



Draft annex to ISPM 46: International movement of fresh *Mangifera indica* fruit

DRAFT ANNEX TO ISPM 46: International movement of fresh *Mangifera indica* fruit (2021-011)

Status box

This is not an official part of the standard and it will be modified by the IPPC Secretariat after adoption.	
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Adoption

[Text to this paragraph will be added following adoption.]

1. Scope

This commodity standard provides guidance for national plant protection organizations (NPPOs) on pests associated with fresh *Mangifera indica* (mango) (Sapindales: Anacardiaceae) fruit and options for phytosanitary measures for the international movement of fresh *M. indica* fruit.

2. Description of the commodity and its intended use

This commodity standard applies to the fresh fruit of *M. indica*. It applies to fresh whole *M. indica* fruit, with or without a small section of fruit stem (pedicel) attached but without leaves. The standard applies to fruit that has been produced for international trade and is intended for consumption or processing in an importing country. It does not apply to fruit that has already been processed (e.g. chopped, dried, frozen, canned).

3. Pests associated with fresh *Mangifera indica* fruit

The pests included in Table 1 are considered to be associated with fresh *M. indica* fruit and are regulated in international trade by at least one contracting party based on technical justification. The list of pests is not exhaustive, nor country specific.

The list of pests does not consider factors that may influence pest infestation of fruit in the country of origin (e.g. cultivar or variety, geographical and ecological factors, agricultural and production practices).

Inclusion of a pest in Table 1 does not constitute technical justification for its regulation by importing countries using this standard. When determining whether to regulate a pest listed in this commodity standard, the NPPO of the importing country should base its decision on technical justification using either a pest risk analysis or, where applicable, another comparable examination and evaluation of available scientific information.

Table 1. Pests considered to be associated with fresh *Mangifera indica* fruit*

Pest group	Family	Species (scientific name and authority) [†]
Weevils (Coleoptera)	Curculionidae	<i>Sternochetus frigidus</i> (Fabricius, 1787)
		<i>Sternochetus mangiferae</i> (Fabricius, 1775)
		<i>Sternochetus olivieri</i> (Faust, 1892)
Fruit flies (Diptera)	Tephritidae	<i>Anastrepha distincta</i> Greene, 1934
		<i>Anastrepha fraterculus</i> (Wiedemann, 1830)
		<i>Anastrepha ludens</i> (Loew, 1873)
		<i>Anastrepha obliqua</i> (Macquart, 1835)
		<i>Anastrepha serpentina</i> (Wiedemann, 1830)
		<i>Anastrepha striata</i> Schiner, 1868
		<i>Bactrocera aquilonis</i> (May, 1965)
		<i>Bactrocera carambolae</i> Drew & Hancock, 1994
		<i>Bactrocera caryeae</i> (Kapoor, 1971)

Pest group	Family	Species (scientific name and authority) [†]
		<i>Bactrocera correcta</i> (Bezzi, 1916)
		<i>Bactrocera curvipennis</i> (Froggatt, 1909)
		<i>Bactrocera dorsalis</i> (Hendel, 1912)
		<i>Bactrocera facialis</i> (Coquillett, 1909)
		<i>Bactrocera frauenfeldi</i> (Schiner, 1868)
		<i>Bactrocera jarvisi</i> (Tryon, 1927)
		<i>Bactrocera kirki</i> (Froggatt, 1911)
		<i>Bactrocera melanotus</i> (Coquillett, 1909)
		<i>Bactrocera neohumeralis</i> (Hardy, 1951)
		<i>Bactrocera occipitalis</i> (Bezzi, 1919)
		<i>Bactrocera passiflorae</i> (Froggatt, 1911)
		<i>Bactrocera psidii</i> (Froggatt, 1899)
		<i>Bactrocera tryoni</i> (Froggatt, 1897)
		<i>Bactrocera tuberculata</i> (Bezzi, 1916)
		<i>Bactrocera umbrosa</i> (Fabricius, 1805)
		<i>Bactrocera xanthodes</i> (Broun, 1904)
		<i>Bactrocera zonata</i> (Saunders, 1842)
		<i>Ceratitis capitata</i> (Wiedemann, 1824)
		<i>Ceratitis cosyra</i> (Walker, 1849)
		<i>Ceratitis rosa</i> Karsch, 1887
		<i>Zeugodacus cucurbitae</i> (Coquillett, 1899)
		<i>Zeugodacus tau</i> (Walker, 1849)
Mealybugs (Hemiptera)	Pseudococcidae	<i>Dysmicoccus neobrevipes</i> Beardsley, 1959
		<i>Ferrisia malvastra</i> (McDaniel, 1962)
		<i>Formicococcus robustus</i> (Ezzat & McConnell, 1956)
		<i>Maconellicoccus hirsutus</i> (Green, 1908)
		<i>Nipaecoccus nipae</i> (Maskell, 1893)
		<i>Paracoccus marginatus</i> Williams & Granara de Willink, 1992
		<i>Planococcus lilacinus</i> (Cockerell, 1905)
		<i>Planococcus minor</i> (Maskell, 1897)
		<i>Pseudococcus baliteus</i> Lit, 1994
		<i>Pseudococcus cryptus</i> Hempel, 1918
		<i>Pseudococcus jackbeardsleyi</i> Gimpel & Miller, 1996
		<i>Pseudococcus solenedyos</i> Gimpel & Miller, 1996
		<i>Rastrococcus iceryoides</i> (Green, 1908)
		<i>Rastrococcus invadens</i> Williams, 1986
		<i>Rastrococcus rubellus</i> Williams, 1989
		<i>Rastrococcus spinosus</i> (Robinson, 1918)
Scales (Hemiptera)	Coccidae	<i>Milviscutulus mangiferae</i> (Green, 1889)

Pest group	Family	Species (scientific name and authority) [†]
Whiteflies (Hemiptera)	Aleyrodidae	<i>Aleurodicus dispersus</i> Russell, 1965
Other Hemiptera	Coreidae	<i>Acanthocoris scabrator</i> (Fabricius, 1803)
		<i>Amblypelta nitida</i> Stål, 1873
	Pentatomidae	<i>Bathycoelia thalassina</i> (Herrich-Schäffer, 1844)
Moths (Lepidoptera)	Crambidae	<i>Deanolis sublimbalis</i> Snellen, 1899
Thrips (Thysanoptera)	Thripidae	<i>Retithrips syriacus</i> (Mayet, 1890)
		<i>Rhipiphorothrips cruentatus</i> Hood, 1919
		<i>Scirtothrips aurantii</i> Faure, 1929
		<i>Thrips palmi</i> Karny, 1925
Fungi	<i>Incertae sedis</i>	<i>Cytosphaera mangiferae</i> Died., 1916
Bacteria	Lysobacteraceae	<i>Xanthomonas citri</i> pv. <i>mangiferaeindicae</i> (Patel, Moniz & Kulkarni, 1948) Constantin <i>et al.</i> , 2016

Notes: * Information used to compile this list was supplied by at least one contracting party and may be provided by the IPPC Secretariat upon request.

[†] Scientific names used in this table are based on the submissions by contracting parties or aligned with ISPM 27 (*Diagnostic protocols for regulated pests*) or ISPM 28 (*Phytosanitary treatments for regulated pests*).

4. Options for phytosanitary measures

This section provides options for phytosanitary measures that may be relevant for the pests listed in Table 1. The options presented are not exhaustive and contracting parties may consider other options as phytosanitary measures.

Table 2 provides general options for phytosanitary measures that may be relevant to pests listed in Table 1.

Table 3 lists some specific options to manage the pest risk of pests listed in Table 1, with further details in Table 4 to Table 8. Abbreviations used for options for phytosanitary measures are listed in Box 1, as well as below in relevant tables.

Importing-country NPPOs should decide whether the options listed in Table 3 are effective at managing the pest risk to an acceptable level before selecting them as phytosanitary measures. Importing-country NPPOs should also consider whether a measure for one pest will effectively manage the pest risk of other regulated pests of *M. indica* fruit. In addition, when applying these options as phytosanitary measures, NPPOs should consider the procedures for successful application.

When considering the use of methyl bromide (Table 7), NPPOs should refer to the Commission on Phytosanitary Measures (CPM) recommendation on the *Replacement or reduction of the use of methyl bromide as a phytosanitary measure* (R-03). Where possible, alternative options to methyl bromide fumigation that are effective and more environmentally friendly should be selected and applied by NPPOs.

Options for phytosanitary measures included in this commodity standard may be effective at managing pest risk when used alone or when integrated with other measures in a systems approach as described in ISPM 14 (*The use of integrated measures in a systems approach for pest risk management*).

Phytosanitary treatments (PTs) that have been adopted by the CPM as annexes to ISPM 28 (*Phytosanitary treatments for regulated pests*) are shown in bold in Table 3 to Table 8.

Table 2. General options for phytosanitary measures

Options for phytosanitary measures	References
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Pest free areas	ISPM 4 (<i>Requirements for the establishment of pest free areas</i>) ISPM 26 (<i>Establishment of pest free areas for fruit flies (Tephritidae)</i>)
Pest free places of production and pest free production sites	ISPM 10 (<i>Requirements for the establishment of pest free places of production and pest free production sites</i>)
Areas of low pest prevalence	ISPM 22 (<i>Requirements for the establishment of areas of low pest prevalence</i>)
Systems approaches	ISPM 14 (<i>The use of integrated measures in a systems approach for pest risk management</i>) ISPM 35 (<i>Systems approach for pest risk management of fruit flies (Tephritidae)</i>)
Phytosanitary treatments	ISPM 28 (<i>Phytosanitary treatments for regulated pests</i>)
Inspection	ISPM 23 (<i>Guidelines for inspection</i>) ISPM 31 (<i>Methodologies for sampling of consignments</i>)
Testing and pest identification	ISPM 27 (<i>Diagnostic protocols for regulated pests</i>)
Phytosanitary certification	ISPM 7 (<i>Phytosanitary certification system</i>) ISPM 12 (<i>Phytosanitary certificates</i>)

Sources: See References section.

Box 1. Abbreviations used in this commodity standard for options for phytosanitary measures

HWIT	hot water immersion treatment
IRDN	irradiation
MB	methyl bromide fumigation
SA	systems approach
VHT	vapour heat treatment

Table 3. Pest-specific options for phytosanitary measures

Pest species	Options for phytosanitary measures
Weevils	
<i>Sternochetus frigidus</i>	IRDN 8 ; SA 1
<i>Sternochetus mangiferae</i>	IRDN 13; SA 1
<i>Sternochetus olivieri</i>	SA 1
Fruit flies	
<i>Anastrepha distincta</i>	HWIT 3; IRDN 1 ; SA 2
<i>Anastrepha fraterculus</i>	HWIT 1, 3; IRDN 1 ; SA 2; VHT 2
<i>Anastrepha ludens</i>	HWIT 1; IRDN 1 ; SA 2
<i>Anastrepha obliqua</i>	HWIT 1, 3; IRDN 1 ; SA 2; VHT 2
<i>Anastrepha serpentina</i>	HWIT 1, 3; IRDN 1 ; SA 2
<i>Anastrepha striata</i>	HWIT 1, 3; IRDN 1 ; SA 2; VHT 2
<i>Bactrocera aquilonis</i>	IRDN 6 ; SA 2; VHT 6
<i>Bactrocera carambolae</i>	HWIT 5; IRDN 6 ; SA 2; VHT 5, 9, 11
<i>Bactrocera caryeae</i>	HWIT 5; IRDN 6 ; SA 2
<i>Bactrocera correcta</i>	HWIT 5; IRDN 3, 6 ; SA 2; VHT 4, 9, 11

Pest species	Options for phytosanitary measures
<i>Bactrocera curvipennis</i>	IRDN 6 ; SA 2; VHT 9
<i>Bactrocera dorsalis</i>	HWIT 2, 4, 5, 6, 7; IRDN 5 ; MB 1; SA 2; VHT 1, 5, 9, 11
<i>Bactrocera facialis</i>	IRDN 6 ; SA 2; VHT 10
<i>Bactrocera frauenfeldi</i>	IRDN 6 ; SA 2; VHT 6
<i>Bactrocera jarvisi</i>	IRDN 4 ; SA 2; VHT 6
<i>Bactrocera kirki</i>	IRDN 6 ; SA 2; VHT 10
<i>Bactrocera melanotus</i>	IRDN 6 ; SA 2; VHT 10
<i>Bactrocera neohumeralis</i>	IRDN 6 ; SA 2; VHT 5, 6
<i>Bactrocera occipitalis</i>	IRDN 6 ; SA 2; VHT 1
<i>Bactrocera passiflorae</i>	IRDN 6 ; SA 2; VHT 10
<i>Bactrocera psidii</i>	IRDN 5 ; SA 2; VHT 10
<i>Bactrocera tryoni</i>	IRDN 4 ; SA 2; VHT 6, 7, 10
<i>Bactrocera tuberculata</i>	IRDN 6 ; SA 2; VHT 5, 9, 11
<i>Bactrocera umbrosa</i>	IRDN 6 ; SA 2; VHT 8
<i>Bactrocera xanthodes</i>	IRDN 6 ; SA 2; VHT 10
<i>Bactrocera zonata</i>	HWIT 5; IRDN 6 ; SA 2; VHT 5, 9, 11
<i>Ceratitis capitata</i>	HWIT 1, 3, 4, 7; IRDN 4 ; MB 1; SA 2; VHT 2, 3, 4, 6
<i>Ceratitis cosyra</i>	HWIT 4, 7; IRDN 6 ; MB 1; SA 2; VHT 3
<i>Ceratitis rosa</i>	HWIT 4, 7; IRDN 6 ; MB 1; SA 2; VHT 3
<i>Zeugodacus cucurbitae</i>	IRDN 6 ; SA 2; VHT 2, 5, 9, 11
<i>Zeugodacus tau</i>	IRDN 2 ; SA 2; VHT 5, 9, 11
Mealybugs	
<i>Dysmicoccus neobrevipes</i>	IRDN 12 ; export inspection*
<i>Ferrisia malvastra</i>	IRDN 14; export inspection*
<i>Formicococcus robustus</i>	IRDN 14; SA 1; export inspection*
<i>Maconellicoccus hirsutus</i>	SA 1; export inspection*
<i>Nipaecoccus nipae</i>	Export inspection*
<i>Paracoccus marginatus</i>	IRDN 11
<i>Planococcus lilacinus</i>	IRDN 7; SA 1; export inspection*
<i>Planococcus minor</i>	IRDN 12 ; SA 1; export inspection*
<i>Pseudococcus baliteus</i>	IRDN 10
<i>Pseudococcus cryptus</i>	IRDN 14; SA 1; export inspection*
<i>Pseudococcus jackbeardsleyi</i>	IRDN 9 ; SA 1; export inspection*
<i>Pseudococcus solenedyos</i>	IRDN 14; SA 1; export inspection*
<i>Rastrococcus iceryoides</i>	IRDN 14; SA 1; export inspection*
<i>Rastrococcus invadens</i>	IRDN 14; SA 1; export inspection*
<i>Rastrococcus rubellus</i>	IRDN 14; SA 1; export inspection*
<i>Rastrococcus spinosus</i>	IRDN 14; SA 1; export inspection*
Scales	
<i>Milviscutulus mangiferae</i>	Field and export inspection [†]

Pest species	Options for phytosanitary measures
Whiteflies	
<i>Aleurodicus dispersus</i>	Export inspection*
Other hemipterans	
<i>Acanthocoris scabrator</i>	Export inspection*
<i>Amblypelta nitida</i>	Export inspection*
<i>Bathycoelia thalassina</i>	Export inspection*
Moths	
<i>Deanolis sublimbalis</i>	IRDN 14; export inspection*
Thrips	
<i>Retithrips syriacus</i>	Export inspection*
<i>Rhipiphorothrips cruentatus</i>	Export inspection*
<i>Scirtothrips aurantii</i>	Export inspection*
<i>Thrips palmi</i>	Export inspection*
Fungi	
<i>Cytosphaera mangiferae</i>	SA 1
Bacteria	
<i>Xanthomonas citri</i> pv. <i>mangiferaeindicae</i>	SA 1

Notes: Options in bold are **PTs** (phytosanitary treatments adopted as annexes to ISPM 28 (*Phytosanitary treatments for regulated pests*)): **PTs** are adopted by the Commission on Phytosanitary Measures (CPM); other treatments included in the table meet the criteria in ISPM 46 (*Commodity-specific standards for phytosanitary measures*) but are not adopted by the CPM.

* Export inspection targeting the pest of concern and the application of a remedial action if the pest is detected.

† Field and export inspection targeting the pest of concern and the application of a corrective or remedial action if the pest is detected.

HWIT, hot water immersion treatment (see Table 4); IRDN, irradiation (see Table 5); MB, methyl bromide fumigation (see Table 6); SA, systems approach (see Table 7); VHT, vapour heat treatment (see Table 8).

Table 4. Options for hot water immersion treatment (HWIT)

Measure number	Weight of a single fruit (g)	Water temperature (°C)	Immersion time of fruit (minutes)	References*
HWIT 1	0–375	46.1	65	APHIS-PPQ (2023)
	376–500	46.1	75	
	501–700	46.1	90	
	701–900	46.1	110	
HWIT 2	400–500	46.1	68	Ndlela <i>et al.</i> (2017)
HWIT 3	0–425	46.1	75	MERCOSUR (2006) MPI (n.d.)
	426–650	46.1	90	
HWIT 4	0–500	46.1	75	Armstrong and Mangan (2007) DAFF (n.d.)
	501–700	46.1	90	
	701–900	46.1	110	
HWIT 5	0–500	48.0	60	APQA (2012, 2016) DAFF (n.d.)
	501–700	48.0	75	
	701–900	48.0	90	

Measure number	Weight of a single fruit (g)	Fruit pulp temperature (°C)	Time (minutes) [†]	References*
HWIT 6	All	46.0	10	Srikachar and Damrak (2024)
HWIT 7	All	50.0	11	European Union (2019) Zakariya and Alhassan (2014)

Notes: National plant protection organizations should also refer to ISPM 42 (*Requirements for the use of temperature treatments as phytosanitary measures*).

* For each option, references are listed in alphabetical order. Specific supporting information is not publicly available for all options listed. Where this information is not publicly available, related references are provided.

[†] Length of time that fruit pulp temperature should be maintained regardless of fruit size and immersion time of fruit.

Sources: See References section.

Table 5. Options for irradiation (IRDN)

Measure number	Minimum absorbed dose (Gy)	References
IRDN 1	70	PT 39 (Irradiation treatment for the genus <i>Anastrepha</i>)
IRDN 2	72 or 85	PT 42 (Irradiation treatment for <i>Zeugodacus tau</i>)
IRDN 3	93	GACC (2023)
IRDN 4	100	PT 4 (Irradiation treatment for <i>Bactrocera jarvis</i>) PT 5 (Irradiation treatment for <i>Bactrocera tryoni</i>) PT 14 (Irradiation treatment for <i>Ceratitidis capitata</i>)
IRDN 5	116	PT 33 (Irradiation treatment for <i>Bactrocera dorsalis</i>)
IRDN 6	150	PT 7 (Irradiation treatment for fruit flies of the family Tephritidae (generic))
IRDN 7	163	Draft PT Irradiation treatment for <i>Planococcus lilacinus</i> (2023-035)
IRDN 8	165	PT 43 (Irradiation treatment for <i>Sternochetus frigidus</i>)
IRDN 9	166	PT 45 (Irradiation treatment for <i>Pseudococcus jackbeardsleyi</i>)
IRDN 10	183	Draft PT Irradiation treatment for <i>Pseudococcus baliteus</i> (2023-033) Zhao <i>et al.</i> (2023)
IRDN 11	185	Song <i>et al.</i> (2023)
IRDN 12	231	PT 19 (Irradiation treatment for <i>Dysmicoccus neobrevipes</i>, <i>Planococcus lilacinus</i> and <i>Planococcus minor</i>)
IRDN 13	300	APHIS-PPQ (2023)
IRDN 14*	400	APPPC (2021)

Notes: Options in bold are **PTs** (phytosanitary treatments adopted as annexes to ISPM 28 (*Phytosanitary treatments for regulated pests*)); **PTs** are adopted by the Commission on Phytosanitary Measures (CPM); other treatments included in the table meet the criteria in ISPM 46 (*Commodity-specific standards for phytosanitary measures*) but are not adopted by the CPM.

National plant protection organizations should also refer to ISPM 18 (*Requirements for the use of irradiation as a phytosanitary measure*).

* IRDN 14 treatment excludes pupae and adults of the order Lepidoptera.

Sources: See References section.

Table 6. Options for methyl bromide fumigation (MB) (applied under normal atmospheric pressure)

Measure number	Minimum temperature (°C)	Minimum dose (g/m ³)	Minimum time (hours)	Reference
MB 1	21	32	2	DAC (2003)

Note: National plant protection organizations should also refer to ISPM 43 (*Requirements for the use of fumigation as a phytosanitary measure*) and the CPM recommendation on *Replacement or reduction of the use of methyl bromide as a phytosanitary measure (R-03)*.

Source: See References section.

Table 7. Options for systems approaches

Systems approach number	Independent measures	Reference
SA 1	<p><i>Pre-harvest control measures</i> (e.g. pest-specific field management using pest control, disposal of fallen and infested fruit)</p> <p><i>Harvest control measures</i> (e.g. removal of infested fruit)</p> <p><i>Post-harvest control measures</i> (e.g. washing and brushing, treatment, targeted inspection and remedial action to remove external pests)</p>	APQA (2016)
SA 2	<p><i>Pre-planting control measures</i> (e.g. area of low pest prevalence)</p> <p><i>Growing period control measures</i> (e.g. chemical controls, sterile insect technique, mass trapping)</p> <p><i>Harvest control measures</i> (e.g. harvest at mature green stage)</p> <p><i>Post-harvest and handling control measures</i> (e.g. activities to prevent infestation, treatments)</p> <p><i>Transportation and distribution control measures</i> (e.g. activities to prevent infestation)</p> <p><i>Control measures applied at several or all stages</i> (e.g. community awareness programme, control on movement of host fruit into the area)</p>	ISPM 35 (<i>Systems approach for pest risk management of fruit flies (Tephritidae)</i>)

Note: National plant protection organizations should also refer to ISPM 14 (*The use of integrated measures in a systems approach for pest risk management*).

Sources: See References section.

Table 8. Options for vapour heat treatment (VHT)

Measure number	Minimum pulp temperature (°C)	Minimum relative humidity (%)	Minimum exposure time (minutes)	References*
VHT 1	46.0	95	10	APHIS-PPQ (2023)
VHT 2	46.0	90	20	ICA (2021)
VHT 3	46.2	95	30	KEPHIS (2022)
VHT 4	46.5	95	10	PT 30 (Vapour heat treatment for <i>Ceratitis capitata</i> on <i>Mangifera indica</i>)

VHT 5	46.5	95	30	APPPC (2021)
VHT 6	47.0	90	15	DAFF (n.d.)
VHT 7	47.0	95	15	PT 31 (Vapour heat treatment for <i>Bactrocera tryoni</i> on <i>Mangifera indica</i>)
VHT 8	47.0	90	20	APQA (2019)
VHT 9	47.0	95	20	APPPC (2021) APQA (2019)
VHT 10	47.2	60	20	APPPC (2021) MPI (n.d.) Waddell <i>et al.</i> (1993)
VHT 11	47.5	95	20	APPPC (2021)

Notes: Options in bold are **PTs** (phytosanitary treatments adopted as annexes to ISPM 28 (*Phytosanitary treatments for regulated pests*)): **PTs** are adopted by the Commission on Phytosanitary Measures (CPM); other treatments included in the table meet the criteria in ISPM 46 (*Commodity-specific standards for phytosanitary measures*) but are not adopted by the CPM.

National plant protection organizations should also refer to ISPM 42 (*Requirements for the use of temperature treatments as phytosanitary measures*).

For VHT 1–8 and VHT 10, fruit is treated in a vapour heat chamber, whereas for VHT 9, fruit is treated in a high temperature forced air chamber.

* For each option, references are listed in alphabetical order. Specific supporting information is not publicly available for all options listed. Where this information is not publicly available, related references are provided.

Sources: See References section.

5. References

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

5.1 Main text

CPM R-03. 2017. *Replacement or reduction of the use of methyl bromide as a phytosanitary measure.* CPM Recommendation. IPPC Secretariat. Rome, FAO. Adopted 2008. <https://www.ippc.int/en/publications/84230>

5.2 Tables

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