various periods, e.g. the first instar is the stage between the egg and the first moult
introduction	The entry of a pest resulting in its establishment (FAO, 1990; revised FAO, 1995; IPPC, 1997)
IPPC	International Plant Protection Convention, as deposited in 1951 with FAO in Rome and as subsequently amended (FAO, 1990; revised ICPM, 2001)
National Plant Protection Organization (NPPO)	Official service established by a government to discharge the functions specified by the IPPC [FAO, 1990; formerly Plant Protection Organization (National)]
pest	Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products (FAO, 1990; revised FAO, 1995; IPPC, 1997)
Pest Risk Analysis (PRA)	The process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it (FAO, 1995; revised IPPC, 1997)
pest risk assessment (for quarantine pests)	Evaluation of the probability of the introduction and spread of a pest and of the associated potential economic consequences (FAO, 1995; revised ISPM Pub. No. 11, 2001)

pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO, 1995; revised ISPM No. 11, 2001)
phytosanitary measure (agreed interpretation)	Any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO, 1995; revised IPPC, 1997; ICPM 2002)
<i>The agreed interpretation of the term phytosanitary measure accounts for the relationship of phytosanitary measures to regulated non-quarantine pests. This relationship is not adequately reflected in the definition found in Article II of the IPPC (1997).</i>	
quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 1990; revised FAO, 1995; IPPC 1997)
spread	Expansion of the geographical distribution of a pest within an area (FAO, 1995)
SPS Agreement*	The WTO Agreement on the Application of Sanitary and Phytosanitary Measures
systems approach(es)	The integration of different pest risk management measures, at least two of which act independently, and which cumulatively achieve the appropriate level of phytosanitary protection (ISPM No. 14, 2002)
treatment	Officially authorized procedure for the killing, inactivation or removal of pests or for rendering pests infertile or for devitalization (FAO, 1990, revised FAO, 1995; ISPM. No. 15, 2002; ISPM No. 18, 2003)
WTO*	World Trade Organization

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\* Indicates terms which are not included in ISPM No. 5 *Glossary of phytosanitary terms*.

## **OUTLINE OF REQUIREMENTS**

The development of a heat disinfestation treatment involves a number of steps. Prior to the development of the treatment, the fruit fly pest or pests should be correctly identified and biological data collected. An appropriate heat disinfestation method should be selected and then small-scale trials undertaken to determine the most heat tolerant stage of the most heat tolerant species of fruit fly. Fruit may be infested using natural or artificial means and 3 000-5 000 fruit fly individuals may be used.

Confirmatory trials to demonstrate the efficacy of the treatment to the level required by the importing country (according to the appropriate level of protection for that country) may use 30 000 or more fruit fly individuals. Appropriate care should be taken over the siting of heat sensors and temperature recording during treatment and the security of the fruit after treatment.

The consideration of other factors that reduce the risk of entry and establishment may allow the heat disinfestation treatment to be used as a component of a systems approach. Large-scale trials may be needed to confirm the commercial and operational feasibility of the treatment.

## **GENERAL REQUIREMENTS**

### **1. Background**

Phytosanitary measures are often required for imported commodities to prevent the introduction of quarantine pests. Such measures need to be appropriate for a specific commodity and effective against the quarantine pests of that commodity.

APPPC member countries cover a wide climatic range and the many different pests present, including fruit fly species, have different geographic distributions and host ranges. For this reason, there may be differences between countries in their phytosanitary requirements for the importation of fruit fly host commodities.

Phytosanitary measures are normally developed on a country/commodity/pest specific basis through a process of bilateral negotiation between the

National Plant Protection Organizations (NPPOs) of the importing and exporting countries.

In developing phytosanitary management options, APPPC member countries should take note of the principle of equivalence and therefore be prepared to use different treatments that are equivalent. For example, alternative phytosanitary management options such as cold disinfestation treatments, chemical disinfestation treatments, irradiation, area freedom, systems approaches, or combinations of the above may be appropriate for consideration of equivalence where feasible.

Among the above measures, heat treatment is regarded as one of the measures that is environmentally friendly and free from residues.

## **2. Purpose**

The purpose of the standard is to provide a sound basis for APPPC member countries when developing heat disinfestation treatment against quarantine fruit flies in host commodities. It is intended to facilitate trade of the commodities by member countries

## **3. Identification of quarantine fruit fly species associated with a commodity**

Fruit fly species associated with the country/commodity combination should be identified by a pest risk assessment. Information on the status of fruit fly pests in the importing and exporting countries and on host preferences should be comprehensive and well documented. Where not available, research should be undertaken.

A fruit fly can be listed as a quarantine pest for a country only if it meets the criteria of the definition of a quarantine pest.

## **4. Identification and development of appropriate heat disinfestation treatments**

### **4.1 Identification of a suitable heat disinfestation treatment**

Heat is commonly used as a physical disinfestation treatment for fruit flies. Heat treatments include hot water dips, vapour heat treatment (VHT) and high temperature forced air (HTFA).

Factors influencing the selection of a treatment include:

- ◆ impact on the commodity
- ◆ effectiveness on the target pests
- ◆ post-harvest shelf-life
- ◆ feasibility (including cost)
- ◆ requirements of the importing country.

Heat disinfestation options are best developed on a case by case basis for each country/commodity/pest combination using the general guidelines described in this standard.

## **4.2 Development of a heat disinfestation treatment**

### **4.2.1 Determination of the most tolerant developmental stage of the most tolerant fruit fly species for a country/commodity combination**

Where more than one quarantine fruit fly species is identified for a specific country/commodity combination, it is necessary to determine which stage of which species is the most tolerant to the treatment that is being proposed. Any large scale confirmatory testing that is required can then be restricted to this species and life stage.

It is important to seek relevant technical expertise (e.g. from biometricians, entomologists) and to consult the relevant scientific literature to ensure that laboratory tests and trials are designed and conducted appropriately. With all tests and trials, untreated controls are required.

Where new treatments are to be developed, it is appropriate for the relevant NPPOs to agree bilaterally on experimental design including the quantity and quality of data required to meet the importing country's requirements.

#### 4.2.1.1 Material

##### **Experimental fruit**

Fruit for use in disinfestation experiments should be:

- ◆ identified botanically, including details of variety or cultivar if this may impact pest response to the treatment
- ◆ free from any chemical treatment before its use in the trial
- ◆ described in relation to stage of maturity, size, shape and quality
- ◆ infested at a susceptible stage
- ◆ in normal commercial condition.

##### **Experimental insects**

The following points must be considered when insects are used in heat disinfestation experiments:

- ◆ the insects should be identified taxonomically; it may be necessary to test for differences within the pest population
- ◆ reference specimens should be made available
- ◆ the laboratory colony should be founded from an appropriate source, preferably from a large quantity of field infested host fruit, ensuring that other species, parasites and disease are removed. This can be aided by rearing different fruit fly species in different rooms.
- ◆ the laboratory colony should be founded from appropriate numbers of individuals (100-1 000)
- ◆ the laboratory colony should be appropriately handled during its rearing history to ensure peak vigour for the duration of the experiment
- ◆ laboratory colonies should be regularly refreshed with new wild flies so that the genetic diversity of the laboratory specimens can be considered to be representative of the population in the field
- ◆ the health of the laboratory colony should be regularly checked by monitoring such factors as per cent hatchability, mean pupal weight, developmental time, eclosion percentage, sex ratio of eclosed flies and fecundity of each generation

- ◆ methods and conditions of rearing should be carefully documented.

#### 4.2.1.2 Methods

##### **Infestation of experimental fruit**

Experimental fruit can be infested through natural (this is preferred) or artificial means.

If not known, it may be necessary to conduct studies on the fruit to determine the most susceptible stage and conditions for infestation.

Natural infestation involves exposing the experimental fruit to ovipositing females of experimental fruit fly species for a set period of time. This is usually done in a laboratory cage under strict conditions. Care should be taken to ensure that the population of ovipositing females in the cage at peak vigour (see 4.2.1.1), the number of flies per cage, the exposure time, the number of fruits per cage and the experimental conditions are adequately controlled. The time allowed for oviposition in the fruit should be kept as short as possible.

Artificial infestation involves placing the experimental species into the trial fruit. A known number of eggs or larvae of the appropriate stage are placed directly into the fruit using a method that is biologically appropriate and minimizes damage to the fruit and insects. Untreated controls are required.

##### **Determination of the most tolerant fruit fly species**

The most tolerant species should be identified through small-scale trials by determining appropriate dose response curves. Small-scale trials should be conducted using replicates of fruit fly individuals (each replicate should have at least 100 fruit fly individuals).

“Naked” (*in vitro*) insect trials are appropriate to determine the most tolerant species. This involves taking eggs and differently staged larvae of different species, dipping them directly into hot water (or appropriate heat source) and then transferring them to

an appropriate rearing medium. Care should be taken to select appropriate number of insects, treatment levels and exposure times. Thermometers and other measuring devices should be accurately calibrated.

#### **Determination of the most tolerant fruit fly development stage**

The most tolerant development stage of the fruit fly should be identified also through small-scale trials using artificially or naturally infested fruit by determining appropriated dose response curves. This can be done by exposing the experimental fruit to ovipositing females of the experimental fruit fly species for a set of period of time to achieve the most tolerant stage. Small-scale trials should be conducted using replicates of fruit fly individuals (each replicate should have at least 100 fruit fly individuals).

In addition, importing countries are likely to require efficacy to be determined by this type of *in vitro* trials.

#### **4.2.2 Determination of a heat desinfestation treatment**

For the determination of the heat disinfestation treatment, the experiment should use the most tolerant developmental stage of the most tolerant fruit fly species.

Treatments of infested experimental fruit would normally be undertaken first on a small scale. Small-scale trials should be conducted using 3 000-5 000 individuals. Following this, a confirmatory test in large-scale trials would normally be required to establish the technical validity of the treatment and to demonstrate the required level of efficacy. At least 30 000 fruit fly individuals should be used in a large-scale trial.

It is necessary to demonstrate that the treatment unit has adequate heating, cooling, insulation, humidity and thermostat controls. In the case of Vapour Heat Treatment and High Temperature Forced Air units, the coolest points should be determined based on a temperature map of the inside of the unit. Heat sensors should be located at these points and placed in the largest fruit in the treatment batch. The rate of heating and cooling should be accurately recorded with measurements taken at appropriate pre-determined intervals (e.g. every 2 minutes).



Treatment units and facilities may need to be approved or certified by the NPPO before treatment commences. It may be agreed between the NPPOs of the importing and exporting countries for officials from the importing country to observe the trials. NPPO officials should ensure that the temperature specifications are met. The owner/operator of the facility is responsible for its efficient operation.

Treatment facilities should be located in a secure area to prevent reinfestation of treated fruits (post-treatment security).

Treated experimental fruit and untreated controls should be held in a secure location under physical conditions that are favourable for the fruit and for the survival of the insect species.

Pupae should be retrieved under appropriate conditions at an appropriate time. All fruit should be examined to find any remaining larvae.

## **5. Treatment efficacy**

The level of efficacy required by importing countries for individual phytosanitary treatments should meet the ‘appropriate level of protection (ALOP)’ of the importing country. ALOP is defined by the WTO in the SPS Agreement as:

*“The level of protection deemed appropriate by the (WTO) Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory.”*

WTO Members have the sovereign right to determine their own ALOP. The ALOP may therefore vary from country to country but it should be based on scientific justification and applied consistently within each country.

NPPOs generally require a very high degree of efficacy for treatments developed against quarantine pests such as fruit flies. Often, lengthy, large-scale trials are required to show that individual treatments are highly effective against the target pest on the commodity.

Traditionally, many of the treatments developed against fruit flies have used probit 9 mortality as a measure of treatment efficacy. However, it is a measure of mortality. Pest risk, on the other hand, should be recognized as being related to the number of survivors and therefore the initial infestation rate should be considered in determining whether the level of efficacy corresponds to the ALOP.

To attain the level of protection to deal with the level of risk associated with fruit fly pests, other factors that may reduce the risk of entry and establishment such as the likelihood of infestation in the imported commodity, survival rate, reproductive potential or establishment potential should be considered. In addition, in cases where the natural rate of pest infestation in the field is low and the chances of survival and reproduction are poor, the probit 9 standard could be too stringent. Some countries are proposing a less severe treatment combined with modifications in packing, distribution, and inspection. Recognizing that treatments may range in severity depending on the risk allows expanded use of controlled atmospheres, systems approaches, and other treatments, which have in the past not met probit 9 requirements.

The heat disinfection treatment could also be used as a component in a 'systems approach' or combination treatment (see ISPM No. 14 *The use of integrated measures in a system approach for pest risk management*).

## **6. Treatment evaluation**

Before commercial trade commences, further large-scale trials may also be required to confirm that the treatments are not only technically sound but also commercially and operationally feasible. The treatment system should be reliable under commercial loading methods and likely product distributions.

## **7. Approval**

Where the evaluation exercises are successful, both parties need to endorse the treatment. The approved treatment may then be part of the trade access agreement between the two countries for the commodity involved.

## **8. Documentation**

All records and data should be kept and made available for audit by NPPO officials if this is required.