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CUCURBITS

GUIDELINE TO FACILITATE INTRA-REGIONAL TRADE IN THE CARIBBEAN

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REGIONAL GUIDELINES FOR
PHYTOSANITARY MEASURES

GUIDELINE TO FACILITATE INTRA-REGIONAL TRADE IN CUCURBITS

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Contents

Adoption

This guideline was adopted by the Council of Trade and Economic Development (COTED) in June 2022.

INTRODUCTION

Scope

This guideline provides guidance to national plant protection organisations (NPPOs) within the Caribbean region for management of the risk of introduction of specific pests associated with cross-border movement of cucurbits intended for consumption or processing. The guidance provided is intended to facilitate intra-regional trade of the commodity in the Caribbean region and applies to all varieties of cucurbits produced in the region.

The major pests of cucurbits as well as the pests of regional priority and pests regulated by countries in the Caribbean region – and phytosanitary measures to manage these pests – are included in this guideline. Recommended measures include those that have been adopted as International Standards for Phytosanitary Measures (ISPMs) as well as those that are used in trade amongst Caribbean countries.

This guideline does not address issues related to living modified organisms, climate change, quality of the commodity, or diversion from intended use.

Definitions

Definitions of phytosanitary terms used in the present guideline can be found in ISPM 5 (*Glossary of phytosanitary terms*).

OUTLINE OF REQUIREMENTS

The issue of pest risk varies within and between countries. It is therefore important for importing NPPOs to apply pest risk analysis (PRA) (see ISPM 2: *Framework for pest risk analysis* and ISPM 11*: Pest risk analysis for quarantine pests*) in the process of identifying quarantine pests and providing the technical justification for the imposition of phytosanitary import requirements. The importing country should consider equivalence of phytosanitary measures if the country of export is unable to conduct specific requests for phytosanitary measures. Such

a process should be in keeping with ISPM 24 (*Guidelines for the determination of equivalence of phytosanitary measures*).

Phytosanitary certification and import regulatory systems should be in accordance with ISPM 7 (*Phytosanitary Certification System*), ISPM 12 (*Guidelines for Phytosanitary Certificates*) and ISPM 20 (*Guidelines for a phytosanitary import regulatory system*). Inspections and sampling of consignments should be in keeping with ISPM 23 (*Guidelines for inspection*) and ISPM 31 (*Methodologies for sampling of consignments*), respectively. Wood packaging materials, including pallets, used for consignments must be in conformance with ISPM 15 (*Regulation of Wood packaging material in international trade*).

This document seeks to provide guidance on procedures to establish phytosanitary import requirements. It also identifies and describes specific phytosanitary measures that may be used to reduce pest risk, and it provides guidance on sampling, inspection and phytosanitary certification of edible, cultivated cucurbits for export.

BACKGROUND

Description of cucurbits

The family of dicotyledonous plants, Cucurbitaceae, is also known as cucurbits or the gourd family and consists of over 950 species, several of which are important as a source of food or for other uses. The *Cucurbita*, *Cucumis* and *Citrullus* genera will be the primary focus of this guideline, given that these are generally produced as crops for human consumption. In general, cucurbits are grown in the tropical, sub-tropical and temperate regions of the world. The fruit is often a modified berry known as a pepo (i.e., a type of botanical berry with a hard outer rind and no internal divisions).

Cucurbita species include the squashes, pumpkin, zucchini, and gourds, the plants of which are herbaceous vines of several meters in length which possess tendrils used for support or to extend along the ground. Left to grow, the vines can become semi-woody. Squashes are at times described as summer or winter squashes; generally, summer squashes are soft-skinned with moist skin and tender flesh – best eaten fresh due to the short shelf life, while winter squashes are hard-skinned with firm flesh and can be cured and stored for extended periods. The fruits of *Cucurbita* species are large and fleshy and vary greatly in size, shape and color.

With the exception of the gourds, the fruits and seeds of the cultivated varieties as well as the flowers, young leaves and shoot tips can be eaten. Heavy metal contamination, inclusive of cadmium, affects plant growth negatively. All of the cultivated species of this genus are warm season crops which have adapted to monthly average temperatures of 18-27ºC (temperatures of 20-35ºC are ideal for growth) and are widely adapted to various soil types – although they prefer good drainage and are intolerant of poorly drained soil. A pH range of 6.0-6.5 is preferred although slightly acidic and slightly alkaline soils are tolerated.

Cucumis is the genus within the Cucurbitaceae that includes the cucumber (*Cucumis sativus*), muskmelons (*C. melo*, including cantaloupe and honeydew melons), the horned melon (*C. metuliferus*), and the West Indian gherkin (*C. anguria*). The cucumber is cylindrical in shape and consumed as a vegetable. The melons (*C. melo*) are grown primarily for their fruit and generally have a sweet aromatic flavor and vary greatly in size (50 grams to 15 kg), flesh color (orange, green, white and pink), rind color (green, yellow, white, orange, red, and gray), form (round, flat, and elongated), and dimension (4 to 200 cm). The West Indian gherkin is consumed as a vegetable, fresh or pickled; it grows best in areas with average annual temperatures in the range 15-28ºC, an average rainfall of 800-1000mm, well drained sandy soils and a pH range of 6-7.5.

Within the *Citrullus* genus, the domesticated watermelon (*C. lanatus*) is the most important crop amongst the seven species of desert vines that fall in the genus. The watermelon is a flowering plant species and also the name of its edible fruit of which there are more than 1,000 varieties. The sweet, juicy flesh of the edible fruit is usually deep red to pink with many black seeds. Seedless varieties with varying flesh colors and also disease-resistant, early-maturing varieties have been produced through considerable breeding efforts over the years. The rind of the fruit is mid- to dark-green and is usually mottled or striped. Watermelon plants require temperatures higher than 25ºC (77ºF) to thrive and prefer well-drained, sandy loam soils with a pH range of 5.5 – 7.

This guideline will focus on measures to facilitate intra-regional trade of fresh cucurbits grown in the Caribbean for consumption.

Identity

Preferred Scientific Name

***Cucurbitaceae*Juss.**

Preferred Common Name

Cucurbits

Other Scientific Names

-

Taxonomic Tree

Domain: Eukaryota
Kingdom: Plantae
Phylum: Spermatophyta
Subphyllum: Angiospermae
Class: Dicotyledonae
Order: Violales
Family: Cucurbitaceae
Genera: *Cucurbita*, *Cucumis*, *Citrullus*

Intended Use

The guideline covers cucurbits for the intended purpose of consumption or for processing.

REQUIREMENTS

Pest risk analysis

The NPPO of the importing country should conduct PRA associated with cucurbits in accordance with ISPM 2 (*Framework for pest risk analysis*) and ISPM 11 (*Pest risk analysis for quarantine pests*) to determine the regulatory status of the pests for the area in which the commodity originates.

Pests of phytosanitary significance affecting trade in cucurbits

A number of pests are known to affect cucurbit crops and could significantly affect yield of marketable produce which meet requirements for trade. Of the priority plant pests identified as being of importance to the Caribbean region, only *Ralstonia solanacearum* race 2 has been isolated from the Cucurbitaceae family of plants and has therefore been included in the list of pests of significance to trade (Table 1). The Mediterranean Fruit Fly, *Ceratitis capitata*, is a priority pest to the region but has not been conclusively shown to affect cucurbit crops and is

therefore of dubious importance to trade in cucurbits in the region. Appendices 1 and 2, respectively provide combined lists of general pests and regulated pests found on, or listed for, cucurbits in the Caribbean region.

Insects and Mites

Cucurbitaceae species are used as food plants by Lepidopteran larvae, including the cabbage moth *(Mamestra brassicae*), the leopard moth species *Hypercompe indecisa*, and the turnip moth (*Agrotis segetum*). Some species can be susceptible to the silverleaf whitefly, *Bemisia argentifolii* and aphids, cucumber beetles (*Acalymma vittatum* and *Diabrotica undecimpunctata howardi*), squash bug *(Anasa tristis*), the squash vine borer (*Melittia cucurbitae*), and the two-spotted spider mite (*Tetranychus urticae*).

Viruses

Species of cucurbits that fall within the *Cucurbita* genus are susceptible to some types of mosaic viruses to include the cucumber mosaic virus (CMV), the cucurbit strain of the papaya ringspot virus (PRSV), the squash mosaic virus (SqMV), the tobacco ringspot virus (TRSV), the watermelon mosaic virus (WMV), and the zucchini yellow mosaic virus (ZYMV). All of these viruses, with the exception of the PRSV, affects all cucurbits, while SqMV and CMV are most common. Aphids can transmit the Cucumber Mosaic Virus (CMV).

Bacteria, Fungi & Oomycetes

Cucurbits can be susceptible to diseases including bacterial wilt (*Erwinia tracheiphila*) and anthracnose (*Colletotrichum* spp.), fusarium wilt (*Fusarium* species), phytophthora blight (*Phytophthora* spp. water molds), powdery mildew (*Erysiphe* spp.), downy mildew (*Pseudoperonospora cubensis*), gummy stem blight (*Didymella bryoniae*), Alternaria leaf spot (*Alternaria cucumerina*), and Cercospora leaf spot (*Cercospora citrullina*). Cucumber beetles transmit bacterial wilt of cucurbits.

Table 1 is a list of pests associated with cucurbits in the Caribbean region that may be identified as regulated pests requiring phytosanitary measures by the PRA process. Measures in Table 3 are recommended for the management of these quarantine pests. These measures may be substituted where technically justified.

In the conduct of the pest risk assessment, significant uncertainty may be identified, making it difficult to evaluate phytosanitary measures. Cases of uncertainty do not mandate the application of measures unless it is determined that a pest is likely to be introduced and result in negative economic impacts in the PRA area. During the PRA process, NPPOs should note any

pests for which there is uncertainty as to association with cucurbits in trade and take appropriate measures necessary t reduce the risk of the uncertainty. In Table 2, included is a list of pests for which there is uncertainty in the Caribbean as to association with cucurbits in trade and a description of the uncertainty.

Table 1. Pest groups associated with cucurbits grown in the Caribbean.

Pest Group	Family	Example species
Ant	Formicidae	*Acromyrmex octospinosus* (Reich)
		Atta cephalotes (Linnaeus)
		Atta sexdens (Linnaeus)
		Solenopsis invicta (Buren, 1972)
Aphid	Aphididae	*Aulacorthum solani* (Kaltenbach)
Bacterium	Ralstoniaceae	*Ralstonia solanacearum* Race 2
Beetle	Chrysomelidae	*Diabrotica balteata* (LeConte)
Fruitflies	Tephritidae	*Anastrepha grandis* (Macquart)
		Bactrocera cucurbitae (Coquillett)
		Batrocera dorsalis (Hendel)
Fungus	Glomerellaceae	*Colletotrichum* spp.
Mite	Tetranychidae	*Tetranychus cinnabarinus* (Boisduval)
Mollusc	Veronicellidae	*Veronicella cubensis* (Pfeiffer)
Moth	Crambidae	*Spoladea recurvali* (Fabricius)
Nematode	Belonolaimidae	*Belonolaimus longicaudatus*
Oomycete	Peronosporaceae	*Phytophthora* spp.
Thrip	Thripidae	*Frankliniella occidentalis* (Pergorde)
		Thrips tabaci Lindeman, 1889
True bug	Coreidae	*Leptoglossus zonatus* (Dollas)
Virus	Bromoviridae	Cucumber Mosaic Virus (CMV)
Weevil	Curculionidae	*Asynonychus godmanni* (Boheman)
Whitefly	Aleyrodidae	*Trialeurodes vaporariorum* Westwood 1856
Wireworm	Elateridae	*Conoderus rudis* (Brown)

Table 2. Pests with uncertain association with cucurbits grown in the Caribbean.

Pest Group	Family	Pest	Description
Fruitflies	Tephritidae	*Ceratitis capitata*	The Mediterranean fruitfly has been found to affect a wild *Cucumis* spp. only under laboratory conditions. The pest is listed as being of unknown importance to *Citrullus* and *Cucurbita* species (Thomas *et al.*, 2010 – reviewed 2019).

General Procedures

Once technically justified, general procedures include the following:

Production:

- Registration of producers, farms and exporters and maintenance of a registry of these entities by the NPPO of the exporting country
- Application of good agricultural practices (GAP) (e.g., site and land selection, use of agrochemicals as recommended by the manufacturer, use of certified seeds and pest resistant or tolerant varieties where available, farm sanitation, weed management)
- Monitoring for pests and their vectors, where applicable

Packaging and grading:

- Registration of packing houses
- Development of, and compliance with, packing house requirements
- Pest management in the packing house
- Packing in new and clean material (including protective material, where required)
- Labelling of packaging
- Storage prior to export and transportation in a secure manner to prevent contamination and infestation (e.g., use of insect-proof packaging)
- Grading (guided by CODEX standards[1]) to ensure suitability of cucurbit vegetables for export, including freedom from damage and/or rot, symptoms of pests and contamination with soil, plant debris and extraneous materials.

Treatment facilities:

- Registration and approval of export treatment facilities (where different to the packing house) in accordance with procedures established by the exporting NPPO.
- Secure management to prevent contamination and re-infestation.

[1] CODEX Alimentarius "Fresh Fruits and Vegetables". https://www.fao.org/3/a1389e/a1389e00.htm

Sanitary (Food Safety) Measures

Food contamination can be caused in several ways, the main types of which are biological, chemical, physical and allergenic. Some such contamination could be due to naturally occurring contaminants in the environment or artificially introduced by certain agricultural practices.

Food contamination is a matter of serious food safety concern because high concentration of chemicals and contaminants present in food can pose serious health risks. Several incidents over the years have demonstrated a food safety problem, particularly with melons. There have been outbreaks of Salmonellosis in melons which seems to be the bacterial pathogen of greatest concern, and it is therefore of utmost importance for public health that only *Salmonella*-free agricultural products reach the consumer. Fecal contamination of the water supply used for irrigation and crop protection must be guarded against, and animals that may be attracted to the fruit, particularly as they ripen in the field and are near harvest must be excluded as far as possible.

The handling, packaging, transporting and storage of commodities intended for consumption are significant contributors to food contamination. It is therefore important that good agricultural practices and good hygiene practices are maintained from the point of production to the point of export to reduce or eliminate contamination of cucurbit consignments. Chemical treatments must be approved for use on these vegetables/commodities and should be applied strictly in accordance with established international standards on maximum residue levels (MRLs).

Persons handling cucurbits in production and after harvest should be (made) aware of proper personal hygiene and apply good hygienic practices at all times.

Phytosanitary Measures

Of the priority plants pests identified for the Caribbean region, *Ralstonia solanacearum* Race 2 is known to be associated with cucurbits. Table 3 below provides information on pests associated with cucurbits in the Caribbean region along with measures considered to be effective in managing each pest group previously identified in Table 1.

NPPOs of importing countries in the region should recognize the effectiveness of treatments demonstrated by the exporting country to manage the target pests or provide technical

justification in support of requests to the exporting country for application of alternative measures. Phytosanitary measures applied to manage the risk(s) from one pest could likely also manage the risks posed by other pests of the commodity.

Table 3. Phytosanitary measures considered to be effective in managing the risk from specified pest groups on cucurbits grown in the Caribbean

Pest Group	Phytosanitary Measure(s)[2]
Ants	PFPP, ALPP, systems approach
Aphids	ALPP, IPM, preservation of natural enemies, visual inspection, use of yellow traps
Bacteria	PFA, PFPP, GAPs (incl. proper field sanitation)
Beetles	Hand pick to remove where possible, eliminate weeds, protect & encourage natural enemies, field sanitation after harvest, till soil
Fruitflies	PFA, PFPP, Vapour heat treatment, irradiation
Fungi	PFPP, use of certified planting material, well-drained fields, proper field sanitization, elimination of weed host plants, fungicidal dip.
Mites	Rationalize use of pesticides to preserve natural enemies; when applying for insect control, apply insecticide soap sparingly & at lowest recommended concentration when mite populations are not too high; apply neem oil for control.
Molluscs	IPM, visual inspection
Moths	PFPP, ALPP, IPM, GAPs (host weed control, pre-planting field sanitation, etc.), visual inspection for eggs & larvae
Nematodes	ALPP, IPM (incl. use of trap crops & correct use of appropriate nematicides)
Oomycetes	PFPP, application of cultural practices (avoid planting in fields in which solanaceous crops were cultivated for at least 3 years, use of well-drained fields, regular scouting & treatment at first signs of disease, mulching), use of certified planting material, fungicide applications after sensitivity testing for signs of resistance
Thrips	PFA, PFPP, IPM, visual inspection
True bugs	PFPP, GAPs, visual inspection, systems approach
Viruses	Manage arthropod vectors; plant disease resistant varieties; use certified seeds; proper weed management
Weevils	ALPP, exclusion of soil
Whiteflies	GAPs (e.g., proper nutrition, irrigation), IPM (e.g., use virus-resistant varieties, plant certified seeds)
Wireworms	Visual inspection, systems approach, ALPP

In the case of phytosanitary import requirements, such should be required solely for pests that countries have identified as regulated pests that require the application of phytosanitary measures thus determined by PRA for the endangered area. In cases where the association of the pest or pest group to the pathway is uncertain, phytosanitary measures should be justified through PRA.

[2] PFPP = Pest Free Place of Production, ALPP = Area of Low Pest Prevalence, IPM = Integrated Pest Management, PFA = Pest Free Area, GAP = Good Agricultural Practice

Pest Free Areas (PFA)

Guidance on pest free areas may be sourced in ISPM 4 (*Requirements for the establishment of pest free areas*) and ISPM 8 (*Determination of pest status in an area*).

Pest Free Places of Production (PFPP) and Areas of Low Pest Prevalence (ALPP)

Guidance on pest free places of production and areas of low pest prevalence is found in ISPM 10 (*Requirements for the establishment of pest free places of production and pest free production sites*) and ISPM 22 (*Requirements for the establishment of areas of low pest prevalence*). The utility of these phytosanitary measures may be limited by some characteristics of pests.

Pre-Harvest and Harvest Management

Pre-harvest management

Production sites selected should preferably have a history of freedom from pests of quarantine significance and be well-drained. To effectively manage *Phytophthora* diseases, it is recommended that fields for the cultivation of cucurbit crops do not have a history of cucurbits, eggplants, peppers and/or tomatoes for at least three years. The timing for planting, the maintenance of appropriate moisture levels, and the application of suitable fertilisers as recommended should be adhered to in order to achieve the best crop outcomes. Excessive irrigation should be avoided. Pest-free and/or certified planting material and pest resistant cultivars should be used where possible and/or available in keeping with market requirements.

Pest surveillance is extremely important in the production of cucurbits and fields should be scouted for signs of pests (including weeds); timely and appropriate actions should be taken to manage these pests, inclusive of the use of pheromone and yellow sticky traps. Fruit fly monitoring should be done regularly from the fruiting stage onwards. Every effort should be made to preserve and/or use natural enemies to effect control of the pests of concern in situations where such natural enemies are available. Anthracnose may be controlled in the field through the use of copper compounds, triazoles and strobilurins but pathogen resistance should be closely monitored to ensure that the pesticides remain effective. Post-harvest losses due to anthracnose should ideally be controlled at the field level prior to harvest.

All tools and equipment used in the production process should be disinfected to prevent spread of disease from one place of production to another.

Harvesting

Harvesting at the correct stage is important. The cucurbits should be harvested promptly upon reaching the required level of maturity to reduce incidence of field disease and ensure best taste. Upon harvesting, stalks should be cut with a sterile knife (immerse in a solution of commercial bleach at the rate of 5 mls of bleach per liter of water for a period of 5 minutes), or broken if they have developed a natural abscission layer, leaving at least an inch (3 cm) of the stem on the fruit. The fruit should not be pulled or twisted off the vine. Melons on dead or dying vines as well as any produce that may have been exposed to faecal contamination should not be harvested. Cucurbits should be harvested in the early morning when it is still cool. To reduce post-harvest losses to disease, mechanical and surface damage to the fruit should be avoided, particularly for melons and summer squashes.

Post-harvest handling and treatments

Handling and sorting

Harvested produce should always be stored in shade and cooled as quickly as possible after harvesting and before they are packed. All infested, damaged, bruised, scarred and overripe produce should be removed and disposed of appropriately. Harvested fruits should be placed in clean field crates. Each load should be stowed stably and be kept well ventilated. Packages should be strong enough to protect the contents and should not be stacked higher than the maximum recommended to prevent collapse under the weight above. Packages should be loaded on dunnage or pallets on the beds of transport vehicles to allow for circulation of air around the stacks.

Transportation

Vehicles used to transport cucurbits should be clean and provide a cool environment for the produce. Records should be kept of all vehicle cleaning activities. Every effort should be made to prevent damage to the produce while being loaded, transported and off-loaded, regardless of the method of transport being used to move the goods.

Cleaning

Cleaning of cucurbits and all equipment and machinery used to harvest and process them is an important step in removing pest-harbouring plant residues and soil. If required, cucurbits should be surface-disinfected by sponging or dipping them in a 10% bleach solution for 1-2 minutes and then allowing them to air dry. Potable water should be used to conduct any necessary washing or treatment of the vegetables.

Storage and Curing

After being harvested, melons should be cooled quickly and stored at conditions that are optimal for the particular species, as follows:

- Watermelons: 10-12°C and 89-90% relative humidity
- Cantaloupes: 3-5°C and 95% relative humidity
- Honeydew melons: 7°C and 95% relative humidity

Winter squashes and pumpkin may be cured, if required and to extend the shelf life, by placing them in a warm (80-85°F), dry location for 3-5 days for squashes and up to 10 days for pumpkins, at a relative humidity of 80-85%. They can then be stored for several months at 55-60°F and 50-70% relative humidity with good air circulation.

Treatments

Treatments include a range of processes that are targeted at the control or eradication of pests and contaminants from approved commodities, empty containers and export vessels. Treatments can include – but are not limited to – fumigation, irradiation, use of controlled atmosphere or temperature, application of a chemical substance, dismantling/repairing or cleaning, repacking, or blending. The choice of the treatment applied is the responsibility of the importing country in keeping with international standards. The process of treatments should be guided by ISPM 28 (*Phytosanitary treatments for regulated pests*).

Specific treatments for cucurbits may be selected and mutually agreed upon between the countries of import and export in accordance with approved international standards and treatments, or where bilaterally agreed.

Irradiation

Treatments for the use of ionizing radiation (irradiation) may be used for pest risk management. Phytosanitary irradiation is a treatment which uses ionizing radiation on commodities such as

fruits and vegetables to inactivate pests. The method is used for international food trade as a means to prevent spread of non-native organisms. NPPOs should be assured that the efficacy of the treatment is scientifically demonstrated for the regulated pest(s) of concern and the required response. The application of irradiation as a phytosanitary treatment, when available and applicable, should be in accordance with ISPM 18 (*Guidelines for the use of irradiation as a phytosanitary measure*). IISPM 28 Annex 7 (*Irradiation treatment for fruit flies of the family Tephritidae [generic]*) and ISPM 28 PT 33 (*Irradiation treatment for Bactrocera dorsalis*) would be a guide for treatment for tephritid fruitflies as indicated.

Fumigation treatment

Fumigation is the treatment with a chemical agent that reaches the commodity and target pest(s) in a gaseous state. The fumigant may be effective against all pest groups or used to target a particular pest group and may address all or most life stages. The application of fumigation as a phytosanitary treatment should be in accordance with ISPM 43 (*Requirements for the use of fumigation as a phytosanitary measure*). Nitric oxide fumigation has been demonstrated as a safe option for postharvest pest control for fresh fruit and vegetables.

Storage facilities, both on- and off-farm, should be approved and outfitted with the required cool stores and warehousing facilities linked to postharvest crop management. Fumigation should only be done when necessary and only by a licensed or trained operator. All fumigation instances, chemical agents used, and dates of application should be documented.

Chemical treatment

Chemical treatments are used on a wide range of agricultural products from pre-planting through to post-harvest stages. These treatments are intended to destroy, repel and control pests of agricultural commodities. The chemicals are commonly applied by dipping (i.e., fully immersing the commodity into a solution) or spraying at a specific concentration for a specified period, to reduce the risk of a broad range of pests in the target area or on the target commodity. Chemical treatments may also be used to destroy pests within empty holds of a vessel or container.

Cucurbits may be subjected to an importing NPPO-approved chemical treatment where necessary. In the selection of chemical treatments, approved copper compounds, triazoles and strobilurins may be considered as a post-harvest treatment for anthracnose.

Temperature treatment

Temperature treatments may be used as a phytosanitary treatment option. The application of heat treatments and systems to support the treatments should be in accordance with ISPM 42 (*Requirements for the use of temperature treatments as phytosanitary measures*) and technically justified by PRA. Post-harvest decay of cucurbits due to *Fusarium* rot may be reduced if subjected to hot water treatments (1 minute at 135ºF).

Vapour Heat Treatment (VHT) is the process in which water vapours are used to heat a commodity until it reaches a minimum temperature for a specified period of time to effectively control live infestations of certain pests. It is an option generally used for commodities that are resistant to high moisture and vulnerable to drying out. ISPM 28 Annex 15 (*Vapour heat treatment for Bactrocera cucurbitae on Cucumis melo var. reticulatus*) provides guidance as indicated.

Cold treatment involves the use of refrigerated air to lower the temperature of a product to, or below, a specific temperature for a specific period to mitigate the risks of infestations of target pests. This treatment is used primarily for fresh fruits and vegetables that are hosts of internally feeding pests. The treatment is generally commodity and pest specific.

Packing, packaging and labelling

Packaging is a pivotal step in the journey of fresh produce from the farm to the table, and a number of options are available depending on the specifications of individual consignments (NC State Extension Publications, 1996). Cucurbits should be packaged using clean or new containers.

A label to be affixed to each carton/container should clearly detail the name of the commodity and other relevant information, including but not limited to: the variety, the farmer's registration number, the name and address of the exporter, the harvest date, the packing date, the gross weight or net weight, and the names of the grower and the processor/exporter. Any other quantitative information should be also included on the label in keeping with the importing country's requirements.

Transportation

In the transportation of cucurbits for consumption, all applicable handling, packaging and storage procedures must serve to prevent damage to the produce and proliferation of pests during the process. Closed trucks used to transport fresh produce should be either refrigerated

or suitably retrofitted to allow for ventilation of the produce. Ventilation of long-distance vehicles should be done by fitting the vehicle with air intakes and louvres to allow for a positive air flow through the load. During the shipping process, cucurbits should not be placed in areas with extreme temperatures. The cartons should not be dropped, thrown, packed in inverted position, rolled or tipped. Bruising of the produce may result from rough handling so that handling should be kept to a minimum. Regardless of the means of transport, the produce must be kept as cool as possible, dry, and moved to market as quickly as possible.

Systems Approaches

Guidance for the use in development and evaluation of integrated measures in a systems approach can be found in ISPM 14 (*The use of integrated measures in a systems approach for pest risk management*). At least two measures which are independent of each other may be used to manage specific quarantine pests and any uncertainty.

Verification of compliance

Sampling and inspection should be carried out by the NPPO to verify compliance of consignments of cucurbits with phytosanitary import requirements.

The NPPO may authorize entities to conduct specific phytosanitary activities (e.g., sampling, inspection and testing) in accordance with the ISPM 45 (*Requirements for national plant protection organizations if authorizing entities to perform phytosanitary actions*).

Sampling and phytosanitary inspection

ISPM 31 (*Methodologies for sampling of consignments*) and ISPM 23 (*Guidelines for Inspection*) may be used for official guidance on sampling and phytosanitary inspection.

In accordance with official procedures, the NPPO of the exporting country should sample and inspect each consignment of cucurbits to verify conformance with importing requirements and freedom from quarantine pests. Each consignment must be visually inspected in keeping with official phytosanitary procedures detailed in ISPM 23 (*Guidelines for inspection*) and ISPM 31 (*Methodologies for sampling of consignments*) for all pests of cucurbits regulated in the Caribbean region.

If infield controls require the registration of the production area or farm(s), sampling and inspection should be conducted in each homogenous grower lot. In instances where live pests are found, the exporting country NPPO should determine whether additional actions are required to meet the conditions of the importing country NPPO.

The number of packages presented for inspection should be consistent with documentation for the consignment. The documentation should certify that basic measures have been applied and that any required traceability labelling is complete. Initial inspection of the consignment should also verify that the phytosanitary security is maintained for the consignment.

Minimum sample size for inspection should be based on a 95% confidence level that not more than 0.5% of the units in the consignment are infested as set out in ISPM 31 (*Methodologies for sampling of consignments* Appendix 2), or as specified by the NPPO of the importing country, with technical justification.

Phytosanitary certification

All commodities intended for export attain a phytosanitary status when they are produced in a PFA or PFPP; after harvest, for commodities from certified farms required to eliminate, manage or monitor specific pests; after a phytosanitary treatment, and after export inspection. A phytosanitary certificate should only be issued when the requirements of the importing country, as set out in an Import Permit issued by its NPPO, have been verified as being met as confirmed in the certifying statement. Phytosanitary certification (for export and re-export) should be in keeping with ISPM 12 (*Phytosanitary certificates*).

An additional declaration may be required by the country of import to verify compliance with the import requirements as specified by the importing country's NPPO.

For consignments of cucurbits for consumption to receive phytosanitary certification, the consignments must:

- Meet the specific requirements as indicated in the Import Permit issued by the importing country
- Originate only from officially approved places of production
- Be clean (i.e., practically free from viable regulated pests, and associated tissue damage, soil, chemical contaminants, or any other unapproved extraneous material and substances)

- Be treated in a manner consistent with the application standard and treatment certificate presented
- Be accompanied by pest free area declaration, where required
- Be packaged in clean and new material (including packaging material used to prevent damage during transport)
- Be exported in a secure manner to prevent contamination.

Cucurbits must be intact and clean, and free from rot, visible foreign matter and damage caused by pests. If viable regulated pests are detected, a phytosanitary certificate should not be issued unless appropriate phytosanitary measures have been applied.

If a consignment of cucurbits is opened, split up or packaging changed prior to arriving in the country of import, a phytosanitary certificate for re-export is required from the re-exporting country. Re-exported consignments must be accompanied by (a copy of) the original phytosanitary certificate.

Phytosanitary certificates, and Phytosanitary Certificates for Re-export should be in accordance with ISPM 12 (*Phytosanitary certificates*).

Phytosanitary security

Once commodities have received phytosanitary certification, and until such commodities are exported, the phytosanitary security of the commodities must be maintained at all times. As such, the commodities must be adequately protected to prevent infestation or contamination and labelled (in keeping with the legislation and importing country requirements) to prevent substitution. Breaches of security during transport or storage disqualifies the phytosanitary status of the commodities.

Phytosanitary security is maintained:

1. when secure packaging (cartons, pallets) is used and/or
2. the consignment is isolated by physical barriers, distance or insect-proof space), AND
3. appropriate measures are taken while loading export containers.

Secure packaging

Secure packaging requirements could comprise of the following:

Container level security

- The commodity is fully enclosed in a container with the lids tightly fixed to the base
- Ventilation holes or other openings are covered with insect-proof mesh that has no more than a 1.6mm diameter pore size diagonally; alternatively, ventilation holes are fully sealed.
- Vented containers having plastic liners or bags must be fully sealed. The overlapping folded edges of the plastic liner with the container lid on top would be considered fully sealed.

Pallet level security

Any pallets used should be compliant with ISPM 15 (*Regulation of wood packaging material in international trade*). For cartons that are palletized, security would be achieved using one of the following options:

- Each pallet is fully shrink-wrapped, with the base and the top of the pallet sealed (e.g., using a sheet of cardboard), as well as all sides, to completely enclose the commodity consignment.
- Each pallet is secured with insect-proof mesh using a pallet net with no more than a 1.6 mm pore size diagonally, to include the surface area between the bottom row of the cartons and the pallet.

Isolation requirements

Commodities that are not secure-packaged may be kept secure if they are isolated from all potential sources of infestation or contamination and from other goods of different or unknown phytosanitary status.

Isolation by physical barriers

Physical barriers (e.g., walls or solid structures) can be used to exclude pest access. This option can be applied when the commodities are stored and handled in insect-proof spaces, shipping containers, enclosed vans or cool rooms.

Isolation by distance

The phytosanitary status of consignments may be maintained by creating a minimal acceptable distance between goods of different or unknown phytosanitary status within insect-proof spaces. This can be achieved if goods are kept at least 0.5m from any other goods.

Isolation by insect-proof spaces

The phytosanitary security of a consignment can be maintained if, at all times, the goods are kept in insect-proof spaces and are kept isolated from all potential sources of infestation or contaminants, to include products of different or unknown phytosanitary status. Pack houses, treatment facilities and cool room storage doors must be suitably insect-proof through the use of double doors, automatic doors, rubber curtains, air curtains or other approved mechanism.

Loading procedures

During the loading process, it is important to maintain phytosanitary security of the consignment by ensuring the following occurs:

- Containers with vent holes and openings must be sealed, with openings no more than 1.6 mm pore size diagonally (e.g., drain holes or air intakes)
- Consignments must be loaded directly into the export container
- Commodities not securely packaged and not immediately loaded must be stored securely to prevent contamination or infestation
- Personnel loading export containers must ensure that the consignments are moved from the secured area into the export containers as quickly as possible
- Consignments must not be left unsecured and loading procedures must mitigate potential infestation.

One or more methods to safeguard cucurbits against infestation after the application of a phytosanitary measure should be applied. Such methods should take into account the biological characteristics of pests and the strength of the phytosanitary measures that have been applied.

Consignments in transit

In the movement of regulated commodities within the Caribbean, such commodities may transit various countries *en route* to the country of import. Procedures to identify, assess and manage pest risks associated with consignments of these commodities which pass through a country

without being imported, should be conducted in such a manner that any phytosanitary measures applied in the country of transit are technically justified and necessary to prevent the introduction into and/or spread of pests within that country. ISPM 25 (*Consignments in transit*) provides guidance for handling of consignments in transit.

Audit and compliance of the export pathway

In keeping with ISPM 20 (*Guidelines for a phytosanitary import regulatory system*), the importing country's NPPO may request an audit of specific elements of the export system for cucurbits. This could relate to entities registered/approved to export as well as the records relating to exported consignments. Verification of compliance of the consignment may be sought by the importing country in the country of export.

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APPENDICES

Appendix 1. List of pests found on cucurbits in the Caribbean region

[source: National Plant Protection Organizations of Member States]

Pest Type	Scientific name	Common name(s)	Host[3]
Bacterium	*Acidovorax avenae subsp. citrulli*	Bacterial fruit blotch	*Citrullus lanatus*
Bacterium	*Erwinia carotovora subsp. carotovora*	Bacterial root rot of sweet potato	*Cucumis melo*
Bacterium	*Erwinia sp.*	Erwinia soft rot	Pumpkin
Bacterium	*Glomerella cingulata* (Jones)	Anthracnose	*Cucumis melo*
Fungus	*Acremonium sp.*	Fruit spots, vine spots, leaf blotch	Pumpkin
Fungus	*Alternaria cucumerina*	Leaf spot	Watermelon
Fungus	*Alternaria dauci*	Leaf blight of carrot	Cucumber
Fungus	*Alternaria sp.*	Chlorosis, Wilting	Pumpkin
Fungus	*Athelia rolsii*	root rot	*Cucumis* spp., *Cucurbita* spp.
Fungus	*Botryodiplodia (Lasiodiplodia) theobromae* Pat.	Brown pod rot of cocoa	Pumpkin
Fungus	*Cercospora citrullina*	leaf spot	*Cucumis* spp., *Cucurbita* spp.
Fungus	*Cercospora cucurbitae* Ell. & Ev. [Mycosphaerella melonis (Pass.)]	Leaf spot	Pumpkin
Fungus	*Chaonephora sp.*	Chaonephora fruit rot	Pumpkin
Fungus	*Cladosporium cucumerinum*	scab of cucurbits	*Cucumis* spp., *Cucurbita* spp.
Fungus	*Colletotrichum lagenarium* (Pass.) Ell. & Halst.	Anthracnose	Pumpkin
Fungus	*Colletotrichum orbiculare*	Anthracnose of cucurbits	Cucumber
Fungus	*Colletotrichum* spp	Anthracnose	*Citrullus lanatus*
Fungus	*Corynespora cassiicola*	Corynespora leaf spot/blight	Pumpkin
Fungus	*Didymella bryoniae*	gummy stem blight of cucurbits	*Cucumis* spp., *Cucurbita* spp.
Fungus	*Erysiphe cichrocearum*	Powdery mildew of cucurbits	All
Fungus	*Fusarium oxysporum*	Fusarium wilt, basal rot	All
Fungus	*Fusarium oxysporum f.sp. melonis* (L&C Snyder & Hanson)	Fusarium wilt	All
Fungus	*Fusarium oxysporum* Schlecht	Fruit spots, vine spots, leaf blotch, root rot	Pumpkin
Fungus	*Fusarium pallidoroseum* (Cooke) Sacc.	Fruit spots, vine spots, leaf blotch, root rot	Pumpkin
Fungus	*Fusarium* sp	fruit rot	*Cucumis* spp., *Cucurbita* spp.
Fungus	*Gloeosporium cucurbitarum* Berk. & Br.	Anthracnose	Pumpkin
Fungus	*Glomerella cingulata*	anthracnose	*Cucumis* spp., *Cucurbita* spp.
Fungus	*Macrophomina phaseolina*	charcoal rot of bean, ashy stem blight	All

[3] As declared by BMCs

Pest Type	Scientific name	Common name(s)	Host[3]
Fungus	*Mycosphaerella melonis*	Gummy stem blight	*Citrullus lanatus*
Fungus	*Myrothecium roridum*	fruit rot	*Cucumis* spp., *Cucurbita* spp.
Fungus	*Oidium* sp.	powdery mildew	*Cucumis* spp., *Cucurbita* spp.
Fungus	*Phomopsis cucurbitae* McKeen	Phomopsis black rot, cucumber black rot, melon soft rot	Pumpkin
Fungus	*Phomopsis sclerotioides* van Kesteren	Black rot of cucumber	Pumpkin
Fungus	*Podosphaera xanthii*	Powdery mildew	Watermelon
Fungus	*Rhagadolobium cucurbitacearum* (Rehm.) Theiss & Syd.	Leaf spot	Pumpkin
Fungus	*Rhizoctonia solani (Thanatephorus cucumeris)*	damping off, crater rot	*Cucumis* spp., *Cucurbita* spp.
Fungus	*Sphaerotheca fuliginea*	Powdery mildew	All
Insect	*Acalymma vittatum*	Cucumber stripe beetle	*Cucumis* spp., *Cucurbita* spp.
Insect	*Aleurodicus dispersus*	Spiral whitefly	All
Insect	*Anasa scorbutica* (F.)	Squash bug	All
Insect	*Anasa spp. (?)*	Squash bug	Cantaloupe
Insect	*Aonidiella orientalis*	oriental yellow scale	All
Insect	*Aphis (Doryalis) fabae* Scop.	Black bean aphid	All, except *C. melo*
Insect	*Aphis gossypii* Glover	Melon aphid	All
Insect	*Aphis spiraecola*	Green citrus aphid	Watermelon, cucumber
Insect	*Aspidiotus destructor*	coconut scale	All
Insect	*Atherigona orientalis* (Schiner)	Pepper fruit fly	*Cucumis melo*
Insect	*Bemisia tabaci*	tobacco whitefly	All
Insect	*Coccus hesperidum*	brown soft scale	All
Insect	*Diabrotica balteata*	Spotted/Banded cucumber beetle	Pumpkin
Insect	*Diabrotica innuba* (F.)	Cucumber beetle, corn root worm	All, except *C. melo*
Insect	*Diabrotica pallipes* Oliver/ *themai* Baly	Striped cucumber beetle / leaf beetle	Pumpkin
Insect	*Diabrotica separate*	Root Worm	All
Insect	*Diabrotica* spp.	Cucumber beetle	*Citrullus lanatus*
Insect	*Diaphania (Margaronia) hyalinata* (L.)	Melonworm	All
Insect	*Diaphania (Margaronia) nitidalis* (Cram)	Pickleworm	All, except *C. melo*
Insect	*Diaphania indica* Saunders	Pumpkin caterpillar	Pumpkin
Insect	*Diaphania nitidalis* (Stoll)	Cucumber worm	All
Insect	*Diaphania sp.*	Caterpillar	Pumpkin
Insect	*Dysmicoccus brevipes*	pineapple mealybug	All
Insect	*Empoasca kraemeri* Ross and Moore	Bean leafhopper	Cucumber
Insect	*Ferrisia virgata*	Guava mealybug	Pumpkin
Insect	*Frankliniella occidentalis*	Californian thrips	Melon
Insect	*Frankliniella schultzei*	Cotton thrips	*Cucumis* spp., *Cucurbita* spp.
Insect	*Helicoverpa zea* (Boddie)	American cotton bollworm	*Cucumis melo*
Insect	*Leptoglossus gonagra*	Coreid bug	All
Insect	*Liriomyza sativae* (Blanchard)	Vegetable leaf miner	All

Pest Type	Scientific name	Common name(s)	Host[3]
Insect	*Liriomyza sp.?*	Leafminer	All
Insect	*Liriomyza trifolii*	American serpentine leafminer	*Cucumis* spp., *Cucurbita* spp.
Insect	*Maconellicoccus hirsutus*	pink hibiscus mealybug	All
Insect	*Myzus persicae*	green peach aphid	All
Insect	*Nezara viridula* (L.)	green stink bug	All, except *C. melo*
Insect	*Phthia picta*	Coreid bug (agromyzid fly)	All
Insect	*Pinnaspis strachani*	Lesser snow scale	Pumpkin
Insect	*Planococcus citri*	citrus mealybug	All
Insect	*Polyphagotarsonemus latus*	Broad mite	Pumpkin, cucumber
Insect	*Pseudaonidia trilobitiformis*	Green (Armoured/Trilobite/ Gingging Scale)	Pumpkin
Insect	*Pseudococcus jackbeardsleyi*	Jack Beardsley mealybug	All
Insect	*Pseudococcus sp.*	Mealy bug	Pumpkin
Insect	*Pycnoderes incurvus* Distant (*P. quadrimaculatus* Guer.	Black bug	Pumpkin
Insect	*Pycnoderes sp. (?)*	Plant bugs	Pumpkin
Insect	*Rhopalosiphum (Myzus) persicae* Sulzer	Cabbage aphid	Pumpkin
Insect	*Scapteriscus vicinus* Scudder	West Indian mole cricket	All, except *C. melo*
Insect	*Spodoptera eridania*	Southern armyworm	All
Insect	*Spodoptera frugiperda*	Fall armyworm	All
Insect	*Spodoptera ornithogalli* (Guernee)	Yellow striped army worm	All
Insect	*Spoladea recurvalis*	Hawaiian beet webworm	All
Insect	*Tetranychus cinnabarinus* Boisd. (T. telarius L.)(*T. bimiculatus* Harvey)	Carmin spider mite / Tropical red spider mite	Pumpkin
Insect	*Thrips palmi* (Karny)	Melon thrips	All
Insect	*Thrips tabaci* (Linderman)	Onion thrip	All
Insect	*Thysanoptera* spp	Thrips	*Citrullus lanatus*
Insect	*Trialeurodes vaporariorum*	whitefly, greenhouse	*Cucumis* spp., *Cucurbita* spp.
Insect	*Trichoplusia ni*	cabbage looper	*Cucumis* spp., *Cucurbita* spp.
Mite	*Tetranychus urticae (telarius)* (Koch)	Red spider mite	All, except *C. melo*
Nematode	*Aphelenchus* sp.	-	Pumpkin
Nematode	*Ditylenchus* sp.	Stem and bulb nematodes	Pumpkin
Nematode	*Helicotylenchus dihystera*	Common spiral nematode	Cucumber
Nematode	*Helicotylenchus sp.*	Spiral nematodes	Pumpkin
Nematode	*Meloidogyne arenaria* (Neal) Chitwood	Peanut root knot nematode	Pumpkin
Nematode	*Meloidogyne incognita* (Kofoid & White) Chitwood	Root knot nematode	All
Nematode	*Paratylenchus* sp.	Pin nematode	All
Nematode	*Pratylenchus* sp.	Root lesion nematode	All
Nematode	*Rotylenchulus reniformis* Linford & Oliveira	Reniform/Spiral nematodes	All, except *C. melo*
Nematode	*Tylenchorhynchus sp.*	Stunt nematodes	Pumpkin
Nematode	*Tylenchus sp*	Stem and bulb nematode	Pumpkin
Nematode	*Xiphinema sp.*	Dagger nematode	Pumpkin
Nematode	*Xiphinema vulgare* Tarjan	Dagger nematode	All

Pest Type	Scientific name	Common name(s)	Host[3]
Oomycete	*Phytophthora cactorum*	Phytophthora fruit rot	Pumpkin
Oomycete	*Pseudoperonospora cubensis* (Berk. & Curt.) Wei	Downy mildew	All
Oomycete	*Pythium sp.*	Pythium fruit rot	Pumpkin
Virus	*CMV*	Cucumber Mosaic Virus	All
Virus	Cucumber mosaic cucumovirus	Cucumber mosaic virus	All
Virus	Cucumber mosaic virus	cucumber mosaic	*Cucumis* spp., *Cucurbita* spp.
Virus	Squash mosaic virus	Squash mosaic	Pumpkin
Virus	Watermelon mosaic virus	Watermelon mosaic	Pumpkin

Appendix 2. List of pests of cucurbits regulated by countries in the Caribbean region

[Source: National Plant Protection Organisations of Member States]

Pest Type	Scientific name	Common name(s)	Host
Insect	*Acromyrmex octospinosus* (Reich)	Leaf cutting ant	
	Anastrepha grandis (Macquart)	Cucurbit fruit fly	All
	Asynonychus godmanni (Boheman)	Fuller's rose weevil	
	Atta cephalotes (Linnaeus)	Bachac/Umbrella ant	
	Atta sexdens (Linnaeus)	Acoushi ant	
	Aulacorthum solani (Kaltenbach)	Foxglove aphid	
	Bactrocera cucurbitae (Coquillett)	Melon fly	All
	Batrocera dorsalis (Hendel)	Oriental Fruit fly	
	Ceratitis capitata	Medfly	*Cucurbita* spp., *Citrullus* spp.
	Conoderus rudis (Brown)	Wireworm	All
	Diabrotica balteata (leconte)	Banded cucumber beetle	
	Frankliniella occidentalis (Pergorde)	Western flower thrips	
	Leptoglossus zonatus (Dollas)	Leaf footed bug	
	Solenopsis invicta (Buren, 1972)	Red imported fire ant	
	Spoladea recurvali (Fabricius)	Hawaiian beet webworm	All
	Thrips tabaci Lindeman, 1889	Onion thrips	All
	Trialeurodes vaporariorum Westwood 1856	Greenhouse whitefly	*Cucumis* spp., *Cucurbita* spp.
Mite	*Tetranychus cinnabarinus* (Boisduval)	Carmine spider mite	All
Mollusc	*Veronicella cubensis* (Pfeiffer)	Two-striped slug	All
Nematode	*Belonolaimus longicaudatus*	Sting nematode	
Virus	Cucumber Mosaic Virus (CMV)	Cucumber Mosaic Virus	All