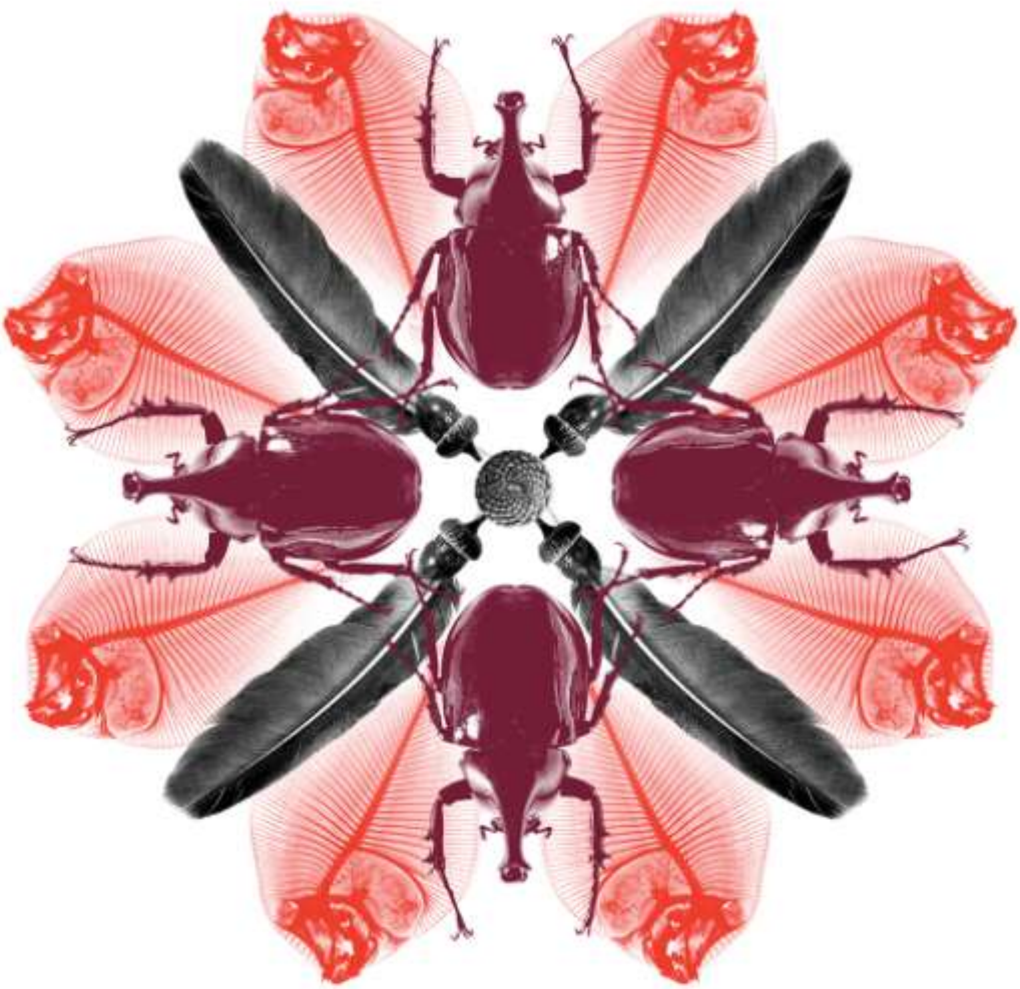
Australian Government
Department of Agriculture

Draft review of policy: importation of *Zantedeschia* dormant tubers into Australia

July 2015



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Acronyms and abbreviations

Term or abbreviation	Definition
ACT	Australian Capital Territory
ALOP	Appropriate level of protection
BA	Biosecurity Advice
CSIRO	Commonwealth Scientific and Industrial Research Organisation
FAO	Food and Agriculture Organization of the United Nations
ICON	The Australian Department of Agriculture import conditions database
IPC	International Phytosanitary Certificate
IPPC	International Plant Protection Convention
IRA	Import risk analysis
ISPM	International Standard for Phytosanitary Measures
NSW	New South Wales
NPPO	National Plant Protection Organisation
NT	Northern Territory
PRA	Pest risk assessment
PEPICC	Post Entry Plant Industry Consultative Committee
PEQ	Post-entry quarantine
QAP	Quarantine Approved Premises
Qld	Queensland
SA	South Australia
SPS	Sanitary and Phytosanitary
Tas.	Tasmania
Vic.	Victoria
WA	Western Australia
WTO	World Trade Organization

Summary

The Australian Government Department of Agriculture (the department) initiated this review in response to a market improvement request from the Ministry for Primary Industries (MPI), New Zealand for dormant Calla lily (*Zantedeschia* species) tubers. Specifically, MPI requested that the department reconsider the requirement for dormant *Zantedeschia* tubers to undergo methyl bromide fumigation and provide an option for post-entry quarantine to occur in open quarantine in Australia. Additionally, Australian importers have requested that the department consider alternative risk management measures for dormant *Zantedeschia* tubers from the United States.

The existing policy allows the importation of *Zantedeschia* dormant tubers subject to mandatory on-arrival inspection, fumigation and growth in a closed PEQ facility for disease screening for a minimum of 12 weeks.

As part of the review, biosecurity risks associated with *Zantedeschia* dormant tubers from all sources were identified. Consequently, the appropriateness of existing risk management measures for the identified risks was evaluated. This review proposes changes to import conditions for dormant tubers, including alternative conditions for dormant tubers produced under a systems approach or certification scheme. This systems approach is based on a combination of production practices, crop monitoring and verification of pathogen freedom through certification. Proposed changes to import conditions for dormant tubers are summarised below:

Dormant tubers (non-approved sources)

- the option to use an alternative treatment to methyl bromide fumigation, including hot water treatment or insecticidal dip. These treatments may be conducted off-shore or on-shore.
- a reduction in the PEQ period from 12 weeks to a minimum of six weeks for pathogen screening or until sufficient new growth (where the plant has developed multiple, open and green leaves) has occurred.

Dormant tubers (produced under a systems approach or certification scheme)

- The proposed components of the systems approach include:
  - sourcing dormant tubers from high health mother stock (pathogen-tested mother stock; or mother stock established from seeds)
  - in-field monitoring and management for quarantine pests and pathogens, as well as thrips vectors
  - mandatory off-shore or on-shore treatment, including either methyl bromide fumigation, or hot water treatment, or insecticidal dip
  - pre-export inspection
  - mandatory on-arrival inspection.

- Dormant tubers meeting all the components of the systems approach are proposed to be released and will not require growth in a PEQ facility.

The ultimate goal of phytosanitary measures is to protect Australia from exotic pests and diseases through maintaining plant health and preventing the introduction of identified quarantine pests associated with *Zantedeschia* dormant tubers. The department considers that the risk management measures proposed in this draft review of policy will be adequate to mitigate the risks posed by the identified pests of quarantine concern.

The department invites comments on the technical aspects of the proposed risk management measures within the consultation period. In particular, comments are sought on their appropriateness and any other measures stakeholders consider would provide equivalent risk management outcomes. The department will consider any comments received before finalising the pest risk analysis and quarantine policy recommendations.

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 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 risk analysis 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 new products into Australia. If the risks are found to exceed Australia's appropriate level of protection (ALOP), risk management measures are recommended to reduce the risks to an acceptable level. But, 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 risk analyses are undertaken by the Department of Agriculture using technical and scientific experts in relevant fields, and involve consultation with stakeholders at various stages during the process.

Further information about Australia's biosecurity framework is provided in Appendix C of this report and in the *Import Risk Analysis Handbook 2011* located on the Department of Agriculture website.

1.2 This review of policy

Australia has an existing policy to import *Zantedeschia* propagative material in the form of dormant tubers from all countries. The policy for imported dormant tubers includes mandatory on-arrival fumigation and growth in a closed post-entry quarantine facility for disease screening.

1.2.1 Background

The purpose of this policy review is to examine a market improvement request from the Ministry for Primary Industries (MPI), New Zealand for dormant *Zantedeschia* tubers. This proposal includes a request for exemption of *Zantedeschia* tubers from mandatory fumigation with methyl bromide and growth in a closed post-entry quarantine facility. Additionally, Australian importers have requested that the department considers alternative risk management measures for dormant *Zantedeschia* tubers from the United States. Specifically, it was requested that the department reconsiders the requirement for dormant *Zantedeschia* tubers to undergo methyl bromide fumigation and release from quarantine if material meets on-arrival inspection requirements in Australia (without undergoing closed post-entry quarantine) and is summarised below.

The review of existing conditions for *Zantedeschia* propagative material is a long standing issue.

2005 Domestic industry requested that the department review *Zantedeschia* tuber import conditions to allow tubers from a US high-health source into Australia under a reduced post-entry quarantine period.

2011 At Australia/New Zealand bilateral plant quarantine discussions, New Zealand requested that the department consider alternative measures for the importation of tubers from New Zealand. MPI has requested the removal of the QAP/PEQ and mandatory fumigation requirements for the import of *Zantedeschia* tubers to Australia from New Zealand.

2012 The New Zealand MPI submitted technical information in support of market access for *Zantedeschia* tubers and advised the department that *Zantedeschia* tubers were their highest priority.

2013 The department discussed the New Zealand request with industry representatives at a Post-Entry Plant Industry Consultative Committee (PEPICC) meeting and proposed a 'priority A' for New Zealand's request. No concerns were raised about the proposal.

An Australian importer provided production information from the US. The department decided to combine both of these requests and, given the small number of additional pests from all countries, the department made the decision to review conditions for *Zantedeschia* dormant tubers from all sources.

The department initiated a preliminary assessment and consulted with the US and New Zealand.

2014 New Zealand provided supplementary information on their market improvement request for *Zantedeschia* dormant tubers to Australia and proposed an 'official assurance program' for the export of *Zantedeschia* dormant tubers to Australia.

1.2.2 Scope

This review assesses the appropriateness of the existing policy for the importation of dormant *Zantedeschia* tubers of into Australia. The scope of this review is limited to:

- the identification of biosecurity risks associated with *Zantedeschia* propagative material (dormant tubers from all countries)
- the identification of phytosanitary measures for the identified risks.

This review did not consider existing phytosanitary measures during the pest risk analysis. Existing phytosanitary measures are only considered during the development of risk management measures, if they are required, following the pest risk analysis.

This policy review is limited to proposing appropriate phytosanitary measures to address the risk of introducing quarantine pests of *Zantedeschia* propagative material into Australia. It is the importer's responsibility to ensure compliance with the requirements of all other regulatory and advisory bodies associated with importing commodities to Australia. Among others, these could include the Australian Customs Service, Department of Health and Ageing, Therapeutic Goods Administration, Australian Pesticides and Veterinary Medicines Authority, Department of the Environment and state departments of agriculture.

1.2.3 Existing policy

There are a number of *Zantedeschia* species that are currently permitted entry into Australia, subject to specific import conditions. These conditions are available on the import conditions database (ICON) at http://www.agriculture.gov.au/icon. The list of *Zantedeschia* species currently permitted entry into Australia from all sources is provided in Table 1.

Table 1 List of *Zantedeschia* species permitted entry into Australia from all sources

Scientific name	Synonyms
Zantedeschia aethiopica (L.) Spreng	*Calla aethiopica* L; *Zantedeschia aethiopica* var. *minor* Engl., *Richardia africana* Kunth
Zantedeschia albomaculata (Hook.) Baill.	
Zantedeschia albomaculata (Hook.) Baill. subspecies *albomaculata*	*Calla oculata* Lindl.; *Richardia albomaculata* Hook.; *Zantedeschia oculata* (Lindl.) Engl.
Zantedeschia albomaculata (Hook.) Baill. subspecies *macrocarpa* (Engl.) Letty	*Zantedeschia macrocarpa* (Engl.) Letty
Zantedeschia albomaculata (Hook.) Baill. var. *macrocarpa* (Engl.) Letty	
Zantedeschia elliottiana (W. Watson) Engl.	*Calla elliottiana* (W. Watson) W. Watson; *Richardia elliottiana* W. Watson
Zantedeschia elliottiana x *pentlandii*	
Zantedeschia pentlandii (W. Watson) Wittm.	*Richardia pentlandii* W. Watson; *Zantedeschia sprengeri* (Comes) Burtt Davy
Zantedeschia jucunda Letty	
Zantedeschia rehmannii Engl.	*Richardia rehmannii* (Engl.) N. E. Br. ex W. Harrow
Zantedeschia rehmannii x *elliottiana*	
Zantedeschia rehmannii x *pentlandii*	

Dormant tubers

Standard nursery stock, import conditions for permitted *Zantedeschia* species include:

- an import permit and a Phytosanitary Certificate
- mandatory on-arrival inspection to verify freedom from live insects, live snails, soil, disease symptoms and any other extraneous contamination of quarantine concern
- mandatory fumigation
- mandatory growth under closed quarantine, at a government post-entry quarantine facility or at a Quarantine Approved Premises (Class 6.1) for a minimum of three months (and until sufficient new growth has occurred) for passive screening.

1.2.4 Consultation

The department advised the Post Entry Plant Industry Consultative Committee (PEPICC) of New Zealand's request seeking removal of mandatory fumigation and exemption of dormant tubers from growth in a closed post-entry quarantine facility. PEPICC industry representatives have been provided updates through PEPICC meetings. The department has also consulted with MPI, New Zealand and the United States Department of Agriculture (USDA).

2 Pest risk analysis

The Department of Agriculture has conducted this 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* (FAO 2013b) that have been developed under the SPS Agreement (WTO 1995). These 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

Phytosanitary terms used in this PRA are defined in ISPM 5: *Glossary of phytosanitary terms* (FAO 2013a). A glossary of the terms used is provided at the back of this report.

The PRAs are conducted in the following three consecutive stages: initiation, pest risk assessment and pest risk management.

2.1 Stage 1: Initiation

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

The department initiated this review in response to requests from the MPI, New Zealand and Australian importers to review pathway specific conditions for *Zantedeschia* dormant tubers from New Zealand and the United States. Given the small number of additional pests from all countries, the department made the decision to review conditions for *Zantedeschia* dormant tubers from all sources.

The pests associated with *Zantedeschia* from all sources were tabulated from information provided by MPI and 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. Synonyms are provided where the current scientific name differs from that provided by the exporting countries NPPO or where the cited literature uses a different scientific name.

In the context of this assessment, *Zantedeschia* dormant tubers are a potential import 'pathway' by which a pest can enter Australia.

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 (for quarantine pests) 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 2013b). 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 entry, establishment, spread or potential economic impact 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.

The following three, consecutive steps were used in the pest risk assessment:

2.2.1 Pest categorisation

Pest categorisation identifies which of the pests with the potential to be on the commodity are quarantine pests for Australia and require pest risk assessment. A 'quarantine pest' is 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 2013a).

The pests identified in Stage 1 were categorised using the following primary elements to identify the quarantine pests for the commodity being assessed:

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

In the context of propagative material, pest categorisation includes all the main elements of a pest risk assessment. However, for propagative material, pests are already with, or within, a suitable, living host that will be grown under favourable conditions to ensure the survival of the host plant. In addition, pests can spread from infected propagative material not only by natural dispersal, but also by domestic trade of infected nursery stock.

Pests were 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 *Zantedeschia* listed in Appendix A were used to develop a pathway-specific pest list for dormant tubers. This list identifies the pathway association of pests recorded on *Zantedeschia* species and their status in Australia, their potential to establish or spread, and their potential for economic consequences. Pests likely to be associated with *Zantedeschia* dormant tubers, and 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 *Zantedeschia* dormant tubers from all sources identified in the pest categorisation (Appendix A) are listed in Table 2. These pests 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)

- these pests are not present in Australia.

Table 2 Quarantine pests for *Zantedeschia* dormant tubers

Pest type	Common name
DIPTERA (flies)	
Eumerus strigatus (Fallen) [Diptera: Syrphidae]	Lesser bulb fly
HEMIPTERA (Mealybugs)	
Pseudococcus maritimus Ehrhorn [Hemiptera: Pseudococcidae]	Grape mealybug
BACTERIA	
Pseudomonas veronii (Elomari et al.) [Pseudomonadales: Pseudomonadaceae]	Bacterial soft rot
FUNGI	
Phytophthora meadii McRae [Peronosporales: Peronosporaceae]	
Phytophthora richardiae Buisman [Peronosporales: Peronosporaceae]	Tuber rot of Calla lily
VIRUSES	
Calla lily chlorotic spot virus (CCSV) [Bunyaviridae: *Tospovirus*]	Calla lily chlorotic spot
Impatiens necrotic spot virus (INSV) [Bunyaviridae: *Tospovirus*]	Necrotic spot
Konjac mosaic virus (KoMV) [Potyviridae: *Potyvirus*]	
Lisianthus necrosis virus (LNV) [Tombusviridae: *Necrovirus*]	
Watermelon silver mottle virus (WSMoV) [Bunyaviridae: *Tospovirus*]	Watermelon silver mottle disease
Zantedeschia mild mosaic virus (ZaMMV) [Potyviridae: *Potyvirus*]	

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 2013b). A summary of this process is given below, followed by a description of the qualitative methodology used in this PRA.

In the case of propagative material imports, the concepts of entry, establishment and spread have to be considered differently. Propagative material 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 associated with the propagative material. Pests 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 associated with propagative material to enter, establish and spread in Australia. These are discussed below.

Probability of entry

- Association with host commodities provides the opportunity for a pest to enter Australia. The pest’s 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.

- For the purpose of this pest risk assessment, 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/infested propagative material is one of the main pathways for the introduction of the pests into new areas. Long latency periods can assist in the introduction of asymptomatic propagative material into Australia.
- Transport and storage of propagative material occurs at moderate temperatures and humidity and these conditions are not expected to affect viability of the associated pests.
- The pests associated with propagative material may be systemic or associated with the vascular system (occur internally in the nursery stock) and they are unlikely to be dislodged during standard harvesting, handling and shipping operations. Therefore, these pests are more likely to escape detection and survive during transport to Australia.

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.
- 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.
- Long latency periods of infection may result in the non-detection of some pathogens; therefore, the pathogens will have ample time to establish into new areas.
- The identified pests are established in areas with a wide range of climatic conditions. There are similar climatic regions in parts of Australia that would be suitable for the establishment of these pests.

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 that 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.

- The systemic nature of some of the pests associated with propagative material is likely to assist in their 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.
  - Although the viruses may differ in particle morphologies, disease symptoms induced, and means of natural spread by insect or nematode vectors, each virus is readily carried and dispersed in nursery stock.
  - In some instances, pathogens may be introduced via infected plants into a region where native vector species reside, resulting in secondary spread to surrounding host 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 2013b). 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 propagative material.

2.2.3 Assessment of potential consequences

The purpose of the assessment of potential consequences in the PRA process is to identify and qualify, 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 (WTO 1995), in particular Article 5.3 and Annex A. Further detail on assessing consequences is given in the 'potential economic consequences' section of ISPM 11 (FAO 2013b). ISPM 11 separates the consequences into 'direct' and 'indirect' and provides examples of factors to consider within each.

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 result in phytosanitary regulations imposed by foreign or domestic trading partners, and increased costs of production, including pest control costs. Introduction and establishment of quarantine pests would also likely result in industry adjustment. The potential economic impact for the nursery trade is high. 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. Quarantine pests that are identified in the PRA process are of economic concern and do not occur in Australia. A summary of these pests and justification is provided below:

- Introduction and establishment of quarantine pests would likely result in industry adjustment. For example, without controls, lesser bulb fly (*Eumerus strigatus*) and grape mealybug (*Pseudococcus maritimus*) have the potential to spread further in the trade network and could potentially expand their host range.
- *Eumerus strigatus* (lesser bulb fly) is considered an economically important pest of ornamentals and some root vegetables, particularly onions (Perry 2007). The larvae of this species tunnel into tuberous plant parts and can cause up to 30 percent crop loss in onion, up to 25 percent crop loss of some varieties of narcissus and approximately 10 percent crop loss in hyacinths (Gherasim 1973; Mulin 1990; Perry 2007).
- Although no information is available on the losses caused by *Pseudococcus maritimus* on *Zantedeschia,* this mealybug causes considerable losses in table grapes through direct feeding (McKenzie 1967; Daane et al. 2003) and is a recognised pest of apricots and pears (Ben-Dov 2013b). In addition, *P. maritimus* vectors grapevine leafroll viruses (Skinkis et al. 2009; Daane et al*.* 2011) and *Little cherry virus* 2 (Mekuria et al. 2013).
- Soft rot is an important disease of *Zantedeschia* production in various countries (Mikiciński et al. 2010b) and *Pseudomonas veronii* is part of the bacterial complex that causes this disease (Mikiciński et al. 2010a). Globally, soft rot results in substantial losses in *Zantedeschia* production. For example, in New Zealand (the biggest producer of *Zantedeschia* tubers and flowers), losses from soft rot accounts for 20 percent of the total income of *Zantedeschia* production (Vanneste 1996; Wright et al. 2005).
- *Phytophthora meadii* and *P. richardiae* cause rots to underground plant parts of *Zantedeschia* species as well as economically important crops such as tomato, cassava, asparagus and carrot. *Phytophthora meadii* is the causal agent of black stripe, patch canker, green pod rot, green twig blight and abnormal leaf fall. Of these diseases, black stripe is the most severe disease of rubber caused by *Phytophthora* (Erwin & Ribeiro 1996), followed by leaf fall. In wet tropical areas, leaf fall is very common and can cause 40 percent yield loss (Drenth & Guest 2004).
- Identified viruses of quarantine concern associated with *Zantedeschia* species belong to diverse virus groups including *Necrovirus* (*Lisianthus necrosis virus* (LNV)); *Potyvirus* (*Konjac mosaic virus* (KoMV) and *Zantedeschia mild mosaic virus* (ZaMMV)); and *Tospovirus* (*Calla lily chlorotic spot virus* (CCSV)*, Impatiens necrotic spot virus* (INSV) and *Watermelon silver mottle virus* (WSMoV)). These viruses cause a variety of direct and indirect economic impacts (CABI/EPPO 1997; Chang et al*.* 2001; Chen et al. 2005; Chen et al*.* 2006c; 2006d; Daughtrey et al*.* 1997; EPPO 1997; Wick 2009). *Zantedeschia* tubers are a popular cut flower and nursery stock commodity that is valued for its ornamental appeal. Therefore, any loss of aesthetic value—such as through yellowing, mosaic, green or discoloured spots on leaves or flowers of *Zantedeschia*—will render nursery stock unsaleable, and result in production losses through the destruction of infected material.

2.3 Stage 3: Pest risk management

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.

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 National Plant Protection Organisation (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—**the importing country may specify steps that must be followed in order to prepare the consignment for shipment. These conditions can include the requirement for plants to be 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 dormant tubers, seed 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 that must be applied to the consignment before it may be imported.

Measures can range from total prohibition to permitting the import of nursery stock 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 Pest risk management

The ultimate goal of phytosanitary measures is to prevent the introduction of identified quarantine pests into the PRA area. To effectively prevent the introduction of pests associated with nursery stock, a series of important safeguards, conditions, or phytosanitary measures must be in place. Risk management options can consist of existing measures or they can be new measures that have been developed specifically to address the risk from the pest or pathway under consideration.

3.1 Existing risk mitigation measures

There are a number of *Zantedeschia* species that are currently permitted entry into Australia, subject to specific import conditions.

3.1.1 Dormant tubers

- an import permit and a Phytosanitary Certificate
- mandatory on-arrival inspection to verify freedom from live insects, live snails, soil, disease symptoms and any other extraneous contamination of quarantine concern
- mandatory on-arrival fumigation
- mandatory growth under closed quarantine, at a government post-entry quarantine facility or at a Quarantine Approved Premises (Class 6.1) for a minimum of three months (and until sufficient new growth has occurred) for passive screening.

3.2 Evaluation of existing policy

As part of the review, the department identified pests of quarantine concern including arthropods (lesser bulb fly, grape mealybug) and pathogens (bacteria, fungi and viruses) associated with *Zantedeschia* dormant tubers. Consequently, the appropriateness of existing risk management measures was evaluated to determine if alternative or additional measures are required.

Mandatory on-arrival inspection

- The existing requirement for mandatory on-arrival inspection of imported dormant tubers to verify freedom from disease symptoms, live insects, soil and other extraneous contaminants of quarantine concern is proposed to continue.
- **Freedom from live insects** will be an appropriate stand-alone measure for managing the risk of the mealybug, *Pseudococcus maritimus* in dormant tubers. The adults of this species are five millimetres in length and eggs are laid in cottony masses (Perry 2007). *Zantedeschia* tubers do not possess adequate hiding places that would cause this species to remain undetected at inspection. Therefore, *P. maritimus* will be readily visible on inspection. The purpose of the inspection is to ensure that import requirements for freedom from identified quarantine pests have been met and to detect new pests that may not have been categorised for their pest risk. Therefore, existing mandatory on-arrival inspection to verify freedom from live insects is proposed to continue.

However, *Eumerus strigatus* is an internal borer of *Zantedeschia* tubers and may not be detectable at inspection. Therefore, on-arrival inspection is not considered an appropriate stand-alone quarantine measure for this pest for dormant tubers.

- **Freedom from disease symptoms** will be adequate for the detection of soft rot symptoms (*Pseudomonas veronii*) dormant tubers. *Pseudomonas veronii* is part of the bacterial soft rot complex and bacterial soft rot rapidly spreads during tuber storage (Vanneste 1996; Wright et al. 2002). Therefore, existing mandatory on-arrival inspection to verify freedom from disease symptoms is proposed to continue. However, other pathogens of quarantine concern identified during this review may not produce symptoms on dormant tubers. Therefore, additional measures will be required to manage these risks in dormant tubers.
- **Freedom from soil and extraneous material** will be adequate to mitigate the risk of trash-borne or soil-borne pests. These insects or pathogens (for example, exotic nematodes and *Phytophthora* species) may not be directly associated with *Zantedeschia* tubers; however, they may be associated with infested soil or potting media in which *Zantedeschia* are grown. Many plant pests can be found in the soil and are able to remain viable in that environment for several years. These pests can be spread by the movement of contaminated soil and include pests of quarantine concern to Australia. Therefore, the department proposes maintaining the requirement for imported *Zantedeschia* tubers to be free from soil and other extraneous contamination of quarantine concern, in-line with general nursery stock import conditions, to prevent the potential introduction of soil-borne and trash-borne pests.

Mandatory on-arrival fumigation

- On-arrival fumigation of imported *Zantedeschia* tubers to manage the risk posed by *Eumerus strigatus* is adequate and is proposed to continue. Hot water treatment and insecticidal dip are proposed as alternative treatment options to methyl bromide fumigation.
- Certified bulbs of *Gladiolus*, *Hippeastrum*, *Hyacinth*, *Iris*, *Lilium* and *Narcissus* are currently permitted entry from countries where lesser bulb fly (*Eumerus strigatus*) is known to occur. The quarantine risks associated with lesser bulb fly on ornamental bulbs are currently managed by fumigation with methyl bromide. Given the volume of imports of bulbs of the above genera over the last decade and the absence of lesser bulb fly, the treatment appears to have been effective at minimising the entry of a wide range of arthropod pests including the lesser bulb fly.
- The department acknowledges that methyl bromide is a commonly used fumigant because of its effectiveness in killing arthropods and nematodes, regardless of the commodity, due to its ability to penetrate material (Fields and White 2002).
- The department will consider alternative treatments to methyl bromide fumigation for dormant tubers, if requested by an exporting country, on a case by case basis.

Mandatory growth in closed PEQ

- The existing requirement for mandatory growth of dormant *Zantedeschia* tubers from non-approved sources under closed quarantine, at a government PEQ facility or at a Quarantine Approved Premises (Class 6.1), for a minimum of three months (or until sufficient new growth has occurred) for disease screening, is not supported as plants produce sufficient foliage for disease screening within six weeks. Additionally, the plants flower within 6–10 weeks and the life of the flower is three weeks (depending on the air temperature). Consequently, the flowers may expire within the 12 week PEQ period and crops will be unsaleable. Therefore, a reduction in the PEQ growth period is proposed.

3.3 Proposed risk mitigation measures

The proposed risk management measures are based on a comprehensive analysis of the scientific literature. Under the SPS Agreement, measures put in place by a country must be based either on an international standard or upon a scientific risk analysis. Under this agreement, countries must adopt quarantine policies that are, wherever appropriate, based on international standards that provide the health safeguards required by government policy in the least trade-restrictive way.

3.3.1 Dormant tubers (non-approved sources)

The existing requirement for mandatory growth of dormant *Zantedeschia* tubers from non-approved sources under closed quarantine, at a government PEQ facility or at a Quarantine Approved Premises (Class 6.1), for a minimum of three months (and until sufficient new growth has occurred) for disease screening, is not supported as the plants produce sufficient growth for pathogen screening within 6–10 weeks. Therefore, a reduction is PEQ growth period is proposed.

Mandatory on-arrival inspection

The existing requirement for mandatory on-arrival inspection of dormant tubers to verify freedom from disease symptoms, live insects, soil and other extraneous contaminants of quarantine concern is proposed to continue.

Mandatory on-arrival treatment

The existing requirement for mandatory on-arrival fumigation of imported *Zantedeschia* tubers to manage the risk posed by arthropod pests is adequate and is proposed to continue.

The department also proposes hot water treatment or insecticidal dip as alternative treatments to methyl bromide fumigation. Other alternative treatments for dormant *Zantedeschia* tubers, if requested by an exporting country, will be considered by the department on a case by case basis.

Methyl bromide is a commonly used fumigant because of its effectiveness in killing arthropods regardless of the commodity, due to its ability to penetrate plant material (Fields and White 2002). Therefore, the department considers that mandatory fumigation of *Zantedeschia* dormant tubers is adequate to manage the risk posed by *Eumerus strigatus* and *Pseudococcus maritimus*.

Hot water treatment is proposed as an alternative to methyl-bromide fumigation. Tuber core temperature must be maintained at a minimum of 44 degrees Celsius for a period of one hour. The department considers hot water treatment to be an effective measure to manage quarantine arthropod pests.

Insecticidal dip is proposed as another alternative to methyl bromide fumigation. Insecticidal dip is currently used by the department for medium risk nursery stock (other than tissue cultures) known to be susceptible to methyl bromide fumigation. Under this treatment, plant material must be immersed in the insecticidal dip (Imidacloprid 100 milligrams per litre and one percent Eco Oil) for a minimum of 30 seconds. As this treatment is considered an appropriate broad spectrum insecticide, regardless of host, the department considers it an effective measure to manage arthropod pests.

Mandatory growth in closed PEQ

Mandatory growth in closed quarantine, at a government PEQ facility or at a Quarantine Approved Premises (Class 6.1) for disease screening is proposed to continue. However, the mandatory growth period is proposed to be reduced from 12 weeks to a minimum of six weeks, or until sufficient new growth occurs for disease screening.

The department considers that this reduction is justified as:

- *Zantedeschia* tubers are imported to be used as a flowering crop and sufficient growth (where the plant has developed multiple, open and green leaves) occurs within 6–10 weeks after potting. The plants will have generated sufficient foliage and flower material to determine virus and disease freedom as identified pathogens produce visible symptoms.

Therefore, the department proposes that the growth period for imported *Zantedeschia* tubers must be reduced to a minimum of six weeks, or until sufficient growth (where the plant has developed multiple, open and green leaves) occurs for disease screening.

3.3.2 Dormant tubers (produced under a systems approach or certification scheme)

The Ministry for Primary Industries, New Zealand and the Australian industry has requested that the department consider alternative risk management measures for dormant *Zantedeschia* tubers from New Zealand and the USA. These stakeholders have requested that dormant *Zantedeschia* tubers produced under the alternative risk management measures should be exempt from mandatory on-arrival fumigation and three months growth in PEQ facilities in Australia. Consistent with the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) Article 4 *Equivalence,* the department is proposing a systems approach to manage quarantine pests as an alternative to the existing measures for importing *Zantedeschia* tubers. Based on this systems approach, the department is proposing:

- sourcing dormant tubers from high health mother stock (pathogen-tested mother stock; or mother stock established from seeds)
- in-field monitoring and management for quarantine pests and pathogens, as well as thrips vectors
- mandatory off-shore or on-shore treatment, including either methyl bromide fumigation, or hot water treatment, or insecticidal dip
- pre-export inspection
- mandatory on-arrival inspection.

The department proposes that dormant tubers meeting all the components of the proposed systems approach may be released and will not require growth in a PEQ facility.

The main components of the proposed systems approach are detailed below and summarised in Table 3.

Sourcing dormant tubers from high health mother stock

The department proposes that dormant tubers for export to Australia should be sourced from high health mother stock that has been pathogen tested or has been established from seeds.

Pathogen tested mother stock

The department proposes that dormant tubers may be sourced from pathogen tested mother stock. The prior inspection and testing of mother stock ensures that a pest- and disease-free source of plant material is used for the production of *Zantedeschia* tubers*.*

Mother stock established from seeds

The department proposes that dormant tubers may be sourced from mother stock that has been established from seeds. None of the pests or pathogens of quarantine concern for *Zantedeschia* tubers are associated with the seed pathway; therefore, mother plants grown from seed will be free of quarantine pests and pathogens.

In field management

Zantedeschia species are susceptible to a number of fungal and bacterial pathogens, including *Phytophthora meadii, P. richardiae and Pseudomonas veronii*, which express above ground symptoms. These pathogens should be managed using a combination of visual crop inspections, pre-planting fungicides and in-field spray regimes as the dormant tubers are produced for export to Australia.

Monitoring and management of pests

The main pests associated with *Zantedeschia* field production are thrips and aphids. However, these pests are associated with the foliage of host plants and are not on the pathway of dormant tubers. However, viruliferous thrips may transmit quarantine viruses to *Zantedeschia* plants during field production. For instance, Western flower thrips is a known vector of INSV and *Thrips palmi* is a known vector of CCSV and WSMoV; therefore, viruliferous thrips in the field may infect Z*antedeschia* with quarantine viruses whilst feeding on vegetative material. Consequently, thrips should be managed through monitoring programmes and insecticidal spray regimes.

The mother crop must be monitored by a NPPO or a NPPO authorised officer. This will allow the inspectors to pick up any infected plants or signs of pest infestation. Removing unhealthy plants is permitted; however, records are to be kept and made available upon request regarding why and how many plants have been affected and removed. At least two field inspections of the crop during the growing season should be undertaken, with at least one inspection at flowering time.

Mandatory treatment

Under the existing policy, mandatory on-arrival fumigation is applied to minimise the risk of accidental introduction of arthropod pests. The department proposes hot water treatment or insecticidal dip as alternative treatment options to methyl bromide fumigation. These treatments may be conducted off-shore or on-shore.

Inspection (pre-export inspection)

The department proposes that dormant tubers for export to Australia will be inspected by NPPO officers immediately prior to export and certified as meeting Australia's import requirements.

On-arrival inspection

The department proposes that it will undertake a documentation compliance examination for consignment verification purposes, at the port of entry in Australia, prior to inspection and discharge of the imported dormant tubers.

Table 3 Proposed systems approach for *Zantedeschia* dormant tubers

Component of systems approach	Effect of the proposed measure
Sourcing dormant tubers from high health mother stock	This component of the proposed systems approach includes: • Using pathogen tested pest free mother stock to produce dormant tubers for Australia; or • Using mother stock that has been established from seeds to produce dormant tubers for Australia. This step will reduce risk of introducing pests of quarantine concern into the production chain.
In-field monitoring and management of thrips	This component of the proposed systems approach includes: • Regular monitoring of *Zantedeschia* tuber crops for fungal, bacterial and viral pathogens as well as thrips. • Fungicidal spray regimes and insecticidal spray regimes to control thrips and aphids during growth to produce dormant tubers for Australia. Regular monitoring allows the inspectors to detect infected plants or signs of pest infestation and will reduce the introduction of pests of quarantine concern to Australia in the supply chain.
Treatment (off-shore, on-shore)	This component of the proposed systems approach includes: • Fumigation or insecticidal dip or hot water treatment of dormant tubers prior to export. The fumigation or insecticidal dip or hot water treatment will ensure that only pest free dormant tubers are supplied to Australia.
Pre-export inspection	This component of the proposed systems approach includes: • pre-export inspection by NPPO officers immediately prior to export for evidence of plant pests or diseases. Inspections will ensure that only pest free dormant tubers are supplied to Australia.
On-arrival inspection	This component of the proposed systems approach includes: • on-arrival inspection by departmental officers for document compliance and consignment verification purposes. Inspections will verify the declared phytosanitary health of the dormant tubers.

3.4 Consideration of alternative measures

Consistent with the principle of equivalence detailed in ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2013b), the department will consider any alternative measure proposed by a NPPO, providing that it achieves Australia's ALOP. Evaluation of such measures or treatments will require a technical submission from the NPPO that details the proposed treatment including data from suitable treatment trials to demonstrate efficacy.

There are a number of risk mitigation measures that can be adopted to protect and minimise the risks of exotic pests under International Plant Protection Convention (IPPC) standards (www.ippc.int/IPP/En/default.jsp).

3.4.1 Sourcing *Zantedeschia* tubers from pest free areas (PFAs)

The establishment and use of a pest free area by a NPPO provides assurance that specific pests are not present in the production area for plant products being exported. This facilitates the commodity's entry into the importing country, without the need for an application of additional phytosanitary measures, when certain requirements are met.

Area freedom is a measure that might be applied to manage the risk posed by *Eumerus strigatus*, *Pseudococcus maritimus*, *Pseudomonas veronii*, *Phytophthora meadii*, *P. richardiae*, *Calla lily chlorotic spot virus*, *Impatiens necrotic spot virus*, *Konjac mosaic virus*, *Lisianthus necrosis virus*, *Watermelon silver mottle virus* and *Zantedeschia mild mosaic virus* with dormant *Zantedeschia* tubers imported into Australia. The requirements for establishing pest free areas or pest free places of production are set out in ISPM No. 4: *Establishment of pest free areas* (FAO 1995) and ISPM No. 10: *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 1999).

The establishment and use of a PFA by a NPPO allows for the export of plants and other regulated articles from the exporting country to the importing country without the need for application of additional phytosanitary measures, when certain requirements are met. Thus, the pest free status of an area may be used as the basis for the phytosanitary certification of plants and other regulated articles with respect to the stated pest(s). The exporting country may also inspect the crop to confirm freedom from the pests and provide that certification. The requirements for the establishment, and subsequent maintenance, of a PFA include:

- systems to establish freedom (general surveillance, specific surveys)
- phytosanitary measures to maintain freedom (regulatory actions, routine monitoring, extension advice to producers)
- checks to verify freedom has been maintained.

4 Conclusion

The findings of this draft review of policy are based on a comprehensive analysis of the scientific literature. This review has identified several pests of quarantine concern that are associated with *Zantedeschia* dormant tubers from all sources.

The ultimate goal of Australia's phytosanitary measures is to protect plant health and prevent the introduction of identified quarantine pests associated with *Zantedeschia* dormant tubers. The department considers that the risk management measures proposed in this draft review of policy are adequate to mitigate the risks posed by the identified pests of quarantine concern.

Existing risk management measures for *Zantedeschia* dormant tubers have been assessed, and changes to the existing policy are proposed for dormant tubers. The proposed risk management measures for *Zantedeschia* dormant tubers are summarised as follows:

Dormant tubers (non-approved sources)

- mandatory on-arrival inspection
- mandatory treatment, including either methyl bromide fumigation, hot water treatment or insecticidal dip
- growth in a closed PEQ facility for a minimum of six weeks for pathogen screening, or until sufficient new growth (where the plant has developed multiple, open and green leaves) has occurred.

Dormant tubers (produced under a systems approach or certification scheme)

The current review proposes that dormant *Zantedeschia* tubers produced under a systems approach or certification scheme should be subject to alternative import conditions. This approach could be used to progressively reduce the risk of infected *Zantedeschia* tubers being imported to Australia, and is based on a combination of production practices, crop monitoring and verification of pathogen freedom through testing and certification. The proposed risk management measures for *Zantedeschia* tubers produced under a systems approach are summarised below:

- sourcing dormant tubers from high health mother stock (pathogen-tested mother stock; or mother stock established from seeds)
- in-field monitoring and management for quarantine pests and pathogens, as well as thrips vectors
- mandatory off-shore or on-shore treatment, including either methyl bromide fumigation, or hot water treatment, or insecticidal dip
- pre-export inspection
- mandatory on-arrival inspection.

The department proposes that dormant tubers meeting all the components of the systems approach may be released and will not require growth in a post-entry quarantine facility.

Appendix A: Initiation and categorisation for pests of *Zantedeschia* dormant tubers from all countries

Initiation identifies the pests that occur on *Zantedeschia* species, their status in Australia and their pathway association. In this assessment, **pathway** is defined as *Zantedeschia* dormant tubers. Dormant tubers are free of roots and leaves, consequently pests associated with roots and leaves are not considered to be on the dormant tuber pathway. Please note that the 'introduction potential' column usually specifies the association of pests with propagative material.

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

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
ARTHROPODS					
ACARI (mites)					
Brevipalpus obovatus Donnadieu 1875 [Acari: Tenuipalpidae]	Yes (O'Dowd 1994)	Assessment not required			
Bryobia neopraetiosa Meyer 1974 [Acari: Tetranychidae]	Not known to occur	No: This polyphagous mite has been recorded on *Zantedeschia aethiopica* (Scott & Neser 1996), but affected plant parts are not mentioned. *Bryobia* species generally feed on the leaves and sometimes flower buds of host plants (Gutierrez & Schichta 1983). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Bryobia praetiosa Koch [Acari: Tetranychidae]	Yes (Arthur et al. 2011)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Calacarus citrifolii Keifer 1955 [Acari: Eriophyidae]	Not known to occur	No: This species occurs on *Zantedeschia* (Ryke & Meyer 1960; Xue et al. 2009). Although affected plant parts are not mentioned, eriophyid mites generally damage leaves, but may also attack twigs and fruit (Lindquist et al*.* 1996). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Rhizoglyphus echinopus (Fumouze & Robin 1868) [Acari: Acaridae]	Yes (Fan & Zhang 2003)	Assessment not required			
Tetranychus amicus Meyer & Rodrigues 1965 [Acari: Tetranychidae]	Not known to occur	No: This species occurs on *Zantedeschia aethiopica* (Bolland et al*.* 1998). Generally, spider mites feed on most plant parts, including the upper and lower surfaces of leaves and the stems and sheaths of some grasses (Flechtmann & Knihinicki 2002). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Tetranychus cinnabarinus (Boisduval 1832) [Acari: Tetranychidae]	Yes (Halliday 1998)	Assessment not required			
Tetranychus desertorum Banks 1900 [Acari: Tetranychidae]	Yes (Flechtmann & Knihinicki 2002)	Assessment not required			
Tetranychus ludeni Zacher 1913 [Acari: Tetranychidae]	Yes (Flechtmann & Knihinicki 2002)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Tetranychus shanghaiensis Ma & Yuan 1975 [Acari: Tetranychidae]	Not known to occur	No: This species occurs on *Zantedeschia aethiopica* (Scott 1997). Generally, spider mites feed on most plant parts, including the upper and lower leaf surfaces and the stems and sheaths of some grasses (Flechtmann & Knihinicki 2002). Therefore, foliage free dormant tubers do not provide a pathway for this species.			
Tetranychus urticae (Koch 1836) [Acari: Tetranychidae]	Yes (Halliday 1998)	Assessment not required			
Tyrophagus neiswanderi Johnston & Bruce 1965 [Acari: Acaridae]	Yes (Fan & Zhang 2007)	Assessment not required			
COLLEMBOLA (Springtails)					
Bourletiella hortensis (Fitch 1863) [Collembola: Sminthuridae]	Yes (Greenslade 2007)	Assessment not required			
Smithurus viridus (Linnaeus 1758) [Collembola: Sminthuridae]	Yes (Greenslade 2007)	Assessment not required			
COLEOPTERA (beetles, weevils)					
Acrocrypta convexa Gressitt & Kimoto 1963 [Coleoptera: Chrysomelidae]	Not known to occur	No: This beetle occurs on *Zantedeschia* (Aston 2009). Generally larvae of chrysomelid beetles feed on roots while adults feed on the leaves of host plants (Beenan & Roques 2010). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Adelium brevicorne Blessig [Coleoptera: Tenebrionidae]	Yes (Gu et al. 2007)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Adoretus tenuimaculatus Waterhouse [Coleoptera: Scarabaeidae] (Synonym: *Adoretus sinicus* Burmeister)	Not known to occur	No: This species is a polyphagous scarab beetle; adults are foliage feeders and larvae are root feeders (Lee et al. 2002). Therefore, foliage free dormant tubers do not provide a pathway for this beetle.	Assessment not required		
Agriotes lineatus (Linnaeus 1767) [Coleoptera: Elateridae]	Not known to occur	No: This click beetle has been recorded on *Zantedeschia* plants (Sacoto Bravo 2010). Eggs are laid in the upper soil layers in damp areas (Frolov 2009). Larvae feed on roots, while adults mostly feed on the pollen of host plants (Borg-Karlson et al. 1988). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Conoderus exsul (Sharp 1877) [Coleoptera: Elateridae]	Yes (Clunie 2004)	Assessment not required			
Costelytra zealandica (White 1846) [Coleoptera: Scarabaeidae]	Not known to occur	No: This beetle has been recorded on *Zantedeschia* (Dymock & Holder 1996). Eggs are laid in the soil and developing larvae feed on the roots while adults are foliage feeders (Fennemore 1984). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Euphoria basalis Gory & Percheron 1833 [Coleoptera: Scarabaeidae]	Not known to occur	No: This species feeds on the pollen and petals of *Zantedeschia* flowers (García 2012). Therefore, dormant tubers do not provide a pathway for this species.	Assessment not required		
Hoplia callipyge Le Conte 1856 [Coleoptera: Scarabaeidae]	Not known to occur	No: Adult hoplia beetles chew on the blossoms and young leaves, while larvae chew on the roots of *Zantedeschia* (Dreistadt 2001). Therefore, dormant tubers do not provide a pathway for this species.	Assessment not required		
Popillia japonica Newman 1841 [Coleoptera: Scarabaeidae]	Not known to occur	No: Adults of this polyphagous species have been reported to chew on the flowers of *Zantedeschia* (Cranshaw 2004). Eggs are laid in the soil and larvae develop on the roots of grasses. Therefore, dormant tubers do not provide a pathway for this species.	Assessment not required		
Phlyctinus callosus (Boheman 1834) [Coleoptera: Curculionidae]	Yes (Walker 1980)	Assessment not required			
DIPTERA (Flies)					
Cerodontha australis (Malloch 1925) [Diptera: Agromyzidae]	Yes (Sasakawa 2010)	Assessment not required			
Delia platura (Meigen 1826) [Diptera: Anthomyiidae]	Yes (Colless 1982)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Eumerus strigatus (Fallen 1817) [Diptera: Syrphidae]	Not known to occur (There is an unconfirmed report of this species occurring in Australia (Thompson 2008). However, there are no confirmed records of this species occurring in Australia)	**Yes**: Eggs are laid on the skin covering or neck of the bulb (Barbour et al. 2008). The larvae hatch and then burrow and overwinter in the bulb (Barbour et al. 2008). This fly has been introduced into many countries by imported bulbs and vegetables (Rojo et al. 1997). Therefore, dormant tubers provide a pathway for this fly.	**Yes**: Bulb flies are established in areas with a wide range of climatic conditions similar to Australia; and may spread naturally in bulbs carrying overwintering larvae (Barbour et al. 2008). In addition, adults and larvae are mobile (Hodson 1927) and therefore are able to disperse naturally. Therefore, this species has the potential to establish and spread in Australia.	**Yes**: Bulb flies are considered economically important pests of ornamentals and some root vegetables, particularly onions (Perry 2007). There are records of up to 30 percent losses in onions; up to 25 percent losses in some varieties of *Narcissus* and 10 percent infestation of hyacinths in some countries (Perry 2007). Therefore, this species has the potential for economic consequences in Australia.	**Yes**
Gaurex flavoapicalis (Malloch 1931) [Diptera: Chloropidae]	Yes (Evenhuis 2012)	Assessment not required			
Gaurax mesopleuralis (Becker 1911) [Diptera: Chloropidae]	Yes (Evenhuis 2012)	Assessment not required			
Hippelates insignificans (Malloch 1931) [Diptera: Chloropidae]	Not known to occur	No: This fly has been recorded on *Zantedeschia* (Dymock & Holder 1996). The larvae are not reported to be associated with *Zantedeschia* tubers. Adults of this fly are common in summer on grasses, sedges, and other low vegetation (Sabrosky 1987). Therefore, dormant tubers do not provide a pathway for this species.	Assessment not required		
Neurochaeta inversa McAlpine 1978 [Diptera: Neurochaetidae]	Yes (McAlpine 1993)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
HEMIPTERA (Aphids, mealybugs, scales)					
Acyrthosiphon malvae (Mosley 1841) [Hemiptera: Aphididae]	Yes (Starý & Carver 1979)	Assessment not required			
Aphis craccivora Koch 1854 [Hemiptera: Aphididae]	Yes (Gutierrez et al. 1974)	Assessment not required			
Aphis fabae Scopoli 1763 [Hemiptera: Aphididae]	Not known to occur	No: This aphid is reported to occur on *Zantedeschia* (Blackman 2013). This aphid overwinters as eggs on its primary hosts (Cammell 1981), including *Euonymus europaeus*, *Viburnum opulus* and *Philadelphus coronarius* (Tosh et al. 2004; Sandrock et al. 2011). Adults move to secondary hosts where they attack the foliage, flowers and twigs (Mackenzie 1996; Liburd et al. 2004). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Aphis gossypii Glover 1877 [Hemiptera: Aphididae]	Yes (Herron et al. 2001)	Assessment not required			
Aulacorthum solani (Kaltenbach 1843) [Hemiptera: Aphididae]	Yes (Berlandier 1997)	Assessment not required			
Aulacorthum circumflexum (Buckton 1876) [Hemiptera: Aphididae]	Yes (Fletcher & Eastop 2005)	Assessment not required			
Bemisia tabaci (Gennadius 1889) [Hemiptera: Aleyrodidae]	Yes (De Barro and Hart 2000)	Assessment not required			
Brachycaudis helichrysi (Kaltenbach 1843) [Hemiptera: Aphididae]	Yes (Martyn and Miller 1963)	Assessment not required			
Calocoris norvegicus (Gmelin 1790) [Hemiptera: Miridiae]	Yes (Haye et al. 2006)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Cavariella aegopodii (Scopoli 1763) [Hemiptera: Aphididae]	Yes (Jones et al. 2006)	Assessment not required			
Cenaeus carnifex (Fabricius 1775) [Hemiptera: Pyrrhocoridae]	Not known to occur	No: This species feeds on the foliage of *Zantedeschia* (Scott & Neser 1996). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Ceroplastes rubens Maskell 1893 [Hemiptera: Coccidae]	Yes (Loch 1997)	Assessment not required			
Coboldia fuscipes (Meigen 1830) [Hemiptera: Scatopsidae]	Yes (Smithers 1998)	Assessment not required			
Coccus hesperidum Linnaeus 1758 [Hemiptera: Coccidae]	Yes (Ben-Dov 2013a)	Assessment not required			
Crenidorsum aroidephagus Martin & Aguiar 2001 [Hemiptera: Aleyrodidae]	Not known to occur	No: This foliage feeding whitefly (Martin et al. 2001; FERA 2008) has been reported on *Zantedeschia* (FERA 2008). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Ctenarytaina eucalypti (Maskell 1890) [Hemiptera: Psyllidae]	Yes (Withers 2001)	Assessment not required			
Dictyotus caenosus (Westwood 1837) [Hemiptera: Pentatomidae]	Yes (Larivière 1995)	Assessment not required			
Dieuches notatus (Dallas 1852) [Hemiptera: Lygaeidae]	Yes (Piper 1985)	Assessment not required			
Dysaphis tulipae Boyer de Fonscolombe 1841 [Hemiptera: Aphididae]	Yes (Hughes et al. 1964)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Heterogaster urticae (Fabricius 1775) [Hemiptera: Heterogastridae]	Not known to occur	No: This ground bug is reported on or in close proximity to *Zantedeschia* (Scudder & Eyles 2003). Eggs are laid in the ground at the base of the host plant and sometimes on the stem or leaves (Scudder & Eyles 2003). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Homalodisca vitripennis Germar 1821 [Hemiptera: Cicadellidae] (Synonym: *Homalodisca coagulata* (Say 1832))	Not known to occur	No: *Zantedeschia* is listed as an oviposition host for this sharpshooter (Walker 2005). However, sharpshooters lay eggs in the tissue on the underside of leaves (Grandgirard et al*.* 2006). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Kilifia acuminata (Signoret 1873) [Hemiptera: Coccidae]	Not known to occur	No: This species is reported to occur on *Zantedeschia* species (Nakahara 1981). This species is normally found on the leaves of host plants (Williams & Watson 1990) and is not reported to be associated with *Zantedeschia* tubers. Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Macrosiphum euphorbiae (Thomas 1878) [Hemiptera: Aphididae]	Yes (Berlandier 1997)	Assessment not required			
Myzus ascalonicus Doncaster 1946 [Hemiptera: Aphididae]	Yes (Eastop 1966)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Myzus persicae (Sulzer 1776) [Hemiptera: Aphididae]	Yes (Berlandier 1997)	Assessment not required			
Nezara viridula (Linnaeus 1758) [Hemiptera: Pentatomidae]	Yes (Knight and Gurr 2007)	Assessment not required			
Nysius huttoni (White 1878) [Hemiptera: Lygaeidae]	Not known to occur	No: *Nysius huttoni* has been recorded on *Zantedeschia* (Dymock & Holder 1996). Eggs are laid in cracks in the soil (Reid & Eyre 2010) and nymphs and adults of *Nysius* species attack the leaves and stems of host plants (Reid & Eyre 2010). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Parafurius discifer (Stäl 1860) [Hemiptera: Miridae]	Not known to occur	No: This plant bug is associated with *Zantedeschia* foliage (Carvalho et al. 2011; 2012). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Parasaissetia nigra (Nietner 1861) [Hemiptera: Coccidae]	Yes (Ben-Dov 2013a)	Assessment not required			
Pentalonia nigronervosa Coq. 1859 [Hemiptera: Aphididae]	Yes (Hughes et al. 1964)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Phenacoccus gossypii Townsend & Cockerell 1898 [Hemiptera: Pseudococcidae]	Not known to occur	**Yes:** This mealybug is reported to occur on *Zantedeschia* (McKenzie 1967). It normally occurs above ground on the leaves and stems of host plants, but is occasionally found feeding on the crowns and roots (McKenzie 1967). Therefore, dormant tubers may provide a pathway for this species.	**Yes**: This mealybug is polyphagous and has established in areas with a wide range of climatic conditions similar to Australia (McKenzie 1967). *Phenacoccus gossypii* can spread naturally in infested propagative material and has the potential for establishment and spread in Australia.	No: Information on the economic consequences of this mealybug on *Zantedeschia* is almost non-existent. *Phenacoccus gossypii* is a common pest of ornamentals and has been reported as a minor pest of lima beans (McKenzie 1967); however, there is no evidence to suggest this species has the potential for economic consequences.	
Philaenus spumarius (Linnaeus 1758) [Hemiptera: Cercopidae]	Yes (Memmott et al. 2000)	Assessment not required			
Planococcus citri (Risso 1813) [Hemiptera: Pseudococcidae]	Yes (Gullan 2000)	Assessment not required			
Pseudococcus calceolariae (Maskell 1879) [Hemiptera: Pseudococcidae]	Yes (Gullan 2000)	Assessment not required			
Pseudococcus maritimus (Ehrhorn 1900) [Hemiptera: Pseudococcidae]	Not known to occur. Ben-Dov (2013b) reports that there are some erroneous records of this species in Australia, but clarifies that this species is not known to occur in Australia.)	**Yes**: This species has been reported on *Zantedeschia* (McKenzie 1967). This mealybug has been recorded on the roots of *Zantedeschia* (Maddison 1993). *Pseudococcus* species can attack the growing crop in the latter stages and leave eggs that hatch post storage, as the bulbs are warmed up (Warren 2012). Because *Pseudococcus* species can be associated with bulbs in storage, dormant tubers may provide a pathway for this mealybug.	**Yes**: This mealybug is polyphagous and has established in areas with a wide range of climatic conditions (Ben-Dov 2013b) similar to Australia. *Pseudococcus maritimus* can spread naturally in infested propagative material by the movement of crawlers and winged males (Grasswitz and James 2008).Therefore, this mealybug has the potential for establishment and spread in Australia.	**Yes**: This mealybug causes considerable losses in table grapes (McKenzie 1967; Daane et al. 2003) and is a recognised pest of apricots and pears (Ben-Dov 2013b). This mealybug not only vectors grapevine leafroll viruses (Skinkis et al. 2009; Daane et al. 2011) but also *Little cherry virus 2* (Mekuria et al. 2013). Therefore, this mealybug has the potential for economic consequences in Australia.	**Yes**

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Pseudococcus longispinus (Targioni 1867) [Hemiptera: Pseudococcidae]	Yes (Gullan 2000)	Assessment not required			
Pseudococcus viburni (Signoret 1875) [Hemiptera: Pseudococcidae] (Synonym: *Pseudococcus affinis* (Maskell 1867))	Yes (Gullan 2000)	Assessment not required			
Pulvinaria psidii Maskell 1893 [Hemiptera: Coccidae]	Yes (Qin & Gullan 1992)	Assessment not required			
Rhizoecus falcifer Kunckel d'Herculais 1878 [Hemiptera: Rhizoecidae]	Yes (Ben-Dov et al. 2013)	Assessment not required			
Rhopalosiphoninus latysiphon (Davidson 1912) [Hemiptera: Aphididae]	Yes (Eastop 1966)	Assessment not required			
Rhypodes clavicornis (Fabricius 1794) [Heteroptera: Lygaeidae]	Yes (Cumber 1959)	Assessment not required			
Scolypopa australis (Walker 1851) [Hemiptera: Ricaniidae]	Yes (Liefting et al. 1997)	Assessment not required			
Sidnia kinbergi (Stål 1859) [Hemiptera: Miridae]	Yes (Pearson 1991)	Assessment not required			
HYMENOPTERA (wasps)					
Trigona spinipes (Jurine 1807) [Hymenoptera: Apidae]	Not known to occur	No: This pollen collector bee (Cortopassi-Laurino & Ramalho 1988) has been reported on *Zantedeschia aethiopica* (Carvalho et al. 2012). Therefore, dormant tubers do not provide a pathway for this species.	Assessment not required		

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
LEPIDOPTERA (moths, butterflies)					
Alabama argillacea (Hübner 1823) [Lepidoptera: Noctuidae]	Not known to occur	No: This moth has been recorded on *Zantedeschia* (Dymock and Holder 1996). Larvae of this moth are generally foliage feeders (Silva et al. 2011). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Cnephasia longana (Haworth 1811) [Lepidoptera: Tortricidae]	Not known to occur	No: The larvae of this species chew, mine and produce webbing on the buds, flowers and leaves of *Zantedeschia* (Dreistadt 2001). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Coleophora versurella (Zeller 1849) [Lepidoptera: Coleophoridae]	Not known to occur	No: The larvae of this moth have been recorded on *Zantedeschia*. Larvae of this moth are generally foliage feeders (Kimber 2012). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Helicoverpa armigera (Hübner 1805) [Lepidoptera: Noctuidae]	Yes (Fitt et al. 1995)	Assessment not required			
Hippotion celerio (Linnaeus 1758) [Lepidoptera: Sphingidae]	Yes (Nielsen et al. 1996)	Assessment not required			
Hippotion eson (Cramer 1779) [Lepidoptera: Sphingidae]	Not known to occur	No: The larvae of this moth feed on *Zantedeschia* (Scott & Neser 1996). The larvae of this moth are foliage feeders (Gerlach 2011). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Hippotion osiris (Dalman 1823) [Lepidoptera: Sphingidae]	Not known to occur	No: This moth has been recorded on *Zantedeschia* (Robinson et al. 2010). The larvae of this moth are foliage feeders (Golding 1927). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Macroglossum stellatarum Linnaeus 1758 [Lepidoptera: Sphingidae]	Not known to occur	No: *Zantedeschia* is listed as a larval host of this moth (Plantbook 2013). Larvae of this species feed on above-ground material (Vieira 2002); therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Nyctemera annulata (Boisduval 1832) [Lepidoptera: Arctiidae]	Yes (Warham and Johns 1975)	Assessment not required			
Opogona omoscopa (Meyrick 1893) [Lepidoptera: Tineidae]	Yes (Nielson et al. 1996; Brockerhoff et al. 2010)	Assessment not required			
Pieris rapae (Linnaeus 1758) [Lepidoptera: Pieridae]	Yes (Nielson et al. 1996)	Assessment not required			
Pyrrharctia isabella (Smith 1797) [Lepidoptera: Erebidae]	Not known to occur	No: This moth has been recorded on *Zantedeschia* (Robinson et al. 2010). Larvae of this moth are generally foliage feeders (Cranshaw & Kondratieff 2006). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Spilosoma virginica Fabricius 1798 [Lepidoptera: Erebidae]	Not known to occur	No: This polyphagous moth has been recorded on *Zantedeschia* (Robinson et al. 2010). Larvae of this moth are generally foliage feeders (Peterson et al. 1993). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Theretra cajus (Cramer 1777) [Lepidoptera: Sphingidae]	Not known to occur	No: These hawk moths have been recorded on *Zantedeschia* (Scott & Neser 1996). Larvae of these moths are foliage feeders (Van den Berg et al. 1975) and adults feed on nectar (Queensland Museum 2013). Therefore, foliage free dormant tubers do not provide a pathway for these species.	Assessment not required		
Theretra monteironis Butler 1882 [Lepidoptera: Sphingidae]	Not known to occur		Assessment not required		
Theretra oldenlandiae (Fabricius 1775) [Lepidoptera: Sphingidae]	Yes (Nielsen et al. 1996)	Assessment not required			
Theretra tryoni (Miskin 1891) [Lepidoptera: Sphingidae]	Yes (Nielsen et al. 1996)	Assessment not required			
Thysanplusia orichalcea (Fabricius 1775) [Lepidoptera: Noctuidae]	Yes (Nielson et al. 1996)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Xanthopastis timais (Cramer 1780) [Lepidoptera: Noctuidae]	Not known to occur	No: *Zantedeschia* is listed as a rare alternate host (Heppner et al. 2002). Females lay eggs on the leaves of host plants and pupation occurs in the soil (Heppner et al. 2002). Larvae cause damage by chewing leaves, bulbs, and rhizomes of the host plants (Heppner 2000; Heppner et al. 2002). There is no evidence to suggest that this species feeds internally on *Zantedeschia* tubers and is therefore not considered to be on the pathway.	Assessment not required		
ORTHOPTERA (Grasshoppers, locusts)					
Teleogryllus commodus (Walker 1869) [Orthoptera: Gryllidae]	Yes (Bussière et al. 2006)	Assessment not required			
THYSANOPTERA (thrips)					
Apterothrips secticornis (Trybom 1896) [Thysanoptera: Thripidae]	Yes (Nakahara 1988)	Assessment not required			
Ceratothrips frici (Uzel 1895) [Thysanoptera: Thripidae]	Yes (Houston et al. 1991)	Assessment not required			
Echinothrips americanus Morgan 1913 [Thysanoptera: Thripidae]	Not known to occur	No: This thrips infests the leaves of *Zantedeschia* (Varga et al. 2010). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Frankliniella intonsa (Trybom 1895) [Thysanoptera: Thripidae]	Not known to occur	No: This thrips has been recorded on flowers and leaves of *Zantedeschia* (Azidah 2011). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Frankliniella occidentalis (Pergande 1895) [Thysanoptera: Thripidae]	Yes (Mound 2004)	Assessment not required			
Haplothrips niger (Osbourne 1883) [Thysanoptera: Phlaeothripidae]	Yes (Mound & Minaei 2007)	Assessment not required			
Heliothrips haemorrhoidalis (Bouché 1883) [Thysanoptera: Thripidae]	Yes (Mound & Gillespie 1997)	Assessment not required			
Hercinothrips femoralis (Reuter) 1891 [Thysanoptera: Thripidae]	Yes (Houston et al. 1991)	Assessment not required			
Limothrips cerealium (Halliday 1836) [Thysanoptera: Thripidae]	Yes (Mound & Gillespie 1997)	Assessment not required			
Pezothrips kellyanus (Bagnall 1916) [Thysanoptera: Thripidae] (Basionym: *Megalurothrips kellyanus* (Bagnall) Bhatti 1969)	Yes (Webster et al. 2006)	Assessment not required			
Teuchothrips disjunctus (Hood 1918) [Thysanoptera: Phlaeothripidae]	Yes (Mound & Gillespie 1997)	Assessment not required			
Thrips flavus Shrank 1776 [Thysanoptera: Thripidae]	Not known to occur	No: This thrips causes scarring, browning and discolouration of flowers (Tillekaratne et al. 2011). Therefore, dormant tubers do not provide a pathway for this species.	Assessment not required		
Thrips hawaiiensis (Morgan 1913) [Thysanoptera: Thripidae]	Yes (Williams et al. 2001)	Assessment not required			
Thrips nigropilosus Uzel 1895 [Thysanoptera: Thripidae]	Yes (Hoddle et al. 2006)	Assessment not required			
Thrips obscuratus (Crawford 1941) [Thysanoptera: Thripidae]	Not known to occur	No: These thrips species have been recorded on flowers and foliage of a variety of host plants including *Zantedeschia* (Dymock & Holder 1996; McLaren et al. 2010; Tillekaratne et al. 2011).	Assessment not required		
Thrips palmi (Karny 1925) [Thysanoptera: Thripidae]	Yes (Mound & Gillespie 1997), but under official control.		Assessment not required		

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Thrips physapus (Linnaeus 1758) [Thysanoptera: Thripidae]	Not known to occur	These species lay eggs in the leaves and growing points (CRC 2012) and adults are found mainly on the flowers of plants (McLaren & Walker 2012). Therefore, foliage free dormant tubers do not provide a pathway for these species.	Assessment not required		
Thrips simplex (Morison 1930) [Thysanoptera: Thripidae]	Yes (Mound & Gillespie 1997)	Assessment not required			
Thrips tabaci (Lindeman 1889) [Thysanoptera: Thripidae]	Yes (Mound 2004)	Assessment not required			
GASTROPODS (snails, slugs, molluscs)					
Cochlicopa lubrica (Müller 1774) [Orthurethra: Cochlicopidae]	Yes (CSIRO 2004)	Assessment not required			
Helix aspersa (Müller 1774) [Sigmurethra: Helicidae]	Yes (Healy & Jamieson 1989)	Assessment not required			
PATHOGENS					
BACTERIA					
Burkholderia cepacia (ex Burkholder 1950) Yabuuchi et al. 1993 [Burkholderiales: Burkholderiaceae] (Synonym: *Pseudomonas cepacia* Burkholder 1950)	Yes (Huang & Wong 1998)	Assessment not required			
Chryseobacterium indologenes (Yabuuchi et al. 1983) [Flavobacteriales: Flavobacteriaceae]	Yes (Burešová et al. 2006)	Assessment not required			

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Erwinia chrysanthemi Burkholder et al. 1953 [Enterobacteriales: Enterobacteriaceae]	Yes (Stirling 2002)	Assessment not required			
Paenibacillus polymyxa (Prazmowski 1880) [Bacillales: Paenibacillaceae] (Synonym: *Bacillus polymyxa* (Prazmowski) Mace 1889)	Yes (Berge et al. 2002)	Assessment not required			
Pectobacterium carotovorum subspecies *carotovorum* (Jones 1901) [Enterobacteriales: Enterobacteriaceae] (Synonym: *Erwinia carotovora* subspecies *carotovora* (Jones 1901))	Yes (Peltzer & Sivasithamparam 1985)	Assessment not required			
Pectobacterium carotovorum subspecies *atrosepticum* (van Hall 1902) [Enterobacteriales: Enterobacteriaceae] (Synonym: *Erwinia carotovorum* subspecies *atroseptica* (van Hall 1902)).	Yes (Toth et al. 2001)	Assessment not required			
Pseudomonas fluorescens (Migula 1895) [Pseudomonadales: Pseudomonadaceae]	Yes (Padaga et al. 2000)	Assessment not required			
Pseudomonas marginalis (Brown 1918) [Pseudomonadales: Pseudomonadaceae]	Yes (Wimalajeewa et al. 1985)	Assessment not required			
Pseudomonas putida (Trevisan 1889) [Pseudomonadales: Pseudomonadaceae]	Yes (Cother et al. 2009)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Pseudomonas veronii (Elomari et al. 1996) [Pseudomonadales: Pseudomonadaceae]	Not known to occur	**Yes**: This bacterium is associated with *Zantedeschia* tubers causing soft rot (Mikiciński et al. 2010a). The main points of entry for soft rot bacteria are the base of the petiole (Vanneste 1996). Therefore, dormant tubers may provide a pathway for this bacterium.	**Yes**: This bacterium has established in areas with a wide range of climatic conditions (Mikiciński et al. 2010a) similar to Australia. This bacterium is present in soil (Nam et al. 2003) and water (Elomari et al. 1996), and can spread naturally in infected tubers. Therefore, this bacterium has the potential for establishment and spread in Australia.	**Yes:** This species is a part of the bacterial complex associated with soft rot (Mikiciński et al. 2010a), which causes significant crop losses. The first symptoms are a loss of turgidity for the whole plant (Mikiciński et al. 2010a), leaves turning yellow and the tuber rotting (Vanneste 1996). Soft rot is considered one the most important diseases of *Zantedeschia* worldwide (Mikiciński et al. 2010a). Therefore, this bacterium has the potential for economic consequences in Australia.	**Yes**
Xanthomonas campestris pv. *zantedeschiae* (Joubert and Truter 1972) [Pseudomonadales: Pseudomonadaceae]	Not known to occur	No: This bacterium is associated with leaves and causes leaf blight (Lee et al. 2005). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
FUNGI					
Alternaria alternata (Fr.) Keissl. [Pleosporales: Pleosporaceae]	Yes (Webley et al. 1997)	Assessment not required			
Alternaria tenuissima (Kunze) Wiltshire [Pleosporales: Pleosporaceae]	Yes (Brown and Ferreira 2000)	Assessment not required			
Armillaria gallica Marxmüller & Romagni [Agaricales: Physalacriaceae]	Not known to occur	No: Members of the genus *Armillaria* occur in the bark and roots of the host plant (Farr et al. 1989; Keane 2000; Van der Kamp	Assessment not required		
Armillaria heimii Pegler [Agaricales: Physalacriaceae]	Not known to occur		Assessment not required		

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Armillaria limonea (G. Stev.) Boesew. [Agaricales: Physalacriaceae]	Not known to occur	& Hood 2002). Therefore, dormant tubers do not provide a pathway for these fungi.	Assessment not required		
Armillaria luteobubalina Watling & Kile [Agaricales: Physalacriaceae]	Yes (Cook & Dubé 1989)	Assessment not required			
Armillaria tabescens (Scop.) Emel [Agaricales: Physalacriaceae]	Not known to occur	No: Members of the genus *Armillaria* occur in the bark and roots of the host plant (Farr et al. 1989; Keane 2000; Kamp & Hood 2002). Therefore, dormant tubers do not provide a pathway for this fungus.	Assessment not required		
Aspergillus niger Tiegh. [Eurotiales: Trichocomaceae]	Yes (Leong et al. 2007)	Assessment not required			
Athelia rolfsii (Curzi) C.C. Tu & Kimbr. [Atheliales: Atheliaceae] (Synonym: *Sclerotium rolfsii* Sacc.)	Yes (Maxwell & Scott 2004)	Assessment not required			
Bionectria ochroleuca (Schwein.) Schroers & Samuels [Hypocreales: Bionectriaceae]	Yes (PHA 2001)	Assessment not required			
Botrytis cinerea Pers.:Fr. [Heliotiales: Sclerotiniaceae] (Synonym: *Botryotinia fuckeliana* (de Bary) Whetzel)	Yes (Salam et al. 2011)	Assessment not required			
Calonectria kyotensis Terash. [Hypocreales: Nectriaceae]	Yes (PHA 2001)	Assessment not required			
Cercospora apii Fresen [Capnodiales: Mycosphaerellaceae]	Yes (Liberato & Stephens 2006)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Cercospora callae f. *aethiopica* Gonz. Frag. [Capnodiales: Mycosphaerellaceae]	Not known to occur	No: *Zantedeschia* is reported as a host for this fungus (Farr & Rossman 2014). *Cercospora* species are associated with foliage causing leaf spot (Scott 1997). Therefore, foliage free dormant tubers do not provide a pathway for this fungus.	Assessment not required		
Cercospora callae Peck & Clinton [Capnodiales: Mycosphaerellaceae]	Not known to occur	No: This fungus is associated with foliage causing leaf spot on *Zantedeschia* (Scott 1997; Farr & Rossman 2014). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Cercospora richardiicola G.F. Atk. [Capnodiales: Mycosphaerellaceae]	Not known to occur	No: *Zantedeschia* is reported as a host for this fungus (Farr & Rossman 2014). *Cercospora* species are associated with foliage causing leaf spot (Scott 1997). Therefore, foliage free dormant tubers do not provide a pathway for this fungus.	Assessment not required		
Cladosporium elatum (Harz) Nannf [Capnodiales: Cladosporiaceae]	Yes (Upsher & Upsher 1995)	Assessment not required			
Cladosporium herbarum (Pers.) Link [Capnodiales: Cladosporiaceae]	Yes (PHA 2001)	Assessment not required			
Cladosporium sphaerospermum Penz. [Capnodiales: Cladosporiaceae]	Yes (Benyon et al. 1999)	Assessment not required			
Clonostachys rosea f. *rosea* (Link) Schroers et al. [Hypocreales: Bionectriaceae] (Synonym: *Gliocladium roseum* Bainier)	Yes (Burgess at al. 1997)	Assessment not required			

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Colletotrichum coccodes (Wallr.) S. Hughes [Incertae sedis: Glomerellaceae]	Yes (Ben-Daniel et al. 2010)	Assessment not required			
Colletotrichum gloeosporioides (Penz.) Penz. & Sacc [Incertae sedis: Glomerellaceae]	Yes (Ireland et al. 2008)	Assessment not required			
Coniothyrium cassiicola Cooke [Pleosporales: Leptosphaeriaceae]	Not known to occur	No: This fungus is associated with foliage causing leaf spot on *Zantedeschia* (Starr 2005). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Corynespora cassiicola (Berk. & M.A. Curtis) C.T. Wei [Pleosporales: Corynesporascaceae]	Yes (Vawdrey et al. 2008)	Assessment not required			
Drechslera dematioidea (Bubák & Wróbl.) Subram. & B.L. Jain [Pleosporales: Pleosporaceae]	Yes (Sivanesan 1990)	Assessment not required			
Epicoccum nigrum Link [Pleosporales: Pleosporaceae]	Yes (PHA 2001)	Assessment not required			
Fusarium culmorum (W.G. Sm.) Sacc. [Hypocreales: Nectriaceae]	Yes (Summerell et al. 2011)	Assessment not required			
Fusarium graminearum Schwabe (Schwein.) Petch [Hypocreales: Nectriaceae]	Yes (Quazi et al. 2009)	Assessment not required			
Fusarium oxysporum Schltdl. [Hypocreales: Nectriaceae]	Yes (Summerell et al. 2011)	Assessment not required			
Fusarium solani (Mart.) Sacc. [Hypocreales: Nectriaceae]	Yes (Pegg et al. 2002)	Assessment not required			
Helicobasidium purpureum (Tul.) Pat. [Helicobasidiales: Helicobasidiaceae]	Yes (Grgurinovic & Cayzer 2003)	Assessment not required			
Leveillula taurica (Lév.) G. Arnaud [Erysiphales: Erysiphaceae]	Yes (Persley et al. 2010)	Assessment not required			

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Mycosphaerella tassiana (De Not.) Johanson [Capnodiales: Mycosphaerellaceae]	Yes (Maxwell & Scott 2008)	Assessment not required			
Nectria inventa Pethybr. [Hypocreales: Nectriaceae]	Yes (PHA 2001)	Assessment not required			
Nectria radicicola Gerlach & L. Nilsson [Incertae sedis: Incertae sedis]	Yes (Summerell et al. 1990)	Assessment not required			
Periconia byssoides Pers. [Pleosporales: Incertae sedis]	Yes (Chakraborty et al. 1994)	Assessment not required			
Phoma glomerata (Corda) Wollenw. & Hochapfel [Pleosporales: Incertae sedis]	Yes (Taylor et al. 1999)	Assessment not required			
Phoma richardiae Mercer [Pleosporales: Incertae sedis]	Not known to occur	No: This fungus is associated with foliage and causes leaf spot on *Zantedeschia* (Farr & Rossman 2014). Therefore, foliage free dormant tubers do not provide a pathway for this fungus.	Assessment not required		
Phoma zantedeschiae Dippen. [Pleosporales: Incertae sedis]	Not known to occur	**Yes**: This fungus has been recorded on *Zantedeschia* (Boerema & Hamers 1990; Farr & Rossman 2014) causing large brown blotches on the leaves and spathes (Boerema et al. 2004). Additionally, this fungus has been isolated from *Zantedeschia* tubers (Aveskamp et al. 2010). Therefore, dormant tubers may provide a pathway for this fungus.	**Yes**: This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2014) similar to Australia and can spread naturally in infected bulbs. Therefore, this fungus has the potential for establishment and spread in Australia.	**No**: There is a historical record of this fungus causing a serious disease of *Zantedeschia* (Brooks 1932). However, no further information could be found to suggest that this fungus causes significant economic losses. Therefore, this fungus is not of economic concern to Australia.	

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Phyllosticta richardiae F.T. Brooks [Pleosporales: Incertae sedis]	Not known to occur	No: This fungus has been recorded on *Zantedeschia* (Farr & and Rossman 2014) causing brown blotches on the aerial shoot system (Brooks 1932). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Phytophthora cryptogea Pethybr. & Laff. [Peronosporales: Peronosporaceae]	Yes (Irwin 1997)	Assessment not required			
Phytophthora erythroseptica Pethybr. [Peronosporales: Peronosporaceae]	Yes (Oxspring et al. 2000; Persley et al. 2010)	Assessment not required			
Phytophthora erythroseptica var. *erythroseptica* Pethybr. [Peronosporales: Peronosporaceae]	Yes (Hall 1989)	Assessment not required			
Phytophthora meadii McRae [Peronosporales: Peronosporaceae]	Not known to occur	**Yes:** This fungus causes leaf blight, flower rot and root rot of *Zantedeschia* (Liou et al. 1999). Therefore, dormant tubers can provide a pathway for this species.	**Yes:** This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2014) similar to Australia; and can spread naturally in infected bulbs. Therefore, this fungus has the potential for establishment and spread in Australia.	**Yes**: *Phytophthora meadii* is associated with a number of commercial crops (for example, pineapple, peach) and has been implicated in economic losses in rubber, causing up to a 40 percent drop in yield (Drenth & Sendall 2004). Therefore, this fungus has the potential to cause economic consequences in Australia.	**Yes**

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Phytophthora richardiae Buisman [Peronosporales: Peronosporaceae]	Not known to occur	**Yes:** This fungus causes root rot of *Zantedeschia* (Boerema & Hamers 1990). The fungus penetrates the tuber at the point of attachment of the roots (Boerema & Hamers 1990; Erwin & Ribeiro 1996). Therefore, dormant tubers can provide a pathway for this species.	**Yes:** This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2014) similar to Australia; and can spread naturally in infected bulbs. Therefore, this fungus has the potential for establishment and spread in Australia.	**Yes:** *Phytophthora richardiae* has a host range that includes a number of commercial crops including asparagus, carrot, tomato and cassava (Verhoeff & Weber 1966; Farr & Rossman 2014; Poltronieri et al. 1997). This species causes a destructive root rot disease in *Zantedeschia*, causing leaf necrosis, flower malformation, root rot and eventual plant death (Erwin & Ribeiro 1996). Therefore, this fungus has the potential to cause economic consequences in Australia.	**Yes**
Pythium aphanidermatum (Edson) Fitzp. [Pythiales: Pythiaceae]	Yes (Cook & Dubé 1989)	Assessment not required			
Pythium coloratum Vaartaja [Pythiales: Pythiaceae]	Yes (Maxwell 1997)	Assessment not required			
Pythium myriotylum Drechsler [Pythiales: Pythiaceae]	Yes (Stirling & Eden 2008)	Assessment not required			
Pythium ultimum Trow [Pythiales: Pythiaceae]	Yes (Fang et al. 2011)	Assessment not required			
Ramularia richardiae Kalchbr. & Cooke [Capnodiales: Mycosphaerellaceae]	Not known to occur	No: This fungus has been recorded on *Zantedeschia* (Farr & Rossman 2014). *Ramularia* species generally occur on leaves and cause leaf spot (Farr et al.1989). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Rhizoctonia solani J.G. Kühn [Cantharellales: Ceratobasidiaceae]	Yes (Neate & Warcup 1985)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Rhizopus stolonifer (Ehrenb.) Vuill. 1902 [Mucorales: Rhizopodaceae]	Yes (Washington et al. 1992)	Assessment not required			
Rosellinia necatrix Berl. ex Prill. 1904 [Xylariales: Xylariaceae]	Yes (Shivas 1989)	Assessment not required			
Septoria aracearum RK Verma & Kamal [Capnodiales: Mycosphaerellaceae]	Not known to occur	No: This species has been recorded on *Zantedeschia* (Farr & Rossman 2014). *Septoria* species generally are associated with the leaves (Koike et al. 2007). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Pyrenochaeta terrestris (HN Hansen) Gorenz et al [Incertae sedis: Incertae sedis] (Synonym: *Setophoma terrestris* (H.N. Hansen) Gruyter et al.)	Yes (Hall et al. 2007)	Assessment not required			
Thielaviopsis basicola (Berk. & Broome) Ferraris [Microascales: Ceratocystidaceae]	Yes (Nehl et al. 2004)	Assessment not required			
Trichopeltheca asiatica Batista et al. [Capnodiales: Euantennariaceae]	Yes (Hughes 1965)	Assessment not required			
Ulocladium zantedeschiae X.G. Zhang & T.Y. Zhang [Pleosporales: Pleosporaceae]	Not known to occur	No: This fungus is associated with the leaves of *Zantedeschia aethiopica* (Zhang & Zhang 2006). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		
Uromyces ari-triphylli (Schwein.) Seeler [Uredinales: Pucciniaceae]	Not known to occur	No: This fungus has been recorded on *Zantedeschia* plants causing rust (Alfieri et al. 1984). Therefore, foliage free dormant tubers do not provide a pathway for this species.	Assessment not required		

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Verticillium cinnabarinum (Corda) Reinke & Berthold) [Incertae sedis: Plectosphaerellaceae]	Yes (PHA 2001)	Assessment not required			
Verticillium tricorpus I. Isaac [Incertae sedis: Plectosphaerellaceae]	Yes (Edwards & Taylor 1998)	Assessment not required			
VIRUSES					
Alfalfa mosaic virus (AMV) [Bromoviridae: *Alphamovirus*]	Yes (Garran & Gibbs 1982)	Assessment not required			
Arabis mosaic virus (ArMV) [Comoviridae: *Nepovirus*]	Yes (Sharkey et al. 1996)	Assessment not required			
Bean yellow mosaic virus (BYMV) [Potyviridae: *Potyvirus*]	Yes (Gibbs et al. 2008)	Assessment not required			
Calla lily chlorotic spot virus (CCSV) [Bunyaviridae: *Tospovirus*]	Not known to occur	**Yes**: CCSV is associated with *Zantedeschia* causing leaf necrosis and chlorotic lesions (Chen 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, dormant tubers may provide a pathway for CCSV.	**Yes**: CCSV has established in areas with a wide range of climatic conditions (Chen et al. 2005; Liu et al. 2012) similar to Australia; and may spread naturally in infected dormant tubers. Additionally, its vector, *Thrips palmi* (Chen et al. 2005), which is present in Australia (Mound 2004), will help spread this virus within Australia. Therefore, CCSV has the potential to establish and spread in Australia.	**Yes**: CCSV affects the marketability of *Zantedeschia* by inducing chlorosis with yellow spots on the leaves (Chen et al. 2005). It also infects spider lily (*Hymenocallis litteralis*) and tobacco plants (*Nicotiana tabacum*), causing systemic yellow spots, chlorotic spots, necrotic spots and rugosity symptoms (Liu et al. 2012). These symptoms would reduce the marketability of the ornamental host plants in the domestic cut flower and nursery industries. Therefore, this virus has the potential for economic consequences in Australia.	**Yes**

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Calla lily latent virus (CLLV) [Potyviridae: *Potyvirus*]	Not known to occur	**Yes**: CLLV infection is symptomless (Chen et al. 2004a). This may lead to the propagation and distribution of infected propagative material. CLLV spreads by vegetative propagation through infected rhizomes or tubers (Chen et al. 2004a). Therefore, dormant tubers may provide a pathway for CLLV.	**Yes:** CLLV has established in areas with a wide range of climatic conditions similar to Australia; and may spread naturally in infected propagative material (Chen et al. 2004a). The symptomless nature of this virus may contribute to the inadvertent propagation and distribution of infected material that will help spread CLLV within Australia. Therefore, CLLV has the potential to establish and spread in Australia.	No: Information on the economic consequences of this virus is almost non-existent. CLLV does not appear to be a threatening pathogen to *Zantedeschia,* as infections are symptomless (Chen et al. 2004a) and infected plants are indistinguishable from uninfected plants in yield and quality (Chen et al. 2006a). Therefore, this virus is unlikely to have the potential for significant economic consequences in Australia.	
Capsicum chlorosis virus (CaCV) [Bunyaviridae: *Tospovirus*]	Yes (McMichael et al. 2002)	Assessment not required			
Carnation mottle virus (CarMV) [Tombusviridae: *Carnovirus*]	Yes (Moran et al. 1985)	Assessment not required			
Cucumber mosaic virus (CMV) [Bromoviridae: *Cucumovirus*]	Yes (Alberts et al. 1985)	Assessment not required			
Dasheen mosaic virus (DsMV) [Potyviridae: *Potyvirus*]	Yes (Greber & Shaw 1986)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Impatiens necrotic spot virus (INSV) [Bunyaviridae: *Tospovirus*]	Not known to occur	**Yes**: INSV is associated with *Zantedeschia* (Elliot et al. 2009; Rizzo et al. 2012). Symptoms of infection include chlorotic or yellow spots on leaves (Rizzo et al. 2012). Viruses, as a rule, infect host plants systemically and all plant parts, including parts used for vegetative propagation, are infected (Bos 1999). Whilst limited information exists on the transmissibility of INSV through *Zantedeschia* bulbs, Tospoviruses, including INSV, have been detected in other bulbs (Sastry 2013). Therefore, dormant tubers may provide a pathway for the entry of INSV into Australia.	**Yes**: INSV has established in areas with a wide range of climatic conditions (CABI/EPPO 1997) similar to Australia; and may spread naturally in infected propagative material. Distribution of infected propagative material and its vector, *Frankliniella occidentalis* (Elliot et al. 2009), which is present in Australia (Mound 2004) will help spread this virus within Australia. Therefore, INSV has the potential to establish and spread in Australia.	**Yes**: INSV has become a major pathogen in the floriculture industry in the USA and Europe (Daughtrey et al. 1997; CABI/EPPO 1997; Wick 2009). There have been severe economic losses from INSV in the United States (Daughtrey et al. 1997). Therefore, INSV has the potential for economic consequences in Australia.	**Yes**
Konjac mosaic virus (KoMV) (Synonym: *Zantedeschia mosaic virus* (ZaMV)) [Potyviridae: *Potyvirus*]	Not known to occur	**Yes**: KoMV is associated with *Zantedeschia* causing mosaic or mottle symptoms on leaves (Chen et al. 2006b). Viruses, as a rule, infect host plants systemically and all plant parts are infected (Bos 1999). Therefore, dormant tubers may provide a pathway for the entry of KoMV into Australia.	**Yes**: KoMV has established in areas with a wide range of climatic conditions (Chang et al. 2001; Chen et al. 2006b; Manikonda et al. 2011) similar to Australia; and may spread naturally in infected dormant bulbs. Additionally, its vector, *Aphis gossypii* (Shimoyama et al. 1992), which is present in Australia (Wool et al. 1995), will help spread KoMV within Australia. Therefore, KoMV has the potential to establish and spread in Australia.	**Yes**: KoMV affects several ornamental plants and causes yellowing, mosaic and green spots on leaves on and discoloured spots on flowers (Chang et al. 2001; Manikonda et al. 2011; Padmavathi et al. 2013). As affected hosts are ornamental commodities, there is the potential for this virus to affect the cut flower industry through the loss of productivity and markets. Therefore, KoMV has the potential for economic consequences in Australia.	**Yes**

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Lisianthus necrosis virus (LNV) [Tombusviridae: *Necrovirus*]	Not known to occur	**Yes**: LNV is associated with *Zantedeschia* causing systemic necrosis (Chen et al. 2006c). Viruses, as a rule, infect host plants systemically and all plant parts are infected (Bos 1999). Therefore, dormant tubers may provide a pathway for the entry of LNV into Australia.	**Yes**: LNV has established in areas with a wide range of climatic conditions (Chen et al. 2006c) similar to Australia; and may spread through propagative material. Therefore, LNV has the potential to establish and spread in Australia.	**Yes**: LNV causes systemic necrosis in *Zantedeschia* and lisianthus (*Eustoma russellianum*) affects plant health (Iwaki et al. 1987; Chen et al. 2006c). As affected species are ornamental commodities, there is the potential for this virus to affect the cut flower industry through the loss of productivity and markets. Therefore, LNV has the potential for economic consequences in Australia.	**Yes**
Potato virus X (PVX) [Alphaflexiviridae: *Potexvirus*]	Yes (Holmes & Teakle 1980)	Assessment not required			
Tobacco mosaic virus (TMV) [Virgaviridae: *Tobamovirus*]	Yes (Cook & Dubé 1989)	Assessment not required			
Tobacco rattle virus (TRV) [Virgaviridae: *Tobravirus*]	Yes (Sharkey et al. 1996)	Assessment not required			
Tomato spotted wilt virus (TSWV) [Bunyaviridae: *Tospovirus*]	Yes (Dietzgen et al. 2005)	Assessment not required			
Turnip mosaic virus (TuMV) [Potyviridae: *Potyvirus*]	Yes (Gibbs et al. 2008)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Watermelon silver mottle virus (WSMoV) [Bunyaviridae: *Tospovirus*]	Not known to occur	**Yes**: WSMoV is associated with the foliage of *Zantedeschia* (Chen et al. 2003) causing yellow-green spots (Chen et al. 2008). Viruses, as a rule, infect host plants systemically and all plant parts are infected (Bos 1999). Therefore, dormant tubers may provide a pathway for the entry of WSMoV into Australia.	**Yes**: WSMoV has established in areas with a wide range of climatic conditions (Chen et al. 2006d) similar to Australia; and may spread naturally in infected dormant bulbs. Distribution of infected bulbs and its vector, *Thrips palmi* (Chu et al. 2001), which is present in Australia (Mound 2004), will help spread WSMoV within Australia. Therefore, WSMoV has the potential to establish and spread in Australia.	**Yes**: WSMoV is the most important pathogen of watermelon and other cucurbits (Chu et al. 2001; Chen et al. 2004b) and is considered to be one of the major limiting factors for melon and watermelon production in Eastern Asia (EPPO 1997; Chen et al. 2006d). Therefore, WSMoV has the potential for economic consequences in Australia.	**Yes**
Zantedeschia mild mosaic virus (ZaMMV) [Potyviridae: *Potyvirus*]	Not known to occur	**Yes**: ZaMMV is associated with *Zantedeschia* causing systemic mild mosaic on leaves and veinal chlorosis (Huang & Chang 2005). ZaMMV has been introduced on *Zantedeschia* tubers into Taiwan (Huang et al. 2007) and has also been detected in tissue cultures (Huang et al. 2007). Therefore, dormant tubers may provide a pathway for the entry of ZaMMV into Australia.	**Yes**: ZaMMV has established in areas with a wide range of climatic conditions (Huang & Chang 2005) similar to Australia; and may spread naturally in infected dormant bulbs and tissue cultures (Huang et al. 2007). Distribution of infected propagative material will help spread ZaMMV within Australia. Therefore, ZaMMV has the potential to establish and spread in Australia.	**Yes**: ZaMMV causes mild mosaic and veinal chlorosis (Huang & Chang 2005; Huang et al. 2007). As an ornamental commodity, these symptoms would reduce the marketability of plants in the domestic cut flower and nursery industries. Therefore, ZaMMV has the potential for economic consequences in Australia.	**Yes**
NEMATODES					
Aphelenchoides fragariae Ritzema-Bos 1890 [Tylenchida: Aphelenchoididae]	Yes (McLeod et al. 1994)	Assessment not required			
Aphelenchus avenae Bastian 1865 [Tylenchida: Aphelenchoididae]	Yes (McLeod et al. 1994)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Criconemella jessiensis Van den Berg 1992 [Tylenchida: Criconematidae]	Not known to occur	No: This nematode occurs around the roots of *Zantedeschia aethiopica* (Van den Berg 1992). *Criconemella* species are ectoparasites (Klass et al. 2012) and as such the nematodes remain in the soil and do not enter the plant's tissues. Therefore, dormant tubers do not provide a pathway for this species.	Assessment not required		
Ditylenchus dipsaci (Kühn) 1857 [Tylenchida: Anguinidae]	Yes (Taylor & Szot 2000)	Assessment not required			
Helicotylenchus dihystera (Cobb) 1893 [Tylenchida: Hoplolaimidae]	Yes (McLeod et al. 1994)	Assessment not required			
Meloidogyne arenaria (Neal) 1889 [Tylenchida: Meloidogynidae]	Yes (McLeod et al. 1994)	Assessment not required			
Meloidogyne hapla (Chitwood) 1949 [Tylenchida: Meloidogynidae]	Yes (McLeod et al. 1994)	Assessment not required			
Meloidogyne incognita (Kofoid and White) 1919 [Tylenchida: Meloidogynidae]	Yes (McLeod et al. 1994)	Assessment not required			
Meloidogyne javanica (Treub) 1885 [Tylenchida: Meloidogynidae]	Yes (Mcleod et al. 1994)	Assessment not required			

Pest type	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Quarantine pest
Paratrichodorus divergens Almeida et al*.* 2005 [Triplonchida: Trichodoridae]	Not known to occur	No: This species has been found around the roots of *Zantedeschia aethiopica* (Almeida et al. 2005). *Trichodoridae* are ectoparasites of roots (Decraemer and Robbins 2007), and as such the nematodes remain in the soil and do not enter the plant's tissues. Therefore, dormant tubers do not provide a pathway for this species.	Assessment not required		
Pratylenchus crenatus (Loof) 1960 [Tylenchida: Pratylenchidae]	Yes (McLeod et al. 1994)	Assessment not required			
Rotylenchus robustus (de Man.) 1876 [Tylenchida: Hoplolaimidae]	Yes (McLeod et al. 1994)	Assessment not required			
Tylenchulus semipenetrans (Cobb) 1913 [Tylenchida: Tylenchulidae]	Yes (McLeod et al. 1994)	Assessment not required			

Appendix B: Additional quarantine pest data

Quarantine pest	***Eumerus strigatus* (Fallen, 1817)**
Synonyms	*Pipiza strigata*; *Pipiza strigatus*
Common name(s)	Onion bulb fly; Lesser bulb fly; Onion fly; Small Narcissus fly; Garlic fly
Main hosts	*Allium cepa*, *Allium cepa* var. *aggregatum*, *Allium sativum*, *Amaryllis* species, *Brassica oleracea*, *Colchicum* species, *Fritillaria imperialis, Fritillaria persica*, *Eurycles* species, *Galtonia* species, *Gladiolus* species, *Hyacinthus* species, *Iris* species, *Lilium* species, *Narcissus* species, *Scilla* species, *Solanum tuberosum*, *Sprekelia formosissima*, *Vallota* species and *Zantedeschia elliottiana* (Poos & Weigel 1927; Gyulai 1980; Capinera 2001; Barbour et al. 2008; Kizil et al. 2008; Alford 2012). Capinera (2001) notes that reports of this species attacking *Daucus carota* and *Pastinaca sativa* are almost certainly incorrect.
Distribution	Chile, Europe (including, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Netherlands, Norway, Serbia, Spain, Sweden, United Kingdom), Japan, Mongolia, New Zealand, widespread in the United States and southern Canada (Gyulai 1980; Dymock & Holder 1996; Gerding et al. 1999; Capinera 2001; Perry 2007; GBIF 2014).
Quarantine pest	***Pseudococcus maritimus* (Ehrhorn 1900)**
Synonyms	*Dactylopius maritimus*; *Pseudococcus bakeri*; *Pseudococcus omniverae*
Common name(s)	American grape mealybug; Baker's mealybug; Grape mealybug; Ocean mealybug
Main hosts	*Acacia julibrissin, Acer* species, *Alternathera* species, *Annona hastata, Arbutus* species, *Astragalus* species, *Berberis compacta gracilis, Boerhavia nivea, Carya* species, *Catalpa* species, *Ceanothus* species, *Celtis* species, *Cestrum* species, *Chysis aurea, Citrus* species, *Cornus florida, Corylus americana, Cotoneaster* species, *Cupressus* species, *Cydonia* species, *Cyperus* species, *Diospyros* species, *Erigeron* species, *Eriogonum* species, *Eustoma russelianum, Fraxinus caroliniana, Genista* species, *Gleditsia triacanthos, Grevillea* species, *Haplopappus ericoides, Illex vomitoria, Ipomoea* species, *Juglans regia, Juniperus maritima, Liquidambar styraciflora, Maclura* species, *Magnolia* species, *Malus* species, *Manihot esculenta, Medicago sativa, Mesembryanthemum* species, *Morus* species, *Narcissus* species, *Odontoglossum grande, Ostrya virginiana, Parthenium* species, *Persea* species, *Platanus* species, *Polygonum* species, *Prunus* species, *Psoralea macrostachya, Pyrus communis, Ramona stachyoides, Rhododendron* species, *Rhus diversiloba, Robinia* species, *Rubus vitifolius, Sambucus glauca, Sambucus* species, *Sassafras* species, *Solanum melongena, Solidago sempervirens, Strelitzia* species, *Tapirira edulis, Taxus* species, *Thuja* species, *Tilia americana, Trifolium* species, *Ulmus* species, *Vaccinium* species, *Vitis* species and *Zantedeschia* species (Ben-Dov et al. 2012).
Distribution	Argentina, Armenia, Bermuda, Canada, Chile, Colombia, French Guiana, Guadeloupe, Guatemala, Indonesia, Mexico, Poland, Puerto Rico & Vieques Island and USA (Ben-Dov et al. 2012).
Quarantine pest	***Pseudomonas veronii* (Elomari et al. 1996)**
Synonyms	-
Common name(s)	Bacterial soft rot
Main hosts	*Zantedeschia* species (Mikiciński et al. 2010a).
Distribution	Canada (Saskatchewan; Hynes et al. 2008), France (Mikiciński et al. 2010a), Korea (Nam et al. 2003), Netherlands (GBIF 2014) and Poland (Mikiciński et al. 2010a).
Quarantine pest	***Phytophthora meadii* McRae (1918)**
Synonyms	-
Common name(s)	Abnormal leaf fall of rubber; Stripe canker; Black thread; Secondary leaf fall; Green pod decay; Top rot of pineapple; Bark rot of rubber; Pod rot of rubber
Main hosts	*Acacia mearnsii, Aglaonema nitidum* cv. *curtisii, Ananas comosus, Areca catechu, Catharanthus roseus, Cocos nucifera, Dianthus caryophyllus, Elettaria cardamomum, Euonymus japonicas, Ficus* species, *Hevea brasiliensis, Leea coccinea, Piper betle, Prunus*

	persica, Solanum melongena, Theobroma cacao, *Thryptomene saxicola*, *Vanilla planifolia* and *Zantedeschia aethiopica* (Stamps 1985; Ann 1992; Aragaki & Uchida 1994; Erwin & Ribeiro 1996; Liou et al. 1999; Uchida & Kadooka 1999; Bhai & Thomas 2000; Ann et al. 2003; Nagel et al. 2013; Farr & Rossman 2014).
Distribution	Brazil, Cambodia, Cameroon, China, Congo, Costa Rica, Ghana, Hawaii, India, Indonesia, Iran, Liberia, Malaysia, Mauritius, Myanmar, New Zealand, Nicaragua, Nigeria, Peru, Philippines, South Africa, Sri Lanka, Taiwan, Thailand, Venezuela and Vietnam (CABI 1989; Pennycook 1989; Erwin & Ribeiro 1996; Liou et al. 1999; Portales 2004; Nagel et al. 2013).
Quarantine pest	***Phytophthora richardiae* Buisman (1927)**
Synonyms	*Phytophthora cryptogea* var. *richardiae* (Buisman) S.F. Ashby
Common name(s)	Tuber rot of Calla lily; Foot rot of tomato; Spear rot of asparagus; Stem and root rot of Calla lily
Main hosts	*Asparagus* species*, Daucus carota, Daucus carota* subspecies *sativus, Manihot esculenta*, *Solanum lycopersicum* and *Zantedeschia* species (Verhoeff & Weber 1966; Boerema & Hamers 1990; Hall 1991; Poltronieri et al. 1997; Falloon et al. 2002; Farr & Rossman 2014).
Distribution	Belgium, Brazil, Bulgaria, Czech Republic, England, Ireland, Japan, Netherlands, Philippines, Slovakia and USA (Hall 1991; Poltronieri et al*.* 1997; Farr & Rossman 2014)
Quarantine pest	***Calla lily chlorotic spot virus***
Synonyms	CCSV
Common name(s)	Calla lily chlorotic spot
Main hosts	*Hymenocallis litteralis*, *Nicotiana tabacum* and *Zantedeschia* species (Chen et al. 2005; Liu et al*.* 2012).
Distribution	China and Taiwan (Chen et al. 2005; Liu et al*.* 2012).
Quarantine pest	***Impatiens necrotic spot virus***
Synonyms	INSV
Common name(s)	Necrotic spot
Main hosts	Ornamental hosts include, *Aconitum*, *Alstroemeria, Anemone*, *Anthemis, Anthurium, Antirrhinum*, *Aquilegia, Ardisia, Argyranthemum, Aster, Aucuba, Begonia*, *Bougainvillea, Bouvardia*, *Browallia, Calendula, Callistephus*, *Campanula, Chelone, Chrysanthemum, Cineraria, Columnea*, *Coreopsis, Cycas, Cyclamen persicum*, *Dahlia*, *Delphinium, Dendranthema* x *grandiflorum*, *Dendrobium, Dianthus, Diascia, Digitalis, Dracaena, Euphorbia marginata, Eustoma*, *Exacum*, *Fatsia japonica*, *Ficus benjamina, Freesia refracta, Gaillardia, Gardenia jasminoides, Gazania, Gerbera*, *Gladiolus*, *Hedera, Hibiscus rosa-sinensis, Hippeastrum, Hosta, Hydrangea, Impatiens, Ipomoea, Iris, Kalanchoe, Kohleria, Lantana, Lavandula, Leucanthemum, Lilium, Limonium, Lobelia, Lupinus, Myosotis, Nemesia strumose, Nicotiana, Oenothera, Oncidium, Paeonia, Papaver, Pelargonium, Penstemon, Petunia* x *hybrid, Phalaenopsis, Phlox, Pittosporum*, *Plectranthus, Polemonium, Pothos, Primula*, *Ranunculus, Rhododendron, Rohdea, Rosa, Ruscus, Saintpaulia, Schefflera, Sedum, Senecio cruentus, Senecio hybridus, Sinningia speciosa, Spathiphyllum, Stephanotis, Stokesia, Streptocarpus, Tagetes, Trachelium, Tropaeolum, Vinca, Viola, Zantedeschia aethiopica, Zantedeschia albomaculata, Zantedeschia odorata* and *Zinnia* (Hausbeck et al. 1992; Ruter & Gitaitis 1993a; Ruter & Gitaitis 1993b; Verhoeven & Roenhorst 1994; Loebenstein et al. 1995; Lockhart & Currier 1996; Bellardi & Lisa 1998; Miller et al.1998; Rudzinska-Langwald & Kaminska 1998; Windham et al. 1998; EPPO 1999; Roggero et al. 1999; Koike & Mayhew 2001; Materazzi & Triolo 2001; Shahraeen et al. 2002; Ghotbi et al. 2005; Baker et al. 2007; Hausbeck 2007; Elliot et al. 2009; Werkman et al. 2010; Zhang et al. 2010; McDonough et al*.* 2011). Fruit and vegetable hosts include *Capsicum annuum, Cichorium*, *Cucumis sativus*, *Lactuca sativa*, *Lycopersicon esculentum, Ocimum basilicum, Rubus, Salvia, Solanum, Spinacia oleracea*, *Valerianella olitoria* and *Vicia faba* (Hausbeck et al. 1992; Daughtrey et al. 1997; EPPO 1999; Liu et al. 2009; Tzanetakis et al. 2009; Werkman et al. 2010; El-Wahab et al. 2011).
Distribution	Belgium, Canada (British Columbia, Manitoba), Chile, China, Costa Rica, Egypt, France, Germany, Iran, Israel, Italy, Japan, Netherlands, New Guinea, New Zealand, Poland, Portugal, Spain, United Kingdom and USA (Lisa et al. 1990; De Avila et al. 1992; Adam & Lesemann 1994; EPPO/CABI 1996; Louro 1996; EPPO 1999; Elliott et al 2009; Kuwabara et al. 2010;

	El-Wahab et al. 2011).
Quarantine pest	***Konjac mosaic virus***
Synonyms	*Zantedeschia mosaic virus; Calla lily mosaic virus; Japanese hornwort mosaic virus*
Common name(s)	KoMV, KMV
Main hosts	*Amorphophallus* species (ICTVdB Management 2006; Padmavathi et al. 2013), *Colocasia esculenta*, *Caladium* species, *Dieffenbachia* species (Manikonda et al. 2011), *Philodendron oxycardium, Philodendron selloum, Philodendron verrucosum* (Nishiguchi et al. 2006), *Tetraginia expansa* (Nishiguchi et al. 2006), *Typhonium flagelliforme* (Shi et al. 2005), *Zamioculcas zamiifolia* (Alexandre et al. 2013) and *Zantedeschia* species (Chang et al. 2001, Chen et al. 2006b).
Distribution	Brazil, Germany, India, Japan, Korea, Taiwan, Netherlands (Manikonda et al. 2011; Alexandre et al. 2013), China (Shi et al. 2005) and New Zealand (Wei et al. 2008).
Quarantine pest	***Lisianthus necrosis virus***
Synonyms	
Common name(s)	LNV
Main hosts	*Dianthus caryophyllus* (Chen & Hsu 2002), *Eustoma russellianum* (Iwaki et al. 1987) and *Zantedeschia* species (Chen et al. 2006c).
Distribution	Japan (Iwaki et al. 1987) and Taiwan (Chen et al. 2006c).
Quarantine pest	***Watermelon silver mottle virus***
Synonyms	*Watermelon silvery mottle virus; Watermelon tospovirus*
Common name(s)	WSMoV; WSMV; Watermelon silver mottle disease
Main hosts	*Amaranthus viridis, Benincasa hispida, Capsicum annuum, Citrullus vulgaris* (= *Citrullus lanatus*), *Cucumis melo, Cucumis sativus, Cucurbita pepo, Lagenaria leucantha*, *Luffa aegyptiaca, Physalis* species, *Solanum lycopersicum*, *Solanum nigrum* and *Zantedeschia* species (EPPO 1997; Chu et al. 2001; Chen et al. 2003; Chen et al. 2004b; Chiemsombat et al. 2008; Anurag 2012).
Distribution	China, India, Japan, Taiwan and Thailand (EPPO 1997; Chen et al. 2003; EPPO 2004; Rao et al. 2011). Reported but not confirmed from Brazil (EPPO 1997) and Texas and Mississippi in the USA (Ali et al. 2012).
Quarantine pest	***Zantedeschia mild mosaic virus***
Synonyms	
Common name(s)	ZaMMV
Main hosts	*Zantedeschia* species (Huang & Chang 2005).
Distribution	Taiwan (Huang & Chang 2005).

Appendix C: Biosecurity framework

Australia's biosecurity policies

The objective of Australia's biosecurity policies and risk management measures is the prevention or control of the entry, establishment or spread of pests and diseases that could cause significant harm to people, animals, plants and other aspects of the environment.

Australia has diverse native flora and fauna and a large agricultural sector, and is relatively free from the more significant pests and diseases present in other countries. Therefore, successive Australian Governments have maintained a conservative, but not a zero-risk, approach to the management of biosecurity risks. This approach is consistent with the World Trade Organization's (WTO's) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement).

The SPS Agreement defines the concept of an 'appropriate level of protection' (ALOP) as the level of protection deemed appropriate by a WTO Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory. Among a number of obligations, a WTO Member should take into account the objective of minimising negative trade effects in setting its ALOP.

Like many other countries, Australia expresses its ALOP in qualitative terms. Australia's ALOP, which reflects community expectations through Australian Government policy, is currently expressed as providing a high level of sanitary and phytosanitary protection, aimed at reducing risk to a very low level, but not to zero.

Consistent with the SPS Agreement, in conducting risk analyses Australia takes into account as relevant economic factors:

- the potential damage in terms of loss of production or sales in the event of the entry, establishment or spread of a pest or disease in the territory of Australia
- the costs of control or eradication of a pest or disease
- and the relative cost-effectiveness of alternative approaches to limiting risks.

Roles and responsibilities within Australia's quarantine system

Australia protects its human, animal and plant life or health through a comprehensive quarantine system that covers the quarantine continuum, from pre-border to border and post-border activities. The Australian Government Department of Health is responsible for human health aspects of quarantine. The Australian Government Department of Agriculture is responsible for animal and plant life or health.

Pre-border, Australia participates in international standard-setting bodies, undertakes risk analyses, develops offshore quarantine arrangements where appropriate, and engages with our neighbours to counter the spread of exotic pests and diseases.

At the border, Australia screens vessels (including aircraft), people and goods entering the country to detect potential threats to Australian human, animal and plant health.

The Australian Government also undertakes targeted measures at the immediate post-border level within Australia. This includes national co-ordination of emergency responses to pest and disease incursions. The movement of goods of quarantine concern within Australia's border is the responsibility of relevant state and territory authorities, which undertake inter- and intra-state quarantine operations that reflect regional differences in pest and disease status, as a part of their wider plant and animal health responsibilities.

Roles and responsibilities within the Department

The Australian Government Department of Agriculture is responsible for the Australian Government's animal and plant biosecurity policy development and the establishment of risk management measures. The Secretary of the Department is appointed as the Director of Animal and Plant Quarantine under the *Quarantine Act 1908* (the Act). The Department takes the lead in biosecurity and quarantine policy development and the establishment and implementation of risk management measures across the biosecurity continuum, and:

- **Pre-border** conducts risk analyses, including IRAs, and develops recommendations for biosecurity policy as well as providing quarantine policy advice to the Director of Animal and Plant Quarantine
- **At the border** develops operational procedures, makes a range of quarantine decisions under the Act (including import permit decisions under delegation from the Director of Animal and Plant Quarantine) and delivers quarantine services
- **Post-border** coordinates pest and disease preparedness, emergency responses and liaison on inter– and intra–state quarantine arrangements for the Australian Government, in conjunction with Australia's state and territory governments.

Roles and responsibilities of other government agencies

State and territory governments play a vital role in the quarantine continuum. The department works in partnership with state and territory governments to address regional differences in pest and disease status and risk within Australia, and develops appropriate sanitary and phytosanitary measures to account for those differences. Australia's partnership approach to quarantine is supported by a formal Memorandum of Understanding that provides for consultation between the Australian Government and the state and territory governments.

Depending on the nature of the goods being imported or proposed for importation, the Department of Agriculture may consult other Australian Government authorities or agencies in developing its recommendations and providing advice.

As well as a Director of Animal and Plant Quarantine, the Act provides for a Director of Human Quarantine. The Australian Government Department of Health is responsible for human health aspects of quarantine and Australia's Chief Medical Officer within that Department holds the position of Director of Human Quarantine. The Department of Agriculture may, where appropriate, consult with that Department on relevant matters that may have implications for human health.

The Act also requires the Director of Animal and Plant Quarantine, before making certain decisions, to request advice from the Environment Minister and to take the advice into account when making those decisions. The Australian Government Department of the Environment is responsible under the *Environment Protection and Biodiversity Conservation Act 1999* for assessing the environmental impact associated with proposals to import live species. Anyone proposing to import such material should contact the Department of the Environment directly for further information.

When undertaking risk analyses, the Department of Agriculture consults with the Department of the Environment about environmental issues and may use or refer to the Department of the Environment's assessment.

Australian quarantine legislation

The Australian quarantine system is supported by Commonwealth, state and territory quarantine laws. Under the Australian Constitution, the Commonwealth Government does not have exclusive power to make laws in relation to quarantine, and as a result, Commonwealth and state quarantine laws can co-exist.

Commonwealth quarantine laws are contained in the *Quarantine Act 1908* and subordinate legislation including the *Quarantine Regulations 2000*, the *Quarantine Proclamation 1998*, the *Quarantine (Cocos Islands) Proclamation 2004* and the *Quarantine (Christmas Island) Proclamation 2004*.

The quarantine proclamations identify goods, which cannot be imported, into Australia, the Cocos Islands and or Christmas Island unless the Director of Animal and Plant Quarantine or delegate grants an import permit or unless they comply with other conditions specified in the proclamations. Section 70 of the *Quarantine Proclamation 1998*, section 34 of the *Quarantine (Cocos Islands) Proclamation 2004* and section 34 of the *Quarantine (Christmas Island) Proclamation 2004* specify the things a Director of Animal and Plant Quarantine must take into account when deciding whether to grant a permit.

In particular, a Director of Animal and Plant Quarantine (or delegate):

- must consider the level of quarantine risk if the permit were granted, and
- must consider whether, if the permit were granted, the imposition of conditions would be necessary to limit the level of quarantine risk to one that is acceptably low, and
- for a permit to import a seed of a plant that was produced by genetic manipulation—must take into account any risk assessment prepared, and any decision made, in relation to the seed under the *Gene Technology Act*, and
- may take into account anything else that he or she knows is relevant.

The level of quarantine risk is defined in section 5D of the *Quarantine Act 1908*. The definition is as follows:

reference in this Act to a *level of quarantine risk* is a reference to:

a) the probability of:

   i) a disease or pest being introduced, established or spread in Australia, the Cocos Islands or Christmas Island; and

ii) the disease or pest causing harm to human beings, animals, plants, other aspects of the environment, or economic activities; and

b) the probable extent of the harm.

The *Quarantine Regulations 2000* were amended in 2007 to regulate keys steps of the import risk analysis process. The Regulations:

- define both a standard and an expanded IRA;
- identify certain steps, which must be included in each type of IRA;
- specify time limits for certain steps and overall timeframes for the completion of IRAs (up to 24 months for a standard IRA and up to 30 months for an expanded IRA);
- specify publication requirements;
- make provision for termination of an IRA; and
- allow for a partially completed risk analysis to be completed as an IRA under the Regulations.

The Regulations are available on the ComLaw website.

International agreements and standards

The process set out in the *Import Risk Analysis Handbook 2011* is consistent with Australia's international obligations under the SPS Agreement. It also takes into account relevant international standards on risk assessment developed under the International Plant Protection Convention (IPPC) and by the World Organisation for Animal Health (OIE).

Australia bases its national risk management measures on international standards where they exist and when they achieve Australia's ALOP. Otherwise, Australia exercises its right under the SPS Agreement to apply science-based sanitary and phytosanitary measures that are not more trade restrictive than required to achieve Australia's ALOP.

Notification obligations

Under the transparency provisions of the SPS Agreement, WTO Members are required, among other things, to notify other members of proposed sanitary or phytosanitary regulations, or changes to existing regulations, that are not substantially the same as the content of an international standard and that may have a significant effect on trade of other WTO Members.

Risk analysis

Within Australia's quarantine framework, the Australian Government uses risk analyses to assist it in considering the level of quarantine risk that may be associated with the importation or proposed importation of animals, plants or other goods.
In conducting a risk analysis, the Department of Agriculture:

- identifies the pests and diseases of quarantine concern that may be carried by the good
- assesses the likelihood that an identified pest or disease would enter, establish or spread

- assesses the probable extent of the harm that would result.

If the assessed level of quarantine risk exceeds Australia's ALOP, the Department of Agriculture will consider whether there are any risk management measures that will reduce quarantine risk to achieve the ALOP. If there are no risk management measures that reduce the risk to that level, trade will not be allowed.

Risk analyses may be carried out by the Department of Agriculture's specialists, but may also involve relevant experts from state and territory agencies, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), universities and industry to access the technical expertise needed for a particular analysis.

Risk analyses are conducted across a spectrum of scientific complexity and available scientific information. An IRA is a type of risk analysis with key steps regulated under the *Quarantine Regulations 2000*. The Department of Agriculture's assessment of risk may also take the form of a non-regulated analysis of existing policy or technical advice. Further information on the types of risk analysis is provided in the *Import Risk Analysis Handbook 2011.*

Glossary

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 2013b).
Appropriate level of protection (ALOP)	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 2013b).
Area of low pest prevalence	An area, whether all of a country, part of a country, or all parts of several countries, as identified by the competent authorities, in which a specific pest occurs at low levels and which is subject to effective surveillance, control or eradication measures (FAO 2013b).
Arthropod	The largest phylum of animals, including the insects, arachnids and crustaceans.
Asexual reproduction	The development of new individual from a single cell or group of cells in the absence of meiosis.
Consignment	A quantity of plants, plant products 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 2013b).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO 2013b).
Disease cycle	This is the sequence of events involved in disease development, including the stages of development of the pathogen and the effect of the disease on the host; the chain of events that occur between the time of infection and the final expression of disease (Shurtleff & Averre 1997).
Drenching	A technique used by quarantine authorities to remove organisms of quarantine concern. The technique involves the sufficient application of liquid to plant material to ensure adequate penetration of chemicals to control the risk of nematodes and fungi (Department of Agriculture 2006).
The department	The Commonwealth Department of Agriculture.
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 2013b).
Endemic	Belonging to, native to, or prevalent in a particular geography, area or environment
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 2013b).
Equivalence (of phytosanitary terms)	The situation where, for a specified pest, different phytosanitary measures achieve a contracting party's appropriate level of protection (FAO 2013a).
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2013b).
Fumigation	A method of pest control that completely fills an area with gaseous pesticides to suffocate or poison the pests within
Host	An organism that harbours a parasite, mutual partner, or commensal partner, typically providing nourishment and shelter
Host range	Species capable, under natural conditions, of sustaining a specific pest or other organism (FAO 2013b).
Hypha(e)	The basic vegetative unit of structure and function of most fungi; a largely microscopic tubular filament that increases in length by growth at its tip. New

	hyphae arise as lateral branches. Some can become specialized for given functions including producing spores, penetrating host tissues, etc. (Erwin & Ribeiro 1996).
Import permit	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2013b).
Import risk analysis	An administrative process through which quarantine policy is developed or reviewed, incorporating risk assessment, risk management and risk communication
Infection	The internal 'endophytic' colonisation of a plant, or plant organ, and is generally associated with the development of disease symptoms as the integrity of cells and/or biological processes are disrupted
Infestation (of a commodity)	Presence in a commodity of a living pest of the plant or plant product concerned. Infestation includes infection (FAO 2013b).
Inspection	Official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (FAO 2013b).
Intended use	Declared purpose for which plants, plant products, or other regulated articles are imported, produced or used (FAO 2013b).
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment (FAO 2013b).
International Standard for Phytosanitary Measures (ISPM)	An international standard adopted by the Conference of the Food and Agriculture Organization, the Interim Commission on Phytosanitary Measures or the Commission on Phytosanitary Measures, established under the IPCC (FAO 2013b).
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO 2013b).
Latency	Stage of an infectious disease, other than the incubation period, where no symptoms are expressed in the host (Shurtleff & Averre 1997).
Latent infection	Infection in a plant without visual symptoms (Shurtleff & Averre 1997).
Larva	A juvenile form of animal with indirect development, undergoing metamorphosis (for example, insects or amphibians)
Life cycle	Cyclical progression of stages in the growth and development of an organism (plant, animal, or pathogen) that occur between the appearance and reappearance of the same stage of the organism (Shurtleff & Averre 1997).
Mycelium	Tubular strands that make up the body of the fungal microorganism. In *Phytophthora*, mycelium is non-septate, but plugs, often called false septa, can be seen in old mycelium (Erwin & Ribeiro 1996).
National Plant Protection Organization (NPPO)	Official service established by a government to discharge the functions specified by the IPPC (FAO 2013b).
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 2013b).
Pathogen	A biological agent that can cause disease to its host
Pathway	Any means that allows the entry or spread of a pest (FAO 2013b).
Pest	Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2013b).
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 2013b).
Pest free area (PFA)	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 2013b).

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 2013b).
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 condition is being 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 2013b).
Pest risk analysis (PRA)	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 2013b).
Pest risk assessment (for quarantine pests)	Evaluation of the probability of the introduction and spread of a pest and of the magnitude of the associated potential economic consequences (FAO 2013b).
Pest risk assessment (for regulated non-quarantine pests)	Evaluation of the probability that a pest in plants for planting affects the indented use of those plants with an economically unacceptable impact (FAO 2013b).
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2013b).
Pest risk management (for regulated non-quarantine pests)	Evaluation and selection of options to reduce the risk that a pest in plants for planting causes an economically unacceptable impact on the intended use of those plants (FAO 2013b).
Pest status (in an area)	Presence or absence, at the present time, of a pest in an area, including where appropriate its distribution, as officially determined using expert judgement on the basis of current and historical pest records and other information (FAO 2013b).
Phytosanitary Certificate	An official paper document or its official electronic equivalent, consistent with the model of certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (FAO 2013b).
Phytosanitary certification	Use of phytosanitary procedures leading to the issue of a Phytosanitary Certificate (FAO 2013b).
Phytosanitary measure	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 2013b).
Phytosanitary procedure	Any official method for implementing phytosanitary measures including the performance of inspections, tests, surveillance or treatments in connection with regulated pests (FAO 2013b).
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 2013b).
PRA area	Area in relation to which a pest risk analysis is conducted (FAO 2013b).
Propagule	Any part of an organism capable of initiating independent growth when separated from the parent body (Shurtleff & Averre 1997).
Quarantine	Official confinement of regulated articles for observation and research or for further inspection, testing or treatment (FAO 2013b).
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 2013b).
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 2013b).

Regulated non-quarantine pest	A non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party (FAO 2013b).
Restricted risk	Risk estimate with phytosanitary measure(s) applied
Soil	The loose surface material of the earth in which plants grow, in most cases consisting of disintegrated rock with an admixture of organic material (NAPPO 2003).
Sporangium/sporangia	Sac within which zoospores form, especially when water is cooled to about 10°C below ambient temperature. In solid substrates, sporangia usually germinate by germ tubes (Erwin & Ribeiro 1996).
Sporulate, sporulation	To form or produce spores (Shurtleff & Averre 1997).
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO 2013b).
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures.
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.
Surveillance	An official process which collects and records data on pest occurrence or absence by surveying, monitoring or other procedures (FAO 2013b).
Systems approach(es)	The integration of different risk management measures, at least two of which act independently, and which cumulatively achieve the appropriate level of protection against regulated pests.
Tissue culture	the products of 'an in vitro technique of cultivating (propagating) cells, tissues, or organs in a sterile synthetic medium' (Shurtleff & Averre 1997); comprising plant cells, tissues or organs, sterile synthetic medium, and the vessel in which cells have been propagated.
Trash	Soil, splinters, twigs, leaves, and other plant material, other than fruit stalks.
Treatment	Official procedure for the killing, inactivation or removal of pests, or for rendering pests infertile or for devitalisation (FAO 2013b).
Unrestricted risk	Unrestricted risk estimates apply in the absence of risk mitigation measures.

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