Australian Government

Department of Agriculture, Fisheries and Forestry
Biosecurity

DRAFT

Review of policy: importation of potato (*Solanum tuberosum*) propagative material into Australia

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The pictures of potato plantlets on the front cover were sourced from www.carolina.com/product/potato+(solanum+tube).

Submissions
This draft report has been issued to give all interested parties an opportunity to comment and draw attention to any scientific, technical, or other gaps in the data, misinterpretations and errors. Any comments should be submitted to the Department of Agriculture, Fisheries and Forestry within the comment period stated in the related Biosecurity Advice on the website. The draft report will then be revised as necessary to take account of the comments received and a final report prepared.

Comments on the draft report should be submitted to:

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Acronyms and abbreviations

Term or abbreviation	Definition
ALOP	Appropriate level of protection
APPPC	Asia and Pacific Plant Protection Commission
APPD	Australian Plant Pest Database (Plant Health Australia)
CABI	CAB International
CMI	Commonwealth Mycological Institute
COSAVE	Comité de Sanidad Vegetal del Cono Sur
CPPC	Caribbean Plant Protection Commission
DAFF	Australian Government Department of Agriculture, Fisheries and Forestry
DBH	Dot-blot hybridization
ELISA	Enzyme-linked immunosorbent assay
EPPO	European and Mediterranean Plant Protection Organisation
FAO	Food and Agriculture Organization of the United Nations
IAPSC	Inter African Phytosanitary Council
IMF	Immunofluorescence
IPC	International Phytosanitary Certificate
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
IRA	Import Risk Analysis
ISPM	International Standard for Phytosanitary Measures
JUNAC	Comisión del Acuerdo de Cartagena
NAPPO	North American Plant Protection Organization
NPPO	National Plant Protection Organization
OEPP	Organisation Européenne et Méditerranéenne pour la Protection des Plantes
PCR	Polymerase chain reaction
PEQ	Post-entry quarantine
PRA	Pest risk analysis
RT-PCR	Reverse-transcription polymerase chain reaction
SPS	Sanitary and phytosanitary
TEM	Transmission electron microscopy
TPS	True potato seed
WTO	World Trade Organisation

Summary

Australia initiated this review as new pathogens have been identified on potatoes and several pathogens have extended their global range. Uncontrolled movement of infected propagative material has helped to spread these pathogens into new areas. Currently, potato propagative material is allowed entry into Australia as true potato seed and tissue culture only; requiring mandatory on arrival inspection and growth in a closed government post-entry quarantine (PEQ) facility, with pathogen screening.

Australia's existing import policy for potato propagative material (tissue culture and true potato seed) is based on on-shore risk management (phytosanitary measures implemented in the importing country). This review of existing policy evaluates the biosecurity risks associated with potato propagative material and the appropriateness of existing risk management measures. New risk management measures are proposed, including a new framework for accreditation of overseas sources as high-health sources (approved sources).

This review has identified pathogens of quarantine concern associated with potato propagative material (true potato seed, tissue culture and potato seed tubers). Currently, potato seed tubers are not allowed entry into Australia, as they are capable of introducing not only pathogens but also nematodes and tuber-borne insects. However, propagative material produced *in vitro* and in a protected environment (e.g. growth chamber, greenhouse) has a lower pest risk than field grown material. Microplantlets and microtubers/minitubers produced in a protected environment represent a lower pest risk as they are not exposed to field-borne pests; therefore, alternative risk management measures can be applied.

Plant Biosecurity considers that the risk management measures proposed in this draft review of policy will adequately mitigate the identified biosecurity risks. Specifically, the proposed risk management measures for the different propagative materials are:

All sources (unknown health status)

True potato seed

- Existing conditions, including mandatory on-arrival inspection, fungicidal treatment, growth in a closed government PEQ facility for a minimum period of six months for visual observation; and
- Active pathogen testing including polymerase chain reaction (PCR) test for Potato spindle tuber viroid (PSTVd) and seed-borne viruses.

Tissue culture (microplantlets)

- General high risk tissue culture conditions; growth in a closed government PEQ facility for a minimum period of six months for visual observation; and
- Active pathogen testing including bio-assay on indicator plants, generic nested primer PCR for phytoplasma, PCR for Potato spindle tuber viroid (PSTVd), generic PCR tests for Potyvirus, Carlavirus, Begomovirus, Crinivirus and Potexvirus and if required pathogen specific ELISA or PCR.

Microtubers or minitubers (produced in a protected environment)

- General nursery stock conditions; growth in a closed government PEQ facility for a minimum period of six months for visual observation; and
- Active pathogen testing including bio-assay on indicator plants, generic nested primer PCR for phytoplasma, PCR for Potato spindle tuber viroid (PSTVd), generic PCR tests for

Potyvirus, Carlavirus, Begomovirus, Crinivirus and Potexvirus and if required pathogen specific ELISA or PCR.

Approved sources framework

Prior to this review, Australia did not have an existing framework for approval of overseas sources to supply pathogen tested potato propagative material to Australia. However, DAFF Biosecurity has proposed a new framework to consider requests for approval of overseas sources, with the following requirements:

- Must meet the requirements of ISPM 33 'Pest free potato (*Solanum* spp) micropropagative material and minitubers for international trade' (FAO 2010), and specifically demonstrate:
  - capacity for national authority oversight;
  - capacity to produce pathogen tested propagative material;
  - capacity to meet containment and security requirements;
  - capacity to meet DAFF Biosecurity audit and inspection requirements;
  - presence of identity preservation systems; and
  - on-arrival verification of pathogen tested status of propagative material.

Approval of SASA, UK)

Based on technical discussions, production site visits to Scotland (June 2010) and assessment against the approval of overseas sources framework, Plant Biosecurity considers that the United Kingdom Potato Quarantine Unit (UKPQU) at Science and Advice for Scottish Agriculture (SASA) meets the criteria outlined in the framework for approval of sources of high health plant material. Therefore, Plant Biosecurity proposes that:

- the United Kingdom Potato Quarantine Unit (UKPQU) at Science and Advice for Scottish Agriculture (SASA) be approved as a high health source to supply pathogen tested potato propagative material and
- potato propagative material from UKPQU must be subjected to reduced period of growth in a closed government PEQ facility.

Potato propagative material produced in UKPQU will require:

- Phytosanitary certificate issued by FERA with additional declaration that 'potato propagative material in this consignment has been tested and found free of pests identified by Australia'
- On arrival mandatory verification inspection and growth in a closed government PEQ facility for a minimum of three months to verify the application of phytosanitary measures
  - random verification testing for a range of pathogens
- If pathogens of quarantine concern are detected during random verification tests the whole consignment will be subject to the same conditions as for potato propagative material from all sources.

Plant Biosecurity invites comments on the technical aspects of the proposed risk management measures for potato propagative material. In particular, comments are sought on their appropriateness and any other measures stakeholders consider would provide equivalent risk management outcomes.

1 Introduction

1.1 Australia's biosecurity policy framework

Australia's biosecurity policies aim to protect Australia against the risks that may arise from exotic pests[1] entering, establishing and spreading in Australia, thereby threatening Australia's unique flora and fauna, as well as those agricultural industries that are relatively free from serious pests.

The pest risk analysis (PRA) process is an important part of Australia's biosecurity policies. It enables the Australian Government to formally consider the risks that could be associated with proposals to import products into Australia. If the risks are found to exceed Australia's appropriate level of protection (ALOP), risk management measures are proposed to reduce the risk to an acceptable level. If it is not possible to reduce the risks to an acceptable level, then no trade will be allowed.

Successive Australian governments have maintained a conservative, but not a zero risk, approach to the management of biosecurity risks. This approach is expressed in terms of Australia's ALOP, which reflects community expectations through government policy and is currently described as providing a high level of protection aimed at reducing risk to a very low level, but not to zero.

Australia's PRAs are undertaken by Biosecurity Australia using teams of technical and scientific experts in relevant fields, and involves consultation with stakeholders at various stages during the process. Biosecurity Australia provides recommendations for animal and plant quarantine policy to Australia's Director of Animal and Plant Quarantine (the Secretary of the Australian Department of Agriculture, Fisheries and Forestry). The Director or delegate is responsible for determining whether or not an importation can be permitted under the *Quarantine Act 1908*, and if so, under what conditions. The Australian Quarantine and Inspection Service (AQIS) is responsible for implementing appropriate risk management measures.

More information about Australia's biosecurity framework is provided in the *Import Risk Analysis Handbook 2007* (update 2009) located on the Biosecurity Australia website www.daff.gov.au/ba.

1.2 This review of existing policy

Australia has an existing policy to import potato propagative material (tissue culture and true potato seed) from all countries; however, this policy has not been reviewed for some time. Propagative material represents one of the highest plant quarantine risks as it can harbour various forms of pathogens and arthropod pests. The introduction of plant pathogens, especially with latent infection, is of particular concern in propagative material. A range of exotic arthropod pests and pathogens can be introduced and established via propagative material when imported in a viable state for ongoing propagation.

There are currently no approved sources to supply pathogen tested potato propagative material to Australia or framework for approving sources.

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[1] A pest is any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2009).

1.2.1 Background

Many pathogens are associated with the production of potatoes worldwide. As potatoes are propagated mainly by vegetative means, there is considerable risk of introducing and spreading pests through international trade of potato propagative material. The introduction of economically important potato pests into Australia could result in substantial costs in eradication, containment or control. Pest establishment and spread could also lead to an increase in the use of chemical controls and could jeopardize export markets.

Australia's existing policy allows importation of potato propagative material (true potato seed, tissue culture) from any source. The policy includes on-arrival inspection and mandatory treatment and growth in a government or AQIS approved post-entry plant quarantine facility, with appropriate disease screening. However, new pathogens have recently been detected on potatoes and several pathogens have extended their geographic range. For instance, Potato yellow vein virus has established and spread into new localities (Venezuela and Peru) and Pepino mosaic virus has been recently discovered in native potato cultivars in the Andes and has become a major threat to tomato production in several countries. Uncontrolled movement of infected propagative material has helped to spread these pathogens into new areas. Consequently, Plant Biosecurity initiated this review of existing policy on the importation of potato propagative material.

Regulated pest

Current pests of quarantine concern (regulated pests) to Australia for potatoes are provided in Table 1.1.

Table 1.1 Current regulated pests of potatoes

Pathogen type	Common name
BACTERIA	
Candidatus Liberibacter psyllaurous Hansen *et al*.	Zebra chip
Clavibacter michiganensis subsp. *sepedonicus* (Spieckermann & Kotthoff) Davis *et al*.	Ring rot
Pseudomonas solanacearum (Smith) Smith	Bacterial wilt
Pseudomonas fluorescens Migula	Pink eye
FUNGI	
Aecidium cantensis Arthur	Deforming rust
Cercospora solani-tuberosi Thirmulachar	Cercospora leaf spot
Gerwasia pittieriana (Henn.) León-Gall. & Cummins	Common potato rust
Mycovellosiella concors (Casp.) Deighton	Cercospora leaf spot
Phoma andigena var. *andina* Turkenst.	Phoma leaf spot
Phytophthora infestans (Mont.) de Bary*	Late blight
Synchytrium endobioticum (Schilb.) Percival)	Potato wart
Thecaphora solani Barrus (*Angiosorus solani* Thirumalachar & M. J. O'Brien)	Potato smut
Verticilium albo-atrum Rein. & Ber.	Verticillium wilt
VIRUSES	
Alfalfa mosaic virus	Alfalfa yellow spot
Andean potato latent virus	APLV
Andean potato mottle virus	Andean mottle of potato
Arracacha virus B – Oca strain	APMV
Beet curly top virus	Curly top of beet
Beet western yellow virus	
Cucumber mosaic virus	
Potato aucuba mosaic virus	
Potato 14R virus	

Pathogen type	**Common name**
Potato black ringspot nepovirus	Calico disease of potato
Potato latent virus (Potato X virus)*	Potato interveinal mosaic
Potato leafroll virus	
Potato mop-top virus	Potato mop-top
Potato virus M	
Potato virus P (Potato virus A)	
Potato virus S	
Potato virus T	
Potato virus U	
Potato virus V	
Potato virus Y*	
Potato yellow dwarf virus	Yellow dwarf of potato
Potato yellow mosaic virus	
Solanum apical leaf curling virus	
Solanum nodiflorum mottle virus	
Solanum yellows virus	
Tobacco etch Potyvirus	
Tobacco mosaic virus	Tobacco mosaic
Tobacco necrosis Necrovirus	
Tobacco rattle virus*	Corky ringspot of potato
Tobacco ringspot virus	
Tobacco streak virus	Stunt of asparagus
Tomato black ring virus	Black ring of tomato
Tomato golden mosaic virus	
Tomato spotted wilt virus	Tomato spotted wilt
Wild potato mosaic virus	
Viroids	
Potato spindle tuber viroid (PSTVd)	Spindle tuber of potato
Nematodes	
Ditylenchus destructor Thorne	Potato rot
Globodera pallida (Stone) Mulvey & Stone	Pale cyst nematode
Globodera rostochiensis (Wollenweber) Mulvey & Stone	Potato cyst nematode
Nacobbus aberrans (Thorne) Thorne & Allen	False root rot

* Strains not present in Australia.

1.2.2 Scope

The scope of this review of existing policy is limited to:

- the identification of biosecurity risks associated with potato nursery stock (true potato seed, tissue culture and potato seed tuber) from all sources;
- the evaluation of existing risk management measures for the identified risks;
- the development of a framework for the approval of high health sources for potato propagative material; and
- the proposal of additional measures where appropriate.

This review does not consider existing phytosanitary measures during the pest risk assessment. Existing phytosanitary measures are only considered during the development of risk management measures, following the pest risk analysis.

1.2.3 Import policy for potato propagative material

Propagative material (true potato seed and tissue culture) of potato (*Solanum tuberosum*) are currently permitted entry into Australia, subject to specific import conditions. These conditions are available on the AQIS Import CONditions database (ICON) at http://www.aqis.gov.au/icon.

True potato seed for sowing

All consignments of imported true potato seed are subject to quarantine/biosecurity measures set out in the import conditions C7161 '*Solanum tuberosum* (Potato) seed for sowing – from non-approved sources'. The requirements include:

- an AQIS import permit;
- on-arrival inspection to verify freedom from soil, disease symptoms and other extraneous contamination of quarantine concern; and
- growth under closed quarantine, at a Government post-entry quarantine facility with pathogen screening or at an approved post-entry quarantine facility operating under a Compliance Agreement with AQIS.

In addition to general conditions (C7161), true potato seeds are subject to specific import conditions (Table 1.2).

Table 1.2 Specific quarantine measures for true potato seed for sowing

Country	ICON Condition	Details
All countries	C7161	All imported seed requires mandatory on arrival dusting with Ridomil® seed fungicide (T9330) and growth in a PEQ facility for indexing for *Potato spindle tuber viroid* (PSTVd) and visually screened for other diseases.

Tissue culture

Tissue culture consignments from all countries are subject to quarantine/biosecurity measures set out in the import conditions '*Solanum tuberosum* (potato) – import conditions for tissue culture' (C18804) and 'general conditions' (C7300). The requirements include:

- an AQIS import permit;
- on-arrival inspection to verify freedom from any bacterial or fungal infection, live insects, disease symptoms or other extraneous contamination of quarantine concern; and
- growth under closed quarantine, at a government or AQIS approved post-entry quarantine facility, with pathogen screening.

In addition to the general measures (C18804), specific quarantine/biosecurity measures for potato tissue culture have also been developed (Table 1.3).

Table 1.3: Specific quarantine measures for potato tissue culture

Country	**ICON Condition**	**Details**
All countries	C18785	Phytosanitary certification requirement: – A Phytosanitary Certificate must accompany each consignment with an additional declaration stating that "*Candidatus* Liberibacter psyllaurous is not known to occur in [insert country of origin]"

Country	ICON Condition	Details
	C18804	All plant material must be grown and tested at a post-entry quarantine facility approved by AQIS for growing *Solanum tuberosum*. – The mother plant/s must be grown in post-entry quarantine for a minimum of six months (and until the required disease screening/testing is completed) with general disease screening, virus indexing and fungal/bacterial screening. – During growth in quarantine mother plant/s will be subject to passive screening and active testing (herbaceous indicators, electron microscopy, PCR, serological testing using ELISA testing, fungal and bacterial testing through culturing of vascular tissue).
Canada; Guatemala; Honduras; Mexico; New Zealand; USA	C7322 (import conditions for tissue cultures originating from a *Candidatus* Liberibacter psyllaurous host country)	All plant material must be grown and tested at a post-entry quarantine facility approved by AQIS for growing *Solanum tuberosum*. – The mother plant/s must be grown in post-entry quarantine for a minimum of 6 months (and until the required disease screening/testing is completed) with general disease screening, virus indexing and fungal/bacterial screening. – During growth in quarantine mother plant/s will be subject to passive screening and active testing (herbaceous indicators, electron microscopy, PCR, serological testing using ELISA testing, fungal and bacterial testing through culturing of vascular tissue). – In addition, *Solanum tuberosum* originating from a *Candidatus* Liberibacter psyllaurous host country must be tested for this bacterium using PCR.

Potato seed tuber

Potato seed tubers intended for planting were permitted entry into Australia from 1996 to 2008 under certain conditions. Prior to withdrawal of these conditions, all imported consignments were subject to quarantine/biosecurity measures set out in import condition C7323 '*Solanum tuberosum* (potato seed tuber), other than tissue culture. The requirements include:

- mandatory on-arrival inspection to verify free from soil, any bacterial or fungal infection, live insects, disease symptoms or other extraneous contamination of quarantine concern;
- mandatory fumigation with methyl-bromide (T9060);
- mandatory sodium hypochlorite treatment (1% NaOCl for 2 hours) for surface sterilisation (T9370); and
- growth under closed quarantine, at a Government post-entry quarantine facility with passive screening and active testing.

However, in 2008 import conditions were amended and import conditions for potato seed tubers were withdrawn.

2 Pest risk analysis

Plant Biosecurity has conducted this pest risk analysis (PRA) in accordance with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for pest risk analysis* (FAO 2007) and ISPM 11: *Pest risk analysis for quarantine pests, including analysis of environmental risks and living modified organisms* (FAO 2004). The standards provide a broad rationale for the analysis of the scientific evidence to be taken into consideration when identifying and assessing the risk posed by quarantine pests.

Following ISPM 11, this pest risk analysis process comprises of three discrete stages:

- Stage 1: Initiation of the PRA
- Stage 2: Pest Risk Assessment
- Stage 3: Pest Risk Management

Phytosanitary terms used in this PRA are defined in ISPM 5 (FAO 2009).

2.1 Stage 1: Initiation of the PRA

The *initiation* of a risk analysis involves identifying the reason for the PRA and the identification of the pest(s) and pathway(s) that should be considered for risk analysis in relation to the identified PRA area.

This commodity-based pest risk assessment was initiated by Plant Biosecurity as a basis for a review of the existing phytosanitary regulations to import potato propagative material into Australia.

In the context of this PRA, *Solanum tuberosum* propagative material (true potato seed, seed tuber and tissue culture) is a potential import 'pathway' by which a pest can enter Australia.

The pests associated with potatoes worldwide were tabulated from published scientific literature, such as reference books, journals and database searches. This information is set out in Appendix A and forms the basis of the pest categorisation.

For this PRA, the 'PRA area' is defined as Australia for pests that are absent from Australia or of limited distribution and under official control in Australia.

2.2 Stage 2: Pest Risk Assessment

A pest risk assessment is the 'evaluation of the probability of the introduction and spread of a pest and of the magnitude of the associated potential economic consequences' (FAO 2009, p. 13). The pest risk assessment provides technical justification for identifying quarantine pests and for establishing phytosanitary import requirements.

This is a commodity-initiated pest risk analysis and risk is estimated through a standard set of factors that contribute to introduction, establishment, spread or economic impact potential of pests. This pest risk assessment was conducted using three consecutive steps: pest categorisation; assessment of the probability of entry, establishment and spread; and assessment of potential consequences.

2.2.1 Pest categorisation

Pest categorisation is a process to examine, for each pest identified in Stage 1 (Initiation of the PRA process), whether the criteria for a quarantine pest is satisfied. In the context of propagative material, pest categorisation includes all the main elements of a full pest risk assessment but is done in less detail and is essentially a quick assessment to identify pests of quarantine concern. The process of pest categorisation is summarised by ISPM 11 (FAO 2004) as a screening procedure based on the following criteria:

- identity of the pest;
- presence or absence in the endangered area;
- regulatory status;
- potential for establishment and spread in the PRA area; and
- potential for economic consequences (including environmental consequences) in the PRA area.

Pests are categorised according to their association with the pathway, their presence or absence or regulatory status, their potential to establish or spread, and their potential for economic consequences. Pests associated with potatoes listed in Appendix A were used to develop a pathway-specific pest list for all pathways (true potato seed, seed tuber and tissue culture). This list identifies the pathway association of pests recorded on potatoes and their status in Australia, their potential to establish or spread, and their potential for economic consequences. Pests likely to be associated with propagative material, and are absent or under official control in Australia, may be capable of establishment or spread within Australia if suitable ecological and climatic conditions exist.

The quarantine pests of potatoes from all sources identified in the pest categorisation are listed in Table 2.1. These pathogens fulfil the International Plant Protection Convention (IPPC) criteria for a quarantine pest, specifically:

- these pests are economically important (as they cause a variety of direct and indirect economic impacts, such as reduced yield, reduced commodity value, loss of foreign or domestic markets); and
- these pests are not present in Australia or have a limited distribution and are under official control.

Table 2.1 Quarantine pests for potato propagative material (true seed potato, seed tubers, tissue culture)

Pathogen type	Disease or Common designation	Pathway association[2]		
		True potato seed	Seed tubers	Tissue cultures
BACTERIA				
Candidatus Liberibacter psyllaurous Hansen *et al.*	Psyllaurous yellows disease/Zebra chip		✓	✓
Clavibacter michiganensis subsp. *sepedonicus* (Spieckermann & Kotthoff) Davis *et al*.	Potato ring rot		✓	✓
Dickeya dadantii Samson *et al*.	Bacterial soft rot		✓	✓
Dickeya dianthicola Samson *et al*.	Bacterial soft rot		✓	✓
Dickeya dieffenbachiae Samson *et al*.	Bacterial soft rot		✓	✓
Dickeya paradisiaca (Fernandez-Borrero& Lopez-Duque) Samson *et al*.	Bacterial soft rot		✓	✓
Dickeya parthenii Samson *et al*.	Bacterial soft rot		✓	✓

2 This review considers that certain pathogens (bacteria, phytoplasma, viroids and viruses) may not be excluded from the pathway and remain associated with micropropagated plantlets.

Pathogen type	**Disease or Common designation**	**Pathway association**[2]		
		True potato seed	**Seed tubers**	**Tissue cultures**
Dickeya solani sp. nov.	Blackleg of potato		✓	✓
Pectobacterium betavasculorum (Thomson *et al*.) Gardan *et al*.	Bacterial soft rot		✓	✓
Pectobacterium carotovorum subsp. *brasiliensis* Duarte *et al*.	Bacterial soft rot		✓	✓
Pectobacterium wasabiae (Goto & Matsumoto) Gardan *et al*.	Bacterial soft rot		✓	✓
Ralstonia solanacearum (Smith) Yabuuchi *et al*.*	Bacterial wilt		✓	✓
FUNGI				
Aecidium cantensis Arthur	Deforming rust			
Gerwasia pittieriana (Henn.) León-Gall. & Cummins	Potato common rust		✓	
Phoma andigena var. *andina* Turkenst.	Phoma leaf spot		✓	
Phoma crystalliniformis (Loer. *et al*.) Noordel. & Gruyter	Carate disease of potato		✓	
Phytophthora infestans (Mont.) de Bary[3]	Late blight of potato		✓	
Synchytrium endobioticum (Schilb.) Percival	Wart disease of potato		✓	
Streptomyces acidiscabies Lambert & Loria	Common scab		✓	
Streptomyces caviscabiei Goyer *et al*.	Common scab		✓	
Streptomyces europaeiscabiei Bouchek-Mechiche *et al*.	Netted scab		✓	
Streptomyces luridiscabiei Park *et al*.	Common scab		✓	
Streptomyces niveiscabiei Park *et al*.	Common scab		✓	
Streptomyces puniciscabiei Park *et al*.	Common scab		✓	
Streptomyces reticuliscabiei Bouchek-Mechiche *et al*.	Netted scab		✓	
Streptomyces scabiei (Thaxter) Waksman and Henrici	Common scab		✓	
Streptomyces stelliscabiei Bouchek-Mechiche *et al*.	Common scab		✓	
Streptomyces turgidiscabies Miyajima *et al*.	Common scab		✓	
Thecaphora solani Barrus	Thecaphora smut		✓	
Verticillium albo-atrum Reinke & Berthold	Verticillium wilt		✓	
Phytoplasma				
Candidatus Phytoplasma asteris [**16SrI** –Aster yellows group]	Aster yellows		✓	✓
Candidatus Phytoplasma aurantifolia [**16SrII**–Peanut Witches' Broom Group]	Purple top disease		✓	✓
Candidatus Phytoplasma pruni [**16SrIII** – X-Disease Group]	Purple top disease		✓	✓
Candidatus Phytoplasma trifolii [1**6SrVI** – Clover Proliferation Group]	Purple top disease		✓	✓
Candidatus Phytoplasma solani [**16SrXII – A** – Stolbur Group]	Purple top disease		✓	✓
Mexican periwinkle virescence group (**16SrXIII)**	Purple top disease		✓	✓
Candidatus Phytoplasma americanum [**16SrXVIII** – American Potato Purple Top Wilt Group]	Purple top disease		✓	✓

[3] A2 mating strain and exotic strains of both the A1 and A2

Pathogen type	**Disease or Common designation**	**Pathway association[2]**		
		True potato seed	**Seed tubers**	**Tissue cultures**
Viroids				
Potato spindle tuber viroid	PSTVd	✓	✓	✓
VIRUSES4				
Alfalfa mosaic virus – potato strains	AMV		✓	✓
Andean potato latent virus	APLV	✓	✓	✓
Andean potato virus	Andean mottle of potato (APMoV)		✓	✓
Arracacha virus B – Oca strain	AVB-O	✓	✓	✓
Beet curly top virus	Beet curly top (BCTV)		✓	✓
Eggplant mottled virus	EMDV		✓	✓
Impatiens necrotic spot virus	INSV		✓	✓
Pepino mosaic virus	PepMV		✓	✓
Potato 14R virus	Potato 14R virus		✓	✓
Potato black ringspot virus	Calico disease of potato (PBRSV)	✓	✓	✓
Potato deforming mosaic virus	Deforming mosaic of potato (PDMV)		✓	✓
Potato latent virus	PLV		✓	✓
Potato mop-top virus	Potato mop-top (PMTV)		✓	✓
Potato rough dwarf virus	PRDV		✓	✓
Potato virus A	PVA		✓	✓
Potato virus M	PVM		✓	✓
Potato virus T	PVT	✓	✓	✓
Potato virus U	PVU		✓	✓
Potato virus V	PVV		✓	✓
Potato virus Y*	PVY		✓	✓
Potato yellow dwarf virus	PYDV		✓	✓
Potato yellow vein virus	PYVV		✓	✓
Potato yellowing virus	(PYV)	✓	✓	✓
Solanum apical leaf curling virus	SALCV		✓	✓
Tobacco mosaic virus– potato strain*	TSV-P		✓	✓
Tobacco necrosis virus*	TNV		✓	✓
Tobacco rattle virus *	TRV		✓	✓
Tomato black ring virus	TBRV	✓	✓	✓
Tomato leaf curl New Delhi virus	ToLCNDV		✓	✓
Tomato mottle Taino virus	ToMoTV		✓	✓
Tomato yellow mosaic virus	ToYMV		✓	✓
NEMATODES				
Ditylenchus destructor (Thorne)	Potato rot nematode		✓	
Globodera pallida (Stone) Behrens	Pale cyst nematode		✓	
Globodera rostochiensis (Wollen.) Skarbilovich	Potato cyst nematode		✓	
Meloidogyne chitwoodii Golden *et al*.	Root-knot nematode		✓	
Nacobbus aberrans (Thorne) Thorne & Allen	False root rot		✓	

* Strains not present in Australia.

[4] Acronyms are those accepted by The International Committee on Taxonomy of Viruses (ICTV).

2.2.2 Assessment of the probability of entry, establishment and spread

Details of how to assess the 'probability of entry', 'probability of establishment' and 'probability of spread' of a pest are given in ISPM 11 (FAO 2004).

In the case of propagative material imports, the concepts of entry, establishment and spread have to be considered differently. Propagative material intended for ongoing propagation purposes is deliberately introduced, distributed and aided to establish and spread. This material will enter and then be maintained in a suitable habitat, potentially in substantial numbers and for an indeterminate period. Significant resources are utilised to ensure the continued welfare of imported propagative material. Therefore, the introduction and establishment of plants from imported propagative material in essence establishes the pests and pathogens associated with the propagative material. Pathogens, in particular, may not need to leave the host to complete their life cycles, further enabling them to establish in the PRA area. Furthermore, propagative material is expected to be shipped at moderate temperatures and humidity, which is unlikely to adversely affect any pest that is present during shipment.

Several key factors contribute to the increased ability of pests and pathogens associated with propagative material to enter, establish and spread in Australia.

Probability of entry

- Association with host commodities provides the opportunity for the pest to enter Australia. Their ability to survive on, or in, propagative material acts to ensure their viability on route to, and during distribution across, Australia.
- Viruses, as a rule, infect host plants systemically and all plant parts, including parts used for vegetative propagation, are infected. Therefore, propagative material provides a pathway for viruses.
- Propagative material is assumed to come from areas where these pests specifically occur and no phytosanitary measures have been applied. The primary conditions for survival of pests are fulfilled by the presence of the live propagative material and the associated environmental conditions. Therefore, association with propagative material can provide long term survival for the pests.
- Infected propagative material is the main pathway for the introduction of the pests into new areas. This mode of introduction is greatly enhanced because of latency periods before conspicuous symptoms develop. Long latency periods can lead to the propagation and distribution of infected propagative material suggesting the pests could be introduced into Australia.
- The pests associated with propagative material may be systemic or associated with the vascular system (or occur internally in the nursery stock) and they are unlikely to be dislodged during standard harvesting, handling and shipping operations. Therefore, pests associated with propagative material are likely to survive during transport.

Probability of establishment

- Association with the host will facilitate the establishment of pests associated with it, as they are already established with, or within, a suitable host. As host plant material is likely to be maintained in places with similar climates to the area of production, climatic conditions are expected to favour the pest's establishment.Some pest specific factors are likely to impact upon a pest's ability to establish in Australia. For example, the likelihood of establishment will vary if an alternative host is required for the pest to complete its life cycle or if multiple individuals are required to form a founder population. Where appropriate these considerations are addressed in the potential for establishment and spread field of the pest categorisation.

- Propagative material intended for ongoing propagation or horticultural purposes is deliberately introduced, distributed and aided to establish. This material will enter and then be maintained in a suitable habitat, potentially in substantial numbers and for an indeterminate period. Therefore, the introduction and establishment of plants from imported propagative material in essence establishes the pests and pathogens associated with the propagative material.
- The latent period of infection before visible symptoms appear may result in non-detection of these pathogens; therefore, the pathogens will have ample time to establish into new areas.

Probability of spread

- The ability of the pest to be introduced and distributed throughout Australia on propagative material through human mediated spread is a high risk for continued spread post-border in Australia. Pest related factors which would aid the spread of the pest once it has established in Australia (such as wind, water or mechanical transmission) will increase the pest's ability to spread from an already high baseline.
- In the absence of statutory control there are high probabilities for the pests to spread quickly in Australia by trade of propagative material. Planting of infected propagative material will bring the pests into the environment. Climatic conditions such as those found in propagation houses may be sufficient for pest survival and spread.
- The systemic nature of some of the pests associated with propagative material is a major pathway for dispersal. Accordingly, local and long-distance spread of these pathogens has been associated with the movement of infected propagative material.
- The symptomless nature of several pathogens may contribute to the inadvertent propagation and distribution of infected material that will help spread these pathogens within Australia. Additionally, insect vectors present in Australia will help spread viruses from infected plants to healthy plants.

As a result of these pathway specific factors, it would be inappropriate to assess the probability of entry, establishment and spread using the processes described in ISPM 11 (FAO 2004). For the purposes of this PRA, the overall likelihood for the probability of entry, establishment and spread is considered to be high for pests entering on potato propagative material.

2.2.3 Assessment of potential consequences

The purpose of assessment of potential consequences in the pest risk assessment process is to identify and quantify, as much as possible, the potential impacts that could be expected to result from a pest's introduction and spread.

The basic requirements for the assessment of consequences are described in the SPS Agreement, in particular Article 5.3 and Annex A. Further detail on assessing consequences is given in the 'potential economic consequences' section of ISPM 11. This ISPM separates the consequences into ‘direct’ and ‘indirect’ and provides examples of factors to consider within each.

The introduction of pests which meet the criteria of a quarantine pest will have unacceptable economic consequences in Australia as these pests will cause a variety of direct and indirect economic impacts. The identified pests are of economic concern and do not occur in Australia. A summary and justification is provided below:

- Direct impacts of the introduction and spread of multi-host pests in Australia will not only affect the imported host but also other hosts. Introduction and establishment of quarantine pests in Australia would not only result in phytosanitary regulations imposed by foreign or domestic trading partners, but also in increased costs of production including pathogen control costs.
- Quarantine pest introduction and establishment would also be likely to result in industry adjustment. The potential economic impact for the nursery trade is high. Without controls these pests have the potential to spread further in the trade network and could potentially expand their host range.
- One of the greatest phytosanitary hazards to the potato crop world-wide is a group of potato viruses which have remained limited in distribution to the potato's zone of origin in South America. These pathogens are considered important as they cause a variety of direct and indirect economic impacts, such as reduced yield, reduced commodity value and loss of foreign or domestic markets. Therefore, these pests have a potential for economic consequences in the PRA area. For example, some of these pathogens are identified as pests of quarantine concern by APPPC, COSAVE, CPPC, EPPO, IAPSC, JUNAC and NAPPO. The presence of these pathogens in Australia would impact upon Australia’s ability to access overseas markets.

Bacteria, phytoplasma, viroids, viruses and nematodes listed in table 3.1 are of economic significance and are either absent from Australia, or if present, are under official control. Therefore, they meet the IPPC criteria for a quarantine pest and phytosanitary measures are justified to manage these pathogens.

2.3 Stage 3: Pest Risk Management

ISPM 11 (FAO 2004) provides details on the identification and selection of appropriate risk management options. Pest risk management describes the process of identifying and implementing phytosanitary measures to manage risks posed by identified quarantine pests, while ensuring that any negative effects on trade are minimised.

Pest risk management evaluates and selects risk management options to reduce the risk of entry, establishment or spread of identified pests for the identified import pathways. To effectively prevent the introduction of pests associated with an identified pathway, a series of important safeguards, conditions or phytosanitary measures must be in place. Propagative material represents a direct pathway for pests identified by the pest categorisation. This pathway is direct since the end-use is the planting of a known host plant.

2.3.1 Identification and selection of appropriate risk management options

Phytosanitary measures to prevent the establishment and spread of quarantine pests may include any combination of measures; including pre- or post-harvest treatments, inspection at various points between production and final distribution, surveillance, official control, documentation, or certification. A measure or combination of measures may be applied at any one or more points along the continuum between the point of origin and the final destination. Pest risk management explores options that can be implemented (i) in the exporting country, (ii) at the point of entry or (iii) within the importing country. The ultimate goal is to protect plants and prevent the introduction of identified quarantine pests.

Examples of phytosanitary measures which may be applied to propagative material consignments include:

- **Import from pest free areas only (ISPM 4, 10)**—the establishment and use of a pest free area by a NPPO provides for the export of plants from the exporting country to the importing country without the need for application of additional phytosanitary measures when certain requirements are met.
- **Inspections or testing for freedom from regulated pests**—this is a practical measure for visible pests or for pests which produce visible symptoms on plants.
- **Inspection and certification (ISPM 7, 12, 23)**—the exporting country may be asked to inspect the shipment and certify that the shipment is free from regulated pests before export.
- **Specified conditions for preparation of the consignment (ISPM 33)**—the importing country may specify steps which must be followed in order to prepare the consignment for shipment. These conditions can include the requirement for the plants to have been produced from appropriately tested parent material.
- **Pre-entry or post-entry quarantine**—the importing country may define certain control conditions, inspection and possible treatment of shipments upon their entry into the country. Post-entry quarantine (PEQ) of tubers, true potato seed (TPS) and even *in vitro* plantlets can help avoid the introduction of new viruses or allied pathogens into the importing countries.
- **Removal of the pest from the consignment by treatment or other methods**—the importing country may specify chemical or physical treatments which must be applied to the consignment before it may be imported.

Measures can range from total prohibition to permitting import subject to visual inspection. In some cases, more than one phytosanitary measure may be required in order to reduce the pest risk to an acceptable level.

3 Risk management measures for potato propagative material from all sources

Australia's existing policy to import potato propagative material (true potato seed and tissue culture) is based on on-shore risk management (phytosanitary measures implemented in the importing country). Current risk management measures include on-arrival inspection and mandatory treatment and growth in a closed government or DAFF Biosecurity approved post-entry quarantine (PEQ) facility, with pathogen screening. Potato propagative material can currently be imported into Australia as true potato seed or tissue culture only. Other potato nursery stock, including potato tubers, is prohibited from entry. All imported true potato seed and tissue culture consignments are subject to the quarantine/biosecurity measures set out in Condition C7161 (seed for sowing), C17837 (seed ex-USA); C18785 (phytosanitary certificate requirement); C18804 (potato tissue culture); C7322 (potato tissue culture from a *Candidatus* Liberibacter psyllaurous host country); and C7300 (general nursery stock). Plant Biosecurity has evaluated the existing policy for potato propagative material (true potato seed and tissue culture) from all sources and proposed additional measures, where required. Additionally, Plant Biosecurity has proposed new measures for potato seed tubers produced in a protected environment.

3.1 Existing risk management measures for potato propagative material

3.1.1 True potato seed for sowing

Australia's existing policy on true potato seed includes:

- a valid import permit;
- on-arrival inspection to verify freedom from soil, disease symptoms and other extraneous contamination of quarantine concern;
- mandatory treatment with Ridomil® seed fungicide (T9330), prior to sowing; and
- growth in a closed government or DAFF Biosecurity approved quarantine facility for a minimum period of six months, with indexing for potato spindle tuber viroid (PSTVd) and visual screening for other diseases.

3.1.2 Potato tissue culture

Australia's existing policy on potato tissue culture includes:

- a valid import permit;
- mandatory on-arrival inspection for any signs of disease symptoms; and
- mandatory growth in a closed government or DAFF Biosecurity approved PEQ facility for a minimum period of six months with viroid, virus, fungal and bacterial testing.

3.2 Proposed risk management measures for potato propagative material

Plant Biosecurity has evaluated the existing policy for imported potato propagative material and has recommended additional measures where required.

3.2.1 True potato seed for sowing

Mandatory on arrival inspection

Imported true potato seed for sowing is subject to mandatory on-arrival inspection to verify freedom from disease symptoms, live insects, soil and other extraneous contaminants of quarantine concern.

Soil-borne pathogens may be hidden in the soil and difficult to detect. Several nematodes and the fungus *Verticillium albo-atrum* (causal agent of Verticillium wilt) are economically significant soil-borne pathogens associated with potato. The mandatory requirement for seed to be free from soil will be effective against Verticillium wilt and nematodes. Therefore, the existing requirement of freedom from soil is supported.

Sole reliance on on-arrival visual inspection to detect pests is inefficient for seed-borne pathogens as pathogens may not produce visible symptoms on the seed. Seed infected with viral pathogens, such as *Andean potato latent virus* (APLV), *Arracacha virus B* (AVB-O), *Potato black ringspot virus* (PBRSV), *Potato spindle tuber viroid* (PSTVd), *Potato virus T* (PVT), *Potato yellowing virus* (PYV) and *Tomato black ring virus* (TBRV) may not display obvious signs of seed infection. For this reason, visual inspection is not considered an appropriate measure to mitigate the risk posed by seed-borne pathogens. Therefore, additional measures are required to mitigate the risk posed by seed-borne pathogens of potato.

Mandatory seed fungicide treatment

Imported true potato seeds undergo mandatory fungicide treatment with Ridomil® systemic seed fungicide (T9330) to mitigate the risk posed by external and internal seed-borne fungi and surface contaminants. The existing Ridomil® treatment of seeds prior to sowing is supported. However, this treatment alone is not considered an appropriate measure to mitigate all seed-borne pathogens, such as, APLV, AVB-O, PBRSV, PSTVd, PVT, PYV and TBRV. Therefore, additional measures are required to mitigate the risk posed by seed-borne pathogens.

Mandatory growth in PEQ facilities

Imported true potato seeds must be grown for a minimum of six months in a closed government or DAFF Biosecurity approved PEQ facility for pathogen screening. The existing requirement of mandatory on-arrival growth in PEQ and pathogen screening is supported. However, currently plants grown in PEQ from true potato seeds are only actively tested for PSTVd. The proposed policy recommends that plants originating from true potato seed grown in PEQ must be actively tested not only for PSTVd but also APLV, AVB-O, PBRSV, PVT, PYV and TBRV, using transmission electron microscopy, biological indicators and/or PCR techniques. Details of pathogen screening including proposed additional requirements are provided below (section 3.2.2).

3.2.2 Potato tissue culture

Mandatory on-arrival inspection

Imported potato tissue cultures (microplantlets) are currently subject to mandatory on-arrival inspection by DAFF Biosecurity officers to verify freedom from bacterial and fungal infections, disease symptoms, live insects and other contaminants of quarantine concern. The existing requirement for mandatory on-arrival inspection of tissue cultures (microplantlets) is supported. The agar culture media must be clear and not contain antibiotics. If diseased material is detected during on-arrival inspection, the material must be held and referred to a plant pathologist for identification/risk assessment.

On-arrival visual inspection of the tissue culture will not be effective in detecting the presence of bacteria, phytoplasmas, viroids and viruses. Therefore, additional measures for these pathogens are required.

Mandatory growth in PEQ facilities

Imported potato tissue cultures (microplantlets) from unknown sources constitute a high risk which justifies Australia's strict post-entry quarantine procedures. Therefore, imported potato tissue cultures are subject to mandatory growth for a minimum period of six months in a government PEQ facility for pathogen screening, until the required pathogen screening/testing is completed. The existing requirement of mandatory on-arrival growth in PEQ and pathogen screening is supported. The tissue culture must be maintained in conditions suitable for disease development and must undergo general disease screening and virus indexing using herbaceous indicators, transmission electron microscopy, ELISA and/or PCR. It is proposed that fungal and bacterial pathogens must be cultured during growth in the PEQ facilities.

Pathogen screening

Although visual assessment is an important method for screening pathogens, potato tissue cultures may be infected and not produce any obvious disease symptoms due to cultivar susceptibility, environmental conditions or other plant related factors. Therefore, the existing requirement for pathogen screening (viroid testing, virus testing and fungal and bacterial testing as outlined in the Potato PEQ Manual (AQIS 2008) is supported. However, this review proposes additional measures.

Bacterial pathogens

The existing testing methods used for bacterial pathogens, including isolation and PCR, is recommended to continue. However, due to the economic importance of *Clavibacter michiganensis* subsp. *sepedonicus* and *Candidatus* Liberibacter psyllaurous, additional PCR tests are proposed (Hansen *et al.* 2008; Bakker *et al*. 1995; van der Wolf *et al*. 1995).

Fungal pathogens

The existing testing methods used for fungal pathogens, including growing season inspection, culture media and microscopy, are proposed to continue.

Phytoplasmas

This review has identified phytoplasmas (*Candidatus* Phytoplasma asteris, *Candidatus* Phytoplasma aurantifolia, *Candidatus* Phytoplasma pruni, *Candidatus* Phytoplasma trifolii, *Candidatus* Phytoplasma solani, Mexican periwinkle virescence group and *Candidatus* Phytoplasma americanum) as quarantine pathogens.

A generic PCR test is recommended to detect phytoplasmas (Lorenz *et al*. 1995, Gundersen and Lee 1996; NZMAF 2007). General tests for phytoplasmas are routinely used by some of the diagnostic laboratories in Australia. DAFF Biosecurity plant pathologists can make arrangements for the phytoplasma PCR test to be carried out at an AQIS approved diagnostic laboratory where the test is available.

Viroids

A reverse-transcription PCR test for PSTVd is proposed.

Viruses

The existing testing methods used for viral pathogens, including electron microscopy, bioassay (indicator species) and serological (ELISA) or molecular testing (PCR), is recommended to continue for all viruses. A summary of proposed indexing procedures is presented in Table 3.1.

Table 3.1 Proposed potato indexing procedures

Pathogen type	Mandatory tests						Additional tests required if disease symptoms develop	Reference(s)
	Growing season	Culture & microscopy	Electron Microscopy	Bioassay	ELISA	PCR or RT-PCR [1]		
BACTERIA								
Candidatus Liberibacter psyllaurous	✓					✓	PCR	Hansen *et al*. 2008
Clavibacter michiganensis subsp. *sepedonicus*	✓	✓					PCR	van Beckhoven *et al*. 2002; Schaad 1988; Li and De Boer 1995;Schneider *et al*. 1993; de la Cruz *et al*. 1992
Dickeya dadantii *Dickeya dianthicola* *Dickeya dieffenbachiae* *Dickeya paradisiaca* *Dickeya parthenii* *Dickeya solani* *Pectobacterium betavasculorum* *Pectobacterium carotovorum* subsp. *brasiliensis* *Pectobacterium wasabiae*	✓	✓					PCR; Real-time PCR	Diallo *et al*. 2009; Laurila *et al*. 2010, 2008; Bdliya and Langerfeld 2005; Hyman *et al*. 2001; Cuppels and Kelman 1974
Ralstonia solanacearum	✓	✓					DASI-ELISA; PCR; Nested-PCR-RFLP, TaqMan PCR	Fegan and Prior 2005; Caruso *et al*. 2002; Poussier and Luisetti 2000; Pastrik and Maiss 2000; Weller *et al*. 2000
Fungi								
Aecidium cantensis *Gerwasia pittieriana* *Phoma andigena* var. *andina* *Phoma crystalliniformis* *Synchytrium endobioticum* *Thecaphora solani* *Verticillium albo-atrum* *Phytophthora infestans*	✓	✓						
Phytoplasma								
Candidatus Phytoplasma asteris *Candidatus* Phytoplasma aurantifolia *Candidatus* Phytoplasma pruni *Candidatus* Phytoplasma trifolii	✓					✓		NZMAF 2007; Gundersen and Lee 1996; Lorenz *et al*. 1995

Pathogen type	**Mandatory tests**						**Additional tests required if disease symptoms develop**	**Reference(s)**
	Growing season	Culture & microscopy	Electron Microscopy	Bioassay	ELISA	PCR or RT-PCR [1]		
Candidatus Phytoplasma solani								
Mexican periwinkle virescence group								
Candidatus Phytoplasma americanum								
Viroids								
Potato spindle tuber viroid	✓					✓		Nakahara *et al*. 1999; Shamloul *et al*.1997
Viruses								
Alfalfa mosaic virus (AMV) – potato infecting strains	✓		✓	✓			ELISA; RT-PCR	Xu and Nie 2006; Jeffries 1998
Andean potato latent virus (APLV)	✓		✓	✓			ELISA	Schroeder and Weidmann 1990
Andean potato virus (APMoV)	✓		✓	✓			ELISA	Schroeder and Weidmann 1990
Arracacha virus B – Oca strain (AVB-O)	✓		✓	✓			ELISA	Jeffries 1998
Beet curly top virus (BCTV)	✓		✓	✓			PCR/RT-PCR	Rojas *et al*. 1993
Eggplant mottled virus (EMDV)	✓		✓	✓			ELISA	Jeffries 1998
Impatiens necrotic spot virus (INSV)	✓		✓	✓			ELISA, RT-PCR	
Pepino mosaic virus (PepMV)	✓		✓	✓			ELISA, RT-PCR	Gutiérrez-Aguirre *et al*. 2009; Salomone and Roggero 2002
Potato 14R virus	✓		✓	✓				
Potato black ringspot virus (PBRSV)	✓		✓	✓			ELISA	Jeffries 1998
Potato deforming mosaic virus (PDMV)	✓		✓	✓			PCR/RT-PCR	Wyatt and Brown 1996; Rojas *et al.* 1993
Potato latent virus (PLV)	✓		✓	✓			ELISA; PCR/RT-PCR	Badge *et al*. 1996
Potato mop-top virus (PMTV)	✓		✓	✓		✓	ELISA; RT-PCR	Latvala-Kilby *et al*. 2009
Potato rough dwarf virus (PRDV)	✓		✓	✓			PCR/RT-PCR	Badge *et al*. 1996
Potato virus A (PVA)	✓		✓	✓			ELISA; PCR/RT-PCR	Gibbs and Mackenzie 1997; Pappu *et al*. 1993; Langeveld *et al.* 1991
Potato virus M (PVM)	✓		✓	✓			ELISA; PCR/RT-PCR	Badge *et al*. 1996
Potato virus T (PVT)	✓		✓	✓	✓		ELISA	Jeffries 1998
Potato virus U (PVU)	✓		✓	✓				Jeffries 1998
Potato virus V (PVV)	✓		✓	✓			PCR/RT-PCR	Gibbs and Mackenzie 1997;

Pathogen type	Mandatory tests						Additional tests required if disease symptoms develop	Reference(s)
	Growing season	Culture & microscopy	Electron Microscopy	Bioassay	ELISA	PCR or RT-PCR [1]		
								Pappu *et al*. 1993; Langeveld *et al.* 1991
Potato virus Y (PYV)	✓		✓	✓			ELISA; PCR/RT-PCR	Nie and Singh 2003; Jeffries 1998; Fernandez-Northcote and Gugerli 1987
Potato yellow dwarf virus (PYDV)	✓		✓	✓			ELISA	Jeffries 1998
Potato yellow vein virus (PYVV)	✓		✓	✓			PCR/RT-PCR	Lopez *et al*. 2006; Salazar *et al*. 2000
Potato yellowing virus (PYV)	✓		✓	✓			ELISA	Jeffries 1998
Solanum apical leaf curling virus (SALCV)	✓		✓	✓			ELISA	Jeffries 1998
Tobacco mosaic virus – potato strain	✓		✓	✓			RT-PCR	Jung *et al*. 2002
Tobacco necrosis virus (TNV)	✓		✓	✓				Jeffries 1998
Tobacco rattle virus (TRV)	✓		✓	✓			PCR/RT-PCR	Jeffries 1998; Crosslin and Thomas 1995; Weidmann 1995; Robinson 1992
Tobacco streak virus – potato strain (TSV-P)	✓		✓	✓			ELISA	Salazar *et al*. 1981
Tomato black ring virus (TBRV)	✓		✓	✓	✓		ELISA	Jeffries 1998
Tomato leaf curl New Delhi virus (ToLCN-DV)	✓		✓	✓			PCR/RT-PCR	Wyatt and Brown 1996; Rojas *et al.* 1993
Tomato mottle virus (ToMoTV)	✓		✓	✓			PCR/RT-PCR	Wyatt and Brown 1996; Rojas *et al.* 1993
Tomato yellow mosaic virus (ToYMV)	✓		✓	✓			PCR/RT-PCR	Wyatt and Brown 1996; Rojas *et al.* 1993

In addition to the mandatory testes listed in the Table 3.1, generic PCR tests are proposed to supplement the detection of Potyvirus, Carlavirus, Begomovirus, Crinivirus and Potexvirus.

3.2.3 Potato seed tubers

Currently, potato seed tubers intended for planting are not allowed entry into Australia as they are known to harbour several tuber-borne pests. Potato seed tubers are capable of introducing not only pathogens (bacteria, phytoplasma, viroids and viruses) but also nematodes (*Ditylenchus destructor*, *Globodera pallida*, *Globodera rostochiensis*, *Meloidogyne chitwoodi* and *Nacobbus aberrans*). Additionally, field-grown seed potatoes are capable of introducing certain insects (*Epitrix tuberis*, *Leptinotarsa decemlineata*, *Phthorimaea operculella*, *Premnotrypes latithorax*, *Premnotrypes sanfordi*, *Premnotrypes solani*, *Premnotrypes vorax*, *Rhigopsidius tucumanus* and *Tecia solanivora*). Mandatory on-arrival methyl-bromide fumigation and surface sterilisation (1% NaOCl for 2 hours) may be effective against external, contaminating pests. However, these measures may not be effective against tuber-borne insects or nematodes. Therefore, this review supports the prohibition of field-grown potato seed tubers.

To effectively prevent the introduction of these pests, a series of important safeguards, conditions or phytosanitary measures must be in place. Therefore, this review proposes that the importation of potato seed tubers should be limited to microtubers or minitubers produced under a protected environment (as outlined in section 5.3). Soil-borne pathogens may be hidden in the soil and difficult to detect. Several nematodes and the fungus *Verticillium albo-atrum* (causal agent of Verticillium wilt) are economically significant soil-borne pathogens associated with potato. The mandatory requirement for seed to be free from soil will be effective against Verticillium wilt and nematodes. Therefore, microtubers or minitubers must be produced in soil-less media.

Microtubers/minitubers produced in protected environments, are not exposed to the field environment and represent a low pest risk; therefore, alternative risk management measures can be applied. The proposed policy to import potato seed tubers will include:

- a valid import permit;
- certification that microtubers or minitubers have been grown in soilless media;
- mandatory on-arrival inspection for any signs of disease symptoms;
- mandatory on-arrival methyl-bromide fumigation (T9060) and surface sterilisation (1% NaOCl for 2 hours, T9370); and
- mandatory growth in a closed government or DAFF Biosecurity approved PEQ facility for a minimum of six months with pathogen (viroid, viral, fungal and bacterial) testing.

Mandatory on-arrival inspection

It is recommended that imported potato seed tubers be subject to on-arrival inspection to verify freedom from disease symptoms, live insects, soil and extraneous contaminants of quarantine concern. If diseased material is detected during on-arrival inspection, the pathogen must be identified. Detection of bacterial or fungal pathogens may result in the destruction or re-export of the potato seed tubers.

On-arrival visual inspection of the potato seed tubers will not be effective in detecting the presence of tuber-borne bacteria, viruses, viroids, phytoplasmas, nematodes and insects. Therefore, additional measures for tuber-borne pests are required.

Mandatory on-arrival fumigation

Mandatory on-arrival fumigation is a standard measure applied to imported nursery stock to manage the risk posed by arthropod pests. Therefore, mandatory on-arrival fumigation of potato seed-tubers from all sources is recommended. Treatments for potato seed tubers other than methyl-bromide fumigation will be considered on a case by case basis by Plant Biosecurity if recommended by an exporting country. Prior to the acceptance of an alternative treatment for potato seed tubers, Plant Biosecurity would need to assess the efficacy of that fumigant to ensure it gives an equal level of protection to methyl-bromide for all pests likely to be associated with the commodity.

Mandatory on-arrival fumigation may not be effective against tuber-borne pathogens including bacteria, viruses, viroids and phytoplasmas. Therefore, additional risk management measures are required for these pathogens.

Mandatory sodium hypochlorite treatment

Imported potato seed tubers must undergo sodium hypochlorite treatment (1% NaOCl for 2 hours) for surface sterilisation. This risk management measure will be effective against superficial contaminating bacterial propagules.

Treatment with sodium hypochlorite alone may not be effective against tuber-borne pathogens including bacteria, viruses, viroids and phytoplasmas. Therefore, additional mitigation measures are required for tuber-borne pathogens including bacteria, viruses, viroids and phytoplasmas.

Mandatory growth in PEQ facilities with pathogen screening

Imported potato microtubers or mintubers from unknown sources constitute a high risk which justifies Australia's strict post-entry quarantine procedures. Therefore, it is recommended that imported potato seed tubers must be grown in a closed government or DAFF Biosecurity approved PEQ facility for a minimum period of six months for visual observation of disease symptoms and pathogen screening and until the required pathogen screening/testing is completed. Details of pathogen screening are provided in section 3.2.2.

4 Framework for approval of high health sources, production requirements and evaluation of SASA

4.1 Framework for approval of high health sources

There are currently no sources approved to supply pathogen tested potato propagative material to Australia. However, Plant Biosecurity will consider requests for approval of overseas sources (e.g. institutions, NPPOs etc) based on the compliance with international standards and a rigorous examination of the proposed facilities.

Microplantlets produced from tested material in aseptic and/or controlled environments are not exposed to field-borne pests, and therefore represent a low pest risk. ISPM 33 outlines the production requirements of pest free potato (*Solanum* spp.) micropropagative material and minitubers for international trade. Australia will approve facilities/institutions producing potato tissue culture plantlets in accordance with ISPM 33 (https://www.ippc.int/file_uploaded/1323947686_ISPM_33_2010_En_2011-11-29_Refor.pdf) on case by case basis, with particular reference to the following:.

Capacity for National Authority oversight—facilities producing pathogen tested propagative material must be authorized/approved or operated directly by the National Plant Protection Organization (NPPO), as import conditions routinely require phytosanitary certification to be provided by the NPPO.

Capacity to produce pathogen tested propagative material—facilities must demonstrate their capacity to produce and maintain high health plant material through appropriate disease screening/testing and monitoring.

Capacity to meet containment and security requirements—facilities for the establishment of pest free propagative material and testing for pest freedom must be subject to strict physical containment and operational requirements to prevent contamination or infestation of material.

Audits and inspections—all facilities producing pathogen tested propagative material should be officially audited by DAFF to ensure that they continue to meet Australia's requirements.

Identity preservation systems—all facilities must be able to demonstrate their ability to maintain adequate and verifiable safeguards to ensure that propagative material undergoing post-entry quarantine procedures are not diverted, contaminated or intermingled with other material during and following completion of the quarantine measures.

On arrival verification—the requirement for the health status of all consignments of high health propagative material to be verified on-arrival through supporting documentation (e.g. Phytosanitary Certificate, NPPO reports, audit report etc.) and testing as required.

Based on this framework Australia will consider replacing the conditions for on-arrival pathogen screening with an equivalent set of conditions for approved sources. The key elements of material produced in approved sources require that:

- pathogen screening/testing must be equivalent to Australia's post-entry quarantine screening/testing

- Each consignment must have a certificate of testing issued by the approved source and certified by the NPPO of the exporting country
- On-arrival verification inspection and growth in a closed government PEQ facility for a minimum of three months to verify the application of phytosanitary measures
- Imported propagative material will be subjected to random verification testing for a range of pathogens
- Where any accredited source does not undertake the complete range of pathogen screening/testing required, those missing tests will be performed during growth in a government PEQ facility in Australia.

4.2 Production of potato propagative material in a protected environment

Production procedures for potato propagative material (tissue culture, microtubers/minitubers) will include:

- **Sourcing potato propagules**—tissue culture will be sourced from visually inspected and pathogen tested mother plants. Minitubers will be sourced from pest free potato micropropagative material (pests listed in Table 2.1). Propagation and laboratory testing must be conducted within a quality assurance program under the supervision of the NPPO.
- **Establishment in aseptic conditions**—pathogen tested potato propagative material will be established in an aseptic facility. Tissue culture will undergo *in vitro* micropropagation while microtubers/minitubers will be grown in a greenhouse using soil-less medium and irrigated with pest free water. Microplantlets must be visually inspected to ensure freedom from microbial contamination and maintenance of aseptic conditions. Pest free microplantlets must be kept clearly separated from pest vectors and non-pest-free plant material at all times during propagation, maintenance and shipping. Each consignment of microplantlets must be traceable to its mother plant.

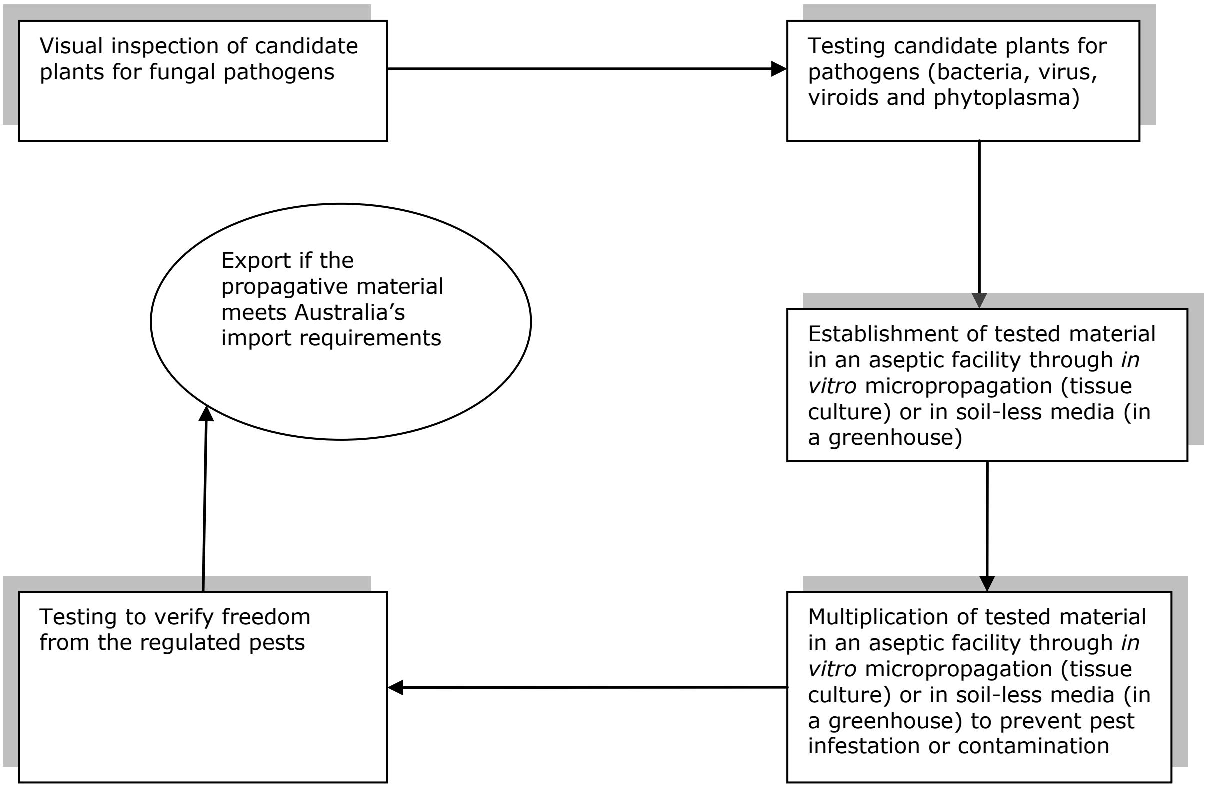
  Minitubers/microtubers must be propagated from certified pest free microplantlets. Production facilities must meet the requirements of a pest free site of production. The minituber establishment facility (i.e. a glasshouse) must be insect-proof with a double door entrance and provision for footwear disinfection prior to entering the protected environment. The facility must have aphid-proof ventilation screening on all intakes and exhaust openings and there must be no holes in the structure that would allow aphids to enter the protected environment. Additionally, neither field-produced seed potatoes nor non-seed potatoes should be grown in the same protected environment facility.
- **Maintenance**—pathogen tested potato propagative material must be maintained in an aseptic facility or in a protected environment (e.g., growth chamber, greenhouse etc.). Microplantlets and minitubers are propagated and maintained free from potato pests by ensuring their isolation from potato pests.
- **Multiplication—**pathogen tested potato propagules are multiplied in an aseptic facility and/or in a protected environment (e.g., growth chamber, greenhouse etc.). The production, maintenance and multiplication facility must be operated as a pest free production site (as described in ISPM 10) with respect to pests of concern (Table 2.1).
- **Testing**—a sample of propagative material must be tested for freedom from pests of quarantine concern (Table 2.1). Pre-export testing of potato foliage is a useful monitoring or survey procedure. However, it is not an appropriate method for determining the absence of PVY^{N} and PVY^{NTN}-like virus isolates in seed potato shipments because the distribution of the virus in the plant is uneven, virus titre in aging plants is low, and late season

infections cannot be detected. Therefore, a sample of tubers collected from the seed potato crop must be tested.

Visual crop inspection by the NPPO or NPPO approved inspectors should be done during the vegetative phase of microtuber/minituber production to ensure pest freedom and adherence of the facility and operational processes to quality standards. Post-harvest audit testing of microtubers/minitubers for one or more pests, serving as sentinel indicators of pest freedom status, should be conducted for each consignment.

These procedures will minimise the risk of pests occurring on potato propagative material produced in a protected environment. A flow chart showing production of pest free potato micropropagative material and minitubers is presented in Figure 4.1.

Figure 4.1: Production of pathogen tested free propagative material



4.3 Review of Science and Advice for Scottish Agriculture (SASA)

There are currently no sources approved to supply pathogen tested potato propagative material to Australia. The United Kingdom Potato Quarantine Unit (UKPQU) at Science and Advice for Scottish Agriculture (SASA) applied for accreditation to supply pathogen tested potato propagative material to Australia.

The UKPQU deals with the import and export of potato propagative material and has made a significant contribution to the development of potato quarantine procedures. The UKPQU procedures are based on the EPPO post-entry quarantine procedures for potato micropropagation (EPPO 2009), except that they are more stringent. In addition to standard EPPO post-entry quarantine procedures for potato propagation, the UKPQU conducts ELISA testing for viruses. Microplantlets undergo ELISA testing once, while glasshouse grown plants are tested twice. In addition, microplantlets are also tested for bacteria (including *Pectobacterium atrosepticum*, *Pectobacterium carotovorum* and *Dickya dianthicola*).

Propagative material at the UKPQU is subjected to visual inspection of tissue cultures for fungi; testing for bacteria; a combination of visual inspection, electron microscopy bioassay, ELISA conventional PCR/RT-PCR or real time PCR for viruses; PCR for phytoplasma and viroids; and visual inspection of tissue cultures for nematodes, insects and mites.

Plant Biosecurity has assessed SASA against the framework for the approval of overseas sources for potato propagative material outlined in section 4.1:

Capacity for National Authority oversight—facilities producing pathogen tested propagative material must be authorized/approved or operated directly by the National Plant Protection Organization (NPPO), as import conditions routinely require phytosanitary certification to be provided by the NPPO.

- SASA runs the UKPQU on behalf of the UK Plant Health Authorities. The UKPQU is overseen by an Inter-Departmental Committee comprising of the Scottish Government; the Food and Environment Research Agency (FERA) on behalf of the Department for Environment and Rural Affairs; the Department of Agriculture and Rural Development for Northern Ireland (DARD-NI); the British Society of Plant Breeders; and research and commercial interest groups. The Food and Environment Research Agency is the NPPO for the United Kingdom.

Capacity to produce pathogen tested propagative material—facilities must demonstrate their capacity to produce and maintain high health plant material through appropriate disease screening/testing and monitoring.

- The UKPQU has been involved in quarantine testing programmes for true potato seed from UK gene banks. Tested seed is held in the Commonwealth Potato Collection at the Scottish Crop Research Institute. The UKPQU collaborates with other potato quarantine scientists internationally to develop new methods, evaluate existing methods for pathogen diagnosis for potato quarantine purposes and to develop guidelines for the safe movement of potato germplasm.
- The *Seed Potatoes (Scotland) Regulations 2000* requires that seed stock derived from Scotland must originate from nuclear stock (*in vitro* pathogen tested microplantlets) produced by SASA. This ensures that the starting material is pathogen-free according to a programme of official testing for indigenous and EU-quarantine pathogens. The nuclear stock is tested for Potato spindle tuber viroid, *Clavibacter michiganensis* subsp. *sepedonicus* and *Ralstonia solanacearum*.
- Detection and identification of a range of potato pathogens is carried out at SASA, mainly in support of plant health regulations. The UKPQU conduct testing (as required by EU legislation) for following viruses:
    - Andean potato latent virus, Andean potato mottle virus, potato black ring spot virus, potato yellow virus, potato leafroll virus, PVA, PVM, PVS, PVT, PVV, PVX, PVY. Additional viruses tested at the UKPQU include: Arracha virus B-Oca strain, potato latent virus, potato mop top virus, PVP, potato yellow vein virus and tomato spotted wilt virus.
- SASA has a dedicated team of bacteriologists providing a range of services and conducting research and development projects on a wide range of bacterial plant pathogens. Most of the Bacteriology Unit's work is focused on bacterial pathogens of potato, though pathogens of strawberry are also covered. The provision of services are either in support of the

Scottish Seed Potato Classification Scheme or as part of Scotland's statutory obligation to ensure it remains free of range of quarantine organisms, specifically *Clavibacter michiganensis* subsp. *sepedonicus* and *Ralstonia solanacearum*. SASA also conduct annual surveys of Scottish potatoes for *Clavibacter michiganensis* subsp. *sepedonicus*, *Ralstonia solanacearum*, and *Dickeya* spp.

- The UKPQU is accredited by New Zealand MAF to supply pathogen tested potato propagative material to New Zealand. To create a specific program for New Zealand, UKPQU included additional tests as required by MAF (electron microscopy and the use of genus-specific primers for detection of viruses). The pathogen testing conducted by the UKPQU for New Zealand is provided in Table 4.1.

Table 4.1 Pathogen testing at the UKPQU for New Zealand

PATHOGEN TYPE	TESTS	PATHOGEN TYPE	TESTS
Bacteria			
Clavibacter michiganensis subsp. *sepedonicus*	V, IF, or E,M or P, M	*Dickeya paradisiaca*	V,S
Dickeya parthenii	V,S	*Pectobacterium betavasculorum*	V,S
Fungi			
Aecidium cantensis	V	*Phoma andigena* var. *andina*	V
Phytophthora infestans (A2 mating type)	V	*Synchytrium endobioticum*	V
Phytoplasma			
Eggplant little leaf phytoplasma	PP	Potato marginal flavescence	PP
Potato phyllody phytoplasma	PP	Potato purple top roll phytoplasma	PP
Potato purple top wilt phytoplasma	PP	Potato round leaf phytoplasma	PP
Potato stolbur phytoplasma	PP	Potato witches broom phytoplasma	PP
Viroids			
Potato spindle tuber viroid	R or D or P		
Viruses			
Andean potato latent virus	E, I	Andean potato mottle virus	E, I
Arracacha virus B – Oca strain	E, I	Beet curly top virus	PG
Eggplant mottled virus	I	Potato 14R virus	V
Potato black ringspot virus	E, I	Potato deforming mosaic virus	EG or PG
Potato latent virus	PG	Potato mop-top virus	E, I
Potato rough dwarf virus	PG	Potato virus P	PG
Potato virus T	E, I	Potato virus U	I
Potato virus V	EG or PG	Potato virus Y	EG or PG, I
Potato yellow dwarf virus	I	Potato yellow mosaic virus	I
Potato yellow vein virus	P or N	Potato yellowing virus	E
Solanum apical leaf curling virus	V	Solanum yellows virus	V
Southern potato latent virus	V	Sowbane mosaic virus	I
Tobacco necrosis virus	I	Tobacco rattle virus	I, P
Tobacco streak virus	I	Tomato black ring virus	E, I
Tomato infectious chlorosis virus	P	Tomato leaf curl New Delhi virus	I
Tomato yellow leaf curl virus	EG, or PG	Tomato yellow mosaic virus	EG or PG, I
Wild potato mosaic virus	I		

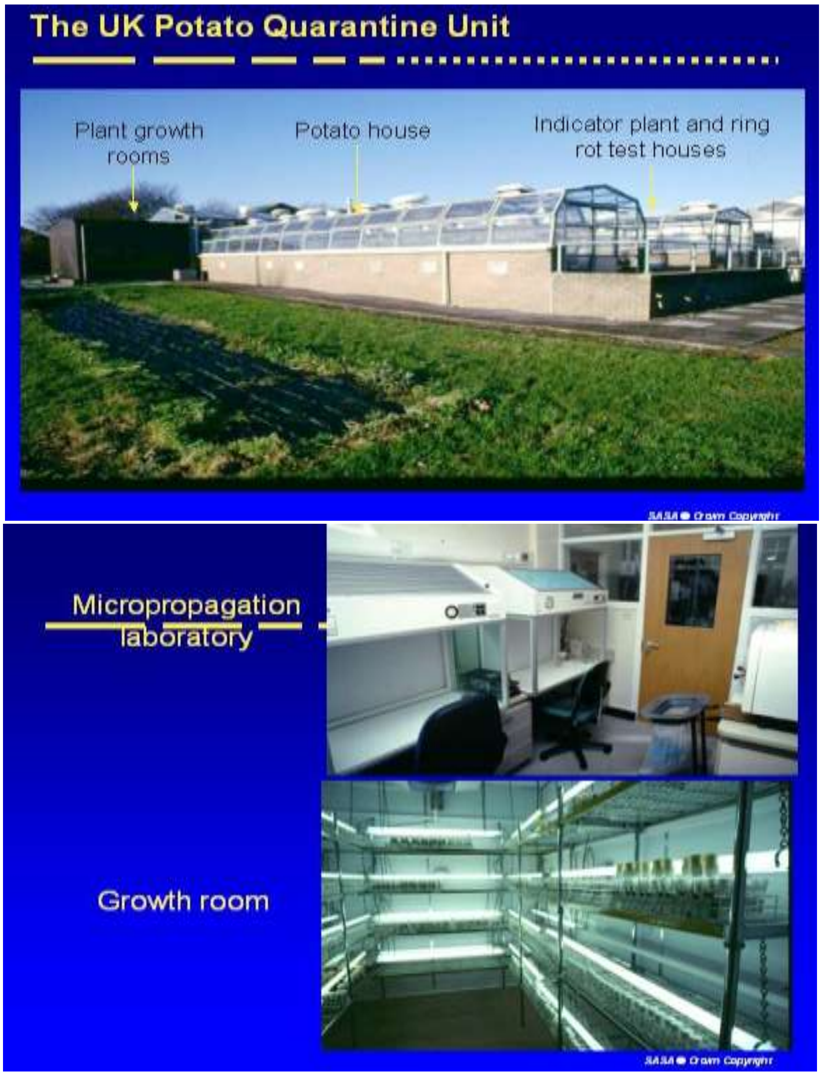
D: Digoxigenin probe **E:** pathogen specific ELISA **EG:** Genus specific ELISA
I: Indicator plants **IF:** Immunofluorescence microscopy
M: Visual examination of Murashige and Skoog medium **N:** Nucleic acid probe
P: pathogen specific PCR **PG:** Virus genus specific PCR **PP:** Phytoplasma PCR
R: Return PAGE **S:** Selective pectate medium **V:** Growing season inspection

Pathogen screening/testing currently undertaken at UKPQU to meet The *Seed Potatoes (Scotland) Regulations 2000*, EU legislation and New Zealand requirement covers most of the pathogens of quarantine concern to Australia. However there are few pathogens that are not covered by the testings in place at UKPQU. Therefore Plant Biosecurity suggests that UKPQU develop a specific testing program for Australia to test for all pathogens identified by Australia.

Capacity to meet containment and security requirements—facilities for the establishment of pest free propagative material and testing for pest freedom must be subject to strict physical containment and operational requirements to prevent contamination or infestation of material.

- All work at the UKPQU is conducted in a purpose built quarantine facility with glasshouses, growth rooms and laboratories (Figure 4.2). The quarantine facility also has two dedicated micropropagation laboratories and a tissue culture growth room, separate from the main quarantine facility.

Figure 4.2: UKPQU potato propagative material quarantine facilities



(Source: SASA)

Identity preservation systems—all facilities must be able to demonstrate their ability to maintain adequate and verifiable safeguards to ensure that propagative material undergoing post-entry quarantine procedures is not diverted, contaminated or intermingled with other material during and following completion of the quarantine measures.

- Each unit of potato propagative material is established as *in vitro* microplantlet cultures, observed over a growing season in the glasshouse for the presence of diseases and tested for specific pathogens. The testing done by the UKPQU exceeds EPPO requirements. Material released by the UKPQU is issued with a plant passport and may be planted without further testing anywhere in the European Union.

Audits and inspections—all facilities producing pathogen tested propagative material should be officially audited by DAFF to ensure that they continue to meet Australia’s requirements.

- DAFF officials visited and reviewed the UKPQU against the framework outlined in Section 4.1 for approval of overseas sources to supply pathogen tested potato propagative material to Australia.
- Based on technical discussions, production site visits to Scotland (June 2010) and assessment of SASA against the approval framework, Plant Biosecurity considers that SASA meets the criteria outlined in the framework for approval of sources of high health plant material. Therefore, Plant Biosecurity proposes that:
- the United Kingdom Potato Quarantine Unit (UKPQU) at Science and Advice for Scottish Agriculture (SASA) be approved as a high health source to supply pathogen tested potato propagative material and
- potato propagative material from UKPQU must be subjected to reduced period of growth in a closed government PEQ facility.

4.3.1 Phytosanitary requirements for potato propagative material from UKPQU

Potato propagative material produced in UKPQU will require:

- Each consignment must accompany Phytosanitary certificate issued by FERA with additional declaration that ‘potato propagative material in this consignment has been tested and found free of pests identified by Australia’
- Consignments from UKPQU must be subjected to mandatory on-arrival verification inspection and growth in a closed government PEQ facility for a minimum of three months to verify the application of phytosanitary measures
  - Imported potato propagative material must be subjected to random verification test for a range of pathogens.
- If pathogens of quarantine concern are detected during random verification tests the whole consignment will be subject to the same conditions for potato propagative material from all sources.

5 Conclusion

The findings of this draft review of policy are based on a comprehensive analysis of the scientific literature. This review has identified pathogens of quarantine concern associated with potato propagative material (true potato seed, tissue culture and potato seed tubers). Currently, potato seed tubers are not allowed entry into Australia. This draft review supports the existing policy for field grown potato seed tubers. However, propagative material produced *in vitro* and/or in a protected environment has a lower pest risk than field grown material because it is not exposed to field-borne pests. Therefore, alternative risk management measures can be applied to propagative material produced in a protected environment.

The ultimate goal of Australia's existing phytosanitary measures is to protect plant health and prevent the introduction of identified quarantine pathogens. Plant Biosecurity considers that the risk management measures proposed in this draft review of policy will be adequate to mitigate the risks posed by the identified biosecurity risks. Specifically, the proposed risk management measures for propagative material from different sources are:

All sources (unknown health status)

- **True potato seed:** existing conditions, mandatory on-arrival inspection, fungicidal treatment, growth in a closed government PEQ facility for a minimum period of six months for visual observation; and
- active testing including polymerase chain reaction (PCR) test for PSTVd and other seed-borne viruses.
- **Tissue culture:** general high risk tissue culture conditions; growth in closed government PEQ facilities for a minimum period of six months for visual observation; and
- active pathogen testing including bio-assay on indicator plants, generic nested primer PCR for phytoplasma, PCR for Potato spindle tuber viroid (PSTVd), generic PCR tests for Potyvirus, Carlavirus, Begomovirus, Crinivirus and Potexvirus and if required pathogen specific ELISA or PCR.
- **Microtubers or minitubers (produced in a protected environment):** general nursery stock conditions, growth in closed government PEQ facilities for a minimum period of six months for visual observation; and
- active pathogen testing including bio-assay on indicator plants, generic nested primer PCR for phytoplasma, PCR for Potato spindle tuber viroid (PSTVd), generic PCR tests for Potyvirus, Carlavirus, Begomovirus, Crinivirus and Potexvirus and if required pathogen specific ELISA or PCR.

Framework for approved sources

Prior to this review, Australia did not have an existing framework for approval of overseas sources to supply pathogen tested potato propagative material to Australia. However, DAFF Biosecurity has proposed a new framework to consider requests for approval of overseas sources, with the following requirements:

- Must meet the requirements of ISPM 33 'Pest free potato (*Solanum* spp) micropropagative material and minitubers for international trade' (FAO 2010), and specifically demonstrate:
  - capacity for national authority oversight;
  - capacity to produce pathogen tested propagative material;
  - capacity to meet containment and security requirements;

  - capacity to meet DAFF Biosecurity audit and inspection requirements;
  - presence of identity preservation systems; and
  - on-arrival verification of pathogen tested status of propagative material.

Approval of SASA, UK)

Based on technical discussions, production site visits to Scotland (June 2010) and assessment against the approval of overseas sources framework, Plant Biosecurity considers that the United Kingdom Potato Quarantine Unit (UKPQU) at Science and Advice for Scottish Agriculture (SASA) meets the criteria outlined in the framework for approval of sources of high health plant material. Therefore, Plant Biosecurity proposes that:

- the United Kingdom Potato Quarantine Unit (UKPQU) at Science and Advice for Scottish Agriculture (SASA) be approved as a high health source to supply pathogen tested potato propagative material and
- potato propagative material from UKPQU be grown for a minimum of 3 months in a government PEQ facility.

Potato propagative material produced in UKPQU will require:

- Phytosanitary certificate issued by FERA with additional declaration that 'potato propagative material in this consignment has been tested and found free of pests identified by Australia'
- On arrival mandatory verification inspection and growth in a closed government PEQ facility for three months to verify the application of phytosanitary measures
  - random verification testing for a range of pathogens
- If pathogens of quarantine concern are detected during random verification tests the whole consignment will be subject to the same conditions for potato propagative material from all sources.

Appendices

Appendix A: Initiation and categorisation of pests associated with potato worldwide

Initiation identifies the pests which occur on *Solanum tuberosum*, their status in Australia and their pathway association. In this assessment **pathway** is defined as potato propagative material (true potato seed, potato seed tubers and tissue culture).

Pest categorisation identifies the potential for pests to enter, establish, spread and cause economic consequences in Australia to determine if they qualify as quarantine pests.

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
PATHOGENS					
BACTERIA					
Candidatus Liberibacter psyllaurous Hansen *et al*. 2008 [Rhizobiales: Rhizobiaceae]	Not known to occur	**Yes.** *Candidatus* Liberibacter psyllaurous is a phloem-limited bacterium and can be associated with all vegetative parts of host plants (Cooke *et al.* 2009; MAFBNZ 2008). This bacterium has been detected in symptomatic as well as asymptomatic plants (MAFBNZ 2008). Therefore, this bacterium could be introduced into Australia in infected propagative material.	**Yes:** This bacterium has established in areas with a wide range of climatic conditions (Abdullah 2008; MAFBNZ 2008; Munyaneza *et al*. 2007) and has spread naturally in infected propagative material (Cooke *et al*. 2009). The natural vector of this bacterium, *Bactericera cockerelli*, (Hansen *et al*. 2008) is not present in Australia. However, the symptomless nature of this bacterium may contribute to the inadvertent propagation and distribution of infected material that will help it spread within Australia. Therefore; this bacterium has the potential for establishment and spread in Australia.	**Yes:** This bacterium affects solanaceous crops including capsicum, potato and tomato; however, symptoms of infection vary in severity and are influenced by host, cultivar, temperature and growing conditions (Liefting *et al*. 2009). This bacterium causes significant losses in potatoes, as yield losses of up to 85% and 50% in western North America during 2001 and 2004, respectively, have been reported (Hansen *et al*. 2008). Tubers from zebra chip affected plants produced potatoes unmarketable for potato chips (Munyaneza *et al*. 2008). This bacterium can also cause severe economic losses in all market classes of potatoes (Secor *et al*. 2009). Therefore, this bacterium has a potential for economic consequences in	**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
				Australia.	
Clavibacter michiganensis subsp. *sepedonicus* (Spieckermann & Kotthoff 1914) Davis *et al*. 1984 [Actinomycetales: Microbacteriaceae]	Not known to occur	**Yes**: This bacterium causes vascular disease and can be associated with all vegetative parts of the host (Pankova *et al*. 2007). Therefore, this bacterium could be introduced into Australia in infected propagative material.	**Yes**: This bacterium has established in areas with a wide range of climatic conditions (van der Wolf *et al*. 2005) and it can spread naturally in infected propagative material (Pankova *et al*. 2007; van der Wolf *et al*. 2005). Therefore, this bacterium has the potential for establishment and spread in Australia.	Yes: This bacterium is considered the most destructive pathogen of potatoes (Pankova *et al*. 2007) as it causes significant economic losses (van der Wolf *et al*. 2005). Losses caused by this bacterium are estimated €15 million annually (van der Wolf *et al*. 2005). Additionally, this bacterium is considered of quarantine significance by APPPC, IAPSC, COSAVE and JUNAC (van der Wolf *et al*. 2005). Presence of this bacterium in Australia would impact upon Australia's ability to access overseas markets. Therefore, this bacterium has a potential for economic consequences in Australia.	**Yes**
Dickeya chrysanthemi (Burkholder *et al*. 1953) Samson *et al*. 2005 [Enterobacteriales: Enterobacteriaceae]	Yes (Cother *et al*. 1992)	Assessment not required			
Dickeya dadantii Samson *et al*. 2005 [Enterobacteriales: Enterobacteriaceae]	Not known to occur	**Yes**: *Dickeya* species infect plants systemically (Czajkowski *et al*. 2010) and may remain latent for long periods (Jeffries 1998). This may lead to the propagation and distribution of infected propagative material (Tsror *et al*. 2009); suggesting *Dickeya* species	**Yes**: *Dickeya* species have established in areas with a wide range of climatic conditions (Toth *et al*. 2011; Slawiak *et al*. 2009; Tsror *et al*. 2009; Tsror *et al*. 2011; Parkinson *et al*. 2009; Palacio-Bielsa *et al*. 2006) and it can spread naturally in infected propagative	**Yes**: *Dickeya* species are economically important pathogens of potatoes (Toth *et al*. 2011) and ornamentals around the world (Parkinson *et al*. 2009). *Dickeya* infections resulted in 20–25% yield reduction (Tsror *et al*. 2009). Direct losses caused by *Dickeya* infections result in downgrading or rejection of potatoes during seed	**Yes**
Dickeya dianthicola Samson *et al*. 2005 [Enterobacteriales: Enterobacteriaceae]	Not known to occur				**Yes**
Dickeya dieffenbachiae Samson *et al*. 2005 [Enterobacteriales: Enterobacteriaceae]	Not known to occur				**Yes**
Dickeya paradisiaca (Fernandez-Borrero and Lopez-Duque 1970) Samson *et al*. 2005 [Enterobacteriales:	Not known to occur				**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
Enterobacteriaceae]		could be introduced into Australia.	material (Czajkowski *et al*. 2010). Therefore, *Dickeya* species have the potential for establishment and spread in Australia.	certification (Toth *et al*. 2011). Therefore, *Dickeya* species have potential for economic consequences in Australia.	
Dickeya parthenii Samson *et al*. 2005 [Enterobacteriales: Enterobacteriaceae]	Not known to occur				**Yes**
Dickeya solani sp. nov. [Enterobacteriales: Enterobacteriaceae]	Not known to occur				**Yes**
Dickeya zeae Samson *et al*. 2005 [Enterobacteriales: Enterobacteriaceae]	Yes (Samson *et al*. 2005)	Assessment not required			
Pectobacterium atrosepticum (van Hall 1902) Gardan *et al*. 2003 [Enterobacteriales: Enterobacteriaceae]	Yes (APPD 2010)	Assessment not required			
Pectobacterium betavasculorum (Thomson *et al*. 1984) Gardan *et al*. 2003	Not known to occur	**Yes:** *Pectobacterium* species are associated with soft rot of potatoes and are associated with seed tubers (van der Merwe *et al* 2010). These bacteria cause blackening and vascular discoloration (van der Merwe *et al*.2010; El-Tassa and Duarte 2006; Duarte *et al*. 2004) and cause latent infection in tubers (Pérombelon 2002).Therefore, *Pectobacterium* species could be introduced into Australia in infected propagative material.	**Yes:** *Pectobacterium* species associated with potatoes have established in areas with a wide range of climatic conditions (Marquez-Villavicencio *et al*. 2011; Pitman *et al*. 2010; Ma *et al*. 2007) and can spread naturally in infected propagative material (van der Merwe *et al*. 2010; El-Tassa and Duarte 2006). Therefore, *Pectobacterium* species have the potential for establishment and spread in Australia.	**Yes:** *Pectobacterium* species cause wilting, soft rot and blackleg and affect plant health during field production and storage (Marquez-Villavicencio *et al*. 2011). Some strains of *Pectobacterium* species are more aggressive on tubers and stems, and infected plants may wilt and ultimately die (Marquez-Villavicencio *et al*. 2011; Duarte *et al*. 2004). *Pectobacterium* species cause severe economic losses to the potato seed and commercial production industries (van der Merwe *et al*. 2010). Therefore, these pathogens have potential for economic consequences in Australia.	**Yes**
Pectobacterium carotovorum subsp. *brasiliensis* Duarte *et al*. 2004 [Enterobacteriales: Enterobacteriaceae]	Not known to occur				**Yes**
Pectobacterium wasabiae (Goto & Matsumoto 1987) Gardan *et al*. 2003 [Enterobacteriales: Enterobacteriaceae]	Not known to occur				**Yes**
Pectobacterium carotovorum (Jones 1901) Gardan *et al*. 2003) [Enterobacteriales: Enterobacteriaceae]	Yes (Horne *et al*. 2002)	Assessment not required			
Ralstonia solanacearum (Smith 1896)	Not known to	**Yes:** Strains of this	**Yes:** Strains of this	**Yes:** This soil-borne bacterial	**Yes**

Pest	**Present within Australia**	**Potential to be on pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Quarantine pest?**
Yabuuchi *et al*. 1996 [Burkholderiales: Burkholderiaceae]	occur[5]	bacterium cause potato plants to wilt and cause latent infection in seed tubers (Graham *et al*. 1979). Therefore, strains of this bacterium could be introduced into Australia in infected propagative material.	bacterium that are associated with potatoes are established in areas with a wide range of climatic conditions (Fegan and Prior 2005) and can spread naturally in infected propagative material (Graham *et al*. 1979). Therefore, this bacterium has the potential for establishment and spread in Australia.	pathogen is a major limiting factor in the production of many crop plants around the world (Olson 2005). This organism is the causal agent of brown rot of potato, bacterial wilt or southern wilt of tomato, tobacco, eggplant, and some ornamentals, and Moko disease of banana (Olson 2005). This bacterium is considered to be a quarantine pest by NAPPO and the presence of strains of this bacterium in Australia would impact upon Australia's ability to access overseas markets. Therefore, RS strains have a potential for economic consequences in Australia.	
Streptomyces acidiscabies Lambert and Loria 1989 [Actinomycetales: Streptomycetaceae]	Not known to occur	**Yes**: *Streptomyces* species cause scab on tubers (Wale *et al*. 2008; Park *et al*. 2003) and are well adapted saprophytes that persist in soil on decaying organic matter (Wale *et al*. 2008). Therefore,poatato tubers	**Yes**: *Streptomyces* species associated with potatoes have established in areas with a wide range of climatic conditions (Bouchek-Mechiche *et al*. 2006; Jaekyeong *et al*. 2004; Park *et al*. 2003) and can spread	**Yes**: Plant-pathogenic *Streptomyces* species cause diseases on a diverse range of root crops such as potato, radish, turnip, beet, carrot and sweet potato (Goyer and Beaulieu 1997; Labeda and Lyons 1992). Scab diseases are characterized by	**Yes**
Streptomyces caviscabiei Goyer *et al*. 1996 [Actinomycetales: Streptomycetaceae]	Not known to occur				**Yes**
Streptomyces europaeiscabiei Bouchek-Mechiche *et al*. 2000 [Actinomycetales:	Not known to occur				**Yes**

[5] Race 1 and race 3 are present in Australia (Graham *et al*. 1979); however, other strains of *Ralstonia solanacearum* (RS) are not present in Australia. Strains of *Ralstonia solanacearum* are differentiated into five races according to host range and five biovars based on biochemical tests (He *et al*. 1983; Buddenhagen and Kelman 1964; Hayward 1964). However, the race and biovar classifications do not correspond to each other, except that race 3 strains causing potato brown rot are generally equivalent to biovar 2, and referred to as race 3 biovar 2 strains. There are no standard laboratory tests to define the "race" of RS because host ranges of RS strains are broad and often overlap. Recently an interspecies characterization of *Ralstonia solanacearum* based on nucleotide sequence analysis has been introduced to distinguish RS strains (Fegan and Prior 2005). Based on nucleotide sequence analysis four phylotypes of RS has been identified that accommodate sequevars as subgroups (Fegan and Prior 2005).

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
Streptomycetaceae]		provide a pathway for these pathogens.	naturally in infected propagative material (van der Merwe *et al*. 2010; El-Tassa and Duarte 2006). Therefore, *Streptomyces* species have the potential for establishment and spread in Australia.	corky lesions on potato tubers and expanded tap roots and cause economically significant losses in yield (Jaekyeong *et al*. 2004). *Streptomyces* species are considered by several countries as of quarantine concern. The presence of *Streptomyces* species in Australia would impact upon Australia's ability to access overseas markets. Therefore, *Streptomyces* species have a potential for economic consequences in Australia.	
Streptomyces luridiscabiei Park *et al* 2003 [Actinomycetales: Streptomycetaceae]	Not known to occur				**Yes**
Streptomyces niveiscabiei Park *et al* 2003 [Actinomycetales: Streptomycetaceae]	Not known to occur				**Yes**
Streptomyces puniciscabiei Park *et al* 2003 [Actinomycetales: Streptomycetaceae]	Not known to occur				**Yes**
Streptomyces reticuliscabiei Bouchek-Mechiche *et al*. 2000 [Actinomycetales: Streptomycetaceae]	Not known to occur				**Yes**
Streptomyces scabiei (Thaxter 1891) Waksman and Henrici 1948 [Actinomycetales: Streptomycetaceae]	Yes (Horne *et al*. 2002)	Assessment not required			
Streptomyces stelliscabiei Bouchek-Mechiche *et al*. 2000 [Actinomycetales: Streptomycetaceae]	Not known to occur	**Yes**: *Streptomyces* species cause scab on tubers (Wale *et al*. 2008) and are well adapted saprophytes that persist in soil on decaying organic matter (Wale *et al*. 2008; Song *et al*. 2004). Therefore, potato tubers do provide a pathway these pathogens.	**Yes**: *Streptomyces* species associated with potatoes have established in areas with a wide range of climatic conditions (Bouchek-Mechiche *et al*. 2006; Jaekyeong *et al*. 2004; Park *et al*. 2003) and can spread naturally in infected propagative material (van der Merwe *et al*. 2010; El-Tassa and Duarte 2006). Therefore, *Streptomyces* species have the potential for establishment and spread in Australia.	**Yes**: Plant-pathogenic *Streptomyces* species cause diseases on a diverse range of root crops such as potato, beet, carrot and sweet potato (Goyer and Beaulieu 1997; Labeda and Lyons 1992). Scab diseases are characterized by corky lesions on potato tubers and expanded tap roots and cause economically significant losses in yield (Jaekyeong *et al*. 2004). *Streptomyces* species are considered by several countries as of quarantine concern. The presence of *Streptomyces* species would impact upon	**Yes**
Streptomyces turgidiscabies Miyajima *et al*. 1998 [Actinomycetales: Streptomycetaceae]	Not known to occur				**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
				Australia's ability to access overseas markets. Therefore, *Streptomyces* species have a potential for economic consequences in Australia.	
FUNGI					
Aecidium cantensis Arthur [Anamorphic Pucciniales]	Not known to occur	**Yes**: This fungus is associated with foliage causing rust pustules on leaves, petioles and stems (Hooker 1981). The fungus can survive throughout the year on plants (Stevenson *et al*. 2001). Therefore, this fungus could be introduced into Australia in infected propagative material.	**Yes:** This pathogen has established in areas with a wide range of climatic conditions (Stevenson *et al*. 2001) and can spread naturally in infected propagative material. Therefore, it has the potential for establishment and spread in Australia.	**Yes**: This pathogen can cause economic losses under rainy conditions in potatoes (Stevenson *et al*. 2001). Additionally, this fungus also affects tomatoes (Stevenson *et al*. 2001; Hooker 1981). Therefore, this fungus has the potential for economic consequences in Australia.	**Yes**
Alternaria alternata (Fr.) Keissl. [Pleosporales: Pleospraceae]	Yes (APPD 2010)	Assessment not required			
Alternaria solani Sorauer [Pleosporales: Pleospraceae]	Yes (Horne *et al.* 2002)	Assessment not required			
Athelia rolfsii (Curzi) C.C. Tu & Kimbr [Atheliales : Atheliaceae]	Yes (APPD 2010)	Assessment not required			
Botrytis cinerea Pers. [Helotiales: Screotiniaceae]	Yes (Floyd 2010)	Assessment not required			
Cercospora solani-tuberosi Thirum. [Capnodiales: Mycosphaerellaceae]	Not known to occur	No: This species is associated with foliage (Tian *et al.* 2008) and propagative material does not provide a pathway for this species.	Assessment not required		
Choanephora cucurbitarum (Berk. & Ravenel) Thaxt. [Mucorales :	Yes (APPD 2010)	Assessment not required			

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
Choanephoraceae]					
Colletotrichum coccodes (Wallr.) S. Hughes [Incertae sedis: Glomerellaceae]	Yes (Horne *et al.* 2002)	Assessment not required			
Fusarium acuminatum Ellis & Everh [Hypocreales: Nectriaceae]	Yes (APPD 2010)	Assessment not required			
Fusarium arthrosporioides Sherbakoff [Hypocreales: Nectriaceae]	Yes (APPD 2010)	Assessment not required			
Fusarium avenaceum (Fr.) Sacc. [Hypocreales: Nectriaceae]	Yes (Summerell *et al*. 2011)	Assessment not required			
Fusarium coeruleum Lib. ex Sacc. [Hypocreales: Nectriaceae]	Yes (Chambers and Millington 1974)	Assessment not required			
Fusarium crookwellense Burgess *et al.* [Hypocreales: Nectriaceae]	Yes (Summerell *et al*. 2011)	Assessment not required			
Fusarium culmorum (W. G. Smith) Sacc. [Hypocreales: Nectriaceae]	Yes (Summerell *et al*. 2011)	Assessment not required			
Fusarium equiseti (Corda) Sacc. [Hypocreales: Nectriaceae]	Yes (Summerell *et al*. 2011)	Assessment not required			
Fusarium graminearum Schwabe [Hypocreales: Nectriaceae]	Yes (Summerell *et al*. 2011)	Assessment not required			
Fusarium javanicum Koord. [Hypocreales: Nectriaceae]	Not known to occur	No: This fungus is associated with host plant roots and therefore propagative material does not provide a pathway for this fungus.	Assessment not required		
Fusarium oxysporum Schltdl. [Hypocreales: Nectriaceae]	Yes (Summerell *et al*. 2011)	Assessment not required			
Fusarium sambucinum Fuckel [Hypocreales: Nectriaceae]	Yes (Summerell *et al*. 2011)	Assessment not required			
Fusarium solani (Mart.) Appel & Wollenweber emend. Snyder & Hansen [Hypocreales: Nectriaceae]	Yes (Summerell *et al*. 2011)	Assessment not required			

Pest	**Present within Australia**	**Potential to be on pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Quarantine pest?**
Fusarium sulphureum Schlect [Hypocreales: Nectriaceae]	Yes (Osborn 1995)	Assessment not required			
Fusarium tabacinum (J.F.H. Beyma) W. Gams [Hypocreales: Nectriaceae]	Yes (Osborn 1995)	Assessment not required			
Fusarium trichothecioides Wollenweber [Hypocreales: Nectriaceae]	Yes (APPD 2010)	Assessment not required			
Gerwasia pittieriana (Henn.) León-Gall. & Cummins [Pucciniales: Pucciniaceae] (synonyms: *Puccinia pittieriana* Henn.)	Not known to occur	**Yes**: This microcyclic fungus is associated with foliage and causes rust pustules on leaves and stems (Hooker 1981). The fungus could be introduced on leaves of living material (e.g. material imported for breeding purposes), or on dead plant material or crop residues (OEPP/EPPO 1988). Therefore, this fungus could be introduced into Australia on infected or contaminated propagative material.	**Yes:** This pathogen has established in areas with a wide range of climatic conditions (Hooker 1981) and can spread naturally in infected propagative material (OEPP/EPPO 1988). Therefore, it has the potential for establishment and spread in Australia.	**Yes:** This pathogen is of significant economic importance in several countries. Epidemic development may result in the death of most plants and severe yield loss (Stevenson *et al*. 2001). This fungus is considered of quarantine significance by EPPO (OEPP/EPPO 1988). The presence of this species in Australia would impact upon Australia's ability to access overseas markets. Therefore, this fungus has the potential for economic consequences in parts of Australia.	**Yes**
Golovinomyces cichoracearum var. *cichoracearum* (DC.) V.P. Heluta [Erysiphales Erysiphaceae]	Yes (APPD 2010)	Assessment not required			
Helicobasidium brebissonii (Desm.) Donk [Helicobasidiales: Helicobasidiaceae] (synonym: *Helicobasidium purpureum* Donk)	Yes (Shivas 1989)	Assessment not required			
Helminthosporium solani Durieu & Mont. [Pleosporales: Massarinaceae]	Yes (Horne *et al.* 2002)	Assessment not required			
Macrophomina phaseolina (Tassi) Goid. [Botryosphaeriales: Botryosphaeriaceae]	Yes (APPD 2010)	Assessment not required			

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
Passalora concors (Casp.) U. Braun & Crous [Capnodiales: Mycosphaerellaceae]	Yes (APPD 2010)	Assessment not required			
Phoma andigena var. *andina* Turkenst. [Anamorphic Leptosphaereceae]	Not known to occur	**Yes**: These pathogens are associated with foliage and stems (Stevenson *et al*. 2001; Agrios 1997). These pathogens survive in soil on crop debris or as chlamydospores in the soil (Stevenson *et al*. 2001). Therefore, *Phoma* species could be introduced into Australia in soil adhering to the potato tubers.	**Yes**: These pathogens have established in areas with a wide range of climatic conditions (Cline 2005a, b) and can spread naturally in infected or contaminated propagative material. Therefore, these pathogens have the potential to establish and spread in Australia.	**Yes**: *Phoma* leaf spot is an important disease in areas where it is established. In susceptible cultivars, yield reductions due to *P. andigena* var. *andina* may reach 80% (Stevenson *et al*. 2001). Therefore, these *Phoma* species have potential for economic consequences in parts of Australia.	**Yes**
Phoma crystalliniformis (Loer. *et al*.) Noordel. & Gruyter [Anamorphic Leptosphaereceae]	Not known to occur				**Yes**
Phoma eupyrena Sacc [Anamorphic Leptosphaereceae]	Yes (APPD 2010)	Assessment not required			
Phoma exigua var. *exigua* Sacc. [Anamorphic Leptosphaereceae]	Yes (Wale *et al*. 2008)	Assessment not required			
Phoma exigua var. *foveate* Foister [Anamorphic Leptosphaereceae]	Yes (Stevenson *et al*. 2001)	Assessment not required			
Pleospora herbarum (Pers.) Rabenh [Pleosporales: Pleosporaceae]	Yes (Irwin *et al*. 1986)	Assessment not required			
Polyscytalum pustulans (M.N. Owen & Wakef.) M.B. Ellis [Anamorphic Pezizomycotina]	Yes (Stevenson *et al*. 2001)	Assessment not required			
Rhizoctonia solani JG Kuhn [Ceratobasidiales: Ceratobasidiaceae]	Yes (Horne *et al.* 2002)	Assessment not required			
Sclerotinia sclerotiorum (Lib.) de Bary [Helotiales: Sclerotiniaceae]	Yes (Horne *et al.* 2002)	Assessment not required			
Septoria lycopersici var. malagutii Ciccar. & Boerema ex E.T. Cline [Capnodiales:	Not known to occur	No: This pathogen is associated with foliage, causing leaf spot, and	Assessment not required		

Pest	**Present within Australia**	**Potential to be on pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Quarantine pest?**
Mycosphaerellaceae]		survives in plant debris (Stevenson *et al*. 2001). Therefore, propagative material does not provide pathway for this fungus.			
Spongospora subterranea (Wallr.) Lagerh. [Plasmodiophorida: Plasmodiophoraceae]	Yes (Stevenson *et al*. 2001)	Assessment not required			
Synchytrium endobioticum (Schilb.) Percival) [Chytridiales: Synchytriaceae]	Not known to occur	**Yes:** This pathogen infects meristematic tissues of growing points, buds, stolons tips, or young leaf primordia (Stevenson *et al*. 2001). Therefore, this fungus could be introduced into Australia in infected propagative material.	**Yes:** This fungus has established in areas with a wide range of climatic conditions and can spread naturally in infected propagative material (Wale *et al*. 2008). Therefore, it has the potential for establishment and spread in Australia.	**Yes:** *Synchytrium endobioticum* is a serious pathogen of potatoes. Once the pathogen has been introduced to a field of cultivated potatoes the whole crop may be devastated and unmarketable (EPPO 1982). Moreover, introduction into the soil not only renders the crop unusable but the soil itself cannot be used for further crop production due to the longevity of the fungus (EPPO 1982. Crops other than potato grown in this soil cannot be used for export (EPPO 1982; Hooker 1981). Therefore, this fungus has the potential for economic consequences in Australia.	**Yes**
Thecaphora solani Barrus [Urocystidiales: Glomosporiaceae]	Not known to occur	**Yes:** This pathogen is soil-borne and infects the meristem region of young sprouts and the hyphae are intercellular (Wale *et al*. 2008; Stevenson *et al*. 2001). The fungus produces galls below the	**Yes:** This pathogen has established in areas with a wide range of climatic conditions (Wale *et al*. 2008) and it can spread naturally in infected propagative material, irrigation water and by grazing livestock	**Yes:** This fungus is an important pathogen of potato crops (Bazan de Segura 1960). Losses of up to 85% have been reported (Stevenson *et al*. 2001). It directly infects the tubers, reducing the quantity and quality of the yield. Additionally, this fungus is	**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		soil line on stems, stolons and tubers (Stevenson *et al*. 2001). The fungus survives in soil (Wale *et al*. 2008) and soil adhering to seed tubers may contain spores of this fungus. Therefore, propagative material provides a pathway for this fungus.	(Stevenson *et al*. 2001). Therefore, this pathogen has the potential for establishment and spread in Australia.	considered of quarantine significance by EPPO (OEPP/EPPO 1979). The presence of this species in Australia would impact upon Australia's ability to access overseas markets. Therefore, this fungus has the potential for economic consequences in parts of Australia.	
Ulocladium atrum Preuss [Pleosporales: Pleosporaceae]	Yes (APPD 2010)	Assessment not required			
Verticillium albo-atrum Reinke & Berthold [Incertae sedis: Plectosphaerellaceae]	Not known to occur	**Yes**: *Verticillium* species can be carried in planting material, including tissue culture, as they colonise the vascular system (Stevenson *et al*. 2001). Therefore, propagative material provides a pathway for this fungus.	**Yes**: This pathogen has established in areas with a wide range of climatic conditions (Stevenson *et al*. 2001) and it can spread naturally in infected propagative material (Wale *et al*. 2008). Therefore, this pathogen has the potential for establishment and spread in Australia.	**Yes:** Verticillium wilt is an economically important disease. The disease causes early senescence of plants. Leaves become pale green or yellow and die prematurely (Hooker 1981). The disease may reduce potato yields and tuber size substantially. Yield losses of more than 40% have been recorded (Stevenson *et al*. 2001). Therefore, this fungus has the potential for economic consequences in Australia.	**Yes**
Verticillium dahliae Kleb. [Incertae sedis: Plectosphaerellaceae]	Yes (Horne *et* al. 2002)	Assessment not required			
STRAMINOPILA					
Phytophthora cryptogea Pethybr. & Laff. [Peronosporales: Peronosporaceae]	Yes (APPD 2010)	Assessment not required			
Phytophthora drechsleri Tucker	Yes (APPD	Assessment not required			

Pest	**Present within Australia**	**Potential to be on pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Quarantine pest?**
[Peronosporales: Peronosporaceae]	2010)				
Phytophthora erythroseptica Pethybr. [Peronosporales: Peronosporaceae]	Yes (Horne *et al*. 2002)	Assessment not required			
Phytophthora infestans (Mont.) de Bary [Peronosporales: Peronosporaceae] [A2 mating strain and exotic strains of both the A1 and A2)	Not known to occur	**Yes:** This pathogen infects foliage and stems and symptom development is weather dependant (Wale *et al*. 2008). Therefore, propagative material provides a pathway for this fungus.	**Yes**: This pathogen has established in areas with a wide range of climatic conditions (Wale *et al*. 2008) and it can spread naturally in infected propagative material (Wale *et al*. 2008). Therefore, this pathogen has the potential to establish and spread in Australia.	**Yes:** This pathogen is one of the most serious pathogens of potatoes (Stevenson *et al*. 2001, Wale *et al*. 2008). The pathogen can result in 100% crop loss (Wale *et al*. 2008). Therefore, this fungus has the potential for economic consequences in Australia.	**Yes**
Phytophthora megasperma Drechsler [Peronosporales: Peronosporaceae]	Yes (APPD 2010)	Assessment not required			
Phytophthora nicotianae Breda de Haan [Peronosporales: Peronosporaceae]	Yes (APPD 2010)	Assessment not required			
Pythium aphanidermatum (Edson) Fitzp. [Pythiales: Pythiaceae]	Yes (APPD 2010)	Assessment not required			
Pythium debaryanum R. Hesse [Pythiales: Pythiaceae]	Yes (APPD 2010)	Assessment not required			
Pythium deliense Meurs [Pythiales: Pythiaceae]	Yes (APPD 2010)	Assessment not required			
Pythium ultimum Trow [Pythiales: Pythiaceae]	Yes (APPD 2010)	Assessment not required			

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
PHYTOPLASMA[6]					
Candidatus Phytoplasma asteris [**16SrI** – Aster yellows group] [7] (Strains: Chinese potato phytoplasma, El Salvador potato phytoplasma, Iranian potato phytoplasma, Nebraska potato purple top phytoplasma, Peruvian (Andahuaylas) potato phytoplasma, Potato marginal flavescence phytoplasma, Potato phyllody phytoplasma, Potato purple-top roll phytoplasma, Potato purple-top wilt phytoplasma, Russian potato purple top phytoplasma, Texas potato purple top phytoplasma)	Not known to occur	**Yes**: Phytoplasmas are restricted to host phloem tissues (Stevenson *et al*. 2001; McCoy 1984). Symptom severity and type vary with different potato cultivars, environmental conditions, and the strain of pathogen involved (Jones *et al*. 2009). These phytoplasmas are associated with all vegetative parts of host plants including tubers (Jones *et al*. 2009). Therefore, propagative material provides a pathway for phytoplasmas.	**Yes**: These phytoplasmas have established in areas with a wide range of climatic conditions (Jones *et al*. 2009) and can spread naturally in infected propagative material (Stevenson *et al*. 2001). Multiplication and marketing of infected propagative material and leafhopper vectors present in Australia will help spread these phytoplasmas within Australia. Therefore, they have the potential to establish and spread in Australia.	**Yes**: These pathogens cause phyllody and virescence (Stevenson *et al*. 2001). Affected plants may exhibit vascular discoloration and wilting and may die prematurely (Stevenson *et al*. 2001). Agents of the aster yellows group of diseases cause considerable losses when incidences of infection are high (Jones *et al*. 2009). Therefore, this phytoplasma group have potential for economic consequences in Australia.	**Yes**
Candidatus Phytoplasma aurantifolia [**16SrII** – Peanut Witches' Broom Group][8]	Not known to	**Yes**: This group of phytoplasmas are	**Yes**: Phytoplasma associated with potato	**Yes**: Phytoplasma associated diseases are an important limiting	**Yes**

[6] Phytoplasmas are classified on the basis of molecular data obtained from 16S rDNA and other conserved genes into distinct groups, subgroups and species belonging to the newly-established '*Candidatus* Phytoplasma' taxon (IRPCM 2004). Initially, differentiation of the phytoplasma was based on the geographical origins of the diseases, the specific hosts and insect vectors and the symptoms exhibited by the host plant. However, given that the same phytoplasma strain may induce different symptoms in different hosts and different strains may share common vectors or cause diseases showing similar symptoms this approach did not provide an accurate means of phytoplasma classification (Weintraub and Jones 2010). Therefore, the designation of a new/distinct '*Candidatus* Phytoplasma' species is based on the nucleotide sequence of the 16S rRNA gene.

[7] The aster yellows group of diseases includes a broad spectrum of allied diseases caused by multiple groups of phytoplasmas (Leyva-López *et al.* 2002). There is considerable confusion over nomenclature in the potato literature as many different names have been used to describe the symptoms and to name the individual diseases in the group.

[8] Five different phytoplasma groups (16SrI, 16SrII, 16SrIII, 16SrVI, and 16SrXVIII) have been associated with PPT disease in different regions of North America and Mexico (Santos-Cervantes *et al*. 2010) and three different phytoplasma groups (16SrI, 16SrII and16SrXII-A) have been associated with PPT disease in Iran (Hosseini *et al*. 2010).

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
(Mexican potato purple top phytoplasma, Peruvian potato phytoplasma, Potato phytoplasma isolate Islamabad, Potato phytoplasma isolate Pot001)	occur[9]	associated with potato purple top disease and symptoms included rolling upward of the top leaves with reddish or purplish discoloration, proliferation of buds, shortened internodes, swollen nodes, aerial tubers, and early senescence (Munyaneza *et al*. 2009a; Lee *et al*. 2004). These phytoplasmas are associated with propagative material (Crosslin *et al*. 2011). Therefore, propagative material provides a pathway for this group of phytoplasmas.	purple top disease (PPT) have established in areas with a wide range of climatic conditions (Hosseini *et al*. 2011; Munyaneza 2010; Leyva-Lopez *et al*. 2002) and can spread naturally in infected propagative material (Crosslin *et al*. 2011). Multiplication and marketing of infected propagative material and leafhopper vectors present in Australia will help spread these phytoplasmas within Australia. Therefore, the PPT phytoplasma group have the potential to establish and spread in Australia.	factor of potato production (Leyva-Lopez *et al*. 2002). These diseases cause significant yield loss and reduction in tuber and seed quality (Munyaneza *et al*. 2007; Munyaneza 2005). This phytoplasma group is included among the non-European potato viruses of the EPPO A1 quarantine list (OEPP/EPPO 1984a, b). The presence of this phytoplasma group in Australia would impact upon Australia's ability to access overseas markets. Therefore, this phytoplasma group has the potential for economic consequences in Australia.	
Candidatus Phytoplasma pruni [**16SrIII** – X-Disease Group] (Alaska potato purple top phytoplasma, Mexican potato purple top phytoplasma COAHP, Mexican potato purple top phytoplasma GTOP, Montana potato purple top phytoplasma)	Not known to occur				**Yes**
Candidatus Phytoplasma trifolii [1**6SrVI** – Clover Proliferation Group] (Columbia Basin potato purple top phytoplasma, Potato purple top phytoplasma PPT, Potato purple top phytoplasma YN-6, Potato witches' broom phytoplasma, Washington potato purple top phytoplasma)	Not known to occur				**Yes**
Candidatus Phytoplasma solani [**16SrXII-A** – Stolbur Group] (strains: Eggplant little leaf phytoplasma, Potato stolbur phytoplasma, Potato round leaf phytoplasma, Potato witche's broom phytoplasma, Iranian potato purple top phytoplasma, Russian potato purple top phytoplasma Rus-PPT, Turkish potato	Not known to occur	**Yes**: This phytoplasma is associated with potato purple top disease (Hosseini *et al*. 2011; Secor *et al*. 2006). Foliar symptoms include stunting, chlorosis, slight purple coloration of new growth,	**Yes**: Phytoplasma associated with potato purple top disease have established in areas with a wide range of climatic conditions (Hosseini *et al*. 2011; Secor *et al*. 2006) and can spread naturally in	**Yes**: Phytoplasma associated diseases are an important limiting factor of potato production (Munyaneza 2006). This phytoplasma is involved in the disease complex contributing to defected processed products produced from infected potatoes.	**Yes**

Phytoplasmas are phloem-limited and insect-transmitted plant pathogens and mixed infections are common (Leyva-López *et al*. 2002, Hosseini *et al*. 2010, Santos-Cervantes *et al*. 2010).

[9] *Candidatus* Phytoplasma aurantifolia has been recorded in Australia (Davis *et al*. 1997; 2003; Strenten and Gibbs 2006); however, strains causing potato purple top disease are not present in Australia.

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
stolbur phytoplasma)		swollen nodes, proliferated axillary buds, and aerial tubers. Tuber symptoms include mild vascular discoloration and brown flecking of medullary rays (Secor *et al*. 2006). Phytoplasmas are generally restricted to phloem sieve tubes and are associated with all vegetative parts of host plants. Therefore, propagative material provides a pathway for these phytoplasmas.	infected propagative material. Multiplication and marketing of infected propagative material and leafhopper vectors present in Australia will help spread these phytoplasmas within Australia. Therefore, this phytoplasma group has the potential to establish and spread in Australia.	The defect consists of patchy brown discoloration of chips and can be a cause for rejection of contracted potatoes by the processor (Secor *et al*. 2006). This phytoplasma group is included among the non-European potato viruses of the EPPO A1 quarantine list (OEPP/EPPO 1984 a, b). The presence of this phytoplasma group in Australia would impact upon Australia's ability to access overseas markets. Therefore, this phytoplasma group has the potential for economic consequences in Australia.	
Mexican periwinkle virescence group (**16SrXIII)**	Not known to occur	**Yes**: This phytoplasma is associated with potato purple top disease (Santos-Cervantes *et al*. 2010; Lee *et al*. 2009). Symptoms of the disease are purple top or yellowing of upper leaflets, apical leafroll, axillary buds, and the formation of aerial tubers. Phytoplasma are generally restricted to phloem sieve tubes and are associated with all vegetative parts of host plants. Therefore, propagative material provides a pathway for	**Yes**: Phytoplasma associated with potato purple top disease have established in areas with a wide range of climatic conditions (Santos-Cervantes *et al*. 2010; Lee *et al*. 2009) and can spread naturally in infected propagative material. Multiplication and marketing of infected propagative material and leafhopper vectors present in Australia will help spread these phytoplasmas within Australia. Therefore, this	**Yes:** Potato purple top is a devastating disease that causes great economic loss to the potato industry through substantially reduced tuber yield and quality Santos-Cervantes *et al*. 2010; Lee *et al*. 2009). Chips and fries processed from infected tubers often develop brown discoloration, greatly reducing their marketability Santos-Cervantes *et al*. 2010; Lee *et* al. 2009). Therefore, this phytoplasma group has the potential for economic consequences in Australia.	

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		these phytoplasmas.	phytoplasma group has the potential to establish and spread in Australia.		
Candidatus Phytoplasma americanum [**16SrXVIII** – American Potato Purple Top Wilt Group] [10] (Strains APPTW1-TX, APPTW2-TX, APPTW9-NE and APPTW12- NE (subgroup 16SrXVIII-A) and APPTW 1883 #6-TX, APPTW10-NE and APPTW13-NE (subgroup 16SrXVIII-B)	Not known to occur	**Yes**: This phytoplasma is associated with potato purple top wilt and symptoms include stunting, chlorosis, slight purple discoloration of new growth, leaf curl, swollen nodes, broken axillary buds and the formation of aerial tubers (Lee *et al*. 2006). Phytoplasma are generally restricted to phloem sieve tubes (McCoy 1984) and are associated with all vegetative parts of host plants (Jones *et al*. 2009). Therefore, propagative material provides a pathway for this phytoplasma group.	**Yes**: Potato purple top wilt phytoplasma group has established in areas with a wide range of climatic conditions (Lee *et al*. 2006) and can spread naturally in infected propagative material (Lee *et al*. 2006). Multiplication and marketing of infected propagative material and leafhopper vectors present in Australia will help spread these phytoplasmas within Australia. Therefore, the PPT phytoplasma group has the potential to establish and spread in Australia.	**Yes**: Potato purple top wilt is a devastating disease of potato This group of phytoplasmas causes ‘dark chips’ produced from infected tubers. Chip defect has resulted in a considerable economic loss in the local potato industry in Texas and Nebraska (Lee *et al*. 2006). This phytoplasma group is included among the non-European potato viruses of the EPPO A1 quarantine list (OEPP/EPPO 1984a, b). The presence of this phytoplasma group in Australia would impact upon Australia’s ability to access overseas markets. Therefore, this phytoplasma group has the potential for economic consequences in Australia.	Yes
VIROIDS					
Potato spindle tuber pospiviroid (PSTVd)	Not known to occur[11]	**Yes**: As the viroid infects host plants systemically, all plant parts including parts used for vegetative	**Yes**: PSTVd has established in areas with a wide range of climatic conditions (Stevenson *et al*. 2001;	**Yes**: PSTVd causes spindle tuber disease in potato and bunchy top in tomato. Yield losses can be up to 65% in potato and up to 50% in	Yes

[10] At least four distinct phytoplasma strains belonging to three different phytoplasma groups have been associated with this disease (Banttari *et al*. 1990; Khadhair *et al*. 1997; Lee *et al*. 2000, 2004; Leyva-Lopez *et al*. 2002, Lee *et al*. 2006).

[11] PSTVd has entered Australia on tomato seed on several occasions and has been eradicated (EPPO 2003).

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		propagation are likely to be infected (Wale *et al*. 2008; Stevenson *et al*. 2001). Mild strains cause symptomless infection or subtle symptoms which are difficult to diagnose (Jones *et al*. 2009). However, leaves of plants infected with severe strains are duller in appearance than normal foliage (Jones *et al*. 2009). Therefore, propagative material provides a pathway for this viroid.	Wale *et al*. 2008) and it can spread naturally in infected propagative material (Jones *et al*. 2009). PSTVd is transmitted through true potato seed and potato tubers (Jones *et al*. 2009). The symptomless nature of this virus may contribute to the inadvertent propagation and distribution of infected material that will help spread PSTVd within Australia. Therefore, PSTVd has the potential to establish and spread in Australia.	tomato (Owens *et al*. 2009, EPPO 2010). Tubers of some cultivars develop knobs and swellings and are severely misshapen. Loss of tuber yield with individual secondarily infected plants is about 20% and 65% with the mild and severe strains, respectively (Jones *et al*. 2009). PSTVd is considered of quarantine significance in many parts of the world (Jones *et al*. 2009). The presence of this viroid in Australia would impact upon Australia's ability to access overseas markets. Therefore, PSTVd has the potential for economic consequences in parts of Australia.	
VIRUSES[12]					
Alfalfa mosaic virus (AMV) [Bromoviridae: Alfamovirus] – Potato infecting strains	Not known to occur[13]	**Yes**: AMV-potato strains cause calico and tuber necrosis and may also cause systemic chlorotic spots and necrotic flecking (Xu and Nie 2006). AMV-potato strain is associated with true potato seeds (Valkonen *et al*. 1992b) and potato tubers. Therefore,	**Yes:** AMV-potato strains have established in areas with a wide range of climatic conditions (Xu and Nie 2006) and it can spread naturally in infected propagative material (Valkonen *et al*. 1992b). Distribution of infected propagative material and	**Yes**: AMV-potato strains can cause problems in regions where aphid vectors move from reservoir hosts to potato fields (Jeffries 1998). AMV-potato strains causing tuber necrosis are of economic significance (Jeffries 1998). Infected tubers may be misshapen, cracked and fewer in number (Jeffries 1998). Aphid	**Yes**

[12] Acronyms are those accepted by The International Committee on Taxonomy of Viruses (ICTV).

[13] Alfalafa mosaic virus is present in Australia (Norton and Johnstone 1998); however, potato infecting strains (Xu and Nie 2006) are not present in Australia.

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		propagative material provides a pathway for this virus.	aphid vectors present in Australia will help spread AMV-potato strains within Australia. Therefore, AMV-potato strains have the potential to establish and spread in Australia.	vectors and reservoir hosts (Alfalfa and *Trifolium*) are widespread in Australia; therefore, this virus has the potential for economic consequences in Australia.	
Andean potato latent virus (APLV)[14] [Tymoviridae: Tymovirus] Strains: Hu, CCC, Col-Caj	Not known to occur	**Yes**: APLV infection is latent (Jones *et al*. 2009), symptomless (Gibbs and Harrison 1973) or shows mild mosaic on potato (Jeffries 1998). APLV is associated with potato tubers or true potato seeds (Jones *et al*. 2009) and tuber infection is symptomless (Jones *et al*. 2009). Therefore, propagative material provides a pathway for APLV.	**Yes**: APLV has established in areas with a wide range of climatic conditions (Jeffries 1998; Koenig *et al*. 1979; Gibbs and Harrison 1973) and it can spread naturally in infected propagative material (OEPP/EPPO 1990). The symptomless nature of this virus may contribute to the inadvertent propagation and distribution of infected material that will help spread APLV within Australia. Therefore, APLV has the potential to establish and spread in Australia.	**Yes**: APLV can cause serious symptoms in secondarily infected potato plants (Jones and Fribourg 1978). Yield reduction in potato has not been studied. However, APLV is included among the non-European potato viruses of the EPPO A1 quarantine list (OEPP/EPPO 1984a, b). APLV is considered of quarantine concern by NAPPO and all regional plant protection organizations outside South America. The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	**Yes**
Andean potato mottle virus (APMoV) [Comoviridae: Comovirus] Strains H, C and B	Not known to occur	**Yes**: APMoV causes mosaic and mottle symptoms and may also cause systemic necrosis (Fribourg *et al*. 1979) APMoV is associated with	**Yes**: APMoV has established in areas with a wide range of climatic conditions (Jeffries 1998; Fribourg *et al*. 1979) and it can spread naturally in	**Yes**: Direct effects on yield have not been studied, but may be severe in susceptible cultivars (Jones *et al*. 1982). In Central America, mixed infections of APMoV with other viruses can	**Yes**

[14] APLV is sometimes considered to be a strain of Eggplant mosaic tymovirus but sequence comparisons show them to be distinct species.

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		potato tubers (OEPP/EPPO 1990). Therefore, propagative material provides a pathway for APMoV.	infected propagative material (OEPP/EPPO 1990). The symptomless nature of this virus may contribute to the inadvertent propagation and distribution of infected material that will help spread APMoV within Australia. APMoV is also able to spread by plant-to-plant contact (Jeffries 1998). Therefore, APMoV has the potential for establishment and spread in Australia.	lead to severe symptoms and substantially lower yields in pepper (Valverde 2003). APMoV is included among the non-European potato viruses of the EPPO A1 quarantine list (OEPP/EPPO 1984a, b). APMoV is considered of quarantine concern by NAPPO and all regional plant protection organizations outside South America. The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	
Arracacha virus B – Oca strain (AVB-O) [Comoviridae: Nepovirus]	Not known to occur	**Yes**: AVB-O causes symptomless infection in potato plants (Jones 1981) and infected plants produce tubers containing the virus (Jones 1982). AVB-O is also associated with true potato seeds (Jones *et al*. 2009). Therefore, propagative material provides a pathway for AVB-O.	**Yes**: AVB-O has established in areas with a wide range of climatic conditions (Jeffries 1998; Jones and Kenten 1983; Jones, 1981) and it can spread naturally in infected propagative material (Jones *et al*. 2009; Jones 1981). The symptomless nature of this virus may contribute to the inadvertent propagation and distribution of infected material that will help spread AVB-O within Australia. Therefore, AVB-O has the	**Yes**: AVB-O is not known to have any direct economic importance in potato (Jeffries 1998). The principal risk is potential market access loss as a result of this virus being present in Australia. In addition, possible yield losses may result from single or mixed virus infection. AVB-O is of south American origin and is included among the non-European potato viruses of the EPPO A1 quarantine list (OEPP/EPPO 1984a, b). AVB-O is considered of quarantine concern by NAPPO and all regional plant protection	**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
			potential for establishment and spread in Australia.	organizations outside South America. The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	
Beet curly top virus (BCTV) [Geminiviridae: Curtovirus]	Not known to occur	**Yes**: Symptoms caused by BCTV vary with potato cultivar and environmental conditions (Jones *et al*. 2009). Primary symptoms include retarded growth, small cluttered leaves and misshapen leaflets that are cupped and become pale green (Jones *et al*. 2009). Infected tubers are symptomless (Jones *et al*. 2009). Propagative material therefore provides a pathway for BCTV.	**Yes**: BCTV has established in areas with a wide range of climatic conditions (Stevenson *et al*. 2001; Jeffries 1998; Thomas and Mink 1979) and it can spread naturally in infected propagative material (Jones *et al*. 2009; Jeffries 1998). Therefore, BCTV has the potential for establishment and spread in Australia.	**Yes:** BCTV occurs rarely in potatoes; however, a high incidence of infection in localized areas can cause severe disease problems (Jeffries 1998). BCTV is also capable of causing damage to resistant cultivars of sugar beet (Duffus and Skoyen 1977). BCTV is considered of quarantine concern by IAPSC and CPPC. The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	**Yes**
Cucumber mosaic virus (CMV) [Bromoviridae: Cucumovirus]	Yes (APPD 2010)	Assessment not required			
Eggplant mottled dwarf virus (EMDV) [Rhabdoviridae: Nucleorhabdovirus]	Not known to occur	**Yes**: EMDV is rarely found in potatoes (Jeffries 1998) but it causes severe stunting, chlorosis, wilting and systemic necrosis (Jeffries 1998). Viruses, as a rule, infect host plants	**Yes:** EMDV has established in areas with a wide range of climatic conditions (Stevenson *et al*. 2001; Jeffries 1998) and multiplication and marketing of infected propagative	**Yes:** EMDV is highly damaging to vegetable crops. It causes severe stunting, chlorosis and wilting in primary infection (Jeffries 1998). Serious economic losses have been reported in plants infected by EMDV (Jackson *et al*. 2005).	**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		systemically and all plant parts, including parts used for vegetative propagation are infected (Bos 1999). Therefore, propagative material provides a pathway for EMDV.	material will help spread EMDV. Therefore, EMDV has the potential for establishment and spread in Australia.	EMDV is considered of quarantine concern by South Korean NPPO. The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	
Impatiens necrotic spot virus (INSV) [Bunyaviridae: Tospovirus]	Not known to occur	**Yes**: INSV infects potato systemically (Jones *et al*. 2009) and causes necrotic lesions on leaves and necrosis of petioles and stems (Crosslin and Hamlin 2010). Viruses, as a rule, infect host plants systemically and all plant parts, including parts used for vegetative propagation, are infected (Bos 1999). Therefore, propagative material provides a pathway for INSV.	**Yes:** INSV is established and in areas with a wide range of climatic conditions (Kuwabara *et al*. 2010; Elliott *et al*. 2009; Brunt *et al.* 1996). Multiplication and marketing of infected propagative material and presence of its vector (western flower thrips) in Australia would help spread INSV into new areas. Therefore, INSV has the potential for establishment and spread in Australia.	**Yes**: INSV causes damage and losses largely on ornamental hosts, but also on some vegetable crops (Vicchi *et al*. 1999). The detection of INSV in tomato in Italy represents a progressive adaptation of INSV to outdoor vegetable crops (Finetti and Gallitelli 2000). The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	**Yes**
Pepino mosaic virus (PepMV) [Flexiviridae: Potexvirus]	Not known to occur	**Yes**: PepMV has been detected in potato in the field and in potato germplasm collection in Peru (CSL 2005). PepMV infects host plants systemically and infection may be latent (Salomone and Roggero 2002). This may lead to the propagation	**Yes:** PepMV has established and spread in areas with a wide range of climatic conditions (EPPO 2010; Ling 2008; CSL 2005; Jones *et al*. 1980). PepMV is highly contagious and can spread by contact and by infected planting material (CSL 2005). Multiplication	**Yes**: Although PepMV has been recorded on potatoes, no information is available on yield losses in this crop. However, PepMV has become a major threat to tomato production around the world. PepMV in tomato was first reported in The Netherlands in 1999, but has since spread rapidly in Europe	**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		and distribution of infected propagative material, suggesting that PepMV could enter Australia on propagative material.	and marketing of infected propagative material would help spread PepMV into new areas. Therefore, PepMV has the potential for establishment and spread in Australia.	and beyond, causing epidemics and severe economic losses (Gómez *et al*. 2009). PepMV has caused serious losses in the quality of tomato fruit in trials in the UK (CSL 2005). PepMV has become a major threat to tomato production in several countries. Therefore, PepMV has the potential for economic consequences in Australia.	
Potato 14R virus [Tombusviridae: Tobamovirus]	Not known to occur	**Yes:** This virus causes yellowish mosaic on leaves (Brunt *et al*. 1996). Viruses, as a rule, infect host plants systemically and all plant parts, including parts used for vegetative propagation are infected (Bos1999). Therefore, propagative material does provide a pathway for this virus.	**Yes**: This virus has established in areas with a wide range of climatic conditions (Brunt *et al*. 1996) and could spread naturally by infected propagative material (Brunt *et al*. 1996). Multiplication and marketing of infected propagative material will help spread this virus within Australia. Therefore, this virus has the potential for establishment and spread in Australia.	**Yes**: Information on the economic consequences of this virus is almost non-existent and it is not known how it will behave in potato growing areas of Australia. Several viruses known to be less important are increasing in importance in several South American countries. The presence of this virus in Australia may result in overseas restrictions on market access for Australian nursery stock. Therefore, this virus has the potential for economic consequences in Australia.	Yes
Potato aucuba mosaic virus (PAMV) [Flexiviridae: Potexvirus]	Yes (Büchen-Osmond *et al.* 1988)	Assessment not required			
Potato black ringspot virus (PBRSV) [Comoviridae: Nepovirus] (synonym: Tobacco ringspot virus, potato calico strain (TRSV-Ca)	Not known to occur	**Yes**: PBRSV naturally infects potatoes and infected plants are symptomless (Jones *et al*. 2009). PBRSV is readily	**Yes:** PBRSV has established in areas with a wide range of climatic conditions (Stevenson *et al*. 2001; Jeffries 1998) and	**Yes:** PBRSV has been recorded to cause damaging symptoms on potatoes under certain conditions (Fribourg 1977), but no information is available on yield	**Yes**

Pest	**Present within Australia**	**Potential to be on pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Quarantine pest?**
		transmitted through tubers to progeny plants, most of which are symptomless but systemically infected (Salazar and Harrison 1978). PBRSV is also associated with true potato seed (Jeffries 1998). Therefore, propagative material does provide a pathway for PBRSV.	could be spread naturally by infected potato tubers or by true seed of potato (Jeffries 1998). Multiplication and marketing of infected propagative material will help spread PBRSV within Australia. Therefore, PBRSV has the potential for establishment and spread in Australia.	losses in this crop. PBRSV is included among the non-European potato viruses of the EPPO A1 quarantine list (OEPP/EPPO 1984a, b). PBRSV is considered of quarantine concern by NAPPO and all regional plant protection organizations outside South America. The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	
Potato deforming mosaic virus (PDMV) [Geminiviridae: Begomovirus] (synonym: Tomato yellow vein streak virus)	Not known to occur	**Yes**: PDMV naturally infects tomatoes and potatoes causing symptoms of leaf deformation and yellow mosaic (Ribeiro *et al*. 2006; Jeffries 1998). Primary infected plants produce healthy as well as diseased tubers (Delhey *et al*. 1981). Therefore, propagative material does provide a pathway for PDMV.	**Yes**: PDMV has established in areas with a wide range of climatic conditions (Ribeiro *et al*. 2006) and can spread naturally in infected propagative material (Ribeiro *et al*. 2006; Delhey *et al.* 1981). Multiplication and marketing of infected propagative material and vector (*Bemisia tabaci*) presence in Australia will help spread this virus. Therefore, PDMV has the potential for establishment and spread in Australia.	**Yes:** PDMV causes leaf deformation and yellow mosaic in potatoes and tomatoes (Ribeiro *et al*. 2006; Delhey *et al.* 1981). Yield reductions of up to 35% have been reported in some cultivars (Jeffries 1998; Hooker 1981). PDMV is considered of quarantine concern by NAPPO and all regional plant protection organizations outside South America. The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
Potato latent virus (PLV) [Flexiviridae: Carlavirus]	Not known to occur	**Yes:** PLV is symptomless in potato plants and tubers (Nie 2009; Jeffries 1998), and infection is systemic (Goth *et al*. 1999). Therefore, propagative material does provide a pathway for PLV.	**Yes**: PLV has established in potato growing areas with a wide range of climatic conditions (Goth *et al*.1999; Jeffries 1998), and could spread with planting materials (Jeffries 1998). The symptomless nature of this virus may contribute to the inadvertent propagation and distribution of infected material that will help spread PLV. Therefore, PLV has the potential for establishment and spread in Australia.	**Yes:** Information on the economic consequences of this virus is almost non-existent. However, as a member of potato infecting carlaviruses, its presence in Australia potato growing areas will have a significant economic effect on the potato industry due to limitations on access to overseas markets where the pathogen is absent. Therefore, this virus has the potential for economic consequences in Australia.	**Yes**
Potato leafroll virus (PLRV) [Luteoviridae: Polerovirus]	Yes (DPIPWE 2011)	Assessment not required			
Potato mop-top virus (PMTV) [Virgaviridae: Pomovirus]	Not known to occur	**Yes**: PMTV infects potato systemically (Latvala-Kilby *et al*. 2009). Primary infection is almost entirely restricted to roots and tubers. Infected tubers may be symptomless or often show raised, concentric rings on their surface at a radius from the point of infection through viruliferous vector zoospores (Jones *et al*. 2009). Therefore, propagative material does provide a pathway for PMTV.	**Yes:** PMTV has established in areas with a wide range of climatic conditions (Santala *et al*. 2010; Latvala-Kilby *et al*. 2009; Harrison and Reavy 2002; Jeffries 1998). Multiplication and marketing of infected propagative material and vector (powdery scab fungus) presence in Australia will help spread this virus (Latvala-Kilby *et al*. 2009; Jeffries 1998). Therefore, PMTV has the potential for establishment and spread in Australia.	**Yes**: PMTV is an economically important pathogen of potato since serious yield and quality reductions can occur in some cultivars. Yield loss can occur with secondarily infected plants (Jeffries 1998). The incidence of spraing symptoms in sensitive cultivars often exceeds 25 and 30–50% in Sweden and Denmark, respectively (Stevenson *et al*. 2001), which could significantly affect the quality of tubers produced for the potato chip industry. Therefore, this virus has the potential for economic consequences in Australia.	**Yes**

Pest	**Present within Australia**	**Potential to be on pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Quarantine pest?**
Potato rough dwarf virus (PRDV) [Flexiviridae: Carlavirus]	Not known to occur	**Yes**: PRDV infects potato systemically and may remain symptomless (Massa *et al.* 2006; Nisbet *et al*. 2006; Jeffries 1998). Therefore, propagative material does provide a pathway for PRDV.	**Yes:** PRDV has established in areas with a wide range of climatic conditions (Massa *et al*. 2006; Jeffries 1998). The symptomless nature of this virus may contribute to the inadvertent propagation and distribution of infected material that will help spread PRDV. Therefore, PRDV has the potential for establishment and spread in Australia.	**Yes:** Potato cultivars infected by PRDV show dwarfing, and a thickening of old leaves. PRDV is reported to be of little importance in the host country (Jeffries 1998). However, it is not known how it will behave in potato growing areas of Australia. Several viruses known to be less important are increasing in importance in several South American countries. The presence of this virus in Australia may result in overseas restrictions on market access for Australian nursery stock. Therefore, this virus has the potential for economic consequences in Australia.	**Yes**
Potato virus A (PVA) [Potyviridae: Potyvirus]	Not known to occur	**Yes**: PVA infects plants systemically and may cause mild mosaic or mottle or remain symptomless depending on the potato cultivar affected (Jones *et al*. 2009; Stevenson *et al*. 2001). Tubers of infected plants are generally symptomless (Stevenson *et al*. 2001). Therefore, propagative material does provide a pathway for PVA.	**Yes**: PVA has established in most potato growing areas worldwide with a wide range of climatic conditions (Jeffries 1998; Brunt *et al*. 1996). Multiplication and marketing of infected propagative material and aphid vectors (potato aphid and green peach aphid) presence in Australia (Stevenson *et al*. 2001; Berlandier 1997; Dillard *et al*. 1993) will help spread PVA. Therefore, PVA can spread and establish in	**Yes:** Infected potato tubers are symptomless (Stevenson *et al*. 2001), and the virus is not reported to cause significant economic losses. However, it causes severe symptoms in combination with Potato virus X or Potato virus Y (Stevenson *et al*. 2001), which can reduce yield. Loses of up to 40% has been reported (Stevenson *et al.* 2001; Jeffries 1998). Therefore, this virus has the potential for economic consequences in Australia.	**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
			Australia.		
Potato virus M (PVM) [Flexiviridae: Carlavirus]	Not known to occur	**Yes:** PVM infects plants systemically (Stevenson *et al*. 2001). It is usually symptomless, but occasionally causes leaf symptoms (Stevenson *et al*. 2001; Jeffries 1998). Viruses, as a rule, infect host plants systemically and all plant parts, including parts used for vegetative propagation are infected (Bos 1999). Therefore, propagative material could provide a pathway for PVM.	**Yes:** PVM has established in areas with a wide range of climatic conditions (Stevenson *et al*. 2001; Brunt *et al*. 1996). The symptomless nature of this virus may contribute to the inadvertent propagation and distribution of infected material, and aphid vectors (potato aphid and green peach aphid) presence in Australia (Berlandier 1997; Dillard *et al*. 1993) will help spread this virus. Therefore, PMV has the potential for establishment and spread in Australia.	**Yes**: PVM causes potato leaf rolling mosaic and paracrinkle diseases. The effects on the plant include stunting of shoots and rolling of the tops (Stevenson *et al*. 2001; Jeffries1998). Yield losses can be significant in some situations, ranging from 14 to 45% (Stevenson *et al*. 2001; Jeffries 1998). PVM is reported to be economically important in Europe and Russia where 100% of some potato cultivars may be infected (Jeffries 1998). Therefore, this virus has the potential for economic consequences in Australia.	**Yes**
Potato virus S (PVS) [Flexiviridae: Carlavirus]	Yes: (Wilson and Jones 1990; Jafarpour *et al*. 1988)	Assessment not required			
Potato virus T (PVT) [Flexiviridae: Trichovirus]	Not known to occur	**Yes**: Primary infection is normally symptomless; however, some cultivars develop initial symptoms of slight vein necrosis and chlorotic spotting, or vein clearing and mosaic, or top necrosis (Jones *et al*. 2009). PVT is associated with true potato seeds as well as potato tubers	**Yes:** PTV has established in areas with a wide range of climatic conditions (Jones *et al*. 2009; Stevenson *et al*. 2001; Jeffries 1998) and spreads naturally in infected propagative material (Stevenson *et al*. 2001; Jeffries 1998). The symptomless nature of this virus may contribute to the	**Yes**: Little is known about diseases caused by PVT. PVT is included among the EPPO A1 quarantine list (OEPP/EPPO 1999). PVT is considered of quarantine concern by NAPPO and all regional plant protection organizations outside South America. The presence of this virus in Australia would impact upon Australia's ability to access	**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		(Stevenson *et al*. 2001). Therefore, propagative material could provide a pathway for PTV.	inadvertent propagation and distribution of infected material that will help spread PTV. Therefore, PTV has the potential for establishment and spread in Australia.	overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	
Potato virus U (PVU) [Comoviridae: Nepovirus]	Not known to occur	**Yes**: PVU infected plants show yellow leaf markings (Jones *et al*. 1983). Viruses, as a rule, infect host plants systemically and all plant parts, including parts used for vegetative propagation are infected (Bos 1999). Therefore, propagative material provides a pathway for PVU.	**Yes:** PVU has established in areas with a wide range of climatic conditions (Jeffries 1998) and spreads naturally in infected propagative material (Jones *et al*. 1983). Multiplication and marketing of infected propagative material will help spread this virus within Australia. Therefore, PVU has the potential for establishment and spread in Australia.	**Yes:** Little is known about economic losses caused by PVU; however, losses up to 10% have been reported (Salazar 2003). PVU is of South American origin and the principal risk is market access loss and possible yield losses from single or mixed virus infections. The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	**Yes**
Potato virus V (PVV) [Potyviridae: Potyvirus]	Not known to occur	**Yes:** PVV can be symptomless, but can also cause symptoms that range in severity from leaf pallor and slight distortion to mild mottle and slight leaf distortion to mild mottle, mosaic, and veinal necrosis of lower leaves (Jones *et al*. 2009). Viruses, as a rule, infect host plants systemically and all plant	**Yes:** PVV has established in areas with a wide range of climatic conditions (Jeffries 1998) and spreads naturally in infected propagative material. The symptomless nature of this virus may contribute to the inadvertent propagation and distribution of infected material and aphid vectors (potato aphid and green peach aphid)	**Yes:** PVV causes severe systemic necrosis and leaf dropping in some potato cultivars (Jeffries 1998). In Bolivia, the virus is reported to cause severe damage in some native potato cultivars (Jeffries 1998). PVV is known to cause losses of up to 10% (Salazar 2003). This virus is of South American origin and several countries may consider it of quarantine concern. The	**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		parts, including parts used for vegetative propagation are infected (Bos 1999). Therefore, propagative material provides a pathway for PVV.	presence in Australia (Berlandier 1997; Dillard *et al*. 1993) would help spread this virus. Therefore, PVV has the potential for establishment and spread in Australia.	presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	
Potato virus X (PVX) [Flexiviridae: Potevirus]	Present (Kirkwood 2009; Holmes and Teakle 1980)	Assessment not required		.	
Potato virus Y (PVY) [Potyviridae: Potyvirus] (strains: PVY^{C}, PVY^{N}, PVY^{NTN}, PVY^{O}, PVY^{Wilga}, $PVY^{N:O}$)	Not known to occur[15]	**Yes:** PVY induces various foliar symptoms ranging from mosaic to leaf-drop streaks and stunting, depending on cultivars and virus strains (Nie *et al*. 2011). PVY causes systemic necrotic (Delgado-Sanchez and Grogan 1970) or mosaic (Singh *et al*. 2003) and is also tuber-borne (Crosslin *et al*. 2006; Singh *et al*. 2003). Therefore, propagative material could provide a pathway for PVY.	**Yes:** PVY has established in areas with a wide range of climatic conditions (Nie *et al*. 2011; Crosslin *et al*. 2006; Jeffries 1998). It spreads naturally in infected propagative material (Crosslin *et al*. 2006; Singh *et al*. 2003). Aphid vectors (potato aphid and green peach aphid) presence in Australia (Stevenson *et al*. 2001, Berlandier 1997; Dillard *et al*. 1993) will help spread PVY. Therefore, PVY has the potential for establishment and spread in Australia.	**Yes:** PVY is one of the most economically important viruses of the potato crop worldwide (Gray *et al*. 2010; Singh *et al*. 2008). The virus is not only responsible for decreases in yield and quality, but may also result in the rejection of certified seed resulting in a significant reduction in crop value, and at times in a shortage of certified seed (Gray *et al*. 2010). PVY is considered of quarantine concern by NAPPO. The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	**Yes**
Potato yellow dwarf virus (PYDV)	Not known to	**Yes:** PYDV causes	**Yes:** PYDV has established	**Yes**: Infected plants produce few	**Yes**

[15] Few strains of this virus are present in Australia (Holmes and Teakle 1980) for example PVY^{C} is present in Australia (Jeffries 1998).

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
[Rhabdoviridae: Nucleorhabdovirus]	occur	stunting, chlorosis; vein yellowing and systemic vein and leaf necrosis (Lockhart, 1989). Viruses, as a rule, infect host plants systemically and all plant parts, including parts used for vegetative propagation are infected (Bos 1999). Infected potato tubers provide a pathway for this virus (OEPP/EPPO1980). Therefore, propagative material could provide a pathway for PYDV.	in areas with a wide range of climatic conditions (Stevenson *et al*. 2001; Jeffries 1998). It spreads naturally in infected propagative material (Jones *et al*. 2009). Multiplication and marketing of infected propagative material will help spread this virus within Australia. Therefore, PYDV has the potential to establish and spread in Australia.	tubers, and tubers are small and misshapen with generalised necrosis (Jones *et al.* 2009). PYDV is included among the non-European potato viruses of the EPPO A1 quarantine list (OEPP/EPPO 1984a, b). The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	
Potato yellow vein virus (PYVV) [Closteroviridae: Crinivirus]	Not known to occur	**Yes**: PYVV causes yellow vein and can be latent in some cultivars (Jeffries 1998; Salazer *et al*. 1998). Trade in seed potatoes provides the major pathway for the virus dissemination in south America (Salazar *et al*. 2000). Therefore, propagative material provides a pathway for PYVV.	**Yes:** PYVV has established in areas with a wide range of climatic conditions (Jones *et al*. 2009) and spreads naturally in infected propagative material (Jones *et al*. 2009; Salazar *et al.* 2000). Multiplication and marketing of infected propagative material will help spread this virus within Australia. Therefore, PYVV has the potential to establish and spread in Australia.	**Yes**: PYVV is recognised as an important constraint to potato production in South America (Salazar *et al*. 2000). Affected potato plants produce fewer and deformed tubers, and yield reductions of about 50% have been reported (Salazar *et al.* 2000; Saldarriaga *et al.* 1988). The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	**Yes**
Potato yellowing virus (PYV) [Bromoviridae: Alfamovirus]	Not known to occur	**Yes**: PYV is symptomless in some potato cultivars (Jeffries 1998). Viruses, as	**Yes:** PYV has established in areas with a wide range of climatic conditions	**Yes:** PYV was found in field samples of potato from Peru with up to 88% infection and causes	**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		a rule, infect host plants systemically and all plant parts, including parts used for vegetative propagation are infected (Bos 1999). PYV is associated with true potato seed and potato tubers (Jeffries 1998). Therefore, propagation material provides a pathway for PYV.	(Stevenson *et al*. 2001; Jeffries 1998) and spreads naturally in infected propagative material (Jeffries 1998). The symptomless nature of this virus may contribute to the inadvertent propagation and distribution of infected material and presence of aphid vectors will assist the spread of the virus in Australia. Therefore, PYV has the potential to establish and spread in Australia.	yellowing symptoms on some potato cultivars (Jeffries 1998; OEPP/EPPO 1984a, b). There is no specific information on effects on yield; however, losses of up to 10% have been reported (Salazar 2003). In general, all regional plant protection organisations outside South America recommend very strict measures for potato material from that continent. The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	
Solanum apical leaf curling virus (SALCV) [Geminiviridae: Begomovirus]	Not known to occur	**Yes**: SALCV causes red, purple or pink discoloration, curling, crinkling and dwarfing of apical leaves (Hooker and Salazar 1983). Viruses, as a rule, infect host plants systemically and all plant parts, including parts used for vegetative propagation are infected (Bos 1999). SALCV is also tuber-borne (Hooker and Salazar 1983). Therefore, propagative material including seed tubers could provide pathway for	**Yes:** SALCV has established in areas with a wide range of climatic conditions and spreads naturally in infected propagative material (Hooker and Salzar 1983). The virus is reported to be best adapted to tropical regions (Jeffries 1998). Multiplication and marketing of infected propagative material will help spread this virus within Australia. Therefore, SALCV has the potential to establish and	**Yes:** SALCV potentially causes losses of up to 10% (Salazar 2003). Infected tubers either do not sprout, or produce short, thin sprouts (Jeffries 1998). As this virus is of South American origin, several countries may consider it of quarantine concern. In general, all regional plant protection organisations outside South America recommend very strict measures for potato material from that continent. The presence of this virus in Australia would impact upon Australia's ability to access overseas markets.	**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		SALCV.	spread in Australia.	Therefore, this virus has the potential for economic consequences in Australia.	
Southern potato latent virus (SoPLV) [Flexiviridae: Carlavirus]	Not known to occur	**Yes**: No information is available on the biology of SoPLV. However, viruses infect host plants systemically and all plant parts, including parts used for vegetative propagation, are infected (Bos1999). Therefore, propagation material provides a pathway for SoPLV.	**Yes**: SoPLV has established in areas with a wide range of climatic conditions (Brunt *et al*. 1996) and may spread naturally in infected propagative material. Multiplication and marketing of infected propagative material will help spread this virus within Australia. Therefore, SoPLV has the potential to establish and spread in Australia.	**Yes**: Information on the economic consequences of this virus is almost non-existent. However, it is not known how it will behave in potato growing areas of Australia. Several viruses known to be less important are increasing in importance in several South American countries. The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	**Yes**
Sowbane mosaic virus (SoMV) [Sobemovirus]	Yes (APPD 2011)	Assessment not required			
Tobacco mosaic virus— Potato strain (TMV-P) [Tombusviridae: Tobamovirus] (Strains: TMV-potato 1, 2, 3, 4)	Not known to occur [16]	**Yes:** TMV potato infecting strains produce necrotic spotting and systemic veinal necrosis (Talens and Talens 2009; Jung *et al*. 2002). Viruses, as a rule, infect host plants	**Yes:** TMV potato infecting strains have established in areas with a wide range of climatic conditions (Talens and Talens 2009; Pathak and Verma 1967) and spread naturally with	**Yes**: There is no specific information on effects on yield caused by TMV-P. However, viruses occur on potatoes in mixed infections (Talens and Talens 2009). Therefore, PMV-P may cause severe symptoms in	**Yes**

[16] Tobacco mosaic virus has been reported on various hosts (Büchen-Osmond *et al*. 1988), but it is unknown if the strains that infect potato are present in Australia. TMV has rigid rod-shaped particles about 300 nm long, a linear 6.3-kb plus-sense ssRNA genome, and is readily detected by inoculation of sap to *N. glutinosa* and other indicator hosts (Zaitlin 2000). A virus with similar shaped particles was found in Chilean potato cultivars (Accatino 1966). Salazar (1977) reported a virus from potatoes in Peru that also had TMV-like particles and code-named it 14R. It resembled the Chilean virus but did not become systemic in potato. No serological relationship with TMV was demonstrated (Jones *et al*. 2009). TMV-P has rigid rod-shaped particles which measures 15nm x 300-350 nm in dimension (Talens and Talens 2009).

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		systemically and all plant parts, including parts used for vegetative propagation, are infected (Bos 1999). TMV-P is also tuber-borne (Talens and Talens 2009; Jung *et al*. 2002). Therefore, propagative material provides a pathway for TMV-P.	infected propagative material (Talens and Talens 2009). Multiplication and marketing of infected propagative material will help spread this virus within Australia. Therefore, TMV-P has the potential to establish and spread in Australia.	combination with other potato viruses. Given the high risk of mechanical transmission in the field, TMV has high potential to cause increased damage in potato fields (Jung *et al*. 2002). Therefore, this virus has the potential for economic consequences in Australia.	
Tobacco necrosis virus (TNV) [Tombusviridae: Necrovirus] (Strains: A, B, C, D, E, S, AC36, AC38, AC39; AC43; and Urbana strain)	Not known to occur[17]	**Yes**: TNV potato infecting strains produce symptoms on tubers (Jeffries 1998). Viruses, as a rule, infect host plants systemically and all plant parts, including parts used for vegetative propagation, are infected (Bos 1999). Therefore, propagative material provides a pathway for TNV.	**Yes:** TNV potato infecting strains have established in areas with a wide range of climatic conditions (Jeffries 1998) and spread naturally with infected propagative material (Jones *et al*. 2009). Multiplication and marketing of infected propagative material will help spread this virus within Australia. Therefore, TNV has the potential to establish and spread in Australia.	**Yes**: There is no specific information on effects on yield, but the quality of tubers is seriously affected in sensitive cultivars. Infected tubers have lesions on the skin; superficial light brown lesions and blisters which collapse during storage to give dark brown sunken lesions (Jones *et al*. 2009). Crops with a high incidence of surface blisters and/or dark brown sunken lesions are unmarketable (Jones *et al*. 2009). Therefore, this virus has the potential for economic consequences in Australia.	**Yes**
Tobacco rattle virus (TRV) [Tombusviridae: Tobamovirus]	Not known to occur	**Yes**: TRV infects plants systemically and primary	**Yes:** TRV has established in areas with a wide range of	**Yes**: TRV causes significant loss of saleable yield because of	**Yes**

[17] The taxonomy of ‘tobacco necrosis virus’ (TNV) has been revised. *Tobacco necrosis virus A* (TNV-A) and *Tobacco necrosis virus D* (TNV-D) have been recognised as distinct species in the *Necrovirus* genus (Meulewaeter *et al*. 1990; Coutts *et al*. 1991), as have *Chenopodium necrosis* virus (ChNV) and *Olive mild mosaic virus* (OMMV), which were previously considered TNV isolates (Tomlinson *et al*. 1983; Cardoso *et al*. 2005). Although TNVs have been reported in Queensland and Victoria (Findlay and Teakle 1969; Teakle 1988), it is not known if the species or strains that infect potato are present in Australia.

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		infection is almost entirely limited to roots and tubers (Jones *et al*. 2009). TRV produces corky ringspot in tuber stems and mottle in foliage (Jones *et al*. 2009). Depending on potato cultivar and TRV strain, infected tubers can be symptomless (Jones *et al*. 2009). Therefore, propagative material provides a pathway for TRV.	climatic conditions (Jones *et al*. 2009; Jeffries 1998) and spreads naturally in infected propagative material (Jones *et al*. 2009). The symptomless nature of this virus may contribute to the inadvertent propagation and distribution of infected material. Furthermore, aphid and nematode vectors present in Australia will also help spread this virus. Therefore, TRV has the potential to establish and spread in Australia.	spraing damage to potatoes (Stevenson *et al*. 2001; Jeffries 1998). In the USA, frequencies of tubers with corky ring spot of 5–10% have been reported, sometimes compromising the sale of the entire production field (Williams *et al*.1996). In Italy, pepper fields with 30–40% infected plants and significant yield losses have been reported (Marte *et al*. 1979). Yearly losses in carrot from virus diseases, including TRV, are reported to exceed 50% in Germany (Wolf and Schmeizer 1973). Therefore, this virus has the potential for economic consequences in Australia.	
Tobacco streak virus—Potato strain (TSV-P) [Bromoviridae: Ilarvirus]	Not known to occur[18]	**Yes:** TSV-P is primarily symptomless in potato (Salazar *et al*. 1981). Viruses, as a rule, infect host plants systemically and all plant parts, including parts used for vegetative propagation, are infected (Bos 1999). Therefore, propagation material could provide a pathway for TSV-P.	**Yes:** TSV-P has established in areas with a wide range of climatic conditions (Smith *et al*. 1992) and spreads naturally in infected propagative material (Stevenson *et al*. 2001; Smith *et al*. 1992). The symptomless nature of this virus may contribute to the inadvertent propagation and distribution of infected material. Therefore, TSV-P	**Yes:** There is no specific information on effects on yield. This virus is of South American origin and several countries may consider it of quarantine concern. In general, all regional plant protection organisations outside South America recommend very strict measures for potato material from that continent. The presence of this virus in Australia would impact upon Australia's ability to access overseas markets.	**Yes**

[18] TSV is present in Australia (Sharman *et al*. 2009) but the potato strain is not recorded in Australia.

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
			has the potential for establishment and spread in Australia.		
Tomato black ring virus (TBRV) [Comoviridae: Nepovirus]	Not known to occur	**Yes**: TBRV symptoms vary with different potato cultivars, and the infection is symptomless on some cultivars (Jones *et al*. 2009). Primary infection is mainly restricted to potato roots and tubers, but when it does spread to shoots, necrotic spots and rings may develop in leaves (Jones *et al*. 2009). Therefore, propagation material could provide a pathway for TBRV.	**Yes:** TBRV has established in areas with a wide range of climatic conditions (Jones *et al*. 2009) and spreads naturally in infected propagative material (Harrison 1959). The symptomless nature of this virus may contribute to the inadvertent propagation and distribution of infected material and nematode vectors (*Longidorus* species) present in Australia will help spread this virus. Therefore, TBRV has the potential to establish and spread in Australia.	**Yes**: Individual plants with severe stunting may show 80% yield loss, and those with no apparent symptoms may show a 30% yield loss (Jeffries 1998). Loss of tuber yield in individual secondarily infected plants can reach 20–30% (Jones *et al*. 2009). TBRV is a quarantine organism for NAPPO (EPPO 1990). The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	**Yes**
Tomato leaf curl New Delhi virus (ToLCNDV) [Geminiviridae: Begomovirus]	Not known to occur	**Yes:** ToLCNDV infects potato causing a severe leaf curl disease (Usharani *et al*. 2003) and infection is systemic in host plants (Hussain *et al*. 2005). Viruses, as a rule, infect host plants systemically and all plant parts, including parts used for vegetative propagation, are infected (Bos 1999). Therefore, propagation material may	**Yes:** ToLCNDV has established in areas with a wide range of climatic conditions (Jones *et al*. 2009; Usharani *et al*. 2004). Multiplication and marketing of infected propagative material and the insect vector, *Bemisia tabaci* (Stonor *et al.* 2003), will help spread this virus within Australia. Therefore, ToLCNDV has the potential	**Yes:** There is no specific information on the effects on yield. But ToLCNDV has the potential to cause large losses in production in potato growing areas where its whitefly vector is common (Jones *et al*. 2009). Whitefly transmitted geminiviruses are economically important pathogens causing serious losses in food crops globally (Stonor *et al*. 2003). The presence of this virus in Australia would impact upon Australia's	**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		provide a pathway for ToLCNDV.	to establish and spread in Australia.	ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	
Tomato mosaic virus (ToMV) [Bunyaviridae: Tobamovirus]	Yes (APPD 2011)	Assessment not required			
Tomato mottle Taino virus (ToMoTV) [Geminiviridae: Begomovirus]	Not known to occur	**Yes**: ToMoTV causes systemic infection in host plants (Collazo *et al.* 2006; Hussain *et al*. 2005). The virus can therefore be found in all parts of the host plant. The virus is reported to be transmitted via tubers (Cordero *et al.* 2003). Therefore, propagation material including seed tubers from countries where the virus occurs may provide a pathway for ToMoTV.	**Yes**: PoMoTV has been reported to spread in South America (Cordero *et al.* 2003) and occur across a wide range of climatic conditions. The virus is a pathogen of solanaceous species, such as, potato, tomato and tobacco (Collazo *et al*. 2006), which are widely cultivated crops in Australia. Further, PoMoTV is spread by whiteflies, which are present in Australia (EPPO 2006). Therefore, ToMoTV has the potential to establish and spread in Australia.	**Yes**: ToMoTV is a pathogen of several economically important solanaceous species (Collazo *et al*. 2006). Yield losses due to begomovirus-like symptoms in some potato cultivars in Cuba ranged from 19 to 56% (Cordero *et al*. 2003). The presence of this virus in Australia would impact upon Australia's ability to access overseas markets. Therefore, this virus has the potential for economic consequences in Australia.	**Yes**
Tomato spotted wilt virus (ToSWV) [Bunyaviridae: Tosp*ovirus*]	Yes (Jones *et al*. 2009)	Assessment not required			
Tomato yellow mosaic virus (ToYMV) [Geminiviridae: Begomovirus] (synonyms: Potato yellow mosaic virus (PYMV)	Not known to occur	**Yes:** ToYMV infects potato systemically (Buragohain *et al*. 1994). Viruses, as a rule, infect host plants systemically and all plant parts, including parts used for vegetative propagation, are infected (Bos 1999).	**Yes:** ToYMV has established in areas with a wide range of climatic conditions and has a wide host range, including potato (Jones *et al*. 2009). Multiplication and marketing of infected propagative	**Yes:** ToYMV is widespread in the Caribbean region, causes significant losses in tomato, and has the potential to cause significant losses in potato growing areas where its whitefly vector is common (Jones *et al*. 2009). ToMYV has caused	**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
		Therefore, propagation material may provide a pathway for ToYMV.	material and the insect vector, *Bemisia tabaci* (Stonor *et al.* 2003), will help spread this virus within Australia. Therefore, ToYMV has the potential to establish and spread in Australia.	millions of dollars in losses in tomato commercial fields in Venezuela (Piven *et al*. 1995). If tomato plants are infected at an early stage they do not produce tomato fruit (Piven *et al*. 1995). Natural infection by ToYMV has once been reported in potato, causing up to 70% losses in potato cv. Sebago (Debrot and Centeno 1985). Therefore, this virus has the potential for economic consequences in Australia.	
NEMATODES					
Belonolaimus longicaudatus Rau 1958 [Tylenchina: Belonolaimidae]	Not known to occur	No: Sting nematodes are ectoparasites of plant roots, meaning that the nematodes remain in the soil and do not enter the plant's tissues (Luc *et al*. 2005). These nematodes feed by inserting a long stylet or mouth spear into the roots of host plants (Luc *et al*. 2005). Potato tubers being fed on by sting nematodes may be stunted and misshapen (Crow and Brammer 2011). Therefore, potato tubers do not provide a pathway for sting nematodes.	Assessment not required		

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
Criconemoides ornatus (Raski 1958) Luc & Raski [Tylenchina: Circonematidae]	Not known to occur	No: This ring nematode is an ectoparasite of plant roots, meaning that the nematode remains in the soil and does not enter the plant's tissues (Luc *et al*. 2005). It feeds by inserting a long stylet or mouth spear into the roots of host plants (Luc *et al*. 2005). Therefore, potato tubers do not provide a pathway for ring nematodes.	Assessment not required		
Ditylenchus destructor Thorne 1945 [Tylenchina: Anguinidae]	Not known to occur[19]	**Yes**: This species is an endoparasitic nematode and all life stages can be found within plant tissue. It enters potato tubers through lenticels (Wale *et al*. 2008). Therefore, propagative material (seed potatoes) provides a pathway for this nematode.	**Yes**: This nematode has established in areas with a wide range of climatic conditions (Wale *et al*. 2008) and it can spread naturally in infested potato tubers (Wale *et al*. 2008). This species has many hosts, allowing its rapid build up and distribution. Therefore, this nematode has the potential for establishment and spread in Australia.	**Yes**: This species occurs on a variety of commodities and is a quarantine pest to a number of Australia's trading partners. This nematode is considered to be a quarantine pest by several countries (Evans *et al*. 1993, CABI/EPPO 1990). The presence of this species in Australia would impact upon Australia's ability to access overseas markets. Therefore, this nematode has the potential for economic consequences in Australia.	**Yes**
Ditylenchus dipsaci (Kuhn) Filipjev) [Tylenchina: Anguinidae]	Yes (Taylor and Szot 2000)	Assessment not required			
Globodera pallida (Stone 1973) Behrens [Tylenchina: Heteroderidae]	Not known to occur	**Yes**: These species are obligate parasites and	**Yes**: These species have established in areas with a	**Yes**: Potato cyst nematodes are major pests of the potato crop in	**Yes**

[19] *Ditylenchus destructor* was reported as present in Australia in 1958 on the basis of mis-identifications. It is now not considered to be present in Australia.

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
Globodera rostochiensis (Wollenweber) Behrens [Tylenchina: Heteroderidae]	Yes (under official control)	attack the roots of the potato (Wale *et al*. 2008). These species can survive as cysts in soil adhering to tubers. Therefore, both infested soil and infested soil adhering to potato tubers can serve as pathways of introduction.	wide range of climatic conditions (Wale *et al*. 2008) and can spread naturally in infested soil adhering to potato tubers (Luc *et al*. 2005). Therefore, potato cyst nematodes have the potential for establishment and spread in Australia.	cool-temperate areas, especially in areas where no resistant cultivars are available. They are also of quarantine significance for APPPC and NAPPO. In addition, *H. rostochiensis* is a quarantine pest for CPPC and IAPSC (CABI/EPPO 1990). The presence of these species in Australia would impact upon Australia's ability to access overseas markets. Therefore, these nematodes have potential for economic consequences in Australia.	**Yes**
Meloidogyne arenaria Chitwood 1949 [Tylenchina: Meloidogynidae]	Yes (Pullman and Berg 2010)	Assessment not required			
Meloidogyne chitwoodii Golden *et al*. [Tylenchina: Meloidogynidae]	Not known to occur	**Yes:** This root knot nematode is able to survive under the skin of potato tubers (Viaene *et al*. 2007; Finley 1981) and in the soil. Potato tubers may contain nematode eggs, second-stage juveniles and mature females (Viaene *et al*. 2007). Therefore, both infested soil and infected tubers can serve as pathways of introduction.	**Yes**: This nematode has established in areas with a wide range of climatic conditions (Wale *et al*. 2008; Viaene *et al*. 2007) and it can spread naturally in infected propagative material (Viaene *et al*. 2007). This species has many hosts, allowing its rapid build up and distribution. Therefore, this nematode has the potential for establishment and spread in Australia.	**Yes**: This species occurs on a variety of commodities and is a quarantine pest to a number of Australia's trading partners. This nematode is considered a quarantine pest by the European Union (Viaene *et al*. 2007; Anon. 2000). Special requirements exist for the planting and movement of seed potatoes (Anon. 2000). The presence of this species in Australia would impact upon Australia's ability to access overseas markets. Therefore, this nematode has the potential for economic consequences in Australia.	**Yes**

Pest	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest?
Meloidogyne fallax Karssen 1996 [Tylenchina: Meloidogynidae]	Yes (Nambiar *et al*. 2008; Vanstone and Nobbs 2007; Nobbs *et al*. 2001).	Assessment not required			
Meloidogyne hapla Chitwood (1949) [Tylenchina: Meloidogynidae]	Yes (Pullman and Berg 2010)	Assessment not required			
Meloidogyne incognita (Kofoid & White, 1919) Chitwood, 1949 [Tylenchina: Meloidogynidae]	Yes (Pullman and Berg 2010)	Assessment not required			
Meloidogyne javanica (Treub 1885) Chitwood 1949 [Tylenchina: Meloidogynidae]	Yes (Pullman and Berg 2010)	Assessment not required			
Nacobbus aberrans (Thorne 1935) Thorne & Allen 1944 [Tylenchina: Pratylenchidae]	Not known to occur	**Yes**: This false root knot nematode is able to survive under the skin of tubers and in the dry soil attached to tubers (Hardy 1996). Therefore, both infested soil and infected tubers can serve as pathways of introduction.	**Yes:** This nematode has established in areas with a wide range of climatic conditions (Luc *et al*. 2005) and it can spread naturally in infected propagative material (Luc *et al*. 2005). This species has many hosts, allowing its rapid build up and distribution. Therefore, this nematode has the potential for establishment and spread in Australia.	**Yes**: This species occurs on a variety of commodities (Luc *et* al. 2005) and estimated losses as high as 65% on potato are reported in South America (Anon 2003). This nematode is a quarantine pest to a number of Australia's trading partners. The presence of this species in Australia would impact upon Australia's ability to access overseas markets. Therefore, this nematode has the potential for economic consequences in Australia.	**Yes**
Paratrichodorus minor (Colbran 1956) Siddiq, 1974 [Diphtherophorina: Trichodoridae]	Yes (Sauer 1981)	Assessment not required			
Pratylenchus brachyurus (Goodfrey	Yes (Riley and	Assessment not required			

Pest	**Present within Australia**	**Potential to be on pathway**	**Potential for establishment and spread**	**Potential for economic consequences**	**Quarantine pest?**
1929) [Tylenchina: Pratylenchidae]	Kelly 2002)				
Pratylenchus coffeae Goodey 1951 [Tylenchina: Pratylenchidae]	Yes (McLeod *et al*. 1994)	Assessment not required			
Pratylenchus crenatus Loof 1960 [Tylenchina: Pratylenchidae]	Yes (McLeod *et al*. 1994)	Assessment not required			
Pratylenchus neglectus (Rensch 1924) Filipjev & Schuurmans-Stekhoven 1941 [Tylenchina: Pratylenchidae]	Yes (Riley and Kelly 2002)	Assessment not required			
Pratylenchus penetrans (Cobb 1917) Filipjev & Schuurmans-Stekhoven 1941 [Tylenchina: Pratylenchidae]	Yes (Riley and Kelly 2002)	Assessment not required			
Pratylenchus scribneri Steiner 1943 [Tylenchina: Pratylenchidae]	Yes (Riley and Kelly 2002)	Assessment not required			
Pratylenchus thornei Sher & Allen 1953 [Tylenchina: Pratylenchidae]	Yes (Riley and Kelly 2002)	Assessment not required			
Pratylenchus vulnus Allen & Jensen 1951 [Tylenchina: Pratylenchidae]	Yes (McLeod *et al*. 1994)	Assessment not required			
Pratylenchus zeae Graham 1951 [Rhabditida: [Tylenchina: Pratylenchidae]	Yes (McLeod *et al*. 1994)	Assessment not required			
Rotylenchulus reniformis Linford & Oliveira 1940 [Tylenchina: Haplolaimidae]	Yes (McLeod *et al*. 1994)	Assessment not required			
Trichodorus andina Allen 1951 [Diphtherophorina: Trichodoridae]	Not known to occur	No: These nematodes feed on tap roots (Wale *et al*. 2008). Therefore, propagative material is not a pathway for the entry of these nematodes.	Assessment not required		
Trichodorus proximus Allen 1957 [Diphtherophorina: Trichodoridae]	Not known to occur		Assessment not required		
Trichodorus viruliflerus Hooper [Diphtherophorina: Trichodoridae]	Not known to occur		Assessment not required		
Tylenchorhynchus claytoni Steiner 1937 [Tylenchina: Belonolaimidae]	Yes (McLeod *et al*. 1994)	Assessment not required			

Appendix B: Additional quarantine pest data

BACTERIA	
Quarantine pest	*Candidatus* Liberibacter psyllaurous Hansen *et al*. 2008
Synonyms	*Candidatus* Liberibacter solanacearum
Common name(s)	Zebra Chip
Main hosts	*Capsicum annuum* L., *Capsicum frutescens* L., *Lycopersicon esculentum* Mill, *Physalis peruviana* L., *Solanum betaceum* Cav., *Solanum tuberosum* L. (Crosslin and Bester 2009, Biosecurity Australia 2009)
Distribution	Canada, Mexico, New Zealand, United States (Crosslin and Bester 2009, Munyaneza *et al*. 2009b).
Quarantine pest	*Clavibacter michiganensis* subsp. *sepedonicus* (Spieck & Kotth.) Davis *et al*. 1984
Synonyms	*Corynebacterium sepedonicum*
Common name(s)	Potato ring rot; Bacterial ring rot of potato
Main hosts	*Solanum tuberosum* (Potato) (Jeffries 1998)
Distribution	Canada, Europe (e.g. Germany, Russia), northern Asia, United States (Jeffries 1998)
Quarantine pest	*Dickeya dadantii* Samson *et al*. 2005
Synonyms	*Erwinia chrysanthemi* biovar 3 (some strains), Pectobacterium *chrysanthemi* biovar 3 (some strains) (Toth *et al*. 2011).
Common name(s)	Bacterial soft rot
Main hosts	*Ananas comosus, Dianthus spp., Euphorbia pulcherrima*, *Ipomoea batatas*, *Musa* spp., *Pelargonium capitatum, Saintpaulia ionantha, Solanum tuberosum*, *Zea mays* (Toth *et al*. 2011; Samson *et al*. 2005; Jeffries 1998).
Distribution	Brazil, Cuba, Finland, Germany, Israel, Malaysia, Netherlands, Poland, Peru, Zimbabwe (Toth *et al*. 2011; Slawiak *et al*. 2009; Tsror *et al*. 2009).
Quarantine pest	*Dickeya dianthicola* Samson *et al*. 2005
Synonyms	*Erwinia chrysanthemi* biovars 1, 7 and 9, *E. chrysanthemi* pv. *dianthicola*, *Pectobacterium chrysanthemi* pv. *dianthicola* (Toth *et al*. 2011).
Common name(s)	Bacterial soft rot
Main hosts	*Cichorium intybus*, *Cynara scolymus*, *Dahlia* spp., *Dianthus caryophyllus, Dianthus* spp.*, Lycopersicon esculentum, Solanum tuberosum* (Toth *et al.* 2011; Slawiak *et al*. 2009; Samson *et al*. 2005).
Distribution	Colombia, Denmark, England, Finland , France, Germany, Greece, Italy, Japan, Poland, Sweden, Romania, Netherlands, New Zealand, Norway, Spain, USA (Toth *et al*. 2011, Samson *et al*. 2005, Slawiak *et al.* 2009).
Quarantine pest	*Dickeya dieffenbachiae* Samson *et al*. 2005
Synonyms	*Erwinia chrysanthemi* biovar 2, *E. chrysanthemi* pv. *dieffenbachiae, Pectobacterium chrysanthemi* pv *dieffenbachiae* (Toth *et al*. 2011).
Common name(s)	Bacterial soft rot
Main hosts	*Dieffenbachia* sp., *Lycopersicon esculentum*, *Musa paradisiacal*, *Solanum tuberosum* (Toth *et al*. 2011; Slawiak *et al*. 2009).
Distribution	Cuba, France, Germany, USA (Slawiak *et al*. 2009; Samson *et al*. 2005).
Quarantine pest	*Dickeya paradisiaca* (Fernandez-Borrero and Lopez-Duque 1970) Samson *et al*. 2005
Synonyms	*Erwinia chrysanthemi* biovar 4, *E. chrysanthemi* pv. *paradisiaca*, *E. paradisiaca*, *Brenneria paradisiacal* (Toth *et al*. 2011).
Common name(s)	Bacterial soft rot

Main hosts	*Musa paradisiaca, Solanum tuberosum, Zea mays* (Toth *et al*. 2011; Slawiak *et al*. 2009).
Distribution	Colombia, Cuba (Slawiak *et al*. 2009).
Quarantine pest	*Dickeya parthenii* Samson *et al*. 2005
Synonyms	*Erwinia chrysanthemi* biovar 6, *E. chrysanthemi* pv. *parthenii*, *Pectobacterium chrysanthemi* pv. *parthenii* (Toth *et al*. 2011).
Common name(s)	Bacterial soft rot
Main hosts	*Cichorium intybus, Cynara scolymus, Dahlia* spp., *Parthenium argentatum, Philodendron oxycardium*, *Solanum tuberosum* (Toth *et al*. 2011; Samson *et al*. 2005).
Distribution	Denmark, France, Romania, Switzerland, Taiwan, USA (Slawiak *et al*. 2009; Samson *et al*. 2005).
Quarantine pest	*Dickeya solani* sp. nov.
Synonyms	*Erwinia chrysanthemi* biovar 3 (some strains)
Common name(s)	Blackleg of potato
Main hosts	*Solanum tuberosum* (Toth *et al*. 2011).
Distribution	Finland, Israel, Netherlands, Poland, Spain, UK (Toth *et al*. 2011)
Quarantine pest	*Pectobacterium betavasculorum* (Thomson *et al*. 1984) Gardan *et al*. 2003
Synonyms	*Erwinia carotovora* subsp. *betavasculorum* Thomson *et al*. 1984; *Pectobacterium carotovorum* subsp. *betavasculorum* (Thomson *et al*. 1984) Hauben *et al*. 1999. (Gardan *et al*. 2003).
Common name(s)	Pectobacterium bacterium
Main hosts	*Beta vulgaris, Eutrema wasabi, Solanum tuberosum* (Pitman *et al*. 2010; Gardan *et al*. 2003).
Distribution	Japan, Mexico, New Zealand, Romania, USA (Pitman *et al*. 2010; Gardan *et al*. 2003).
Quarantine pest	*Pectobacterium carotovorum* subsp. *brasiliensis* Duarte *et al*. 2004
Synonyms	*Erwinia carotovorum* subsp. *brasiliensis* (Pitman *et al*. 2010)
Common name(s)	Bacterial soft rot, Blackleg of potato.
Main hosts	*Solanum tuberosum* (Pitman *et al*. 2010).
Distribution	Brazil, USA (Pitman *et al*. 2010).
Quarantine pest	*Pectobacterium wasabiae* (Goto & Matsumoto 1987) Gardan *et al*. 2003
Synonyms	*Erwinia carotovora* subsp. *wasabiae* Goto and Matsumoto 1987 (Gardan *et al*. 2003).
Common name(s)	Bacterial soft rot
Main hosts	*Eutrema wasabi, Solanum tuberosum* (Pitman *et al*. 2010; Gardan *et al*. 2003)
Distribution	Japan, New Zealand, USA (Pitman *et al*. 2010; Gardan *et al*. 2003).
Quarantine pest	*Ralstonia solanacearum* (Smith 1896) Yabuuchi *et al*. (1995)
Synonyms	*Pseudomonas solanacearum* (Smith 1896) Smith 1914; *Burkholderia solanacearum* (Smith, 1896) Yabuuchi *et al*. 1992; many other synonyms in literature
Common name(s)	brown rot of potato, bacterial wilt
Main hosts	Race 1 attacks tobacco, many other solanaceous crops and many hosts in other plant families. Race 2 attacks bananas and *Heliconia* (causing so called Moko disease), but also in the Philippines (causing so-called bugtok disease on plantains). Race 3 attacks potato, tomato, occasionally *Pelargonium zonale,* aubergine and capsicum, some solanaceous weeds like *Solanum nigrum* and *Solanum dulcamara.* A number of non-solanaceous weed hosts have also been found to harbour race 3 infections, often asymptomatically (Pradhanang *et al*. 2000; Wenneker *et al*. 1999; Strider *et al*. 1981). Race 4 is particularly aggressive on ginger and race 5 (biovar 5) is specialized on *Morus* (OEPP/EPPO 2004)

Distribution	Race 1 occurs in tropical areas all over the world, Race 2 occurs mainly in tropical areas of South America, Race 3, occurring at higher altitudes in the tropics and in subtropical and temperate areas and race 4 and 5 occurs in Asia, the Americas and Australia. Detailed geographical distribution is provided in CABI 1999.
Quarantine pest	*Streptomyces acidiscabies* Lambert and Loria 1989
Synonyms	
Common name(s)	Scab
Main hosts	*Solanum tuberosum*
Distribution	China (Zhao *et al*. 2009), Korea (Park *et al*. 2003), UK (Thwaites *et al*. 2009), USA (Loria *et al*. 1997)
Quarantine pest	*Streptomyces caviscabiei* Goyer *et al*. 1996
Synonyms	
Common name(s)	Scab
Main hosts	*Solanum tuberosum*
Distribution	Canada (Goyer et al. 1996)
Quarantine pest	*Streptomyces europaeiscabiei* Bouchek-Mechiche *et al*. 2000
Synonyms	
Common name(s)	Netted scab
Main hosts	*Solanum tuberosum*
Distribution	Europe (Wale *et al*. 2008)
Quarantine pest	*Streptomyces luridiscabiei* Park *et al* 2003
Synonyms	
Common name(s)	Scab
Main hosts	*Solanum tuberosum*
Distribution	Korea (Park *et al*. 2003).
Quarantine pest	*Streptomyces niveiscabiei* Park *et al* 2003
Synonyms	
Common name(s)	Scab
Main hosts	*Solanum tuberosum*
Distribution	Korea (Park *et al*. 2003).
Quarantine pest	*Streptomyces puniciscabiei* Park *et al* 2003
Synonyms	
Common name(s)	Scab
Main hosts	*Solanum tuberosum*
Distribution	Korea (Park *et al*. 2003).
Quarantine pest	*Streptomyces reticuliscabiei* Bouchek-Mechiche *et al*. 2000
Synonyms	
Common name(s)	Scab
Main hosts	*Solanum tuberosum*
Distribution	Canada, Europe (Wanner *et al*. 2006)
Quarantine pest	*Streptomyces stelliscabiei* Bouchek-Mechiche *et al*. 2000
Synonyms	

Common name(s)	Scab
Main hosts	*Solanum tuberosum*
Distribution	Canada and eastern United States (Bukhalid *et al*. 2002)
Quarantine pest	*Streptomyces turgidiscabies* Miyajima *et al*. 1998
Synonyms	
Common name(s)	Netted scab
Main hosts	*Solanum tuberosum*
Distribution	Finland, Japan, Korea, Sweden (Wanner 2006), UK (Thwaites *et al*. 2009)
FUNGI	
Quarantine pest	*Aecidium cantensis* Arthur
Synonyms	
Common name(s)	Potato deforming rust, Peruvian rust
Main hosts	*Solanum tuberosum* and *Lycopersicon esculentum* (Stevenson *et al*. 2001).
Distribution	South America (Argentina, Peru) (Stevenson *et al.* 2001).
Quarantine pest	*Gerwasia pittieriana* (Henn.) León-Gall. & Cummins
Synonyms	*Puccinia pittieriana* Henn. 1904
Common name(s)	Potato rust
Main hosts	*Lycopersicon esculentum*, *Solanum* spp. including *Solanum tuberosum* (Farr and Rossman 2011; Stevenson *et al.* 2001).
Distribution	Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Mexico, Peru, Venezuela (Stevenson *et al.* 2001).
Quarantine pest	*Phoma andigena* var. *andina* Turkenst
Synonyms	*Stagonosporopsis andigena*
Common name(s)	Phoma leaf spot
Main hosts	*Solanum* spp. including *Solanum tuberosum, Lycopersicon esculentum* (Farr and Rossman 2011; Stevenson *et al.* 2001).
Distribution	Peru, Bolivia (Stevenson *et al* 2001).
Quarantine pest	*Phoma crystalliniformis* (Loer. *et al*.) Noordel. & Gruyter
Synonyms	
Common name(s)	Carate disease of tomato and potato
Main hosts	*Solanum tuberosum, Lycopersicon esculentum* (Stevenson *et al.* 2001).
Distribution	Colombia, Venezuela (Stevenson *et al.* 2001).
Quarantine pest	*Synchytrium endobioticum* (Schilb.) Percival)
Synonyms	*Chrysophlyctis endobioticum* Schilb. 1896, *Synchytrium solani* Massee 1910
Common name(s)	Potato wart disease
Main hosts	*Solanum tuberosum* (Farr and Rossman 2011; Stevenson *et al.* 2001).
Distribution	Europe, Asia, Africa, South America, Canada, USA, New Zealand (Farr and Rossman 2011; Stevenson *et al.* 2001).
Quarantine pest	*Thecaphora solani* (Thirum. & M. O'Brien) Mordue 1988
Synonyms	*Angiosorus solani* Thirum. & M. O'Brien 1974 [1972], *Thecaphora solani* (Barrus & Muller ex Thirum. & M. O'Brien) Vánky 1988
Common name(s)	Potato smut, Thecaphora smut

Main hosts	*Solanum tuberosum*, *Solanum stoloniferum, Datura stramonium* (Farr and Rossman 2011; Stevenson *et al.* 2001).
Distribution	Bolivia, Chile, Colombia, Ecuador, Peru, Venezuela, Mexico, Panama (Farr and Rossman 2011; Stevenson *et al.* 2001).
Quarantine pest	*Verticillium albo-atrum* Reinke & Berthold
Synonyms	*Verticillium albo-atrum* var. *tuberosum* B.A. Rudolph
Common name(s)	Verticilium wilt of potato
Main hosts	*Solanum tuberosum* (Stevenson *et al.* 2001)
Distribution	Cosmopolitan, most common in temperate regions (Farr and Rossman 2011).
Quarantine pest	*Phytophthora infestans* (Mont.) de Bary [A2 mating strain and exotic strains of both the A1 and A2]
Synonyms	*Botrytis infestans* Mont. 1845, *Peronospora infestans* (Mont.) Casp. 1854
Common name(s)	Late blight of potato
Main hosts	*Solanum* spp. including *Solanum tuberosum, Lycopersicon esculentum* (Farr and Rossman 2011; Stevenson *et al.* 2001). Also occurs on hosts in 15 other genera and in 10 other families (Farr and Rossman 2011).
Distribution	Cosmopolitan (Farr and Rossman 2011; Stevenson *et al.* 2001).
PHYTOPLASMA	
Quarantine pest	*Candidatus* Phytoplasma asteris [**16SrI** – Aster yellows group]
Synonyms	
Strains	Chinese potato phytoplasma, El Salvador potato phytoplasma, Iranian potato phytoplasma, Nebraska potato purple top phytoplasma, Peruvian (Andahuaylas) potato phytoplasma, Potato marginal flavescence phytoplasma, Potato phyllody phytoplasma, Potato purple-top roll phytoplasma, Potato purple-top wilt phytoplasma, Russian potato purple top phytoplasma, Texas potato purple top phytoplasma
Common name(s)	Aster yellows
Main hosts	Wide host range including *Solanum tuberosum* (Cheng *et al*. 2011b; Santos-Cervantes *et al*. 2010; Firrao *et al*. 2005)
Distribution	China, El Salvador, India, Mexico, USA (Cheng *et al*. 2011b; Santos-Cervantes *et al*. 2010; Lee *et al*. 2006; Lee *et al*. 2007), Russia (Girsova *et al*. 2008)
Quarantine pest	*Candidatus* Phytoplasma aurantifolia [**16SrII** – Peanut Witches' broom Group]
Synonyms	
Common name(s)	
Strains	Mexican potato purple top phytoplasma, Peruvian potato phytoplasma, Potato phytoplasma isolate Islamabad, Potato phytoplasma isolate Pot001
Main hosts	*Solanum tuberosum* (Lee *et al*. 2006)
Distribution	
Quarantine pest	*Candidatus* Phytoplasma pruni [**16SrIII** – X-Disease Group]
Synonyms	
Common name(s)	
Strains	Alaska potato purple top phytoplasma, Mexican potato purple top phytoplasma COAHP, Mexican potato purple top phytoplasma GTOP, Montana potato purple top phytoplasma

Main hosts	*Solanum tuberosum* (Lee *et al*. 2006)
Distribution	Iran, Mexico, Sudan, Taiwan, Thailand, United Arab Emirates (Santos-Cervantes *et al*. 2010, Lee et al. 1998, Firrao et al. 2005)
Quarantine pest	*Candidatus* Phytoplasma trifolii [1**6SrVI** – Clover Proliferation Group]
Synonyms	
Common name(s)	Potato purple top disease
Strains	Columbia Basin potato purple top phytoplasma, Potato purple top phytoplasma PPT, Potato purple top phytoplasma YN-6, Potato witches' broom phytoplasma, Washington potato purple top phytoplasma
Main hosts	Wide host range including *Solanum tuberosum* (Munyaneza 2010)
Distribution	Canada (Lee *et al*. 2009); China (Cheng *et al*. 2011a); Iran (Hosseini *et al*. 2011); Mexico (Lee *et al*. 2009); Russia (Girsova *et al*. 2008); USA (Munyaneza 2010)
Quarantine pest	*Candidatus* Phytoplasma solani [**16SrXII-A** – Stolbur Group]
Synonyms	
Common name(s)	Potato purple top disease
Strains	Eggplant little leaf phytoplasma, Potato stolbur phytoplasma, Potato round leaf phytoplasma, Potato witche's broom phytoplasma, Iranian potato purple top phytoplasma, Russian potato purple top phytoplasma Rus-PPT, Turkish potato stolbur phytoplasma
Main hosts	Wide host range including *Capsicum annuum*, *Lotus corniculatus*, *Lycopersicon esculentum*, *Medicago sativa*, *Solanum melongena*, *Solanum tuberosum*, *Trifolium pratense, T. repens* (Munyaneza 2010; Girosova *et al.* 2008; Jeffries 1998).
Distribution	Asia, Canada, Europe, Iran, Israel, Mexico, Russia, South America, Turkey, USA (Hosseini *et al*. 2011; Munyaneza 2010; Lee *et al*. 2009; Girosova *et al.* 2008; Jeffries 1998).
Quarantine pest	Mexican periwinkle virescence group (**16SrXIII)**
Synonyms	
Common name(s)	Potato purple top disease
Strains	
Main hosts	Potato (Santos-Cervantes *et al*. 2010; Lee *et al*. 2009).
Distribution	Canada, Mexico, Russia, United States (Lee *et al*. 2009)
Quarantine pest	*Candidatus* Phytoplasma americanum [**16SrXVIII** – American Potato Purple Top Wilt Group]
Synonyms	
Common name(s)	American potato purple top wilt phytoplasma, Purple top syndrome
strains	APPTW1-TX, APPTW2-TX, APPTW9-NE and APPTW12- NE (subgroup 16SrXVIII-A) and APPTW 1883 #6-TX, APPTW10-NE and APPTW13-NE (subgroup 16SrXVIII-B
Main hosts	*Solanum tuberosum* (Lee *et al*. 2006)
Distribution	USA (Lee *et al*. 2007; Lee *et al*. 2006)
VIROID	
Quarantine pest	Potato spindle tuber viroid (PSTVd)
Synonyms	

Common name(s)	*Tomato bunchy top (South Africa), Potato "gothic" disease (old USSR)*
Main hosts	The natural host range of PSTVd includes many solanaceous species including *Solanum tuberosum* (potato), *S. lycopersicum* (tomato), and *Capsicum annuum* (pepper). Infections in other hosts are symptomless; e.g., *Brugmansia* spp., *Datura* sp., *Lycianthes rantonneti* (syn. *S. rantonneti*), *Persea americana* (avocado), *Physalis peruviana* (Cape gooseberry), *S. jasminoides*, *S. muricatum* (pepino) and *Streptosolen jamesonii* (Owens and Verhoeven 2009).
Distribution	Asia, Africa, North America, South America, Europe and New Zealand (Mackie and Jones 2006).
VIRUSES	
Quarantine pest	Alfalfa mosaic virus – Potato strains
Synonyms	
Common name(s)	Calico and tuber necrosis
Main hosts	Wide host range (150 species in 22 families): *Lycopersicon esculentum*, *Medicago sativa*, *Pisum sativum*, *Solanum tuberosum* (Xu and Nie 2006; Jaspars and Bos 1980).
Distribution	Canada, Italy, Korea, New Zealand (Xu and Nie 2006)
Quarantine pest	Andean potato latent virus
Synonyms	
Common name(s)	
Main hosts	*Solanum tuberosum*, *Ullucus tuberosus* (Jeffries 1998).
Distribution	Widespread in the Andean Region of South America including Bolivia, Chile, Colombia, Ecuador and Peru (Jeffries 1998; Contreras and Banse1982; Fribourg *et al*. 1977), especially at higher altitudes (Koenig *et al*. 1979).
Quarantine pest	Andean potato mottle virus
Synonyms	Potato Andean mottle virus, Potato Andean mottlevirus
Common name(s)	Andean mottle of potato
Main hosts	*Solanum tuberosum, Solanum melongena* (Jeffries 1998, Brioso *et al* 1993).
Distribution	Andean region of South America including Brazil (Avila *et al*. 1984), Chile (Contreras *et al*. 1981), Ecuador (Smith *et al*. 1997a) and Peru (Fribourg 1977)
Quarantine pest	Arracacha B virus – Oca strain
Synonyms	Arracacha virus B
Common name(s)	
Main hosts	*Solanum tuberosum, Oxalis tuberose* (Jeffries 1998).
Distribution	Bolivia (Atkey and Brunt 1982), Peru (Jones 1981; Jones and Kentan1981)
Quarantine pest	Beet curly top virus
Synonyms	Sugarbeet curly top virus, Potato green dwarf virus, Western yellow blight virus
Common name(s)	Potato green dwarf, Curly top of beet, Beet curly top
Main hosts	Wide host range including *Beta vulgaris*, *Capsicum* spp., various cucurbits, *Lycopersicon esculentum*, *Phaseolus* spp., *Spinacia oleracea* and *Solanum tuberosum* (Jeffries 1998).
Distribution	Arid and semi-arid regions of the Eastern Mediterranean basin, Middle East, North, Central and South America (Jeffries 1998; Jones *et al*. 1982).

Quarantine pest	Eggplant mottled dwarf virus
Synonyms	Eggplant mottled dwarf virus
Common name(s)	Tomato vein yellowing virus, Tomato vein clearing virus
Main hosts	*Lycopersicon esculentum*, *Solanum melongena, Solanum tuberosum* (Roggero *et* al. 1995; Jeffries 1998).
Distribution	In potatoes, only reported in Iran (Danesh and Lockhart 1989). In other solanaceous hosts, found in the Mediterranean basin and the Middle East (Jeffries 1998).
Quarantine pest	Pepino mosaic potexvirus
Synonyms	
Common name(s)	Pepino mozaïek virus
Main hosts	*Lycopersicon esculentum* (Martínez-Culebras *et al*. 2002; van der Vlugt *et al*. 2002), wild *Lycopersicon* spp. (Soler *et al*. 2002), *Solanum muricatum* (pepino) (van der Vlugt *et al*. 2002), *Solanum tuberosum* (CSL 2005), weed spp. (CSL 2005).
Distribution	Africa, Asia, Europe, North America, South America (CSL 2005).
Quarantine pest	Potato 14R virus
Synonyms	
Common name(s)	
Main hosts	*Solanum tuberosum* ssp. *andigena* × *S. tuberosum* ssp. *tuberosum* (Brunt *et al*. 1996).
Distribution	Peru (Brunt *et al* 1996).
Quarantine pest	Potato black ringspot virus
Synonyms	Potato calico strain of tobacco ringspot virus, Potato Andean calico virus
Common name(s)	Calico disease of potato
Main hosts	*Arracacia xanthorrhiza* (arracacha)*, Oxalis tuberosa* (oca), *Solanum tuberosum* (Jeffries 1998).
Distribution	Peru (Fribourg 1977)
Quarantine pest	Potato deforming mosaic virus
Synonyms	Potato deforming mosaic disease, Potato mosaic deformante virus
Common name(s)	Deforming mosaic of potato
Main hosts	*Solanum chacoense*, *S. sisymbrifolium*, *Solanum tuberosum* (Jeffries 1998).
Distribution	Argentina and Southern Brazil (Daniels and Castro 1985).
Quarantine pest	Potato latent virus
Synonyms	
Common name(s)	
Main hosts	*Solanum tuberosum* (Jeffries 1998).
Distribution	North America (Jeffries 1998).
Quarantine pest	Potato mop-top virus
Synonyms	Potato mop-top furovirus
Common name(s)	Potato mop-top
Main hosts	*Solanum tuberosum* (Jeffries 1998).

Distribution	Andean region of South America (Salazar and Jones 1975), Canada, China, Japan (Imoto *et al*. 1981), Northern Europe (Van Hoof and Rozendaal 1969).
Quarantine pest	Potato rough dwarf virus
Synonyms	
Common name(s)	
Main hosts	*Solanum tuberosum* (Jeffries 1998).
Distribution	Argentina, Uruguay (Jeffries 1998).
Quarantine pest	Potato virus A
Synonyms	Potato mild mosaic virus, Potato virus P, Solanum virus 3
Common name(s)	Potato mild mosaic , Potato veinal mosaic , Potato common mosaic
Main hosts	*Solanum tuberosum* (Jeffries 1998).
Distribution	Worldwide except the Andean Region of South America (Salazar 1990).
Quarantine pest	Potato virus M
Synonyms	Potato paracrinkle virus, Potato interveinal mosaic virus, Potato virus E, Potato virus K
Common name(s)	
Main hosts	*Solanum tuberosum* (Jeffries 1998).
Distribution	Worldwide except the Andean region of South America (Salazar 1990).
Quarantine pest	Potato virus T
Synonyms	
Common name(s)	
Main hosts	*Oxalis tuberosa*, *Solanum tuberosum*, *Tropaeolum tuberosum*, *Ullucus tuberosus* (Jeffries 1998).
Distribution	Bolivia, Peru (Jeffries 1998; Salazar and Harrison 1978).
Quarantine pest	Potato virus U
Synonyms	
Common name(s)	
Main hosts	*Solanum tuberosum* (Jeffries 1998; Brunt *et al*. 1996).
Distribution	Peru (Jeffries 1998).
Quarantine pest	Potato virus V
Synonyms	
Common name(s)	
Main hosts	*Lycopersicon esculentum*, *Solanum tuberosum* (Jeffries 1998).
Distribution	Bolivian highlands, France, Germany, the Netherlands, Peru, United Kingdom (Brunt *et al*. 1996; Jeffries 1998).
Quarantine pest	Potato virus Y
Synonyms	
Common name(s)	
Main hosts	*Lycopersicon esculentum*, *Solanum tuberosum* (Jeffries 1998).
Distribution	Canada (Xu *et al*. 2005)

Quarantine pest	Potato yellow dwarf virus
Synonyms	
Common name(s)	
Main hosts	*Chrysanthemum leucanthemum, Solanum tuberosum, Trifolium incarnatum* (Jeffries 1998; Brunt *et al*. 1996).
Distribution	Canada, USA (Jeffries 1998; Brunt *et al*. 1996).
Quarantine pest	Potato yellow vein virus
Synonyms	Potato vein-yellowing disease, Potato yellow vein disease
Common name(s)	Yellow vein of potato, Vein-yellowing of potato
Main hosts	Wild *Lycopersicon* spp., *Polygonum mepalense*, *Solanum tuberosum, Solanum nigrumare* (Jeffries 1998).
Distribution	Columbia, Ecuador, Peru (Jeffries 1998).
Quarantine pest	Potato yellowing virus
Synonyms	Andean potato yellowing virus , Virus SB-22
Common name(s)	
Main hosts	*Solanum tuberosum* (Jeffries 1998)
Distribution	Bolivia, Chile, Peru (Jeffries 1998; Valkonen *et al* 1992a).
Quarantine pest	Solanum apical leaf curling virus
Synonyms	Solanum apical leaf curling virus
Common name(s)	
Main hosts	*Datura tatula, Nicandra physalodes, Physalis peruviana, Solanum basendopogon, Solanum nigrum, Solanum tuberosum* (Hooker and Salazar 1983; Brunt *et al*. 1996).
Distribution	Peru (Jeffries 1998; Brunt *et al*. 1996).
Quarantine pest	Tobacco mosaic virus – Potato infecting strain
Synonyms	
Common name(s)	
Main hosts	Solanaceous crops including pepper, potato, tobacco and tomato (Jung *et al*. 2002).
Distribution	China, Hungary, India (Horvath 1977), Korea (Jung *et al*. 2002), the Peruvian Andes (Phatak and Verma 1967), Philippines (Talens and Talens 2009), Saudi Arabia (Al-Shahwan *et al*. 1997)
Quarantine pest	Tobacco rattle virus
Synonyms	Aster ringspot virus, potato stem mottle virus, potato corky ringspot virus, Oregon yellow virus, spinach yellow mottle virus (CABI 2007).
Common name(s)	Spraing of potato, Corky ringspot of potato, Internal rust of potato (CABI 2007).
Main hosts	Wide host range, including *Beta vulgaris*, *Gladiolus* spp*., Hyacinthus* spp., *Lactuca sativa*, *Narcissus* spp., *Nicotiana* spp., *Solanum tuberosum, Spinacia oleracae*, *Tulipa* spp., and many weed spp. (Jeffries 1998).
Distribution	Central America, China, Europe, Japan, New Zealand, North America, South America, USSR (Jeffries 1998).
Quarantine pest	Tobacco streak virus potato strain
Synonyms	

Common name(s)	
Main hosts	*Solanum tuberosum* (Salazar *et al*. 1981).
Distribution	TSV-P was found in a clone plant of the International Potato Center (CIP) germplasm collection in Peru and is possibly restricted to the Andean region (Anon 2000)
Quarantine pest	Tomato black ring virus
Synonyms	Potato bouquet virus, Potato pseudo-aucuba virus, Tomato black ring virus.
Common name(s)	Ring spot of beet
Main hosts	Wide host range, including *Solanum tuberosum*, *Vitis Vinifera* and other species of fruit vegetables, ornamentals and weeds (Jeffries 1998).
Distribution	Asia, Africa, Germany, North America, Poland, South America, UK (Smith *et al*. 1997b; Jeffries 1998).
Quarantine pest	Tomato leaf curl New Delhi virus
Synonyms	Indian tomato leaf curl virus
Common name(s)	Potato leaf curl
Main hosts	*Capsicum annuum, Citrullus lanatus*, *Lycopersicon esculentum, Momordica charantia, Solanum tuberosum* (Hussain *et al*. 2005; Tahir and Haider 2005; Usharani *et al*. 2003).
Distribution	India, Pakistan (Tahir and Haider 2005; Usharani *et al*. 2003).
Quarantine pest	Tomato mottle Taino virus
Synonyms	
Common name(s)	
Main hosts	*Lycopersicon esculentum*, *Solanum tuberosum* (Cordero *et al*. 2003; Ramos *et al* 2003).
Distribution	Cuba (Cordero *et al*. 2003; Ramos *et al*. 2003).
Quarantine pest	Tomato yellow mosaic virus
Synonyms	Potato yellow mosaic virus
Common name(s)	Yellowish mosaic of tomato
Main hosts	*Lycopersicon esculentum*, *Solanum tuberosum* (Morales *et al*. 2001; Polston and Anderson 1997).
Distribution	Guadeloupe, Martinique, Puerto Rico, Trinidad, Tobago, Venezuela (Polston and Anderson 1997).
NEMATODES	
Quarantine pest	*Ditylenchus destructor* Thorne 1945
Synonyms	
Common name(s)	Potato rot nematode, Tuber rot-eelworm
Main hosts	A wide range of plants, especially root crops such as carrots, garlic, potatoes and sugar beets (CFIA 2011). Potatoes are the main host of *D. destructor*, but the nematode can also be found on dahlia, gladiolus, groundnuts, hops, iris, onion, sweet potato, *Trifolium* spp. and tulip (CFIA 2011).
Distribution	Temperate regions; China, Europe, North America (Marin County, California), South Africa (CABI/EPPO 2009).This nematode has been detected in parts of Africa, Asia, Canada, Europe, Mexico, Oceania, South America and the United States (CFIA 2011).
Quarantine pest	*Globodera pallida* (Stone, 1973) Behrens, 1975

Synonyms	*Heterodera pallida* (Stone)
Common name(s)	White potato cyst nematode, Pale potato cyst nematode
Main hosts	Potatoes are by far the most important host crop. Aubergines and tomatoes are also attacked. Other *Solanum* spp. and their hybrids can also act as hosts (EPPO 2011b).
Distribution	The centre of origin of this species is in the Andes Mountains in South America from where it was introduced to other areas. Its range includes Algeria, Argentina, Austria, Belgium, Bolivia, Canada, Chile, Columbia, Costa Rica, Cyprus, Ecuador, France, Germany, Iceland, India, Ireland, Italy, Luxembourg, Malta, Netherlands, New Zealand, Norway, Pakistan, Panama, Peru, Poland, Portugal, Romania, Slovenia, Spain, South Africa, Sweden, Switzerland, Tunisia, Turkey, USA, Venezuela, Ukraine, UK, Yugoslavia (EPPO 2011b).
Quarantine pest	*Globodera rostochiensis* (Wollenweber, 1923) Behrens, 1975
Synonyms	*Heterodera rostochiensis* Wollenweber
Common name(s)	Yellow potato cyst nematode, Golden potato cyst nematode, Golden nematode
Main hosts	Potatoes are by far the most important host crop. Aubergines and tomatoes are also attacked. Other *Solanum* spp. and their hybrids can also act as hosts (EPPO 2011b).
Distribution	The centre of origin of this species is in the Andes Mountains in South America from where it was introduced to other areas. Its range includes Albania, Algeria, Argentina, Austria, Belarus, Belgium, Bolivia, Brazil, Bulgaria, Canada, Chile, Colombia, Costa Rica, Cyprus, Czech Republic, Denmark, Ecuador, Egypt, Estonia, Faroe Islands, Finland, France, Germany, Greece, Iceland, India, Ireland, Japan, Latvia, Lebanon, Libya, Lithuania, Luxembourg, Malta, Mexico, Morocco, Netherlands, New Zealand, Norfolk Island, Norway, Panama, Pakistan, Peru, Philippines, Poland, Portugal, Russia, Sierra Leone, Slovakia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Tajikistan, Tunisia, UK, USA and Venezuela (EPPO 2011b) .
Quarantine pest	*Meloidogyne chitwoodi* Golden *et al*. 1980
Synonyms	
Common name(s)	Columbia root-knot nematode
Main hosts	*M. chitwoodi* has a wide host range among several plant families (O'Bannon *et al*. 1982; Santo *et al*. 1980), including crop plants and common weed species. Potatoes (*Solanum tuberosum*) and tomatoes (*Lycopersicon esculentum*) are good hosts, while barley (*Hordeum vulgare*), maize (*Zea mays*), oats (*Avena sativa*), sugarbeet (*Beta vulgaris* var. *saccharifera*), wheat (*Triticum aestivum*) and various Poaceae (grasses and weeds) will maintain the nematode. In the Netherlands, host crops recorded to be attacked by *M. chitwoodi* are carrots, cereals, maize, peas (*Pisum sativum*), *Phaseolus vulgaris*, potatoes, *Scorzonera hispanica*, sugarbeet and tomatoes.
Distribution	Argentina, Belgium, Netherlands (CABI/EPPO 1998), North-western United States (potato growing regions of Colorado, Idaho, the Klamath Basin of northern California, southern Oregon, Utah, Washington, (Nyczepir *et al*. 1982; Pinkerton and McIntyre 1987; Santo *et al*. 1980) and South Africa (Fourie *et al*. 2002)
Quarantine pest	*Nacobbus aberrans* (Thorne, 1935) Thorne & Allen, 1944
Synonyms	*Anguillulina aberrans* Thorne, *Nacobbus batatiformis* Thorne & Schuster, *Nacobbus bolivianus* Lordello, Zamith & Boock, 1961, *Pratylenchus aberrans* (Thorne) Filipjev
Common name(s)	False root-knot nematode or Potato rosary nematode
Main hosts	The false root-knot nematode reproduces on the following agronomic and vegetable crops, *Brassica nigra*, *Brassica oleracea*, *Brassica rapa*, *Capsicum annuum*, *Cucumis sativus*, *Cucurbita maxima*, *Cucurbita pepo*, *Daucus carota*, *Ipomea batata*, *Lactuca sativa*, *Lycopersicon esculentum*, *Pisum sativum* var. arvense, *Solanum melogena*, *Solanum tuberosum*, *Spinacia oleracea* and *Tropaeolum tuberosum* (CAB International

	2001; Evans *et al*. 1993).
Distribution	Highland Andean regions of Argentina, Bolivia, Chile, and Peru, and MexicoGuadeloupe, Martinique, Puerto Rico, Trinidad, Tobago, Venezuela (Polston and Anderson 1997).

Glossary

Term or abbreviation	Definition
Additional declaration	A statement that is required by an importing country to be entered on a Phytosanitary Certificate and which provides specific additional information on a consignment in relation to regulated pests (FAO 2009).
Appropriate level of protection	The level of protection deemed appropriate by the Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory (WTO 1995).
Area	An officially defined country, part of a country or all or parts of several countries (FAO 2009).
Biosecurity Australia	A prescribed agency, within the Australian Government Department of Agriculture, Fisheries and Forestry, responsible for recommendations for the development of Australia's biosecurity policy.
Certificate	An official document which attests to the phytosanitary status of any consignment affected by phytosanitary regulations (FAO 2009).
Consignment	A quantity of plants, plant products and/or other articles being moved from one country to another and covered, when required, by a single phytosanitary certificate (a consignment may be composed of one or more commodities or lots) (FAO 2009).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO 2009).
Endangered area	An area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss (FAO 2009).
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO 2009).
Establishment	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2009).
Fruits and vegetables	A commodity class for fresh parts of plants intended for consumption or processing and not for planting (FAO 2009).
Host range	Species capable, under natural conditions, of sustaining a specific pest or other organism (FAO 2009).
Import Permit	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2009).
Import Risk Analysis	An administrative process through which quarantine policy is developed or reviewed, incorporating risk assessment, risk management and risk communication.
Infestation (of a commodity)	Presence in a commodity of a living pest of the plant or plant product concerned. Infestation includes infection (FAO 2009).
Inspection	Official visual examination of plants, plant products or other regulated articles to determine if pests are present and/or to determine compliance with phytosanitary regulations (FAO 2009).
Intended use	Declared purpose for which plants, plant products, or other regulated articles are imported, produced, or used (FAO 2009).
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment (FAO 2009).
International Standard for Phytosanitary Measures	An international standard adopted by the Conference of FAO [Food and Agriculture Organization], the Interim Commission on phytosanitary measures or the Commission on phytosanitary measures, established under the IPPC (FAO 2009).
Introduction	The entry of a pest resulting in its establishment (FAO 2009).
National Plant Protection Organisation	Official service established by a government to discharge the functions specified by the IPPC (FAO 2009).
Official control	The active enforcement of mandatory phytosanitary regulations and the application of mandatory phytosanitary procedures with the objective of eradication or containment of quarantine pests or for the management of regulated non-quarantine pests (FAO 2006).

Term or abbreviation	Definition
Pathway	Any means that allows the entry or spread of a pest (FAO 2009).
Pest	Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2009).
Pest categorisation	The process for determining whether a pest has or has not the characteristics of a quarantine pest or those of a regulated non-quarantine pest (FAO 2009).
Pest Free Area	An area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained (FAO 2009).
Pest free place of production	Place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period (FAO 2009).
Pest free production site	A defined portion of a place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this conditions is begin officially maintained for a defined period and that is managed as a separate unit in the same way as a pest free place of production (FAO 2009).
Pest Risk Analysis (agreed interpretation)	The process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any phytosanitary measures to be taken against it (FAO 2009).
Pest risk assessment (for quarantine pests)	Evaluation of the probability of the introduction and spread of a pest and the magnitude of the associated potential economic consequences (FAO 2009).
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2009).
Phytosanitary Certificate	Certificate patterned after the model certificates of the IPPC (FAO 2009).
Phytosanitary measure (agreed interpretation)	Any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO 2009).
Phytosanitary regulation	Official rule to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests, including establishment of procedures for phytosanitary certification (FAO 2009).
Polyphagous	Feeding on a relatively large number of host plants from different plant families.
PRA area	Area in relation to which a Pest Risk Analysis is conducted (FAO 2009).
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO 2009).
Regulated article	Any plant, plant product, storage place, packaging, conveyance, container, soil and any other organism, object or material capable of harbouring or spreading pests, deemed to require phytosanitary measures, particularly where international transportation is involved (FAO 2009).
Restricted risk	Risk estimate with phytosanitary measure(s) applied.
Rhizomes	A horizontal plant stem with shoots above and roots below serving as a reproductive structure. Rhizomes may also be referred to as creeping rootstalks, or rootstocks
Spread	Expansion of the geographical distribution of a pest within an area (FAO 2009).
Stakeholders	Government agencies, individuals, community or industry groups or organizations, whether in Australia or overseas, including the proponent/applicant for a specific proposal, who have an interest in the policy issues.
Unrestricted risk	Unrestricted risk estimates apply in the absence of risk management measures.

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