

ISPM 33



**INTERNATIONAL STANDARDS FOR  
PHYTOSANITARY MEASURES**

**ISPM 33**

**PEST FREE POTATO (*SOLANUM* SPP.)  
MICROPROPAGATIVE MATERIAL AND MINITUBERS  
FOR INTERNATIONAL TRADE**

**(2010)**

Produced by the Secretariat of the International Plant Protection Convention



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## Adoption

This Standard was adopted by the Fifth Session of the Commission on Phytosanitary Measures in March 2010.

## INTRODUCTION

### Scope

This standard provides guidance on the production, maintenance and phytosanitary certification of pest free potato (*Solanum tuberosum* and related tuber-forming species) micropropagative material and minitubers intended for international trade.

This standard does not apply to field-grown propagative material of potato or to potatoes intended for consumption or processing.

### References

**ISPM 2.** 2007. *Framework for pest risk analysis*. Rome, IPPC, FAO.

**ISPM 5.** *Glossary of phytosanitary terms*. Rome, IPPC, FAO.

**ISPM 10.** 1999. *Requirements for the establishment of pest free places of production and pest free production sites*. Rome, IPPC, FAO.

**ISPM 11.** 2004. *Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms*. Rome, IPPC, FAO.

**ISPM 12.** 2001. *Guidelines for phytosanitary certificates*. Rome, IPPC, FAO.

**ISPM 14.** 2002. *The use of integrated measures in a systems approach for pest risk management*. Rome, IPPC, FAO.

**ISPM 16.** 2002. *Regulated non-quarantine pests: concept and application*. Rome, IPPC, FAO.

**ISPM 19.** 2003. *Guidelines on lists of regulated pests*. Rome, IPPC, FAO.

**ISPM 21.** 2004. *Pest risk analysis for regulated non-quarantine pests*. Rome, IPPC, FAO.

### Definitions

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

In addition to definitions in ISPM 5, in this standard the following definitions apply:

potato micropropagative material      **Plants *in vitro*** of tuber-forming *Solanum* spp.

minituber      A tuber produced from potato micropropagative material in pest-free growing medium in a facility under specified protected conditions

seed potatoes      Tubers (including minitubers) and potato micropropagative material of cultivated tuber-forming *Solanum* spp. for planting

### Outline of Requirements

Facilities used for the production of potato micropropagative material and minitubers for export should be authorized or operated directly by the national plant protection organization (NPPO) of the exporting country. Pest risk analysis (PRA), carried out by the NPPO of the importing country, should

provide the justification for establishing phytosanitary import requirements for regulated pests in trade of potato micropropagative material and minitubers.

The phytosanitary measures for managing risks related to potato micropropagative material include testing for the pests regulated by the importing country, and management systems for the maintenance and propagation of potato micropropagative material derived from candidate plants that have been determined to be pest free in closed, aseptic conditions. For the production of minitubers, measures include derivation from pest free potato micropropagative material and production in a pest free production site.

To establish pest free potato micropropagative material, candidate plants should be tested in a testing laboratory authorized or operated directly by the NPPO. This laboratory should meet general requirements for ensuring that all material moved into a maintenance and propagation facility is free from pests regulated by the importing country.

Facilities for the establishment of pest free potato micropropagative material and testing for pest freedom are subject to strict requirements to prevent contamination or infestation of material. Facilities for maintenance and propagation of pest free potato micropropagative material and minituber production are also subject to stringent requirements to maintain pest freedom. Staff should be trained and competent in techniques for the establishment and maintenance of pest free potato micropropagative material, the production of pest free minitubers, diagnostic testing as required, and in following administrative, management and record-keeping procedures. The management system and procedures of each facility and the testing laboratory should be defined in a manual(s). Throughout all production and testing processes, the identity of all propagative material should be preserved, and traceability should be maintained through adequate documentation.

All facilities should be officially audited to ensure that they continue to meet requirements. In addition, inspections should ensure that the potato micropropagative material and minitubers meet the importing country's phytosanitary import requirements. Pest free potato micropropagative material and minitubers moving in international trade should be accompanied by a phytosanitary certificate.

## BACKGROUND

Many pests are associated with the production of potato (*Solanum tuberosum* and related tuber-forming species) worldwide. As potatoes are propagated mainly by vegetative means, there is considerable risk of introducing and spreading pests through international trade of seed potatoes. Potato micropropagative material derived from appropriately tested material and using suitable phytosanitary measures should be considered free from regulated pests. Use of such material as starting material for further potato production reduces the risks of introduction and spread of regulated pests. Potato micropropagative material can be multiplied under specified protected conditions to produce minitubers. Provided that minituber production is carried out under pest free conditions using pest free micropropagative material, minitubers can also be traded with minimum risk.

Conventional micropropagation does not necessarily result in material that is free from pests. The presence or absence of pests is verified by appropriate testing of the material.

As per ISPM 16:2002, programmes for the certification of plants for planting for seed potatoes (sometimes known as “seed potato certification schemes”) frequently include specific requirements for pests as well as non-phytosanitary requirements such as varietal purity, size of the product etc. Many seed potato certification schemes require potato micropropagative material to be derived from plants that have been tested and found free from the pests covered by the scheme. Such schemes are usually designed to control pests present in the production country that are of national economic importance. Therefore, the pests covered by a specific scheme or the strength of measures may not always meet all of the phytosanitary import requirements of importing countries. In such cases, additional phytosanitary measures may be required.

In this standard, pest free potato micropropagative material is potato micropropagative material that has been tested and found free from the pests regulated by the importing country, or derived from such tested material, and maintained under conditions to prevent contamination and infestation.

## REQUIREMENTS

### 1. Responsibilities

The NPPO of the importing country is responsible for pest risk analysis and should, on request, have access to documentation and facilities to enable it to verify that the phytosanitary procedures in the facility meet its phytosanitary import requirements.

Only facilities authorized or operated directly by a NPPO should be used for the production and maintenance of potato micropropagative material and minitubers for export as described in this standard. The NPPO of the exporting country is responsible for ensuring that the phytosanitary aspects of these facilities and of the related seed potato propagation system meet the importing country’s phytosanitary import requirements. The NPPO of the exporting country is also responsible for phytosanitary certification.

### 2. Pest Risk Analysis

PRA provides technical justification for identifying regulated pests and for establishing phytosanitary import requirements for potato micropropagative material and minitubers. PRA should be carried out by the NPPO of the importing country in accordance with ISPM 2:2007 and ISPM 11:2004 for the pathways of “potato micropropagative material” and “minitubers” from given origins. The PRA may identify quarantine pests associated with these pathways. The PRA should also be carried out in accordance with ISPM 21:2004 as appropriate in order to identify regulated non-quarantine pests.

Importing countries should notify NPPOs of exporting countries of the outcome of the PRAs.

## **2.1 Pathway-specific lists of regulated potato pests**

For the purposes of this standard, the NPPO of the importing country is encouraged to establish pathway-specific regulated pest lists for potato micropropagative material and minitubers respectively and, on request, should provide these lists to NPPOs of exporting countries. Guidance on regulated pest lists is provided in ISPM 19:2003.

## **2.2 Pest risk management options**

The pest risk management measures are determined based on the PRA. It may be appropriate for the measures to be integrated into a systems approach for production of potato material (as described in ISPM 14:2002). A flow chart showing the normal sequence of establishment, maintenance and production of pest free potato micropropagative material and minitubers is provided in Appendix 3.

### **2.2.1 Potato micropropagative material**

Phytosanitary measures for managing pest risks related to potato micropropagative material include:

- testing individual plants (candidate plants) for the pests regulated by the importing country and establishing potato micropropagative material in establishment facilities. Pest freedom is verified once all relevant testing is successfully completed (the status of the micropropagative material derived from the tested candidate plant changes to pest free potato micropropagative material)
- maintaining pest freedom using management systems for the maintenance and propagation of the pest free potato micropropagative material in a closed, aseptic environment in maintenance and propagation facilities.

### **2.2.2 Minitubers**

Phytosanitary measures for managing pest risks related specifically to minituber production should be based on pest risk assessment information related to the area of production and include:

- derivation of the minitubers from pest free potato micropropagative material
- production in pest free growing media under specified protected conditions in a pest free production site free from the pests (and their vectors) regulated for minitubers by the importing country.

## **3. Production of Pest Free Potato Micropropagative Material**

### **3.1 Establishment of pest free potato micropropagative material**

A candidate plant, from which the pest free potato micropropagative material is derived, should be inspected, tested and found free from regulated pests. It may also be required to be grown through a complete vegetative cycle, inspected, tested and found free from regulated pests. In addition to the laboratory testing procedure for regulated pests described below, potato micropropagative material should be inspected and found free from other pests or their symptoms and general microbial contamination.

Where a candidate plant is determined to be infested it will normally be disposed of. However, for certain types of regulated pests, the NPPO may allow that recognized techniques (e.g. meristem tip culture, thermotherapy) be used in combination with conventional micropropagation to eliminate the pest from the candidate plant, and prior to the initiation of the *in vitro* multiplication programme. In such cases, laboratory testing must be used to confirm the success of this approach before multiplication commences.

### 3.1.1 Testing programme to verify pest freedom

A testing programme on the candidate plant should be applied in an official testing laboratory. This laboratory should meet general requirements (described in Annex 1) to ensure that all potato micropropagative material moved to maintenance and propagation facilities is free from the pests regulated by the importing country. Conventional micropropagation does not consistently exclude some pests, for example, viruses, viroids, phytoplasmas and bacteria. A list of pests that may be of concern to potato micropropagative material is provided in Appendix 1.

### 3.1.2 Establishment facilities

A facility used to establish pest free potato micropropagative material from new candidate plants should be authorized or directly operated by the NPPO specifically for this purpose. The facility should provide a secure means for establishing individual pest free potato micropropagative material from candidate plants and for holding these plants separately from tested material while awaiting required test results. Because both infested and pest free potato propagative material (tubers, plants *in vitro* etc.) may be handled in the same facility, strict procedures should be implemented to prevent contamination or infestation of pest free material. Such procedures should include:

- prohibition of entry of unauthorized personnel and control of the entry of authorized staff
- provision for the use of dedicated protective clothing (including dedicated footwear or disinfection of footwear) and hand washing on entry (with particular care being taken if staff members work in areas of higher phytosanitary risk, e.g. the testing facility)
- chronological records of actions in handling material so that production can, if necessary, be checked easily for contamination and infestation if pests are detected
- stringent aseptic techniques, including disinfection of work areas and sterilization of instruments (e.g. by autoclaving) between handling materials of a different phytosanitary status.

## 3.2 Maintenance and propagation facilities for pest free potato micropropagative material

A facility that maintains and propagates pest free potato micropropagative material should be operated separately from the facilities that establish potato plants *in vitro* and conduct the testing for regulated pests (although exceptional circumstances are described in section 3.3). The facility should be operated as a pest free production site (as described in ISPM 10:1999) with respect to the pests of potato regulated by the importing country for potato micropropagative material. The facility should:

- maintain and propagate only officially certified pest free potato micropropagative material and permit only pest free material to enter the facility
- grow other plant species only if this is officially permitted and if:
  - . the pest risks to potato propagative material have been assessed and, if identified, the plants have been tested and found to be free from regulated pests before entering the facility
  - . adequate precautions are taken to separate them in space or time from the potato plants
- implement officially approved operational procedures to prevent entry of regulated pests
- control the entry of staff and provide for the use of protective clothing, disinfection of footwear and hand washing on entry (with particular care being taken if staff members work in areas of higher phytosanitary risk, e.g. the testing facility)
- use aseptic procedures
- implement regular management system checks by the manager or a designated responsible staff member and keep records
- prohibit the entry of unauthorized personnel.

### **3.3 Combined establishment and maintenance facilities**

Exceptionally, establishment facilities may also maintain pest free potato micropropagative material provided that strict procedures are adopted and applied to prevent infestation of maintained material from other material of a lower phytosanitary status.

These strict procedures include:

- the procedures in sections 3.1 and 3.2 to prevent infestation of the pest free potato micropropagative material and to keep material of different phytosanitary status separate
- the use of separate laminar flow cabinets and instruments for the maintained material and for material of a lower phytosanitary status or implementation of stringent procedures to keep the processes of establishment and maintenance separate
- scheduled audit tests on the material maintained.

### **3.4 Additional specifications for potato micropropagation facilities**

Additional specifications for potato micropropagation facilities are provided in Annex 2 and may be required depending on the pests present in the area and the results of PRA.

Pest free potato micropropagative material established and maintained in these facilities may be propagated further to produce minitubers or may be traded internationally as such.

## **4. Production of Pest Free Minitubers**

The following guidance for minituber production also applies to parts of minitubers that are traded internationally, such as sprouts.

### **4.1 Eligible material**

The only potato material allowed to enter the minituber production facility should be pest free potato micropropagative material. Plants of other plant species may be permitted to be grown in the facility provided that:

- the phytosanitary risks to minitubers have been assessed and, if identified, the other plant species have been tested and found to be pest free before entering the facility
- adequate precautions are taken to separate them in space and/or time from the potato plants to prevent contamination.

### **4.2 Minituber facilities**

A minituber production facility should be operated as a pest free production site (as described in ISPM 10:1999) with respect to pests regulated by the importing country for minitubers. Pests that may be of concern include those for potato micropropagative material i.e. viruses, viroids, phytoplasmas and bacteria (listed in Appendix 1) and also fungi, nematodes, arthropods etc. (listed in Appendix 2).

Production should be under protected conditions, for example a growth room, glasshouse, polythene tunnel or (if appropriate, based on local pest status) a screen house with suitable mesh size, constructed and maintained to prevent the entry of pests. If the facility includes adequate physical and operational safeguards against the introduction of the regulated pests, no additional requirements should be necessary. However, in cases where these safeguards can not be met, additional requirements should be considered. Depending on conditions in the area of production, these may include:

- location of the facility in a pest free area, or an area or site that is well isolated from sources of the regulated pests
- a buffer zone around the facility for regulated pests

- location of the facility in an area with low pest and pest vector incidence
- production at a time of year when there is low pest and pest vector incidence.

The entry of authorized personnel to the facility should be controlled and provision should be made for use of protective clothing, disinfection of footwear and hand washing on entry to prevent contamination from dirty to clean areas. It should also be possible to decontaminate the facility if required. The growing medium, water supply and fertilizer or plant additives used in the facility should be pest free.

The facility should be monitored for the regulated pests and pest vectors during the production cycle and, if necessary, pest control measures or other corrective actions should be undertaken and documented. The facility should be well maintained and cleaned after each production cycle.

The minitubers should be handled, stored, packed and transported under conditions preventing infestation and contamination by the regulated pests.

Additional requirements for minituber production facilities are provided in Annex 3 and may be required depending on the pests present in the area and the results of PRA.

## **5. Staff Competence**

Staff should be trained and competent in:

- techniques for the establishment of pest free potato micropropagative material, the maintenance of pest free potato micropropagative material, the production of pest free minitubers, and diagnostic testing as relevant
- following administrative, management and record-keeping procedures.

Procedures for maintaining staff competence should be in place and training should be updated, in particular, when phytosanitary import requirements change.

## **6. Documentation and Record-Keeping**

The management system, and operating procedures and instructions of each facility and the testing laboratory, should be documented in a manual(s). In developing such manual(s), the following should be addressed:

- the establishment, maintenance and propagation of pest free potato micropropagative material with particular attention paid to those control measures used to prevent infestation and contamination between the pest free potato micropropagative material and any material of another phytosanitary status
- the production of pest free minitubers, covering management, technical and operational procedures, with particular attention paid to those control measures used to prevent pest infection, infestation and contamination of the minitubers during their production, harvest and storage, and during transport to their destination
- all laboratory test procedures or processes to verify pest freedom.

Throughout all production and testing, the identity of all propagative material should be preserved and traceability should be maintained by adequate record-keeping. Records of all tests done on the material, as well as the results, lineage and records of the distribution of the material, should be kept in a manner that ensures traceability for the importing or exporting countries for at least five years. For pest free potato micropropagative material, the records that determine its pest free status should be maintained for as long as the micropropagative material is maintained.

Records of staff training and competencies should be maintained as determined by the NPPO and, if appropriate, in consultation with the NPPO of the importing country.

## **7. Auditing**

All facilities, systems and records should be officially audited to ensure compliance with the procedures and to meet the importing country's phytosanitary import requirements.

The NPPO of the importing country may ask to participate in such an audit, based on bilateral agreement.

## **8. Phytosanitary Certification**

The potato micropropagation facility, relevant records and the plants should be subjected to appropriate phytosanitary procedures to ensure that the micropropagative material meets the importing country's phytosanitary import requirements.

The potato minituber production facility, relevant records, the growing crop, and the minitubers should be subjected to appropriate phytosanitary procedures to ensure that the minitubers meet the importing country's phytosanitary import requirements.

Pest free potato micropropagative material and minitubers moving in international trade should be accompanied by a phytosanitary certificate issued by the NPPO of the exporting country according to ISPM 12:2001 and complying with the phytosanitary import requirements of the importing country. The use of seed potato certification labels may assist with lot identification, in particular when these labels specify the reference number of the lot, including where appropriate the producer's identification number.

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This annex is a prescriptive part of the standard.

## **ANNEX 1: General requirements for official testing laboratories for potato micropropagative material and minitubers**

The requirements for laboratories testing potato micropropagative material and minitubers operated or authorized by NPPOs include the following:

- competent staff with adequate knowledge and experience of conducting appropriate test methods and interpreting the results
- adequate and appropriate equipment to conduct microbiological, serological, molecular and bioassay tests, as appropriate
- relevant validation data for the tests conducted or at least sufficient evidence for the suitability of the test applied
- procedures to prevent contamination of samples
- adequate isolation from production facilities
- a manual(s) that describes policy, organizational structure, work instructions, and testing standards and any quality management procedures
- appropriate record-keeping and traceability for test results.

This annex is a prescriptive part of the standard.

## **ANNEX 2: Additional requirements for potato micropropagation facilities**

In addition to the requirements in section 3, the following requirements for physical structure, equipment and operating procedures should be considered for micropropagation facilities, depending on the presence of pests in the area and the results of PRA.

### **Physical structure**

- a double door entry with an air-curtain and with a changing area between the double doors
- appropriate rooms for washing, media preparation, subculturing and growth of plants

### **Equipment**

- high-efficiency particulate air (HEPA)-filtered positive air pressure systems or their equivalent for media, subculture and growth rooms
- growth rooms with appropriate light, temperature and humidity control
- adequate equipment or procedures in the subculture room to control pest contamination (e.g. ultraviolet (UV) germicidal lamps)
- laminar flow cabinets for subculturing, which are serviced regularly
- laminar flow cabinets fitted with UV germicidal lamps

### **Operating procedures**

- a programme for periodic disinfection/fumigation of the facility
- use by staff of disposable/dedicated footwear or disinfection of footwear
- appropriate hygienic practices for handling plant material (e.g. cutting in vitro plantlets with a sterile scalpel over a sterile disposable surface)
- a monitoring programme to check the level of air-borne contaminants in the subculture room, cabinets and growth room
- an inspection and disposal procedure for infested potato micropropagative material.

This annex is a prescriptive part of the standard.

### **ANNEX 3: Additional requirements for minituber production facilities**

The following additional requirements for minituber production facilities should be considered, and when necessary included, depending on the presence of pests and vectors in the area and the results of PRA:

#### **Physical structure**

- double door entry with a change area for changing garments and donning protective overcoats and gloves, the change area to contain foot disinfecting pads and a washing facility for washing and disinfecting hands
- entry doors and all vents and openings covered with insect-proof screens with mesh that will prevent entry of the local pests and pest vectors
- gaps between the external to internal environment to be sealed
- production isolated from soil (e.g. concrete floors or floors covered with a protective membrane)
- designated areas for washing and disinfecting containers, and cleaning, grading, packing and storing minitubers
- air filtration and/or sterilization system
- in places where there is unreliable supply of electricity and water, standby facilities for emergencies

#### **Management of environment**

- suitable temperature, light, air circulation and humidity controls
- misting for acclimatization of transplants

#### **Crop management**

- regular pest and pest vector monitoring (e.g. using sticky insect traps) at specified intervals
- hygienic practices for handling plant material
- correct disposal procedures
- identification of production lots
- a suitable separation between lots
- use of raised benches

#### **Growing media, fertilizer, water**

- use of pest free soil-less growing medium
- fumigation/disinfestations/steam sterilization of the growing medium before planting or other methods that guarantee freedom from potato pests
- transport and storage of growing medium under conditions preventing contamination
- a water supply free of plant pests (either treated water or deep-well spring water), together with regular testing for potato pests if required
- use of inorganic fertilizer or organic fertilizer that has been treated to eliminate pests

#### **Post-harvest handling**

- sampling of minitubers for post-harvest tuber testing for indicator pests (i.e. pests whose presence indicates that the pest free status of the minituber production facility has not been maintained)
- suitable storage conditions
- grading and packing (if appropriate, according to a seed potato certification scheme)
- new or adequately sterilized containers used for packing minitubers

- containers for shipment adequate for preventing contamination by pests and pest vectors
- adequate cleaning and disinfection of handling equipment and storage facilities.

This appendix is for reference purposes only and is not a prescriptive part of the standard.

## APPENDIX 1: Examples of pests that may be of concern with respect to potato micropropagative material

Please note that the following list does not constitute a technical justification for regulating these pests.

VIRUSES	ABBREVIATION	GENUS
<i>Alfalfa mosaic virus</i>	AMV	<i>Alfamovirus</i>
<i>Andean potato latent virus</i>	APLV	<i>Tymovirus</i>
<i>Andean potato mottle virus</i>	APMoV	<i>Comovirus</i>
<i>Arracacha virus B-oca strain</i>	AVB-O	<i>Cheravirus</i> (tentative)
<i>Beet curly top virus</i>	BCTV	<i>Curtovirus</i>
<i>Belladonna mottle virus</i>	BeMV	<i>Tymovirus</i>
<i>Cucumber mosaic virus</i>	CMV	<i>Cucumovirus</i>
<i>Eggplant mottled dwarf virus</i>	EMDV	<i>Nucleorhabdovirus</i>
<i>Impatiens necrotic spot virus</i>	INSV	<i>Tospovirus</i>
<i>Potato aucuba mosaic virus</i>	PAMV	<i>Potexvirus</i>
<i>Potato black ringspot virus</i>	PBRV	<i>Nepovirus</i>
<i>Potato latent virus</i>	PotLV	<i>Carlavirus</i>
<i>Potato leafroll virus</i>	PLRV	<i>Polerovirus</i>
<i>Potato mop-top virus</i>	PMTV	<i>Pomovirus</i>
<i>Potato rough dwarf virus</i>	PRDV	<i>Carlavirus</i> (tentative)
<i>Potato virus A</i>	PVA	<i>Potyvirus</i>
<i>Potato virus M</i>	PVM	<i>Carlavirus</i>
<i>Potato virus P</i>	PVP	<i>Carlavirus</i> (tentative)
<i>Potato virus S</i>	PVS	<i>Carlavirus</i>
<i>Potato virus T</i>	PVT	<i>Trichovirus</i>
<i>Potato virus U</i>	PVU	<i>Nepovirus</i>
<i>Potato virus V</i>	PVV	<i>Potyvirus</i>
<i>Potato virus X</i>	PVX	<i>Potexvirus</i>
<i>Potato virus Y</i> (all strains)	PVY	<i>Potyvirus</i>
<i>Potato yellow dwarf virus</i>	PYDV	<i>Nucleorhabdovirus</i>
<i>Potato yellow mosaic virus</i>	PYMV	<i>Begomovirus</i>
<i>Potato yellow vein virus</i>	PYVV	<i>Crinivirus</i> (tentative)
<i>Potato yellowing virus</i>	PYV	<i>Alfamovirus</i>
<i>Solanum apical leaf curling virus</i>	SALCV	<i>Begomovirus</i> (tentative)
<i>Sowbane mosaic virus</i>	SoMV	<i>Sobemovirus</i>
<i>Tobacco mosaic virus</i>	TMV	<i>Tobamovirus</i>
<i>Tobacco necrosis virus A or Tobacco necrosis virus D</i>	TNV-A or TNV-D	<i>Necrovirus</i>
<i>Tobacco rattle virus</i>	TRV	<i>Tobravirus</i>
<i>Tobacco streak virus</i>	TSV	<i>Ilarvirus</i>

<b>VIRUSES</b>	<b>ABBREVIATION</b>	<b>GENUS</b>
<i>Tomato black ring virus</i>	TBRV	<i>Nepovirus</i>
<i>Tomato chlorotic spot virus</i>	TCSV	<i>Tospovirus</i>
<i>Tomato leaf curl New Delhi virus</i>	ToLCNDV	<i>Begomovirus</i>
<i>Tomato mosaic virus</i>	ToMV	<i>Tobamovirus</i>
<i>Tomato mottle Taino virus</i>	ToMoTV	<i>Begomovirus</i>
<i>Tomato spotted wilt virus</i>	TSWV	<i>Tospovirus</i>
<i>Tomato yellow leaf curl virus</i>	TYLCV	<i>Begomovirus</i>
<i>Tomato yellow mosaic virus</i>	ToYMV	<i>Begomovirus</i> (tentative)
<i>Tomato yellow vein streak virus</i>	ToYVSV	<i>Geminivirus</i> (tentative)
<i>Wild potato mosaic virus</i>	WPMV	<i>Potyvirus</i>
<b>VIROIDS</b>		
<i>Mexican papita viroid</i>	MPVd	<i>Pospiviroid</i>
<i>Potato spindle tuber viroid</i>	PSTVd	<i>Pospiviroid</i>
<b>BACTERIA</b>		
<i>Clavibacter michiganensis</i> subsp. <i>sepedonicus</i>		
<i>Dickeya</i> spp.		
<i>Pectobacterium atrosepticum</i>		
<i>P. carotovorum</i> subsp. <i>carotovorum</i>		
<i>Ralstonia solanacearum</i>		
<b>PHYTOPLASMAS</b>		
e.g. purple top, stolbur		

This appendix is for reference purposes only and is not a prescriptive part of the standard.

## **APPENDIX 2: Examples of pests that may be of concern with respect to potato minituber production**

Please note that the following list of pests does not constitute a technical justification for regulating these pests.

In addition to pests listed in Appendix 1, many contracting parties require pests to be excluded from certified minituber potato production either as quarantine pests or as regulated non-quarantine pests according to the pest status in the country concerned. Some examples are:

### **Bacteria**

- *Streptomyces* spp.

### **Chromista**

- *Phytophthora erythroseptica* Pethybr. var. *erythroseptica*
- *P. infestans* (Mont.) de Bary

### **Fungi**

- *Angiosorus (Thecaphora) solani* Thirumalachar & M.J. O'Brien Mordue
- *Fusarium* spp.
- *Polyscytalum pustulans* (M.N. Owen & Wakef.) M.B. Ellis
- *Rhizoctonia solani* J.G. Kühn
- *Synchytrium endobioticum* (Schilb.) Percival
- *Verticillium dahliae* Kleb.
- *V. albo-atrum* Reinke & Berthold

### **Insects**

- *Epitrix tuberis* Gentner
- *Leptinotarsa decemlineata* (Say)
- *Phthorimaea operculella* (Zeller)
- *Premnotrypes* spp.
- *Tecia solanivora* (Povolny)

### **Nematodes**

- *Ditylenchus destructor* (Thorne)
- *D. dipsaci* (Kühn) Filipjev
- *Globodera pallida* (Stone) Behrens
- *G. rostochiensis* (Wollenweber) Skarbilovich
- *Meloidogyne* spp. Göldi
- *Nacobbus aberrans* (Thorne) Thorne & Allen

### **Protozoa**

- *Spongospora subterranea* (Wallr.) Lagerh.

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### APPENDIX 3: Flow chart showing the normal sequence of establishment, maintenance and production of pest free potato micropropagative material and minitubers

