INTERNATIONAL STANDARD FOR PHYTOSANITARY MEASURES 42

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ISPM 42

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Requirements for the use of temperature treatments as phytosanitary measures

Produced by the Secretariat of the
International Plant Protection Convention (IPPC)

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PHYTOSANITARY MEASURES

ISPM 42

Requirements for the use of temperature treatments as phytosanitary measures

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This is not an official part of the standard

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2017-10 Steward revised the draft based on consultation comments.

2017-11 SC revised the draft and approved for adoption by CPM.

2018-04 CPM-13 adopted the standard.

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Adoption

This standard was adopted by the Thirteenth Session of the Commission on Phytosanitary Measures in April 2018.

INTRODUCTION

Scope

This standard provides technical guidance on the application of various temperature treatments as phytosanitary measures for regulated pests on regulated articles. This standard does not provide details on specific treatments.

References

The present standard refers to ISPMs. ISPMs are available on the International Phytosanitary Portal (IPP) at https://www.ippc.int/core-activities/standards-setting/ispms.

Definitions

Definitions of phytosanitary terms used in this standard can be found in ISPM 5 (*Glossary of phytosanitary terms*).

Outline of Requirements

This standard provides guidance on how temperature treatments may be used for pest management to comply with phytosanitary import requirements.

This standard provides guidance on the main operational requirements for the application of each type of temperature treatment to achieve pest mortality at a specified efficacy.

This standard also provides guidance on monitoring and recording systems and temperature mapping of facilities to ensure that the specific facility–commodity configuration will enable the treatment to be effective.

The national plant protection organization (NPPO) should be responsible for approving the treatment facilities, and procedures should be in place to ensure the accurate measuring, recording and documentation of treatments applied.

BACKGROUND

Phytosanitary treatments based on temperature are considered to be effective when the specific temperature–time combination required for the stated efficacy to be achieved is attained.

The purpose of this standard is to provide generic requirements for the application of phytosanitary temperature treatments, specifically those adopted under ISPM 28 (*Phytosanitary treatments for regulated pests*).

ISPM 28 was adopted to harmonize effective phytosanitary treatments over a wide range of circumstances and to enhance the mutual recognition of treatment efficacy by NPPOs, which may facilitate trade. ISPM 28 provides requirements for submission and evaluation of efficacy data and other relevant information on phytosanitary treatments, and annexes with specific temperature treatments that have been evaluated and adopted by the Commission on Phytosanitary Measures.

IMPACTS ON BIODIVERSITY AND THE ENVIRONMENT

The use of temperature treatments as phytosanitary measures has a beneficial impact on biodiversity and the environment by preventing the introduction and spread of regulated pests with the trade of plants and plant products.

REQUIREMENTS

1. Treatment Objective

The objective of using a temperature treatment as a phytosanitary measure is to achieve pest mortality (including devitalization of seeds as pests) at a specified efficacy.

2. Treatment Application

Temperature treatments may be applied at any point along the supply chain, for example:

- as an integral part of production or packaging operations
- after packaging (e.g. once the commodity is packaged for dispatch)
- during storage
- immediately before dispatch (e.g. at centralized locations at a port)
- during transport
- after unloading.

The requirement of a temperature treatment is that the scheduled temperature is attained throughout the commodity for the specified treatment duration, allowing the required efficacy to be achieved.

Parameters to consider when implementing a temperature treatment are the temperature and duration of the treatment and, where applicable, the humidity of the treatment environment or moisture content of the commodity. The specified level for each parameter should be met to achieve the required efficacy.

Packaging size and controlled atmospheres or modified atmospheres created by packaging may alter treatment efficacy. Packaging should allow the treatment to be properly applied throughout the load.

Where the treatment specifies a minimum humidity level, impervious packaging must be removed, opened or adequately punctured to allow the humidity to reach the level required by the treatment.

The treatment protocol should describe the process of pre- and post-conditioning to reach the required temperature and humidity, where these processes are critical to the treatment achieving the required efficacy while preserving commodity quality. The protocol should also include contingency procedures and guidance on corrective actions for treatment failures.

3. Treatment Types

3.1 Cold treatment

Cold treatment uses refrigerated air to lower the temperature of the commodity to or below a specific temperature for a specific period. Cold treatment is used primarily for perishable commodities that are hosts of pests that are internal feeders.

Cold treatment may be applied during transport to the importing country (e.g. refrigerated cargo holds in vessels and refrigerated sea containers). The treatment may start before dispatch and be completed prior to or at the point of entry. Prior to beginning treatment, the commodity may be precooled to the temperature at which the commodity will be treated. Where applicable, mixed consignments (e.g. fresh lemon and orange fruits loaded in the same facility) may also be treated pre-dispatch or during transport. In all cases, the commodities should be protected from infestation throughout treatment, transport and storage. Cold treatment may be used in combination with chemical treatment (e.g. fumigation).

3.2 Heat treatment

Heat treatment raises the temperature of the commodity to the minimum required temperature or higher throughout a specific period.

Following the completion of a heat treatment, rapid cooling to preserve commodity quality (when applicable) should be carried out only if this has been shown not to reduce the treatment efficacy.

Heat treatment may be used in combination with chemical treatment, usually done sequentially (e.g. fumigation and immersion treatment).

3.2.1 Hot water immersion treatment

Hot water immersion treatment (also known as hydrothermal treatment) uses heated water at a required temperature to heat the surface of the commodity for a specific period or to raise the temperature of the entire commodity to the required temperature for a specific period. This treatment is used primarily for certain fruits and vegetables that are hosts of fruit flies, but it may also be used for plants for planting (e.g. ornamental bulbs, grapevine material) and some seeds (e.g. paddy and ornamental palm seeds).

3.2.2 Vapour heat treatment

Vapour heat treatment (VHT), including high temperature forced air (HTFA)[1], uses water vapour to heat the commodity throughout a specific period. The high heat energy of hot moist air enables vapour heat to raise the commodity temperature faster than dry air.

This treatment is suitable for those plant products that are tolerant of high moisture but are vulnerable to drying out, such as fruits, vegetables and flower bulbs. It is also used for the treatment of wood products.

Variable humidity heat treatment is a type of VHT or HTFA. Hot and relatively dry fan-driven air is used initially, avoiding condensation, to heat the entire commodity from ambient temperature to the required temperature, which is then maintained in humid air, just below dew point, for a specific period.

3.2.3 Dry heat treatment

Dry heat treatment uses heated air at the required temperature to heat the surface of the commodity or to raise the entire commodity to the required temperature for a specific period. This treatment is used primarily for commodities with low moisture content, such as seeds, grain and wood, that should not be exposed to moisture.

3.2.4 Dielectric heat treatment

Dielectric heating raises the temperature of the commodity by subjecting it to high frequency electromagnetic waves that cause heating by molecular dipole rotation of polar molecules, especially water. Dielectric heating may be provided by the application of electromagnetic radiation over a range of frequencies, including microwaves and radio waves.

Unlike traditional heating techniques, where heat moves via conduction from the surface to the inside of the commodity, and where therefore the surface is the hottest, dielectric heating generates heat throughout the material, including the internal part, and the heat propagates by convection and conduction outwards, reducing treatment time. The inside of the commodity tends to be hotter than the surface due to heat radiation.

[1] The main distinction between VHT and HTFA relates to the moisture content of the heated air and the consequential heating. VHT typically uses air near saturation, which results in condensation of water on the commodity surface until the commodity surface temperature increases to near the air temperature, while during HTFA the dew point is always kept below the surface temperature of the commodity being heated resulting in no condensation.

Dielectric heating has the potential advantage of selectively heating moist substances, such as pests, within relatively drier commodities, such as wood and grain, resulting in a shorter treatment time than if the entire commodity were heated with water or air until it reached a uniform temperature throughout.

4. Temperature and Humidity Calibration, Monitoring and Recording

Monitoring and recording equipment for temperature and humidity, when required, should be appropriate for the selected temperature treatment. The equipment should be evaluated for the accuracy and consistency of its measurement of temperature, humidity and duration of treatment.

To ensure that the required temperature, humidity and duration of treatment are achieved for a particular commodity, the temperature monitoring equipment should be calibrated in accordance with the manufacturer's instructions and international standards or appropriate national standards, at the temperature and humidity specified in the treatment schedule for heat treatments or in an ice slurry for cold treatments.

Temperature monitoring methods should consider the following factors in the commodity being treated: (1) density and composition (including insulative property of the commodity); (2) shape, size and volume; (3) orientation in the facility (e.g. stacking and spacing); and (4) packaging.

The NPPO of the country in which the treatment is initiated or conducted should ensure that monitoring and recording of temperature and humidity are properly conducted, thus allowing for verification that the treatment parameters have been met. The monitoring and recording system, number and location of sensors, and the frequency of monitoring (i.e. temperature and humidity readings) or recording should be appropriate for the specific treatment equipment, commodities, relevant technical standards and phytosanitary import requirements.

4.1 Temperature mapping

Temperature mapping should be conducted by the NPPO or an authorized entity (person or organization) of the country in which the treatment is initiated or conducted. The NPPO should ensure that the temperature mapping follows the approved procedures and is appropriate for:

- the packaging type
- the arrangement and density of the commodity within the packaging
- the load configuration to be used in the treatment facility
- the type of treatment facility.

Temperature mapping studies should be conducted to characterize the temperature distribution within the temperature treatment facility and the commodity (in relation to the volume and arrangement of the commodity). Such information is used to identify where the temperature monitoring and recording devices should be placed during the application of a temperature treatment using the same facility and commodity configuration. Temperature mapping is not required for each consignment, as it is designed for each facility. Temperature mapping may rely on historical use of treatments for information on the configuration, arrangement and density of a facility or commodity. In other cases, based on recognized research, the positions of the sensors may be fixed. Temperature mapping may also be conducted regularly to check possible changes of temperature distribution over time. Independent temperature mapping for a partially filled treatment facility is required to determine whether the temperature distribution is significantly different from a filled facility and therefore whether the treatment needs to be adjusted accordingly.

Temperature mapping should be carried out following modifications or adjustments in equipment or processes that affect attainment of the required temperature for the treatment. Mapping should also be carried out following changes in packaging or pack configuration.

4.2 Sensor placement for temperature monitoring

When the core temperature of the commodity needs to be monitored during treatment, sensors should be placed into appropriate units of the commodity, with the exception of dielectric heat treatment where surface temperature is measured. In mixed commodities, sensors should be placed appropriately to allow monitoring of the different commodities to ensure that they have all reached the required temperature and met the temperature conditions throughout the treatment cycle.

Sensors should be placed in areas of the commodity that will take the longest time to reach the required core temperature (e.g. the centre of a bag in the centre bag of a pallet).

The sensor should be appropriately secured to the commodity so that it does not become dislodged and in a manner that does not interfere with heat transfer in and out of the commodity.

The sensor should be completely encased by the commodity to avoid false readings. Core sensors that are not completely encased should be sealed into the insertion holes using heat resistant, insulating filler.

Placing the sensor close to metal objects such as nails should be avoided, as heat transfer along the metal objects may interfere with the integrity of the temperature recorded by the core sensor.

For small commodities such as cherries and grapes, the sensor should be inserted through enough of the fruits to ensure that it monitors pulp temperature and not ambient air temperature.

For larger commodities, the sensors should be placed in the largest items, which may take the longest time to reach the required core temperature.

4.2.1 Cold treatment

Cold treatment requires:

- monitoring of the core temperature of the commodity
- adequate air circulation to ensure that the required temperature is uniformly maintained.

The number of sensors required depends on factors such as the treatment schedule, commodity size, commodity type and the type of treatment facility. The number of sensors required to monitor the temperature of the commodity also depends on the temperature mapping and the size of the treatment facility.

Monitoring of the air temperature provides useful information for the verification of the commodity treatment, but not as a replacement for commodity temperature.

In the temperature treatment facility, at least three sensors should be used. The number of additional sensors should be adjusted to take into account factors such as the density and composition of the commodity, and the load configuration. Monitoring of the outlet air temperature may also be required.

Additional sensors may be installed in accordance with the mapping to compensate for possible sensor malfunction of one or more of the minimum required sensors.

4.2.2 Hot water immersion treatment

Hot water immersion treatment requires:

- monitoring of the water temperature
- adequate water circulation to ensure that the required temperature is uniformly maintained
- a means to ensure that the commodity is fully submerged.

Sensors should be fully submerged in the water to ensure that they can monitor the uniformity of the treatment temperature. Depending on the requirements of the treatment (e.g. whether it is the core temperature of the commodity or the water temperature that needs to be maintained at a specific

temperature for a given time), commodity sensors may or may not be required. If they are required, the largest units of the commodity should be selected for sensor placement.

4.2.3 Vapour heat treatment

Vapour heat treatment requires:

- monitoring of the air temperature and humidity within the facility
- monitoring of the core temperature of the commodity
- adequate circulation of vapour heated air to ensure uniformity of temperature and relative humidity in the facility.

The number of sensors required depends on factors such as temperature mapping, commodity size and configuration and the type of treatment facility. The largest units of the commodity should be selected for sensor placement and the sensors should be placed in the coldest part of the commodity and the heat treatment facility, as identified by temperature mapping.

The treatment schedule should include:

(1) heat-up time (also known as run-up or ramp-up time): the minimum time allowed for all the temperature sensors to reach the required minimum temperature in the commodity

(2) minimum air temperature and heating time: the maximum time to raise the room temperature to the minimum temperature required for the air in the facility

(3) minimum commodity temperature at the end of heat-up time: the minimum temperature required for all commodity core temperature sensors

(4) dwell time: the length of time all commodity temperature sensors must maintain the minimum core or pulp temperature and air temperature sensors must maintain the minimum air temperature

(5) total heat treatment time: total time from the start of heating of the commodity to the end of dwell time

(6) humidity control parameters during treatment

(7) the type of post-treatment cooling (if appropriate).

4.2.4 Dry heat treatment

Dry heat treatment requires:

- monitoring of the air temperature and humidity in the facility
- monitoring of the core temperature of the commodity, when appropriate
- adequate circulation of air to ensure uniformity of temperature and relative humidity in the facility.

In dry heat treatment schedules that specify air temperature and humidity requirements, air temperature should be monitored using temperature sensors (analogue or digital) and humidity should be monitored using wet and dry bulb thermometers or humidity sensors.

Sensors should be located away from any heat source and as far from the wall of the treatment facility as possible or, alternatively, schedules may be developed based on a series of test treatments during which the temperature farthest from the wall of the facility has been measured and correlated with the temperature at the sensor location.

Additional sensors may be installed to compensate for possible sensor malfunctioning.

Dry heat treatment for nuts and seeds should have a minimum of three temperature sensors placed in the commodity at locations determined by temperature mapping studies.

Where the treatment temperature is monitored using sensors inserted into the commodity, they should be suitable for measuring commodity core temperature. The overall number of sensors should be adjusted according to the treatment type, commodity type, commodity size and configuration,

temperature mapping and the type of treatment facility. Monitoring the core temperature of the commodity, when appropriate, may provide additional information on the verification of dry heat treatment, compared to monitoring air temperature alone.

4.2.5 Dielectric heat treatment

Dielectric heat treatment requires monitoring of the temperature at the coolest region of the commodity.

The nature of dielectric heating means that systems for monitoring and recording temperature need to be compatible with this technology. Examples include infrared cameras, temperature sensors not affected by the electromagnetic fields generated, thermocouples and fibre-optic sensors.

Depending on the specific treatment to be applied to a particular commodity (e.g. whether the core or the surface of the commodity is the coolest region identified by temperature mapping), internal temperature sensors may be required as appropriate.

Sensors should be positioned, according to approved procedures, to monitor the uniformity of the treatment temperature in the largest part of the commodity.

5. Adequate Systems for Treatment Facilities

Confidence in the adequacy of a temperature treatment as a phytosanitary measure is primarily based on assurance that the treatment is effective against the pest of concern under specific conditions and the treatment has been properly applied. Systems for treatment delivery should be designed, used and monitored to ensure that treatments are properly conducted and commodities are protected from infestation and contamination after treatment.

The NPPO of the country in which the treatment facility is located or where treatments are initiated is responsible for ensuring that the system requirements are met.

5.1 Approval of facilities

Treatment facilities should be subject to approval by the NPPO in the country in which the facility is located before phytosanitary treatments are applied there. In cases where the treatment is applied during transport, the NPPO may approve the procedures for this application. NPPOs should maintain a list of approved facilities.

5.2 Prevention of infestation after treatment

The treatment facility should provide the necessary measures to prevent possible infestation or contamination of the commodity after treatment. The following measures may be required:

- keeping the commodity in a pest free enclosure
- packing the commodity immediately after treatment
- segregating and identifying treated commodities
- dispatching the commodity immediately after treatment.

5.3 Labelling

Commodities may be labelled with treatment lot numbers or other features of identification allowing trace-back for non-compliant consignments. The labels should be easily identifiable and placed on visible locations.

5.4 Monitoring and auditing

The NPPO of the country in which the temperature treatment is conducted is responsible for monitoring and auditing the application of phytosanitary treatments and the facilities within which the treatments are conducted. Continuous supervision of treatments should not be necessary provided that there is a system for continuous temperature monitoring and for ensuring the security of the facility, process and

commodity in question. The monitoring and auditing should be sufficient to detect and correct deficiencies promptly.

5.5 Requirements for treatment facilities

Treatment facilities should meet the requirements specified by the NPPO. These may include the following elements:

- approval of the facility by the NPPO of the country in which the facility is located
- authorization of entities by the NPPO
- access for the NPPO of the country in which the facility is located to documentation and records of the treatment facility
- corrective action to be taken in cases of non-compliance.

6. Documentation

The NPPO of the country in which the treatment facility is located is responsible for ensuring that treatment providers keep appropriate records, such as raw data on temperature and humidity recorded during the treatment. Accurate record keeping is essential to allow for trace-back capability.

6.1 Documentation of procedures

Procedures should be documented to ensure that commodities are consistently treated, as required. Process controls and operational parameters should be established to provide the details necessary for a specific approval of a treatment facility. Calibration and quality control procedures should be documented by the treatment facility operator. As a minimum, they should address the following:

- commodity handling procedures before, during and after treatment
- orientation and configuration of the commodity during treatment
- critical process parameters and the means for their monitoring
- temperature calibration and recording and, where appropriate, humidity calibration and recording
- contingency plans and corrective actions to be taken in the event of treatment failure or problems with critical treatment processes
- procedures for handling rejected lots
- labelling (if required), record keeping and documentation requirements
- training of personnel.

6.2 Record keeping

Treatment facility operators should keep records for each treatment application. These records should be made available to the NPPO of the importing or exporting country when, for example, a trace-back is necessary.

Appropriate records for temperature treatments as phytosanitary measures should be kept by the treatment facility for at least one year to enable the trace-back of treated lots. Information that may be required to be recorded includes:

- identification of facility
- commodity treated
- target regulated pest
- packer, grower and place of production of the commodity
- lot size and volume, including number of articles or packages
- identifying markings or characteristics
- date of treatment
- any observed deviation from the treatment schedule

- temperature, humidity (if required) and time recorded
- calibration data.

6.3 Documentation by the NPPO

All NPPO procedures should be appropriately documented and records, including those of monitoring inspections made and phytosanitary certificates issued, should be maintained for at least one year. In cases of non-compliance or new or unexpected phytosanitary situations, documentation should be made available upon request as described in ISPM 13 (*Guidelines for the notification of non-compliance and emergency action*).

7. Inspection

Inspection is carried out to determine compliance with phytosanitary import requirements. Where live non-target pests are found after treatment, the NPPO should consider if their survival indicates a treatment failure and whether additional measures may be necessary.

The NPPO of the importing country may inspect documentation and records for treatments conducted during transport to determine compliance with phytosanitary import requirements.

8. Responsibilities

The NPPO of the country in which the temperature treatment is initiated or conducted is responsible for the evaluation, approval and monitoring of the application of temperature treatments as phytosanitary measures, including those performed by other authorized entities. However, when treatments are conducted or completed during transport, the NPPO of the exporting country is usually responsible for authorizing the entity applying the treatment during transport, and the NPPO of the importing country is responsible for verifying if the treatment requirements have been met.

IPPC

The International Plant Protection Convention (IPPC) is an international plant health agreement that aims to protect cultivated and wild plants by preventing the introduction and spread of pests. International travel and trade are greater than ever before. As people and commodities move around the world, organisms that present risks to plants travel with them.

Organization

- There are over 180 contracting parties to the IPPC.
- Each contracting party has a national plant protection organization (NPPO) and an Official IPPC contact point.
- Nine regional plant protection organizations (RPPOs) work to facilitate the implementation of the IPPC in countries.
- IPPC liaises with relevant international organizations to help build regional and national capacities.
- The Secretariat is provided by the Food and Agriculture Organization of the United Nations (FAO).

Food and Agriculture Organization of the United Nations

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