Australian Government

Biosecurity Australia

Draft Import Risk Analysis Report for Table grapes from the People's Republic of China

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Cover image: Table grapes cultivated in Xinjiang Uygur Autonomous Region in the People's Republic of China.

Submissions

This draft import risk analysis (IRA) report has been issued to give all interested parties an opportunity to comment and draw attention to any scientific, technical, or other gaps in the data, misinterpretations and errors. Any comments should be submitted to Biosecurity Australia within the comment period stated in the related Biosecurity Australia Advice on the Biosecurity Australia website. The draft IRA report will then be revised as necessary to take account of the comments received and a provisional final IRA report will be released at a later date.

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Contents

Acronyms and abbreviations xi

Abbreviations of units xii

Summary xiii

1 Introduction 1

1.1 Australia's biosecurity policy framework 1
1.2 This import risk analysis 1

2 Method for pest risk analysis 5

2.1 Stage 1: Initiation 5
2.2 Stage 2: Pest risk assessment 6
2.3 Stage 3: Pest risk management 13

3 China's commercial production practices for table grapes 15

3.1 Assumptions used in estimating unrestricted risk 15
3.2 Climate in production areas 15
3.3 Pre-harvest 19
3.4 Harvesting and handling procedures 23
3.5 Post-harvest 24
3.6 Export capability 28

4 Pest risk assessments for quarantine pests 31

4.1 Kanzawa spider mite 35
4.2 Harlequin ladybird 43
4.3 Grape berry weevil 50
4.4 Japanese beetle 57
4.5 Ruteline beetles (other than Japanese beetle) 64
4.6 Oriental fruit fly 69
4.7 Grape midge 74
4.8 Grape whitefly 80
4.9 Grape phylloxera 86
4.10 Soft scales 95
4.11 Mealybugs 99
4.12 European grape berry moth 104
4.13 Grape plume moth 110
4.14 Apple heliodinid 116
4.15 Thrips 120
4.16 Grape cluster black rot 126

4.17 Bitter rot 132
4.18 Black rot 138
4.19 Spike stalk brown spot 145
4.20 Brown rot 151
4.21 Grapevine leaf rust 157
4.22 Phomopsis cane and leaf spot 163
4.23 Tobacco necrosis viruses 168
4.24 Sanitary pests 175
4.25 Pest risk assessment conclusions 178

5 Pest risk management 183

5.1 Pest risk management measures and phytosanitary procedures 183
5.2 Responsibility of competent authority 201
5.3 Review of processes 201
5.4 Uncategorised pests 202

6 Conclusion 203

Appendix A1 Initiation and categorisation for quarantine pests of table grapes from China 207

Appendix A2 Sanitary pests 257

Appendix B Additional quarantine pest data 259

Appendix C Biosecurity framework 269

Glossary 275

References 277

Tables

Table 2.1	Nomenclature for qualitative likelihoods	9
Table 2.2	Matrix of rules for combining qualitative likelihoods	9
Table 2.3	Decision rules for determining the consequence impact score based on the magnitude of consequences at four geographic scales	11
Table 2.4	Decision rules for determining the overall consequence rating for each pest	12
Table 2.5	Risk estimation matrix	12
Table 3.1	Integrated pest and disease management for the main pests of Red Globe table grapes (AQSIQ 2008)	23
Table 4.1	Quarantine pests for table grapes from China.	31
Table 4.2	Summary of unrestricted risk estimates for quarantine pests associated with table grapes from China	179
Table 5.1	Phytosanitary and sanitary measures proposed for quarantine pests for table grapes from China	185

Figures

Figure 1	Map of Australia	viii
Figure 2	A guide to Australia's bio-climate zones	viii
Figure 3	Structure of table grape bunch	ix
Figure 3.1	Map of China showing the main grape-producing provinces and regions in blue (adapted from AQSIQ 2009). The 32 °N latitude line is the northern limit of the occurrence of *Bactrocera dorsalis* (Oriental fruit fly) in China.	16
Figure 3.2	Mean maximum (—♦—) and minimum (—■—) temperatures and mean relative humidity (—▲—) in table grape-producing provinces of Hebei, Henan, Jilin, Liaoning, Ningxia, Shaanxi, Shandong, Shanxi, Xinjiang and Yunnan in China, based on average monthly weather data from 1951 to 1988	17
Figure 3.3	Trellis systems – horizontal (left) and vertical (right)	20
Figure 3.4	Grape bunches covered in paper bags (left), and a single bunch in a cellophane and paper bag (right)	21
Figure 3.5	Harvesting grape bunches and preliminary sorting	24
Figure 3.6	Sorting and packing of table grapes	25
Figure 3.7	Cold room fan-forced pre-cooling (left) and automated pre-cooling unit (right)	26
Figure 3.8	Summary of vineyard and post-harvest packing house, storage and distribution steps for table grapes grown in China for export – adapted from AQSIQ (2008; 2009c)	27
Figure 3.9	Grape production in the main table grape producing provinces/regions in China, 2000–2006 in US tons (USDA 2007)	29

Figure 1 Map of Australia

Figure 2 A guide to Australia's bio-climate zones

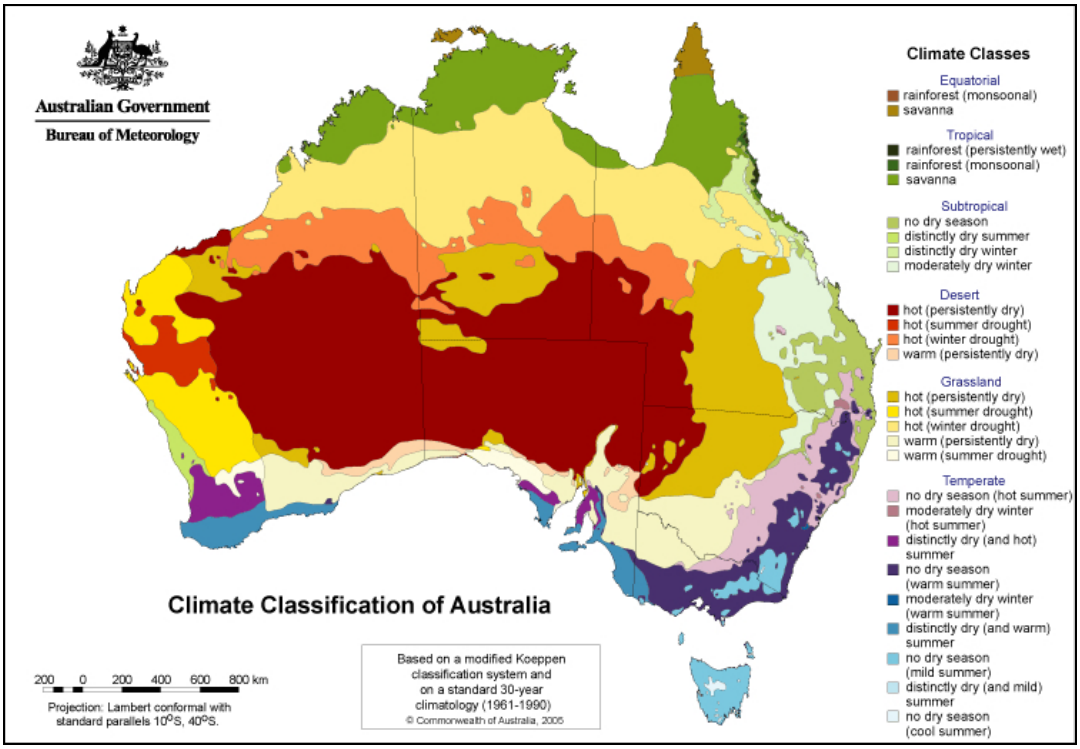
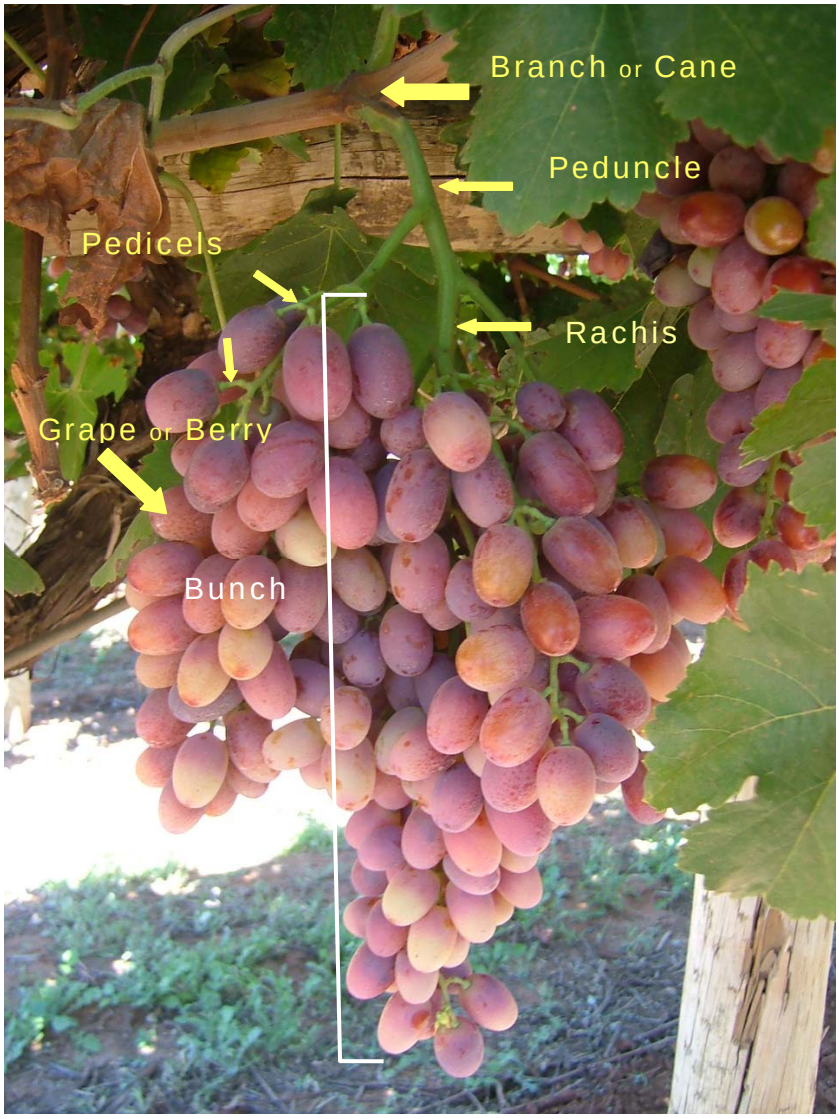


Figure 3 Structure of table grape bunch



Acronyms and abbreviations

Term or abbreviation	Definition
ALOP	Appropriate level of protection
APPD	Australian Plant Pest Database (Plant Health Australia)
APVMA	Australian Pesticides and Veterinary Medicines Authority
AQIS	Australian Quarantine and Inspection Service
AQSIQ	General Administration for Quality Supervision, Inspection and Quarantine of the People's Republic of China
ATGA	Australian Table Grape Growers Association
BAA	Biosecurity Australia Advice
BSG	Biosecurity Services Group
CIQ	China Entry-Exit Inspection and Quarantine Bureau
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Australian Government Department of Agriculture, Fisheries and Forestry
DAFWA	Department of Agriculture and Food, Western Australia (formerly DAWA: Department of Agriculture, Western Australia)
EP	existing policy
FAO	Food and Agriculture Organization of the United Nations
FSANZ	Food Standards Australia and New Zealand
IDM	Integrated Disease Management
IPC	International Phytosanitary Certificate
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
IRA	import risk analysis
ISPM	International Standard for Phytosanitary Measures
NPPO	National Plant Protection Organization
NSW	New South Wales
NT	Northern Territory
NZ	New Zealand
PRA	pest risk analysis
Qld	Queensland
SA	South Australia
SPS	sanitary and phytosanitary measures
Tas.	Tasmania
USA	United States of America
USDA	United States Department of Agriculture
Vic.	Victoria
WA	Western Australia
WTO	World Trade Organization

Abbreviations of units

Term or abbreviation	Definition
ºC	degree Celsius
ºF	degree Fahrenheit
ha	hectare
kg	kilogram
km	kilometre
m	metre
µm	micrometre (one millionth of a metre)
ml	millilitre
mm	millimetre
mu	unit of area used in China (one fifteenth of a hectare)
ppm	parts per million
s	second
ton	US ton = 0.91 tonnes
tonne	metric tonne = 1000 kilograms

Summary

This import risk analysis (IRA) assesses a proposal from the People's Republic of China (China) for market access to Australia for table grapes.

The draft report proposes that the importation of table grapes to Australia from all commercial production areas of China be permitted, subject to a range of quarantine conditions.

Australia permits the importation of table grapes from Chile, United States of America (California), and New Zealand, for human consumption provided they meet Australian quarantine requirements.

This draft report identifies pests that require quarantine measures to manage risks to a very low level in order to achieve Australia's appropriate level of protection (ALOP). The pests requiring measures are arthropods – *Tetranychus kanzawai* (kanzawa spider mite), *Harmonia axyridis* (harlequin ladybird), *Popillia japonica* (Japanese beetle), *Aleurolobus taeonabe* (grape whitefly), *Bactrocera dorsalis* (Oriental fruit fly), *Daktulosphaira vitifoliae* (grapevine phylloxera), *Planococcus kraunhiae* (Japanese mealybug), *Pseudococcus comstocki* (Comstock's mealybug), *Pseudococcus maritimus* (grape mealybug), *Frankliniella occidentalis* (western flower thrips) and *Rhipiphorothrips cruentatus* (grapevine thrips); pathogens causing diseases – *Physalospora baccae* (grape cluster black rot), *Greeneria uvicola* (bitter rot), *Guignardia bidwellii* (black rot), *Alternaria viticola* (spike stalk brown spot), *Monilinia fructigena* (brown rot) and *Phakopsora euvitis* (grapevine leaf rust); and two sanitary pests – *Latrodectus mactans* (black widow spider) and *Latrodectus tredecimguttatus* (European black widow spider).

Three pests have been identified as regional quarantine pests: *Tetranychus kanzawai* and *Greeneria uvicola* for Western Australia, and *Frankliniella occidentalis* for Tasmania and the Northern Territory. The proposed quarantine measures take into account regional differences. Western Australia state legislation currently prohibits the importation of table grapes from any source, including other parts of Australia due to the absence of grape phylloxera (*Daktulosphaira vitifoliae),* grapevine fanleaf virus and phomopsis cane and leaf spot *(Phomopsis viticola).* The state legislation would need to be modified before the importation of table grapes into Western Australia can occur.

This draft report proposes a combination of risk management measures and operational systems that will reduce the risk associated with the importation of table grapes from China into Australia to achieve Australia's ALOP, specifically:

- area freedom or cold treatment for Oriental fruit fly
- a systems approach (vineyard control and surveillance, fruit bagging and visual inspection and remedial action) for kanzawa spider mite, harlequin ladybird, Japanese beetle, grape whitefly, mealybugs and thrips
- area freedom or sulphur treatment or pre-shipment fumigation with SO_2/CO_2 for phylloxera
- area freedom for grape cluster black rot, black rot and spike stalk brown spot
- area freedom or a systems approach for bitter rot, grapevine leaf rust and brown rot
- pre-shipment fumigation with SO_2/CO_2 for venomous black widow spiders

- a supporting operational system to maintain and verify the phytosanitary status of consignments. The Australian Quarantine and Inspection Service (AQIS) will verify that the proposed phytosanitary measures have occurred and an AQIS officer will be present under a pre-clearance arrangement to inspect and verify pest freedom prior to export.

This draft IRA report contains details of the risk assessments for the quarantine pests and the proposed quarantine measures in order to allow interested parties to provide comments and submissions to Biosecurity Australia within the 60 day consultation period.

1 Introduction

1.1 Australia's biosecurity policy framework

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

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

More information about Australia's biosecurity framework is provided in Appendix C of this report and in the *Import Risk Analysis Handbook 2007 (update 2009)* located on the Biosecurity Australia website www.biosecurityaustralia.gov.au.

1.2 This import risk analysis

1.2.1 Background

The General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ), requested market access to Australia for table grapes in July 2005. The access request was reconfirmed for all table grape production areas in China in April 2006 and a submission provided in July 2006.

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

1.2.2 Scope

The scope of this IRA is to consider the quarantine risk that may be associated with the importation of commercially-produced fresh table grapes *Vitis vinifera* L. and hybrids (henceforth these will be referred to as table grapes) free from trash from the People's Republic of China (China), for human consumption in Australia.

In this IRA table grapes are defined as table grape bunches or clusters, which include peduncles, rachises, laterals, pedicels and berries but not plant parts (Pratt 1988). This IRA assesses all the commercially-produced table grapes (*Vitis* spp.) and varieties of China and the provinces or regions in which they are grown.

1.2.3 Existing policy

Import policies exist for table grapes imported from Chile (Biosecurity Australia 2005d), the United States of America (California) (AQIS 2000) and New Zealand.

The import requirements for these commodities can be found at the Australian Quarantine and Inspection Service (AQIS) Import Conditions database http://www.aqis.gov.au/icon.

Domestic arrangements

The Commonwealth Government is responsible for regulating the movement of plants and plant products in and out of Australia. However, the state and territory governments are responsible for plant health controls within Australia. Legislation relating to resource management or plant health may be used by state or territory government agencies to control interstate movement of plants or their products.

Currently importation of fresh table grapes, seed, plants and used machinery into Western Australia from any source is prohibited due to the absence of grape phylloxera (*Daktulosphaira vitifoliae),* grapevine fanleaf virus and phomopsis cane and leaf spot *(Phomopsis viticola)* (DAFWA 2009a).

1.2.4 Contaminating pests

In addition to the pests of table grapes from China that are identified in this IRA, there are other organisms that may arrive with the table grapes. These organisms could include pests of other crops or predators and parasitoids of other arthropods. Biosecurity Australia considers these organisms to be contaminating pests that could pose sanitary and phytosanitary risks. These risks are addressed by the procedures indicated in section 5.4.

1.2.5 Consultation

Biosecurity Australia notified stakeholders on 12 September 2007 in Biosecurity Australia Policy Memorandum 2007/20 of the new IRA process and access requests that would be considered under the new IRA process, including table grapes from China. On 18 August 2008, Biosecurity Australia notified stakeholders in Biosecurity Australia Advice 2008/28 of the formal commencement of this IRA as a standard IRA under the regulated IRA process to consider a proposal to import table grapes from China.

Biosecurity Australia provided a draft pest categorisation table for table grapes from China to the state and territory departments of primary industry/agriculture on 15 January 2010 for their informal consideration of regional pests.

1.2.6 Next steps

This draft IRA report gives stakeholders the opportunity to comment and draw attention to any scientific, technical, or other gaps in the data, misinterpretations and errors.

Biosecurity Australia will consider submissions received on the draft IRA report and may consult informally with stakeholders. Biosecurity Australia will revise the draft IRA report as appropriate.

Biosecurity Australia will then prepare a provisional final IRA report, taking into account stakeholder comments.

State and territory governments will be consulted on the proposed outcomes of the IRA.

The report will be distributed to the proposer and registered stakeholders and the documents will be placed on the public file and the Biosecurity Australia website.

The regulated timeframe for an IRA ends when a provisional final IRA report is issued.

Stakeholders who believe there was a significant deviation from the IRA process set out in the *Import Risk Analysis Handbook 2007 (update 2009)* that adversely affected their interests may appeal to the Import Risk Analysis Appeals Panel (IRAAP). Appeals must be lodged within 30 days of the publication of the provisional final IRA report.

The appeals process is independent of Biosecurity Australia. It is a non-judicial review that is not regulated under the Quarantine Regulations 2000 made under the *Quarantine Act 1908*.

Further details of the appeal process may be found at Annex 6 of the IRA Handbook.

At the conclusion of the appeal process and after any issues arising from the IRAAP process have been addressed, the Chief Executive of Biosecurity Australia will provide the final IRA report and a recommendation for a policy determination to the Director of Animal and Plant Quarantine.

The Director of Animal and Plant Quarantine will then make a determination. The determination provides a policy framework for decisions on whether or not to grant an import permit and any conditions that may be attached to a permit.

A policy determination represents the completion of the IRA process.

The Director of Animal and Plant Quarantine notifies AQIS and Biosecurity Australia of the policy determination. In turn, Biosecurity Australia notifies the proposer and registered stakeholders, and the Department of Agriculture, Fisheries and Forestry notifies the WTO Secretariat, of the determination. The determination will also be placed on the public file and on the Biosecurity Australia website.

2 Method for pest risk analysis

This section sets out the method used for the pest risk analysis (PRA) in this report. Biosecurity Australia 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, including analysis of environmental risks and living modified organisms* (FAO 2004).

A PRA is 'the process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it' (FAO 2009). A pest is 'any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products' (FAO 2009).

Quarantine risk consists of two major components: the probability of a pest entering, establishing and spreading in Australia from imports; and the consequences should this happen. These two components are combined to give an overall estimate of the risk.

Unrestricted risk is estimated taking into account the existing commercial production practices of the exporting country and that, on arrival in Australia, AQIS will verify that the consignment received is as described on the commercial documents and its integrity has been maintained.

Restricted risk is estimated with phytosanitary measure(s) applied. A phytosanitary measure is 'any legislation, regulation or official procedure having the purpose to prevent the introduction and spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests' (FAO 2009).

A glossary of the terms used is provided at the back of this IRA report.

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

2.1 Stage 1: Initiation

Initiation identifies the pest(s) and pathway(s) that are of quarantine concern and should be considered for risk analysis in relation to the identified PRA area.

The pests assessed for their potential to be on the exported commodity (produced using commercial production and packing procedures) are listed in column 1 of Appendix A. Appendix A does not present a comprehensive list of all the pests associated with the entire plant, but concentrates on the pests that could be on the assessed commodity. Pests that are determined to not be associated with the commodity in column 3 are not considered further in the PRA. Contaminating pests that have no specific relation to the commodity or the export pathway have not been listed and would be addressed by Australia's current approach to contaminating pests.

The identity of the pests is given in Appendix A. The species name is used in most instances but a lower taxonomic level is used where appropriate. Synonyms are provided where the current scientific name differs from that provided by the exporting country's NPPO or where the cited literature uses a different scientific name.

For this PRA, the 'PRA area' is defined as Australia for pests that are absent, or of limited distribution and under official control. For areas with regional freedom from a pest, the 'PRA

area' may be defined on the basis of a state or territory of Australia or may be defined as a region of Australia consisting of parts of a state or territory or several states or territories.

For pests that had been considered by Biosecurity Australia in other risk assessments and for which import policies already exist, a judgement based on the specific circumstances was made on the likelihood of entry of pests on the commodity and whether existing policy is adequate to manage the risks associated with its import. Where appropriate, the previous risk assessment was taken into consideration when developing the new policy.

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 likelihood of associated potential economic consequences' (FAO 2009).

In this PRA, pest risk assessment was divided into the following interrelated processes:

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, as defined in ISPM 5: *Glossary of phytosanitary terms* (FAO 2009).

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

- 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.

The results of pest categorisation are set out in columns 4 - 7 in Appendix A. The steps in the categorisation process are considered sequentially, with the assessment terminating with a 'Yes" in column 4 or the first "No' in columns 5 or 6. The quarantine pests identified during pest categorisation were carried forward for pest risk assessment and are listed in Table 4.1.

Details of how to assess the 'probability of entry', 'probability of establishment' and 'probability of spread' of a pest are given in ISPM 11 (FAO 2004). A summary of this process is given below, followed by a description of the qualitative methodology used in this IRA.

2.2.2 Assessment of the probability of entry, establishment and spread

Details of how to assess the 'probability of entry', 'probability of establishment' and 'probability of spread' of a pest are given in ISPM 11 (FAO 2004). A summary of this process is given below, followed by a description of the qualitative methodology used in this IRA.

Probability of entry

The probability of entry describes the probability that a quarantine pest will enter Australia as a result of trade in a given commodity, be distributed in a viable state in the PRA area and subsequently be transferred to a host. It is based on pathway scenarios depicting necessary steps in the sourcing of the commodity for export, its processing, transport and storage, its use in Australia and the generation and disposal of waste. In particular, the ability of the pest to survive is considered for each of these various stages.

The probability of entry estimates for the quarantine pests for a commodity are based on the use of the existing commercial production, packaging and shipping practices of the exporting country. Details of the existing commercial production practices for the commodity are set out in Section 3. These practices are taken into consideration by Biosecurity Australia when estimating the probability of entry.

For the purpose of considering the probability of entry, Biosecurity Australia divides this step of this stage of the PRA into two components:

- **Probability of importation**: the probability that a pest will arrive in Australia when a given commodity is imported
- **Probability of distribution**: the probability that the pest will be distributed, as a result of the processing, sale or disposal of the commodity, in the PRA area and subsequently transfer to a susceptible part of a host.

Factors considered in the probability of importation include:

- distribution and incidence of the pest in the source area
- occurrence of the pest in a life-stage that would be associated with the commodity
- mode of trade (e.g. bulk, packed)
- volume and frequency of movement of the commodity along each pathway
- seasonal timing of imports
- pest management, cultural and commercial procedures applied at the place of origin
- speed of transport and conditions of storage compared with the duration of the life cycle of the pest
- vulnerability of the life-stages of the pest during transport or storage
- incidence of the pest likely to be associated with a consignment
- commercial procedures (e.g. refrigeration) applied to consignments during transport and storage in the country of origin, and during transport to Australia.

Factors considered in the probability of distribution include:

- commercial procedures (e.g. refrigeration) applied to consignments during distribution in Australia
- dispersal mechanisms of the pest, including vectors, to allow movement from the pathway to a host
- whether the imported commodity is to be sent to a few or many destination points in the PRA area
- proximity of entry, transit and destination points to hosts

- time of year at which import takes place
- intended use of the commodity (e.g. for planting, processing or consumption)
- risks from by-products and waste.

Probability of establishment

Establishment is defined as the 'perpetuation for the foreseeable future, of a pest within an area after entry' (FAO 2004). In order to estimate the probability of establishment of a pest, reliable biological information (life cycle, host range, epidemiology, survival, etc.) is obtained from the areas where the pest currently occurs. The situation in the PRA area can then be compared with that in the areas where it currently occurs and expert judgement used to assess the probability of establishment.

Factors considered in the probability of establishment in the PRA area include:

- availability of hosts, alternative hosts and vectors
- suitability of the environment
- reproductive strategy and potential for adaptation
- minimum population needed for establishment
- cultural practices and control measures.

Probability of spread

Spread is defined as 'the expansion of the geographical distribution of a pest within an area' (FAO 2004). The probability of spread considers the factors relevant to the movement of the pest, after establishment on a host plant or plants, to other susceptible host plants of the same or different species in other areas. In order to estimate the probability of spread of the pest, reliable biological information is obtained from areas where the pest currently occurs. The situation in the PRA area is then carefully compared with that in the areas where the pest currently occurs and expert judgement used to assess the probability of spread.

Factors considered in the probability of spread include:

- suitability of the natural and/or managed environment for natural spread of the pest
- presence of natural barriers
- potential for movement with commodities, conveyances or by vectors
- intended use of the commodity
- potential vectors of the pest in the PRA area
- potential natural enemies of the pest in the PRA area.

Assigning qualitative likelihoods for the probability of entry, establishment and spread

In its qualitative PRAs, Biosecurity Australia uses the term 'likelihood' for the descriptors it uses for its estimates of probability of entry, establishment and spread. Qualitative likelihoods are assigned to each step of entry, establishment and spread. Six descriptors are used: high; moderate; low; very low; extremely low; and negligible (Table 2.1). Descriptive definitions for these descriptors and their indicative probability ranges are given in Table 2.1. The indicative probability ranges are only provided to illustrate the boundaries of the descriptors. These indicative probability ranges are not used beyond this purpose in qualitative PRAs. The

standardised likelihood descriptors and the associated indicative probability ranges provide guidance to the risk analyst and promote consistency between different risk analyses.

Table 2.1 Nomenclature for qualitative likelihoods

Likelihood	Descriptive definition	Indicative probability (P) range
High	The event would be very likely to occur	0.7 < P ≤ 1
Moderate	The event would occur with an even probability	0.3 < P ≤ 0.7
Low	The event would be unlikely to occur	0.05 < P ≤ 0.3
Very low	The event would be very unlikely to occur	0.001 < P ≤ 0.05
Extremely low	The event would be extremely unlikely to occur	0.000001 < P ≤ 0.001
Negligible	The event would almost certainly not occur	0 ≤ P ≤ 0.000001

The likelihood of entry is determined by combining the likelihood that the pest will be imported into the PRA area and the likelihood that the pest will be distributed within the PRA area, using a matrix of rules (Table 2.2). This matrix is then used to combine the likelihood of entry and the likelihood of establishment, and the likelihood of entry and establishment is then combined with the likelihood of spread to determine the overall likelihood of entry, establishment and spread.

For example, if the probability of importation is assigned a likelihood of 'low' and the probability of distribution is assigned a likelihood of 'moderate', then they are combined to give a likelihood of 'low' for the probability of entry. The likelihood for the probability of entry is then combined with the likelihood assigned to the probability of establishment (e.g. 'high') to give a likelihood for the probability of entry and establishment of 'low'. The likelihood for the probability of entry and establishment is then combined with the likelihood assigned to the probability of spread (e.g. 'very low') to give the overall likelihood for the probability of entry, establishment and spread of 'very low'.

Table 2.2 Matrix of rules for combining qualitative likelihoods

	High	**Moderate**	**Low**	**Very low**	**Extremely low**	**Negligible**
High	High	Moderate	Low	Very low	Extremely low	Negligible
Moderate	Low	Low	Very low	Very low	Extremely low	Negligible
Low	Very low	Very low	Very low	Extremely low	Extremely low	Negligible
Very low	Extremely low	Extremely low	Extremely low	Extremely low	Negligible	Negligible
Extremely low	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

Time and volume of trade

One factor affecting the likelihood of entry is the volume and duration of trade. If all other conditions remain the same, the overall likelihood of entry will increase as time passes and the overall volume of trade increases.

Biosecurity Australia normally considers the likelihood of entry on the basis of the estimated volume of one year's trade. This is a convenient value for the analysis that is relatively easy to estimate and allows for expert consideration of seasonal variations in pest presence, incidence and behaviour to be taken into account. The consideration of the likelihood of entry, establishment and spread and subsequent consequences takes into account events that might

happen over a number of years even though only one year's volume of trade is being considered. This reflects biological and ecological facts, for example where a pest or disease may establish in the year of import but spread may take many years.

These considerations have been taken into account when setting up the matrix. Therefore, any policy based on this analysis does not simply apply to one year of trade. Policy decisions that are based on Biosecurity Australia's method that uses the estimated volume of one year's trade are consistent with Australia's policy on appropriate level of protection and meet the Australian Government's requirement for ongoing quarantine protection. Of course, if there are substantial changes in the volume and nature of the trade in specific commodities then Biosecurity Australia has an obligation to review the risk analysis and, if necessary, provide updated policy advice.

In assessing the volume of trade in this PRA, Biosecurity Australia assumed that a substantial volume of trade will occur.

2.2.3 Assessment of potential consequences

The objective of the consequence assessment is to provide a structured and transparent analysis of the likely consequences if the pests or disease agents were to enter, establish and spread in Australia. The assessment considers direct and indirect pest effects and their economic and environmental consequences. The requirements for assessing potential consequences are given in Article 5.3 of the SPS Agreement (WTO 1995), ISPM 5 (FAO 2009) and ISPM 11 (FAO 2004).

Direct pest effects are considered in the context of the effects on:

- plant life or health
- other aspects of the environment.

Indirect pest effects are considered in the context of the effects on:

- eradication, control, etc
- domestic trade
- international trade
- environment.

For each of these six criteria, the consequences were estimated over four geographic levels, defined as:

- **Local**: an aggregate of households or enterprises (a rural community, a town or a local government area).
- **District**: a geographically or geopolitically associated collection of aggregates (generally a recognised section of a state or territory, such as 'Far North Queensland').
- **Regional**: a geographically or geopolitically associated collection of districts in a geographic area (generally a state or territory, although there may be exceptions with larger states such as Western Australia).
- **National**: Australia wide (Australian mainland states and territories and Tasmania).

For each criterion, the magnitude of the potential consequence at each of these levels was described using four categories, defined as:

- **Indiscernible**: pest impact unlikely to be noticeable.
- **Minor significance**: expected to lead to a minor increase in mortality/morbidity of hosts or a minor decrease in production but not expected to threaten the economic viability of production. Expected to decrease the value of non-commercial criteria but not threaten the criterion's intrinsic value. Effects would generally be reversible.
- **Significant**: expected to threaten the economic viability of production through a moderate increase in mortality/morbidity of hosts, or a moderate decrease in production. Expected to significantly diminish or threaten the intrinsic value of non-commercial criteria. Effects may not be reversible.
- **Major significance**: expected to threaten the economic viability through a large increase in mortality/morbidity of hosts, or a large decrease in production. Expected to severely or irreversibly damage the intrinsic 'value' of non-commercial criteria.

The estimates of the magnitude of the potential consequences over the four geographic levels were translated into a qualitative impact score (A–G)[2] using Table 2.3[3]. For example, a consequence with a magnitude of 'significant' at the 'district' level will have a consequence impact score of D.

Table 2.3 Decision rules for determining the consequence impact score based on the magnitude of consequences at four geographic scales

		Geographic scale			
		Local	**District**	**Region**	**Nation**
Magnitude	Indiscernible	A	A	A	A
	Minor significance	B	C	D	E
	Significant	C	D	E	F
	Major significance	D	E	F	G

The overall consequence for each pest is achieved by combining the qualitative impact scores (A–G) for each direct and indirect consequence using a series of decision rules (Table 2.4). These rules are mutually exclusive, and are assessed in numerical order until one applies.

[2] In earlier qualitative IRAs, the scale for the impact scores went from A to F and did not explicitly allow for the rating 'indiscernible' at all four levels. This combination might be applicable for some criteria. In this report, the impact scale of A-F has changed to become B-G and a new lowest category A ('indiscernible' at all four levels) was added. The rules for combining impacts in Table 2.4 were adjusted accordingly.

[3] The decision rules for determining the consequence impact score are presented in a simpler form in Table 2.3 from earlier IRAs, to make the table easier to use. The outcome of the decision rules is the same as the previous table and makes no difference to the final impact score.

Table 2.4 Decision rules for determining the overall consequence rating for each pest

Rule	The impact scores for consequences of direct and indirect criteria	Overall consequence rating
1	Any criterion has an impact of 'G'; or more than one criterion has an impact of 'F'; or a single criterion has an impact of 'F' and each remaining criterion an 'E'.	Extreme
2	A single criterion has an impact of 'F'; or all criteria have an impact of 'E'.	High
3	One or more criteria have an impact of 'E'; or all criteria have an impact of 'D'.	Moderate
4	One or more criteria have an impact of 'D'; or all criteria have an impact of 'C'.	Low
5	One or more criteria have an impact of 'C'; or all criteria have an impact of 'B'.	Very Low
6	One or more but not all criteria have an impact of 'B', and all remaining criteria have an impact of 'A'.	Negligible

2.2.4 Estimation of the unrestricted risk

Once the above assessments are completed, the unrestricted risk can be determined for each pest or groups of pests. This is determined by using a risk estimation matrix (Table 2.5) to combine the estimates of the probability of entry, establishment and spread and the overall consequences of pest establishment and spread. Therefore, risk is the product of likelihood and consequence.

When interpreting the risk estimation matrix, note the descriptors for each axis are similar (e.g. low, moderate, high) but the vertical axis refers to likelihood and the horizontal axis refers to consequences. Accordingly, a 'low' likelihood combined with 'high' consequences, is not the same as a 'high' likelihood combined with 'low' consequences – the matrix is not symmetrical. For example, the former combination would give an unrestricted risk rating of 'moderate', whereas, the latter would be rated as a 'low' unrestricted risk.

Table 2.5 Risk estimation matrix

Likelihood of pest entry, establishment and spread	Negligible	Very low	Low	Moderate	High	Extreme
High	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
Moderate	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
Low	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk	High risk
Very low	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk
Extremely low	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk
Negligible	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk

Consequences of pest entry, establishment and spread

2.2.5 Australia's appropriate level of protection (ALOP)

The SPS Agreement defines the concept of an 'appropriate level of sanitary or phytosanitary protection (ALOP)' as the level of protection deemed appropriate by the WTO Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory.

Australia expresses its ALOP in qualitative terms. Australia's ALOP, which reflects community expectations through government policy, is currently expressed as providing a high level of sanitary or phytosanitary protection aimed at reducing risk to a very low level, but not to zero. The band of cells in Table 2.5 marked 'very low risk' represents Australia's ALOP.

2.3 Stage 3: Pest risk management

Pest risk management describes the process of identifying and implementing phytosanitary measures to manage risks to achieve Australia's ALOP, while ensuring that any negative effects on trade are minimised.

The conclusions from pest risk assessment are used to decide whether risk management is required and if so, the appropriate measures to be used. Where the unrestricted risk estimate exceeds Australia's ALOP, risk management measures are required to reduce this risk to a very low level. The guiding principle for risk management is to manage risk to achieve Australia's ALOP. The effectiveness of any proposed phytosanitary measure (or combination of measures) is evaluated, using the same approach as used to evaluate the unrestricted risk, to ensure it reduces the restricted risk for the relevant pest or pests to meet Australia's ALOP.

ISPM 11 (FAO 2004) provides details on the identification and selection of appropriate risk management options and notes that the choice of measures should be based on their effectiveness in reducing the probability of entry of the pest.

Examples given of measures commonly applied to traded commodities include:

- options for consignments – e.g., inspection or testing for freedom from pests, prohibition of parts of the host, a pre-entry or post-entry quarantine system, specified conditions on preparation of the consignment, specified treatment of the consignment, restrictions on end-use, distribution and periods of entry of the commodity
- options preventing or reducing infestation in the crop – e.g., treatment of the crop, restriction on the composition of a consignment so it is composed of plants belonging to resistant or less susceptible species, harvesting of plants at a certain age or specified time of the year, production in a certification scheme
- options ensuring that the area, place or site of production or crop is free from the pest – e.g., pest-free area, pest-free place of production or pest-free production site
- options for other types of pathways – e.g., consider natural spread, measures for human travellers and their baggage, cleaning or disinfestation of contaminated machinery
- options within the importing country – e.g., surveillance and eradication programs
- prohibition of commodities – if no satisfactory measure can be found.

Risk management measures are identified for each quarantine pest where the risk exceeds Australia's ALOP. These are presented in the 'Pest Risk Management' section of this report.

3 China's commercial production practices for table grapes

This chapter provides information on the pre-harvest, harvest and post-harvest practices of China for table grapes considered to be commercial production practices. The export capability of China is also outlined.

3.1 Assumptions used in estimating unrestricted risk

China provided Biosecurity Australia with information on the standard commercial practices adopted in the production of table grapes in the different provinces/regions and for all the commercially-produced table grape cultivars in China. This information was complemented with data from other sources and taken into account when estimating the unrestricted risk of pests that may be associated with the import of this commodity.

Biosecurity Australia visited table grape production areas in Hebei and Xinjiang Uygur Autonomous Region of China, 14-21 September 2009 to verify pest status and vineyard pest management, and observe the harvest, processing and packing procedures for export of table grapes. Additional information provided and observations made during the visit have verified the standard practices and procedures.

Where a specific practice described in Section 3.3 is not taken into account to estimate the unrestricted risk, this has been identified and explained in Chapter 4.

3.2 Climate in production areas

The main commercial table grape growing regions of China are located mostly in the temperate north of China (Hebei, Henan, Jilin, Liaoning, Shaanxi, Ningxia Hui Autonomous Region, Shandong, Shanxi, Xinjiang Uygur Autonomous Region), with some production in the south (Yunnan) as shown in Figure 3.1. Climate data, mean maximum and minimum temperatures and mean relative humidity, for these provinces/regions of China are presented in Figure 3.2.

The climatic conditions in the main table grape growing areas in China are diverse, with hot and humid summers in the Yantze Valley in eastern China, and very dry summer conditions in Xinjiang in western China (Li 2001).

For the coastal provinces of Hebei, Shandong and Liaoning, the climate can be described as temperate, with hot and humid summers and cold wet/snowy winters. These table grape growing provinces have similar mean maximum temperatures during summer of approximately 30 °C.

The climate in Xinjiang, Liaoning and Jilin is considerably colder in winter than the other table grape growing regions. Xinjiang has hot dry summers (maximum mean temperature 30 °C, relative humidity 43% and mean rainfall 150 mm) and very cold winters (FCC 1997). Xinjiang is the driest province and has the highest number of days of snow cover followed by Jilin and Liaoning. Average winter temperatures are considerably lower in the table grape-producing regions of China than in the commercial table grape-producing regions of Australia.

The southern province of Yunnan is in the subtropical monsoon weather zone, with a high altitude resulting in an even temperature all year and a dry and wet season. The annual mean temperature range is 13–20 °C in most parts of Yunnan, and the annual difference in

temperature is only 10–15 °C (Ministry of Commerce 2009). The mean annual rainfall is above 1000 mm in the majority of the province, with 85% of the rains occurring from May to October. In the central region of Yunnan (e.g. Dali and Chuxiong) the frost-free period is 250 days per year (YFAO 2007).

Figure 3.1 Map of China showing the main grape-producing provinces and regions in blue (adapted from AQSIQ 2009). The 32 °N latitude line is the northern limit of the occurrence of *Bactrocera dorsalis* (Oriental fruit fly) in China.

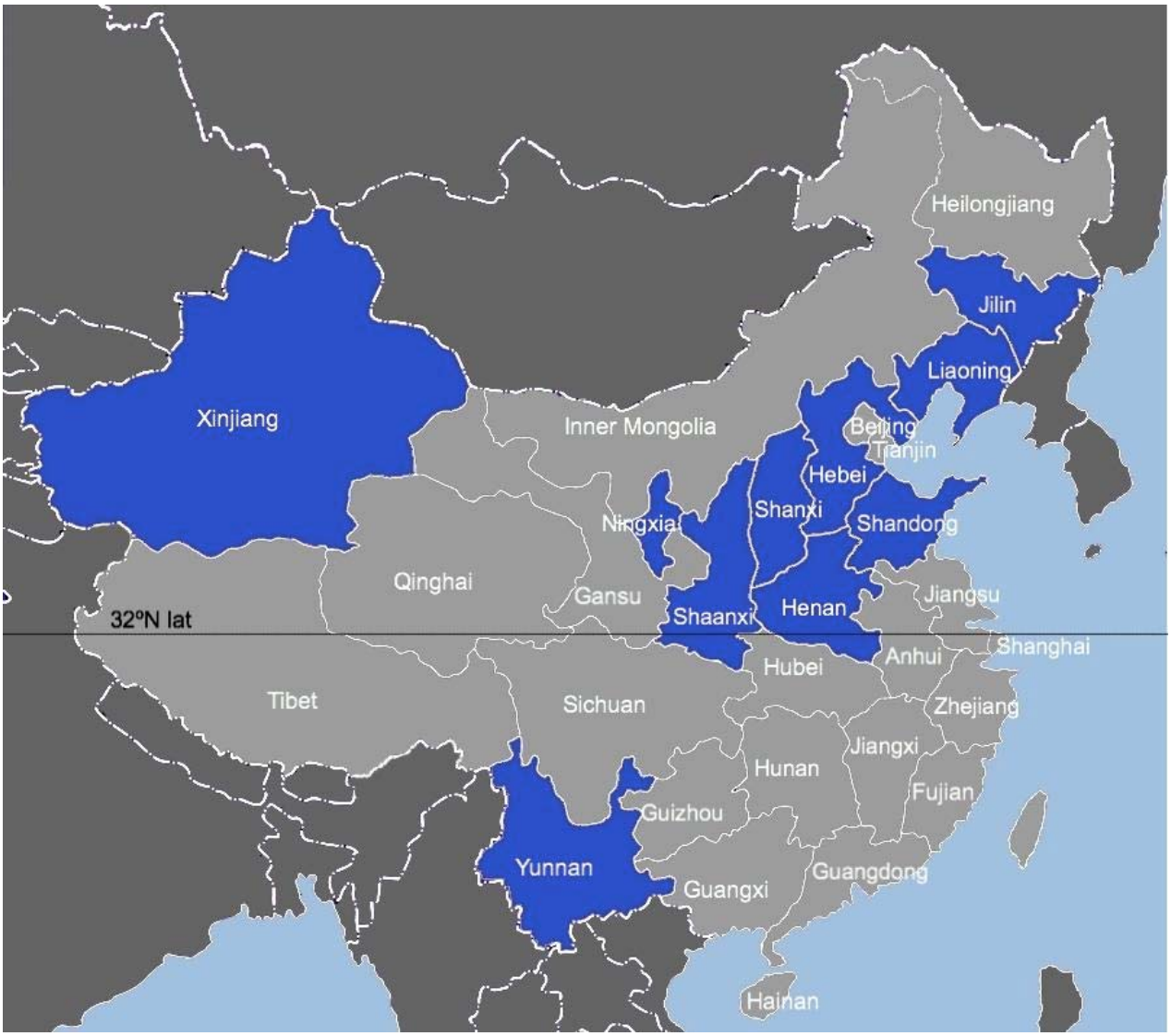
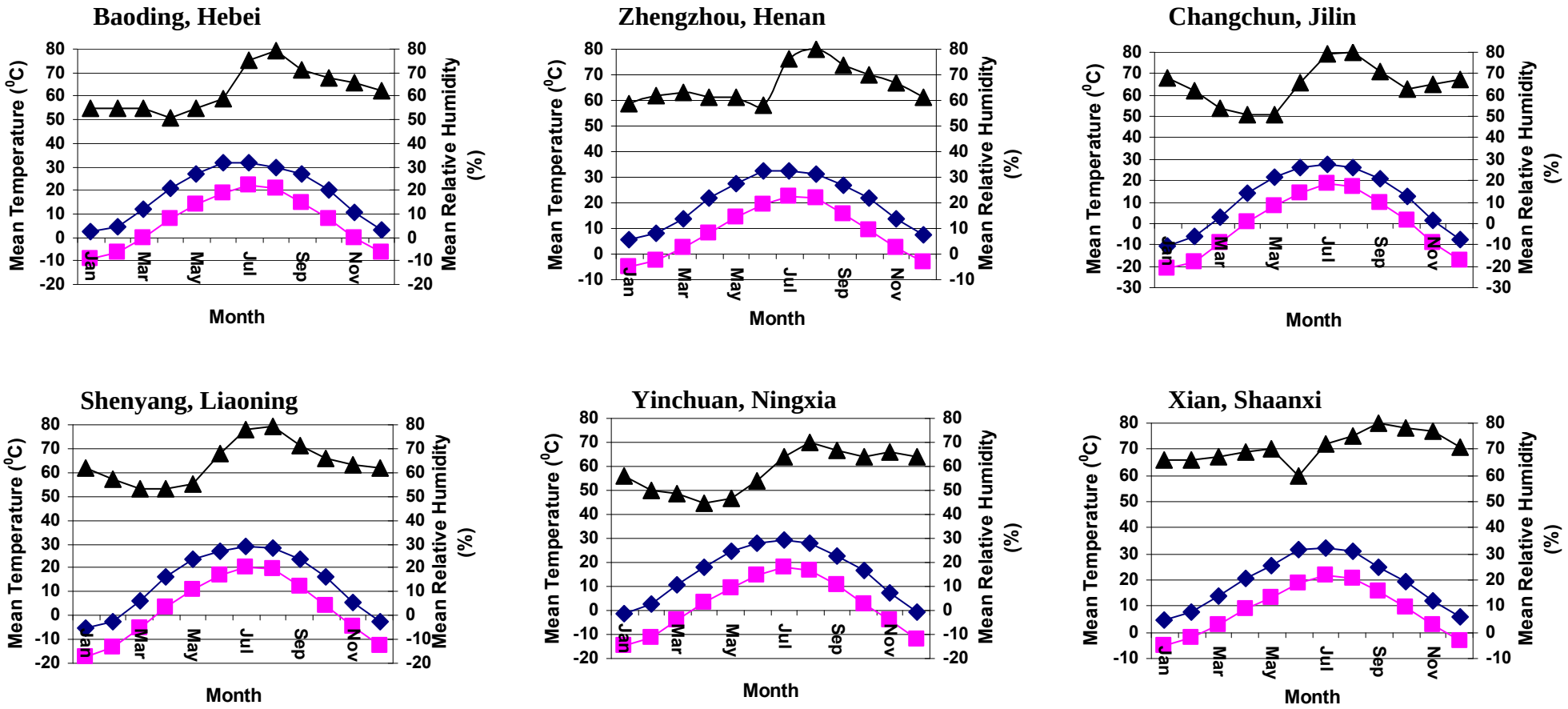
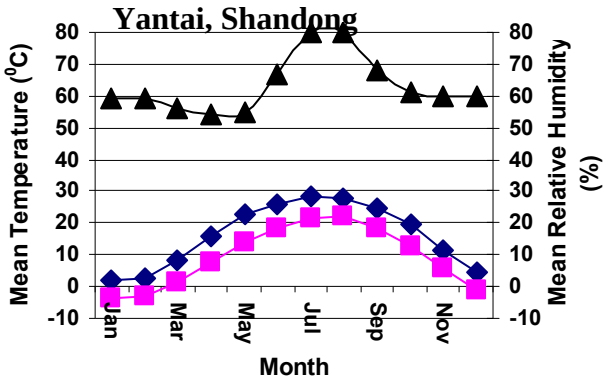
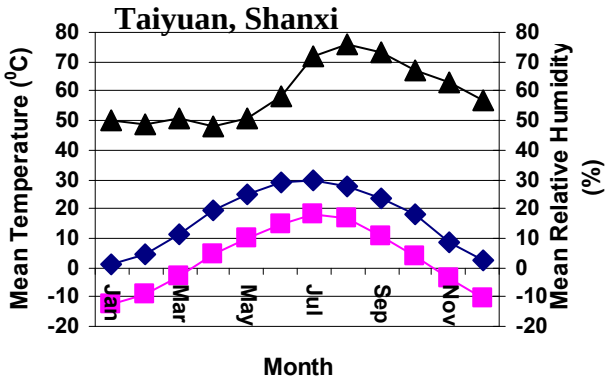
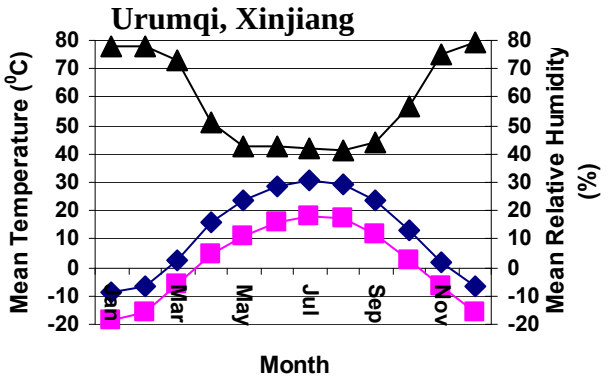


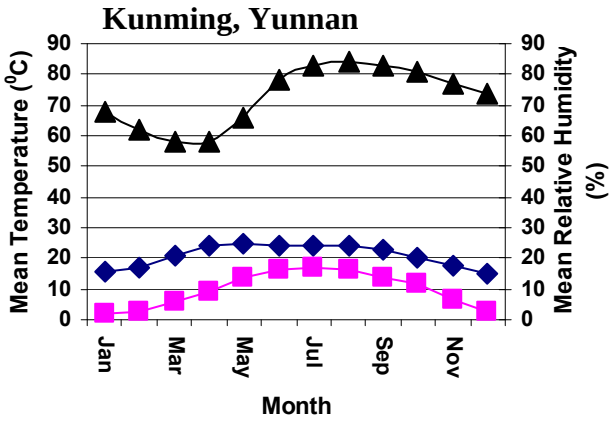
Figure 3.2 Mean maximum (—♦—) and minimum (—■—) temperatures and mean relative humidity (—▲—) in table grape-producing provinces of Hebei, Henan, Jilin, Liaoning, Ningxia, Shaanxi, Shandong, Shanxi, Xinjiang and Yunnan in China, based on average monthly weather data from 1951 to 1988











Meteorological data source (FCC 1997).

3.3 Pre-harvest

3.3.1 Cultivars

Grapes (*Vitis vinifera* L. and other *Vitis* spp.) have been grown in China for more than 2000 years (Li 2001). Grapes are grown for fresh table grapes, dried fruit and for wine production. However, commercial production of table grapes has dramatically increased since the 1960s with the introduction of major cultivars into China. Four major expansion periods can be traced to introduced cultivars: Muscat Hamburg (Meiguixang) during the 1960s, Kyoho (also known as Jufeng) in the 1980s (AQSIQ 2006) and Red Globe (Hong Ti) in the 1990s (Zhang 2005a). More recently a number of imported seedless varieties such as Crimson, Flame and Thompson, as well as a locally developed variety (Munake), have also been grown (AQSIQ 2009b).

Hundreds of local varieties are grown and although they taste good and have high domestic demand they are not as robust as introduced internationally traded cultivars that will better withstand storage and transport. These cultivars offer larger berries, longer stems, translucent flesh, non-seededness, good taste, later growing periods and longer storage capability (AQSIQ 2009c). Although approximately 70% of the table grapes grown in China are of the Kyoho (Jufeng) variety (Zhang 2005a), the intended table grape cultivars for export are Red Globe, seedless green grapes (i.e. Thompson) and seedless red grapes (i.e. Crimson and Flame) (AQSIQ 2009b).

3.3.2 Cultivation practices

Most grape planting material used in China is propagated from cuttings (Li 2001). In some cold areas, vines are grafted on cold-resistant rootstocks, such as the hybrid Beta (a probable hybrid between *Vitis riparia* and *Vitis labrusca*) and lines from *Vitis amurensis* (Li 2001).

Thorough preparation of the land is essential for the successful establishment of the vines and for their vigorous growth during the first two to three years. Trenches are dug and the soil is mixed with organic matter or other fertilisers and the improved soil is filled back into the trenches before planting the cuttings. The plant spacing used for vines varies depending on the regions and the training systems used (Li 2001) and the cultivar. For example, plant spacing along the row of 70–100 cm were common for Red Globe and 50 cm for Flame in Xinjiang (AQSIQ 2009c) and rows were 3–4 m apart. New plantings can be commercially productive within three years.

In China, dormant pruning is undertaken in late autumn or winter before growth begins. This is one of the most important aspects of vine management to obtain consistent high yields and quality fruit. One-year-old hardwood cuttings can be left as fruiting canes and cut back to 5–9 buds. If the ‘cane pruning’ technique is used there may be up to 10 buds. Summer pruning is completed during the early growing season by thinning and pinching out flowers or bunches (Li 2001). Depending on the cultivar, the branches are trimmed to a set number of bunches to encourage a high number of berries per bunch.

The table grape branches in older vineyards are trained up and over a horizontal wire trellis forming a canopy to the next row. The majority of grape bunches hang down from the branches overhead. In newer vineyards or younger vines most of the bunches are found on the vertical trellis (Figure 3.3).

Figure 3.3 Trellis systems – horizontal (left) and vertical (right)

Generally, there are three to four applications of chemical fertilisers: after bud break, at flowering, during rapid growth of young fruit, and during the maturation of the grape berries. Nitrogenous and phosphorous fertilisers are usually supplied for the first two to three applications while potash is used only at the time of berry maturation. In addition, after harvest or in late autumn animal manure is often applied in large quantities to supplement the organic matter content of the soil (Li 2001).

In northern China, for example in Xinjiang, Ningxia, Jilin and Liaoning, vines are buried during winter to insulate them from the freezing temperatures and snow (Rombough 2002). These vines consist of short trunks with one or two cordons or 'arms' that are attached to a wire. In the autumn, the cordons are dropped into trenches ripped or dug under the wires by machine and/or hand. Both the trunks and cordons are covered under mounds of soil that insulate them from the cold and snow. In spring the mounds are levelled and the cordons are hauled up and tied back onto the wires.

In most regions it is necessary to supply extra irrigation for growing vines due to China's continental climate which has hot dry or hot rainy summers, and very dry and cold winters. Normally at least two irrigations take place, one before the vines are buried during winter and the other one after bud break (Li 2001). In Xinjiang, grapevines are often totally dependent on irrigation (AQSIQ 2009c).

The bagging of the individual table grape bunches/clusters during fruit development is a relatively new practice in this industry compared to the use of bagging in apple and pear production in China. However, it has quickly become a routine practice for the commercial production of both domestic and export-quality table grapes. AQSIQ (2009c) advised that bagging will continue to be a standard practice for table grapes for export despite the labour costs involved.

Fruit bagging has a number of advantages, namely: improving berry and bunch shape; ensuring an even colour during development: preventing scorching from the sun and grape splitting: and keeping bunches clean from dust and other contaminants. Fruit bagging also offers some protection against arthropod and disease-causing pathogen pests and birds.

In regions with humid conditions and rain during development table grapes must be bagged to produce export quality, whereas in drier areas it is not so critical but considered good practice and has been adopted by all major growers.

The bagging practices appear to vary greatly, according to the grape cultivar, the climatic conditions and the geographic location of the vineyards. For example, Red Globe grapes grown in Xinjiang are usually bagged in early to mid August and the bags are removed from early to mid September (10–15 days before harvesting) (AQSIQ 2008; AQSIQ 2009c) and therefore the grapes are only covered by the bags for one month of their development. Earlier season cultivars in Xinjiang may be bagged 15–20 June when the berries are 8-10 mm and removed 10–15 August, 10–15 days before harvest in late August.

In Hebei, Red Globe grapes were bagged in mid-June when the berries were the size of a soybean or peanut, following established guidelines for bagging of export table grapes (AQSIQ 2009c). The bunches were sprayed with pesticides and fungicides prior to bagging and one bag was used per bunch. The bags were removed 10–15 days before harvest which occurs in the last week of August or the first week of September. The intensity of the berry colour (red or purple) required for the market will often determine when the bags are removed and the bunch harvested, a longer exposure to the sun producing a darker berry (AQSIQ 2009c) (Figure 3.4, right).

The removal of the bags depends not only on the variety and colouring of the berry sought, but also on the type of bag used. The bags are not always removed at once, initially the bottom end may be cut open and the bag left in place to protect the bunch from the sun and birds (as a 'hat'). Where necessary, bird nets are set up prior to the bags being removed (AQSIQ 2009c). A number of types of bags are used. The bags are certified or approved by China Entry-Exit Inspection and Quarantine Bureau (CIQ) and 100% of export table grapes are bagged. Most are plain white paper bags (37 cm x 27 cm) with open bottom corners, secured to the stalk at the top of the bunch with an in-built wire tie. Other bags include ones with clear cellophane on one side with a white paper backing (Figure 3.4), white synthetic cloth-like bags or firm plastic bags.

Figure 3.4 Grape bunches covered in paper bags (left), and a single bunch in a cellophane and paper bag (right)

Vineyards intending to export table grapes are required to be registered by CIQ and AQSIQ. The requirements include a minimum vineyard size; freedom from contaminated sources of water in the surrounding area; use of the services of plant protection officers to monitor and control pests; ability to implement the approved quality management system and comply with the import conditions between China and the importing country. The registration applications received from growers are assessed and only accepted after an initial and final verification to confirm all the requirements are fulfilled. Training of plant protection officers and growers in identification and management of pests, including fruit flies, and relevant food safety issues forms an important component in the export program (AQSIQ 2009c).

3.3.3 Pest management

The following information on pest management was provided by China (AQSIQ 2006; AQSIQ 2008; AQSIQ 2009c). All export grapes are produced in vineyards registered by CIQ. Each registered vineyard follows detailed guidelines covering pest monitoring, pest prevention and control. CIQ is also responsible for instructing and overseeing the implementation of these guidelines.

The Integrated Pest/Disease Management (IPM/IDM) programs used include a range of agronomic practices to reduce the number of arthropod and pathogen pests, namely: the application of fertiliser, irrigation, pruning and bagging; as well as physical, biological and chemical control measures.

Table 3.1 exemplifies one IPM/IDM regime for Red Globe table grapes. Bordeaux mixture, effective against downy mildew and to some extent powdery mildew, was the most commonly used spray applied prior to fruit bagging and on the bagged vines in mid-August for harvest in September (AQSIQ 2009c). Some vineyards and table grape production systems in China are recognised domestically and by some importers as meeting organic production requirements (AQSIQ 2009c).

Only approved agricultural chemicals are permitted for use on fruit and vegetables in China. Each vineyard has strict registration procedures for the use of agricultural chemicals and use of these must be supervised by technical personnel (AQSIQ 2008). In June 2009, China enacted new food safety laws that apply to food and food products for both domestic production and consumption, and for imported and exported commodities (The National People's Congress 2009). Fresh table grapes for export from China need to meet both the Chinese food safety requirements and the maximum residues limits of the importing country.

In 2000, China established a system called the National Fruit Flies Trapping Network (NFFTN) to monitor the Oriental fruit fly (*Bactrocera dorsalis*) and other economically important fruit flies throughout China. No Oriental fruit fly has ever been detected in northern China above 32 °N latitude (Figure 3.1), where the majority of the commercial table grape production is located since this trapping system commenced in 2000. Biosecurity Australia audited and verified the NFFTN in Xinjiang, Hebei, Shandong, Shaanxi, Shanxi, Gansu, Liaoning and Beijing and found that the network has been well established and maintained and complies with ISPM 26 *Establishment of pest free areas for fruit flies (Tephritidae)* (FAO 2006) and Trapping Guidelines for Area-Wide Fruit Fly Programmes (IAEA 2003).

Table 3.1 Integrated pest and disease management for the main pests of Red Globe table grapes (AQSIQ 2008)[4]

Growth Stage	Target Pest/Disease *	Preventative measure
Grape dormancy	Control various plant diseases and insects, as well as overwintering pathogens and insects	Thorough cleaning of vineyard: dry leaves and stems removed and disposed of by burning or deep burial
Bud break: after grapevine buds, pre-leaf unfold	**Powdery mildew**, downy mildew, **grapevine leaf mite**, **two-spotted spider mite**	Lime sulphur mixture (1.02 specific gravity (wt/vol))
Pre-blossoming	**Downy mildew**, grey mould	Bordeaux mixture (1:0.5:240 dilution)
Post-blossoming (after blossoms fall)	**Downy mildew, powdery mildew**, red mite, **white rot**	Bordeaux mixture (1:0.5:200 dilution) and Carbendazim (800 dilution)
Young berry formation	White rot, **powdery mildew**, red mite	Bordeaux mixture (1:1:200 dilution)
From berry hardening to initial grape colour development	White rot, **powdery mildew**, **downy mildew**	Bordeaux mixture (1:1:200 dilution)
From grape colour development to maturity	White rot, **powdery mildew**, **downy mildew**	Bordeaux mixture (1:1:200 dilution)
After harvest	Downy mildew, **white rot**, red mite	Carbendazim (800 dilution)
After leaf-fall	Various pests and diseases	Thorough cleaning of vineyard during autumn: dry leaves and stems removed and disposed of by burning or deep burial. Spray lime sulphur mixture (1.02 specific gravity (wt/vol) and 0.3% soap powder)
* Grey mould (*Botrytis cinerea*), grapevine leaf mite (*Colomerus vitis*), powdery mildew (*Erysiphe necator/Oidium* spp.), downy mildew (*Plasmopara viticola*), white rot (*Pilidiella diplodiella*) and two-spotted mite (*Tetranychus telarius*).		

3.4 Harvesting and handling procedures

Grapes do not ripen off the vine and must be harvested at optimal maturity. Timing of harvest will depend on the colour, taste and firmness of the grapes required and also on their sugar and acid content (AQSIQ 2008). For example, Red Globe grapes planted in Xinjiang are harvested when the glucose content of the berries surpasses 18%.

Chinese table grapes for export are generally harvested from August to October (AQSIQ 2008). The introduction of new varieties and Chinese-type greenhouse facilities has allowed a small proportion of grapes to be harvested before August (Zhang 2005b) and beyond the normal season in some provinces; however, most of these table grapes would be mainly for domestic supply or limited regional export.

Harvesting is generally conducted during the coolest hours of the day, in the morning after the dew or moisture has dried off or in the late afternoon when it is cool, to minimise the temperature of the harvested fruit. In Xinjiang in mid-September, picking did not commence before mid-morning and was completed in early afternoon (AQSIQ 2009c). Vines may be harvested several times according to the quality classification, including colour requirements.

During harvest, the pickers wear gloves and a bunch of grapes is held in one hand while the stalk is cut with small secateurs close to the branch. The harvested bunches are placed gently

[4] This information on integrated pest and disease management was provided by AQSIQ. Biosecurity Australia notes that the preventive measures are only effective against the target pest/disease in **bold text**.

upright in a single layer into a lined wicker basket or larger plastic crates avoiding damage to the fruit or the removal of the blush from the grapes (AQSIQ 2008; AQSIQ 2009c).

During commercial harvesting procedures undertaken in the vineyard, pickers select and harvest only sound bunches of fruit to go to the packing house. Defective (i.e. diseased, blemished, infested, small or damaged) bunches are unlikely to be selected for harvest. Inferior berries are likely to be trimmed from bunches during harvesting (AQSIQ 2008). This initial trimming occurs either when the bunch is cut from the vine or when the harvested fruit is taken to a preliminary sorting area at the vineyard where the crates are weighed and docketed identifying the picker, row, vineyard and supervisor. Where wicker baskets are used, the grape bunches are then sorted, trimmed, placed in lined plastic crates (Figure 3.5) and docketed before transport to the packing house by tractor and trailer covered by a tarpaulin or by truck (AQSIQ 2009c).

Figure 3.5 Harvesting grape bunches and preliminary sorting

3.5 Post-harvest

3.5.1 Packing house

Sorting, grading and packaging

Harvested table grapes are transported to the packing shed in a timely manner and may be stored in single layers under shade for 6–8 hours, in the packing house or in a cool room to allow them to cool down and evaporate excess moisture, prior to sorting, grading and packing (AQSIQ 2008).

Harvested table grapes are sorted according to grape size, shape and colour, total acid content and soluble solid content. The bunches are also graded according to their size, uniformity and shape (AQSIQ 2008). All graded table grape bunches must be complete and clean without plant pests or diseases, unusual odours or excessive moisture and be fully developed with vigorous and healthy fruit stalks (AQSIQ 2008).

In the packing house during routine commercial post-harvest procedures (e.g. sorting, grading, packing and quality inspection and control), inferior or defective grapes are trimmed and removed from bunches of table grapes (AQSIQ 2008). Defective grapes are downgraded

and removed by packing house staff during sorting and grading and before packing for export. These measures assist in culling fruit that is not suitable for export.

Trained sorters and packers, carefully select, trim and place grapes into cartons or trays lined with a ventilated plastic bag in a pattern that ensures good air flow and the most efficient use of space in the carton or tray (Figure 3.6) (AQSIQ 2008; AQSIQ 2009c).

Figure 3.6 Sorting and packing of table grapes

Depending on the export market requirements, grapes may be packed in retail-ready ventilated plastic bags holding 0.5–2 kg grapes per bag and placed in fibre-board cartons, plastic trays or styrofoam boxes/trays that carry 5–10 kg. Alternatively, grapes are packed directly in the trays or boxes lined with a perforated plastic bag liner. The table grape cartons, boxes or trays are marked or labelled with the name of the company, the cultivar, the name and/or registration number identifying the vineyard and packing house to ensure traceability.

Discarded fruit is removed from the sorting and packing area and may be sold locally or for processing. Unpacked and packed fruit are kept separate in different ends of the packing house. The packed product is stored in a clean environment during pre-cooling and cold storage (AQSIQ 2008).

Pre-cooling storage

Packed table grapes are rapidly cooled before cold storage. Cold rooms used for this purpose are disinfected and pre-cooled to -2 ºC for 3 to 5 days to decrease the room temperature ahead of table grape storage (AQSIQ 2006). Pre-cooling temperatures depend on the variety of table grape and range from -2 ºC for Red Globe to -1 ºC for Kyoho grape and to -0.5 ºC for Munake and seedless white grapes. The pre-cooling rapidly reduces the fruit temperature close to the required storage temperature and lasts for a period of 12–24 h in a fan-forced cold room environment (Figure 3.7 (left)). However it may be as quick as 1–2 h under an automated pre-cooling unit for packed fruit (Figure 3.7 (right)) which runs at -2 ºC to 0 ºC and draws down the ambient fruit temperature quickly and effectively

and avoids the development of moisture (AQSIQ 2009c). When the fruit is pre-cooled sufficiently the boxes/trays are fitted with a sulphur pad and the lid before moving to cold storage facilities. Packing houses use sulphur pads sourced from Chile, South Africa or China to minimise the development of storage rots (AQSIQ 2009c).

Figure 3.7 Cold room fan-forced pre-cooling (left) and automated pre-cooling unit (right)

Storage

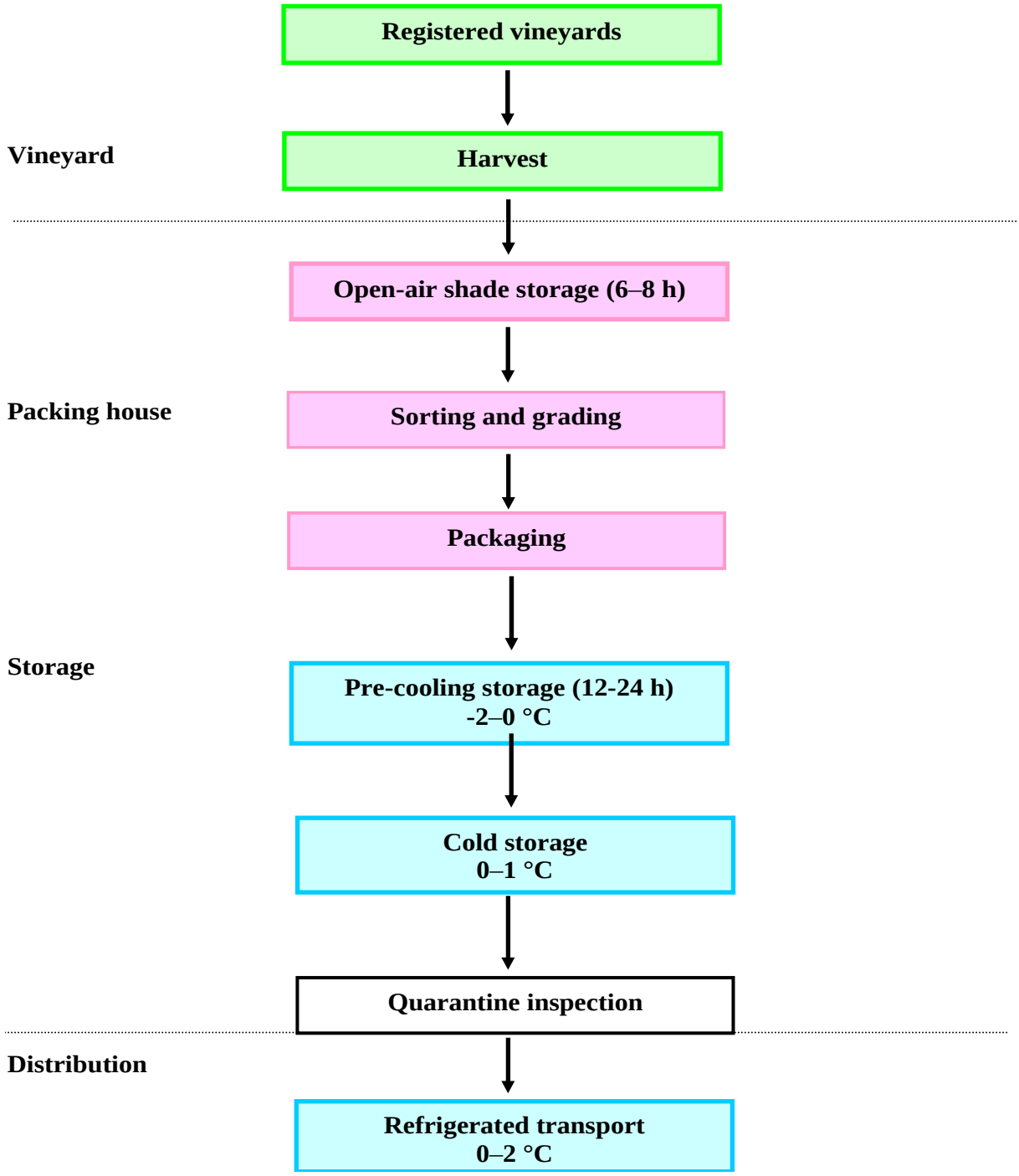
Commercial cold storage conditions for table grapes depend on the table grape cultivars, and range from 0.5 ºC to 1 ºC for Red Globe and Kyoho grapes and 0 ºC to 0.5 ºC for Munake and seedless white grapes. All varieties are stored under a relative humidity of 85% to 95% (AQSIQ 2008).

The storage conditions are monitored and recorded on a regular basis to guarantee they are kept within the allowable temperature ranges (AQSIQ 2006).

Cool chain management is essential during the transport of table grapes from the vineyard to the customer to ensure their quality is maintained (AQSIQ 2008).

Figure 3.8 summarises the post-harvest packing house, storage and distribution steps for Chinese table grapes produced for export.

Figure 3.8 Summary of vineyard and post-harvest packing house, storage and distribution steps for table grapes grown in China for export – adapted from AQSIQ (2008; 2009c)



3.5.2 Export procedures

Packing houses have quality control systems in place for each batch of table grapes and conduct self-inspections. CIQ inspects packing houses to ensure these systems adhere with domestic requirements and export conditions. Only grapes that meet the requirements of the importing countries are certified and will be issued with a Phytosanitary Certificate for export by CIQ (AQSIQ 2006).

3.5.3 Transport

The clearance and loading of packed table grapes into transportation containers follows strict operating guidelines. The containers must be clean and must only transport table grapes for export. The table grapes are transported in refrigerated containers by rail or road from the production areas to China's major ports for export by sea (AQSIQ 2006; AQSIQ 2008).

Grapes packed for export to Australia from the most distant parts of western Xinjiang will take approximately 4–7 days by road to reach the nearest seaport in Guangdong Province in the south of China (AQSIQ 2009c). Grapes packed in Hebei, Shandong and Liaoning in eastern China have closer access to the seaports of Tianjin, Qindao and Dalian, respectively. Depending on the port of departure and arrival it can take 2–6 weeks (14–42 days) for general sea freight from China to Australia (China Australia Shipping 2008). Sea transport from China to Australia for perishable fresh horticultural commodities is usually 2–3 weeks. Grapes could potentially be air freighted from China to Australia within about a week after harvest. After transit by air or sea freight, which could take from one to three weeks, table grapes from China are likely to arrive in Australia from August to November (AQSIQ 2009c).

3.6 Export capability

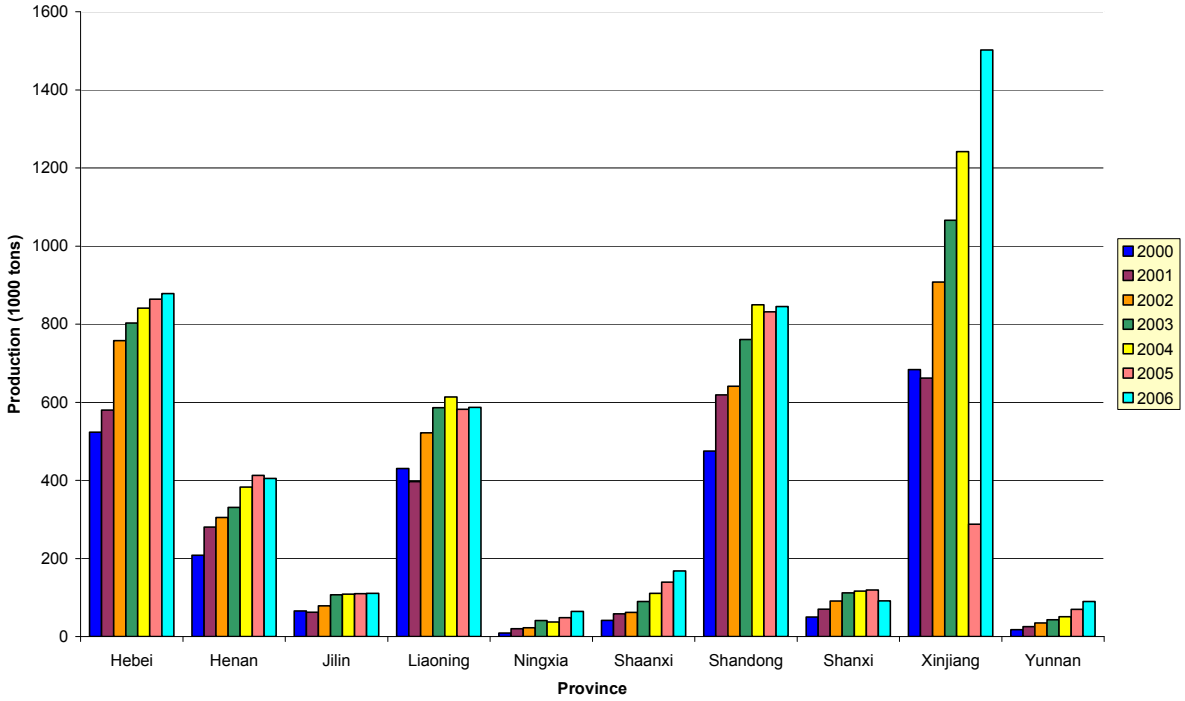
3.6.1 Production statistics

China's total area of grape cultivation (table and wine grape) covers approximately 490 000 hectares, with a total production of 7.3 million tonnes of grapes per year. China ranks sixth in the world in terms of growing area and fifth in terms of production volume (AQSIQ 2009c). China uses 8.3% of its grapes for production of raisins or sultanas and is the fourth largest producer in the world (AQSIQ 2009c).

Although grapes are grown locally throughout China (ABARE 2006), the main commercial table grape production areas in China are Xinjiang, Shandong, Hebei and Liaoning, followed by Shanxi, Shaanxi, Jilin, Henan, Yunnan and Ningxia (Figure 3.1). Xinjiang accounts for 38.5% of the total table grape yield in China and Shandong produces 16.2% (AQSIQ 2006; AQSIQ 2009b). In Xinjiang in 2006, 52% of grapes were used for dried fruit, 40% for fresh table grapes and 8% for wine. Since that time there has been a big increase in new production areas of table grapes (AQSIQ 2009c). Presently in the south, Yunnan has a production area greater than 1333 hectares with 23 Red Globe vineyards registered for export in the regions of Chuxiong, Hongue and Dali, located west, south-west and north-west of Kunming, respectively (AQSIQ 2009c).

Figure 3.9 summarises the production of grapes in the main table grape producing provinces/regions from 2000 to 2006 (USDA 2007).

Figure 3.9 Grape production in the main table grape producing provinces/regions in China, 2000–2006 in US tons (USDA 2007)



3.6.2 Export statistics

China is the world's largest producer of table grapes accounting for nearly one third of world production. Average annual growth rate of table grape production in China is reported to be 42% (Magenta Consulting Limited 2008). The top five consumer countries of table grapes are China, Turkey, USA, Italy and Chile (Magenta Consulting Limited 2008).

The majority of table grapes produced in China are sold in its domestic market. Exports have increased from less than 1000 tonnes in 2001 to almost 14 000 tonnes in the period 2001–2003 (ABARE 2006) and in 2008/2009 were expected to reach 72 000 tonnes (USDA 2009a).

The main destinations for China's grape exports have been neighbouring countries and south-east Asia. China is beginning to target some key markets for their grape exports including the European Union, the Middle East, South Africa, Russia, Singapore, Hong Kong, Thailand, Malaysia, Vietnam and Pakistan (AQSIQ 2009b; AQSIQ 2009c).

The growth of China's exports in such a short period of time may be attributed to not only the improved quality of Chinese table grapes, but also the investments in infrastructure that have resulted in a more efficient supply chain (ABARE 2006).

3.6.3 Export season

Table grapes for export are harvested in China and exported usually between August and October each year depending on the cultivar and geographical location (AQSIQ 2008).

There may be potential for the export season to commence before or be extended beyond these three months; however, this is the anticipated export season advised by AQSIQ under current practices.

4 Pest risk assessments for quarantine pests

Quarantine pests associated with table grapes from China are identified in the pest categorisation process (Appendix A1). This chapter assesses the probability of the entry, establishment and spread of these pests and the likelihood of associated potential economic consequences.

Pest categorisation identified 28 quarantine pests associated with table grapes from China. Of these quarantine pests, 23 pests are of national concern and five are of regional concern. In addition, pest categorisation identified two venomous spiders as pests of sanitary concern (Appendix A2). Table 4.1 identifies these quarantine and sanitary pests and full details of the pest categorisation are given in Appendix A. Assessments of risks associated with these pests are presented in this chapter. Pests are listed according to their taxonomic classification, consistent with Appendix A and Appendix B.

Table 4.1 Quarantine pests for table grapes from China.

Pest	Common name
Spider mite (Trombidiformes: Tetranychidae)	
Tetranychus kanzawai [WA]	Kanzawa spider mite
Ladybird (Coleoptera: Coccinellidae)	
Harmonia axyridis	Harlequin ladybird
Weevil (Coleoptera: Rhynchitidae)	
Merhynchites sp.	Grape berry weevil
Beetle (Coleoptera: Scarabaeidae)	
Popillia japonica	Japanese beetle
Popillia mutans [EP]	Scarab beetle
Popillia quadriguttata [EP]	Chinese rose beetle
Fruit fly (Diptera: Tephritidae)	
Bactrocera dorsalis [EP]	Oriental fruit fly
Midge (Diptera: Cecidomyiidae)	
Cecidomyia sp.	Grape midge
Whitefly (Hemiptera: Aleroydidae)	
Aleurolobus taeonabe	Grape whitefly
Phylloxera (Hemiptera: Phylloxeridae)	
Daktulosphaira vitifoliae	Grapevine phylloxera
Armoured scale (Hemiptera: Coccidae)	
Parthenolecanium corni [EP, WA]	European fruit lecanium scale
Parthenolecanium orientalis	Scales
Mealybugs (Hemiptera: Pseudococcidae)	
Planococcus kraunhiae [EP]	Japanese mealybug
Pseudococcus comstocki [EP]	Comstock's mealybug
Pseudococcus maritimus [EP]	Grapevine mealybug
Moths (Lepidoptera: Tortricidae)	
Eupoecilia ambiguella	European grape berry moth

Pest	Common name
Moths (Lepidoptera: Pterophoridae)	
Nippoptilia vitis	Grape plume moth
Moths (Lepidoptera: Stathmopdidae)	
Stathmopoda auriferella [EP]	Apple heliodinid
Thrips (Thysanoptera: Thripidae)	
Frankliniella occidentalis [EP, Tas., NT]	Western flower thrips
Rhipiphorothrips cruentatus [EP]	Grapevine thrips, Rose thrips
Fungi	
Physalospora baccae	Grape cluster black rot
Greeneria uvicola [WA]	Bitter rot
Guignardia bidwellii	Black rot
Alternaria viticola	Spike stalk brown spot
Monilinia fructigena [EP]	Brown rot
Phakopsora euvitis	Grapevine leaf rust
Phomopsis viticola [EP, WA]	Phomopsis cane and leaf spot
Viruses	
Tobacco necrosis viruses	
Sanitary Pests	
Latrodectus mactans [EP]	Black widow spider
Latrodectus tredecimguttatus [EP]	European black widow spider

Pest risk assessments were done to determine whether the risk posed by each pest exceeds Australia's ALOP and thus whether phytosanitary measures are required to manage the risk. Pest risk assessments already exist for some of the pests considered here as they have been assessed previously by Biosecurity Australia. Two types of existing pest risk assessments are considered in this IRA report.

- The first type is where there may be a change to the likelihood of entry (importation and/or distribution) from previous assessments due to differences in the commodity and/or country assessed (for example, Oriental fruit fly, apple heliodinid, western flower thrips and phomopsis cane and leaf spot).
- The second is where the assessments were carried out before the introduction of Biosecurity Australia's current risk assessment method (for example, black rot and brown rot). In this case, the pest is re-assessed according to the current method.

The two types of assessments are reflected in the introduction and layout of the risk assessments that follow. In this IRA the superscript '**EP**' is used for pests that have previously been assessed and a policy already exists.

Some pests identified in this assessment have been recorded in some regions of Australia, and due to interstate quarantine regulations are considered pests of regional concern. These organisms are identified with a superscript, such as '**NT**', '**Tas.**' or '**WA**', for the state for which the regional pest status is considered.

The unrestricted risk estimate (URE) for each quarantine pest is based on the assumption that table grapes are produced for export without fruit bagging. Biosecurity Australia considers

there may be situations either currently or in the future where the practice of bagging may not be consistent, feasible or commercially viable. This approach is consistent with that taken on previous and current IRAs on apples and pears from China and other countries where fruit bagging is used. This approach also ensures consistency in the assessment of similar pests on table grapes between IRAs in countries where bagging is not used.

Grapes harvested, packed, stored and transported for export to Australia may need to travel variable distances to ports. Depending on the port of departure and arrival it can take 2–6 weeks for general sea freight from China to Australia (China Australia Shipping 2008). Sea transport from China to Australia for perishable fresh horticultural commodities is usually 2–3 weeks. Grapes could potentially be air freighted from China to Australia within about a week from harvest. While the unrestricted risk assessments undertaken in this IRA do not impose any mandatory measures during storage and transport, common commercial practices may impact on the survival of some pests. If these conditions are applied to all consignments for a minimum period of time, then those conditions can be considered as part of the unrestricted risk assessment. As the minimum period in storage and transport after harvest is likely to be around one week, with an optimal cool chain temperature of 0–2 ºC, the impact of these conditions on pests has been broadly but conservatively considered.

Grapevine seed germination and seed-transmitted pathogens

Biosecurity Australia considered the possibility that certain seed-transmitted viruses and viroids might be transmitted from seed in imported table grapes, if the seed germinates.

Australia regulates the importation of seed of *Vitis* sp. Imported grapevine seed that does not have an acceptable Phytosanitary Certificate is treated, grown in Quarantine Approved Premises and tested for seed-borne viruses before it is released.

China proposes to export fruit of seeded and seedless table grape cultivars (See section 3.3.1). If trade is permitted, Biosecurity Australia assumes that some viable grapevine seed from fruit consumed by the public will be discarded into natural and unmanaged environments.

In general, grapevines are cultivated vegetatively, being propagated from cuttings by grafting onto rootstock or, less commonly, on their own roots (Zohary 1996). Seed is not used to establish vineyards because vines propagated from seed are likely to produce inferior berries; they are unlikely to be true to type after genetic segregation (Zohary 1996). This aspect of grapevine propagation is likely to deter members of the public from growing grapevines from seed from imported fruit, as will the relatively long time taken to grow a productive vine from seed (Olmo 1976) and the ready availability of grafted vines.

The proportion of grapevine seed that germinates depends on the cultivar, seed maturity, storage, stratification and planting conditions (Doijode 2001). Most grapevine seed is dormant and will not germinate unless it has been stratified. Successful stratification is usually achieved by storing seed at 0–5 °C for two months or longer (Ellis *et al.* 1985; Doijode 2001). Seed of some cultivars will not germinate without stratification, other cultivars have very low germination rates when not stratified, but germination rates of up to 33% from seed from fresh untreated berries of some cultivars has been reported (Scott and Ink 1950; Singh 1961; Forlani and Coppola 1977).

Germination of some untreated seed is reported to be slow and some seedlings grown from untreated seed are stunted (Scott and Ink 1950; Mamarov *et al.* 1958). However, grapevine seedlings sometimes occur in vineyards (Office of the Gene Technology Regulator 2003). In Europe, volunteer grapevines grow as weeds in small numbers. Most of these weedy vines are

probably rootstocks that have escaped vegetatively or have grown from seed, although some may be escaped cultivars of *Vitis vinifera* that have grown from seed (Zohary 1996; Arrigo and Arnold 2007; Ocete *et al.* 2008). Some *Vitis* spp. native to the USA, including the fox grape (*Vitis labrusca*), are invasive in the USA (Buckstrup and Bassuk 2000).

During winter months, alpine areas in NSW and Vic. are consistently cooler than 6 °C (Bureau of Meteorology 2010) and therefore discarded seed could cool sufficiently for stratification. However, no reports were found of *Vitis* spp. growing as weeds in these cooler areas of Australia, nor were reports found of *Vitis* spp. being naturalised or invasive in any area of Australia (Hnatiuk 1990). The absence of reports of naturalised and weedy grapevines in Australia suggests that conditions do not favour germination or survival of *Vitis* spp.

A small proportion of seed from table grapes may germinate but the available evidence indicates that the seedlings do not survive. The risk that seed-transmitted pathogens might be transmitted from seed in imported table grapes was considered to be very small, in view of information about grapevine seed germination and propagation and the absence of evidence of grapevines in the Australian environment except where cultivated. This information was taken into account when categorising seed-transmitted viroids and viruses that may be associated with table grapes from China. Pest risk assessments were not conducted for these viruses and viroids.

4.1 Kanzawa spider mite

Tetranychus kanzawai [WA]

Tetranychus kanzawai is not present in the state of Western Australia and is a pest of regional quarantine concern for that state.

Tetranychus kanzawai, the kanzawa spider mite, belongs to the spider mite family, Tetranychidae (Migeon and Dorkeld 2006; CABI 2009). Spider mites are given this name as they often spin characteristic protective silk webs (Zhang 2008). *Tetranychus kanzawai* is one of the most common spider mites in the entire East Asia region (Takafuji and Hinomoto 2008).

Tetranychus kanzawai is a serious pest on a variety of agricultural crops and is most abundant in East and Southeast Asia (Ehara 1963; Bolland *et al.* 1998; Zhang 2003).

There are five stages in the life cycle of spider mites: egg, larva, two nymphal stages (protonymph and deutonymph) and adult (Zhang 2008). Adult females of *T. kanzawai* are dark red with bodies 0.51 mm long and 0.31 mm wide (CABI 2009). Unfertilised eggs develop into males, while fertilised eggs develop into females (Shih 1979). The proportion of females in a population averaged between 0.76 and 0.83. The sex ratio is determined by the genotype and age of the mother. Four-day-old females produced only females, while 15-day-old females produced only males (Shih 1979; Takafuji and Ishii 1989). Some overwintering populations consist of 100% females (Takafuji *et al.* 2007).

In Fuzhou, China, populations of *T. kanzawa* on strawberries peaked in late December and mid-February and reached outbreak proportions at the end of the growing season (Zhang *et al.* 1996b; CABI 2009). Females tend to oviposit in a localised area, with most of the eggs produced during a peak period of a few days (Shih 1979).

The average generation time was 15.4 days at 27 °±2 ^{o}C and 65±3.0% relative humidity (RH). The preoviposition period was 0.9±0.5 days. The intrinsic rate of increase is 0.38 eggs/female/day, while the net reproductive rate is 44.64 females/female/generation (Shih *et al.* 1978). At 35 °C and 60% RH, the generation time was 6.2±0.4 4 days. The average number of eggs laid was 7.18±1.56 per day, while the oviposition period was 9.65±1.53 days. At 15 °C and 80% RH, the mites have a generation time of 27.49±2.33 days and the mean number of eggs laid per day was 2.04±0.55, while the oviposition period was 28.4±4.06 days. The optimal developmental temperature is considered to be between 25 °C and 30 °C (Cao *et al.* 1998).

The developmental threshold temperatures for the egg, protonymphal and deutonymphal stages were 13.9, 12.6 and 12.6 °C, respectively, and the corresponding temperature sums for development 39.2, 21.4 and 18.2 day-degrees C (Tsai *et al.* 1989). A preliminary study on mature, *T. kanzawai* showed they could survive up to 10 days at -1 ^{o}C to -5 ^{o}C (Yang *et al.* 1991).

In Japan, populations of *T. kanzawai* had a strong diapause capacity on all host species. They expressed more than 90% diapause at 15 °C in the four main islands of Japan, whereas the populations on the Okinawa islands further south exhibited a very low incidence or no diapause (Takafuji *et al.* 2001; Takafuji *et al.* 2003). Geographic variation in diapause capacity among populations of *T. kanzawai* has been observed (Takafuji and Hinomoto 2008).

On hydrangea (*Hydrangea macrophylla*) in Japan two different seasonal population trends occur: one with a single peak occurrence between May and June, and the other with a spring peak in June and an autumn peak in September–October. Each year the populations declined abruptly just after the spring peak, possibly due to the change in secondary compounds in plants (CABI 2009). Studies on strawberry gardens in China showed that eggs and active stages are aggregated (Zhang *et al.* 1996b). The incidence of plant infestation may be as high as 90–100%, with the number of mites on each leaf reaching 2000–3000 (Zhang *et al.* 1996a).

Tetranychus kanzawai constructs complicated webs over the surface of a leaf and usually lives under these. In addition to predator avoidance *T. kanzawai* uses the webs as a place for refuge. It secretes pellets that repel predators on leaf surfaces (Oku 2008). In the presence of a predator, a significantly greater proportion of *T. kanzawai* females entered the quiescent stage (inactive adult) on webs than on leaves (Oku *et al.* 2003). Furthermore, significantly more females survived on webs than on leaves. In contrast, significantly fewer males guard females on webs, resulting in less opportunity to mate (Oku *et al.* 2003). The positive correlation between leaf hair traits (hair height and hair density) and host plant acceptance by *T. kanzawai* suggests that leaf hairs provide a refuge from predators for the females (Oku *et al.* 2006). Life history parameters of grape-adapted and bean-adapted populations of *T. kanzawai* were studied on grape and bean leaves and have found that beans are a better host than grapes, but the intrinsic rate of natural increase of grape-adapted population was higher than that of the bean-adapted population on grape (Kondo *et al.* 1987).

Tetranychus kanzawai was found in very low numbers in vineyards in Taiwan, where *T. urticae* Koch was the major spider mite found. *Tetranychus kanzawai* were found on grape clusters in eight out of 10 surveyed vineyards. Ten percent of grape clusters were infested, but the density was low, with only 0.63 mites per cluster. The percentage of grape berries infested with mites was 0.4% (Ho and Chen 1994). Experimental inoculation of unripe berries with *T. kanzawai* resulted in the mites either dying before development into the next instars or running away. Inoculating ripe berries led to mites being able to feed, develop and reproduce (Ho and Chen 1994). The population density varied considerably between grape cultivars (Ashihara 1996). High developmental success was observed on Muscat Bailey A (*Vitis labrusca* x *V. vinifera* x *V. linsecumii*) and Delaware (*V. labrusca* x *V. vinifera* x *V. aestivalis*) cultivars. On Kychou (*V. vinifera* x *V. labrusca*) 25% of larvae developed to adults, on Muscat of Alexandria (*V. vinifera*) only 2% , while none were observed on Neo Muscat (*V. vinifera*) and Campbell Early (*V. labrusca* x *V. vinifera*) (Ashihara 1996).

The risk scenario of concern for *T. kanzawai* is the presence of eggs, nymphs or adults on the peduncle, pedicel, or grape berry in the grape cluster.

4.1.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Probability of importation

The likelihood that *T. kanzawai* will arrive in Western Australia with the importation of table grapes from China is: **HIGH**.

Supporting information for this assessment is provided below:

- *Tetranychus kanzawai* is found in most of the grape growing areas (Anhui, Fujian, Jiansu, Jiangxi, Jilian, Liaoning, Shaanxi, Shandong, Shanghai and Zhejiang) of China (Yang *et*

al. 1991; Zhang *et al.* 1996b; Cao *et al.* 1998; EPPO 2006b; Takafuji and Hinomoto 2008; CABI 2009). There is no evidence of official control measures in place to prevent its spread to other provinces.

- Most Chinese table grapes for export are likely to be sourced from Xinjiang (38.5% of production area), Liaoning (7–15%) and Shandong (16.2%) (AQSIQ 2006; AQSIQ 2009b).
- *Tetranychus kanzawai* can feed, develop and reproduce on ripe grape berries (Ho and Chen 1994).
- *Tetranychus kanzawai* is a serious pest of greenhouse grapevines in Japan (Ashihara 1995).
- On strawberries in China, the incidence of plant infestation may be as high as 90–100%, with the number of mites on each leaf reaching 2000–3000 (Zhang *et al.* 1996a). In contrast, in a survey of grapes in Taiwan, 10% of grape clusters were infested with a low density of mites per cluster.
- The small size (0.52 mm by 0.31 mm) (CABI 2009) of the organism and the possibility of low levels of infestation make it possible that they will be missed by a standard grading and packing process.
- The population density can vary considerably between grape cultivars (Ashihara 1996), with mites on some cultivars showing high developmental success.
- A preliminary study on mature *T. kanzawai* showed they could survive up to 10 days at -1 ^{o}C to -5 ^{o}C (Yang *et al.* 1991). This suggests that adults and nymphs may be able to survive under cold storage and transport.
- *Tetranychus* species are regularly intercepted on horticultural commodities at the border in Australia, New Zealand and other countries (Brake 2003; PDI 2003; MAF Biosecurity New Zealand 2009).

The mite's ability to feed, develop and reproduce on ripe grape berries, their small size and the wide distribution of this species throughout China, all support a risk rating for importation into Western Australia of 'high'.

Probability of distribution

The likelihood that *T. kanzawai* will be distributed within Western Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **MODERATE**.

Supporting information for this assessment is provided below:

- Packed grapes are usually not processed or handled again until they arrive at the retailers, as grapes are easily damaged through rough handling and impacts due to their thin skins (Mencarelli and Bellincontro 2005). Therefore, any pests or pathogens in the packed grapes are unlikely to be detected during transportation and distribution to retailers.
- A preliminary study on mature *T. kanzawai* showed they could survive up to 10 days at -1 ^{o}C to -5 ^{o}C (Yang *et al.* 1991). This suggests adults and nymphs inside packages of grapes would be able to survive cold storage.

- Grapes will be distributed throughout Western Australia for retail sale as the intended use is human consumption and waste material would be generated (e.g. infested grapes). The majority of cold store facilities, grape retailers and consumers are located in metropolitan and suburban areas.
- Individual consumers may distribute small quantities of grapes to urban, rural and wild environments. Pedicels, peduncle and uneaten berries will be thrown away. If these are discarded near hosts, it is assumed that adults would be able to move off the discarded grapes and infest nearby hosts.
- *Tetranychus kanzawai* adults and nymphs may be found within bunches of packed grapes and are likely to travel to their destination without being detected. This pest may enter the environment as adults and nymphs discarded with infested grapes.
- *Tetranychus kanzawai* has 160 known hosts (Migeon and Dorkeld 2006). Major hosts include citrus, grapevine, hydrangea, peach and strawberry, which are widely grown in Western Australia. Furthermore, *T. kanzawai* occurs not only on cultivated plants but also on wild ones (Oku *et al.* 2002a).
- Juveniles (nymphs) might complete their development to adults on discarded grapes and adults and possibly juveniles might disperse to other nearby plants.
- Spider mites disperse predominantly within and between host plants through crawling (Kennedy and Smitley 1985). Adult female spider mites can also be carried on air currents. While there is the potential for long range transport on wind currents, aerial dispersal is generally initiated at high population densities and is entirely passive once airborne (Kennedy and Smitley 1985). Most mites fall out of the air currents fairly soon after they are carried aloft (Kennedy and Smitley 1985). Ballooning does not occur in *T. kanzawai* (Yano *et al.* 2003). The probability of mites on discarded grape waste locating a suitable host would be reduced when the short dispersal range by crawling is considered.

The evidence that adults and nymphs may be distributed on grape bunches, the ability of adults and nymphs to survive cold storage and the wide host range of the mite, moderated by the limited distance the mite could disperse by crawling from discarded waste, support a risk rating for distribution in Western Australia of ‘moderate’.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *T. kanzawai* will enter Western Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **MODERATE**.

4.1.2 Probability of establishment

The likelihood that *T. kanzawai* will establish within Western Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **HIGH**.

Supporting information for this assessment is provided below:

- *Tetranychus kanzawai* has 160 known hosts (Migeon and Dorkeld 2006). Major hosts are groundnut, tea, papaw, citrus, soybean, strawberry, peach, apple, cherry, aubergine,

watermelon and grapevine (Migeon and Dorkeld 2006; Moon *et al.* 2008; CABI 2009), which are found in Western Australia. The species is highly polyphagous, and occurs on host plants of various taxa (Takafuji *et al.* 2000; Oku 2008). *Tetranychus kanzawai* also depends on wild host plants and there are frequent exchanges of individuals (mites) between crops and wild hosts (*Clerodendrum*, *Akebia*, *Trifolium* and *Hydrangea*) (Takafuji and Morishita 2003; Takafuji and Hinomoto 2008).

- *Tetranychus kanzawai* can reproduce sexually and by parthenogenesis (asexually) (Kondo and Takafuji 1985; Oku *et al.* 2002b).
- *Tetranychus kanzawai* has the capability to increase their population 2.3 or 10–16 fold weekly at 20 ^{o}C or 30 ^{o}C, respectively (Ho 2000). The intrinsic rates of natural increase (r_m) varied largely from 0.187/day to 0.283/day (depending upon hosts) (Gotoh and Gomi 2003), which also indicates that it has good adaptive capacity.
- If populations established from a large number of individuals, the high fecundity could result in significant genetic diversity (Gotoh and Gomi 2003), thus increasing the potential for adaption. Spider mites rapidly adapt to new host plants, even plants that are considered resistant to mites (Gould 1979).
- The optimal temperature for their development is considered to be within 25–30 ^{o}C (Cao *et al.* 1998). So, a warm and humid climate would favour the development of high population densities of this mite in Australia.
- Potential establishment of *T. kanzawai* is supported by the knowledge that other species of *Tetranychus* are established in Western Australia and *T. kanzawai* is already established in New South Wales and Queensland (CSIRO and DAFF 2004c).
- *Tetranychus kanzawai* population is also reported to develop resistance to pesticides quickly (Ho 2000; Kondo 2004). Acaricide resistance is a serious problem, with regional variation in resistance levels (Ho 2000). In Japan, most of the spider mite populations have become notably less susceptible to acaricides (Kondo 2004). Therefore, controls for other mites may not prevent establishment.
- Spider mite populations are usually kept low by predators, either natural or introduced (Ohlendorf 2000). Suitable natural enemies may be present in Australia, but their potential impact is unknown. *Tetranychus kanzawai* constructs webs over leaf surfaces and usually lives under these webs. *Tetranychus kanzawai* produces two types of excreta, black and yellow pellets, and uses its webs as a place for excreta. *Tetranychus kanzawai* also uses its webs as refuge when predatory mites are present and use its yellow pellets to reduce the risk of predation (Oku 2008). This behaviour gives it some defence against predators.
- The use of pesticides can result in an increase in spider mite populations as the predators are often more susceptible to pesticides than the pests (Ohlendorf 2000) and spider mites can develop resistance to pesticides (Ho 2000; Kondo 2004). In the absence of suitable predators, spider mite populations could increase rapidly in Western Australian vineyards or orchards or the environment.

The mite has already established in parts of Australia, is reproducing on a wide variety of host plants in Australia and has the capability to increase its population rapidly, supporting a risk rating for establishment in Western Australia of ‘high’.

4.1.3 Probability of spread

The likelihood that *T. kanzawai* will spread within Western Australia, based on a comparison of factors in the source and destination areas that affect the expansion of the geographic distribution of the pest, is: **MODERATE**.

Supporting information for this assessment is provided below:

- *Tetranychus kanzawai* has been reported from a variety of environments including North America (Mexico), Africa (South Africa), Asia (China, India, Japan, Korea, Thailand, Indonesia) and Oceania (Australia, Papua New Guinea) (Migeon and Dorkeld 2006; CABI 2009). There are similar environments in warmer parts of Western Australia that would be suitable for their spread.
- *Tetranychus kanzawai* is able to survive in both cooler (Jilian, Liaoning, Shaanxi, Shandong) and warmer (Fujian, Hongkong, Jiangsu, Jianxi, Zheijiang) areas in China (Migeon and Dorkeld 2006; CABI 2009).
- Higher fecundity rates and reduced development times have been reported with increasing temperatures and humidities (Cao *et al.* 1998). Additionally, *T. kanzawai* undergoes a reproductive diapause mainly induced by short-days and low temperatures (Takafuji *et al.* 2007). The comparatively warmer Western Australian environment may therefore provide a larger choice of suitable habitats for the *T. kanzawai* to expand its current host range in Australia.
- The long distances between some commercial vineyards, orchards and production areas in Western Australia may make it difficult for the spider mite to disperse unaided from one production area to another.
- Wind-assisted aerial dispersal is an important mechanism for spread within and between adjacent vineyards or orchards or through urban areas (Takafuji and Hinomoto 2008).
- The polyphagous nature of this species may enable it to locate suitable hosts in the intervening areas, particularly towns or suburban areas (Takafuji *et al.* 2000; Oku 2008).
- There is little information on the ability of this spider mite to spread naturally beyond natural barriers such as deserts or mountain ranges.
- Due to the small size of *T. kanzawai* and limited capacity for independent dispersal by natural means, it is likely that the natural rate of spread of this spider mite in Western Australia would be relatively slow.
- *Tetranychus kanzawai* may infest leaves, peduncles, pedicels and grape berry and may be associated with nursery stock or amenity trees in addition to commercial crops. Movement of infested nursery stock or other plants would be an important mechanism for long distance spread.
- Existing interstate quarantine control on the movement of nursery stock and other plant material could reduce the rate of spread between states, but would be of limited use within states where control measures may not be applied.
- Spider mites may also contaminate the clothing of vineyard workers, machinery and other equipment associated with horticultural production in Australia, providing additional opportunities for spider mites to spread within vineyards or orchards or long distances between vineyards or orchards.

The wide host range and polyphagous nature, moderated by the limited mobility of the mites, support a risk rating for spread in Western Australia of 'moderate'.

4.1.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *T. kanzawai* will enter Western Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Western Australia and subsequently spread within Western Australia is: **LOW**.

4.1.5 Consequences

The consequences of the establishment of *T. kanzawai* in Western Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**E**', the overall consequences are estimated to be **MODERATE**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score:** E – Significant at the regional level. *Tetranychus kanzawai* is known as one of the most injurious mite species to various agricultural crops (Gomi and Gotoh 1996; Gotoh and Gomi 2000) and is recognised as an agricultural pest requiring control measures (Ho *et al.* 1997; Ho 2000; Takafuji *et al.* 2000; Kondo 2004). It is rated as a pest of economic concern in Japan, Korea, Taiwan and China, where it can damage the leaves and the fruit of the host plant (Zhang *et al.* 1996b; Ho *et al.* 1997; Ho 2000; Takafuji *et al.* 2000; Ohlendorf 2000; Kondo 2004). Spider mites in large numbers may deplete nutrients from the host plant to such an extent as to cause severe damage, resulting in very heavy production losses and even death of the plant (Cheng 2007). Groundnut, tea, papaw, citrus, soybean, strawberry, peach, apple, cherry, aubergine, watermelon and grapevine (Migeon and Dorkeld 2006; Moon *et al.* 2008; CABI 2009) are all reported as commercial hosts. *Tetranychus kanzawai* also feeds on wild host plants and there are frequent exchanges of individuals between crops and wild hosts (C*lerodendrum*, *Akebia*, *Trifolium* and *Hydrangea*) (Takafuji and Morishita 2003; Takafuji and Hinomoto 2008). C*lerodendrum* and *Trifolium* are present in Western Australia (FloraBase 2009a; FloraBase 2009b).
Other aspects of the environment	**Impact score:** B – Minor at the local level. There are no known direct consequences of this species on the natural or built environment but its introduction into a new environment may lead to competition for resources with native mite species. Loss in plant vigour and the potential for defoliation of amenity plants may have perceptible effects in urban areas.
Indirect	
Eradication, control etc.	**Impact score:** D – Significant at the district level. Indirect consequences of control or an eradication program as a result of the introduction of *T. kanzawai* may be: (i) an increase in the use of acaricides for control of the pest due to difficulties involved in estimating optimum times for application; (ii) disruption to IPM programs due to the increased need to use acaricides. Numerous acaricides have been recommended to control this particular spider mite and resistance to acaricides has also been reported (Ho 2000; Kondo 2004); (iii) additional applications of costly pesticides that may alter the economic viability of some crops; (iv) increases in control measures and impacts on existing production practices; (v) some of the reported natural enemies of spider mite such as the phytoseiid mite *Neoseiulus fallacis*, predatory thrips and ladybird beetles (*Stethorus* species) which are present in Australia are adversely affected by acaricides/pesticides (Azam 2002); (vi) subsequent increases in costs of production to producers; (vii) increased costs for crop monitoring and consultative advice to producers.

Criterion	Estimate and rationale
Domestic trade	**Impact score: C** – Significant at the local level. If *T. kanzawai* became established in Western Australia it is likely to result in some intrastate trade restrictions on many commodities such as apples, citrus, peaches, cherries, strawberries, watermelons and table grapes. This could lead to loss of markets or additional costs to manage the pest on the commodity.
International trade	**Impact score:** D – Significant at the district level. The presence of *T. kanzawai* in commercial production areas on a wide range of horticultural commodities (e.g. apples, cherries, strawberries, peaches, table grapes, citrus) may limit access to overseas markets where the pest is not present (e.g. Canada, UK, Italy, Germany, France, Chile, and Spain) (Migeon and Dorkeld 2006). The pest is widely present in Japan, Korea, India, Taiwan and Thailand (Migeon and Dorkeld 2006; CABI 2009). However, measures are available to mitigate spider mite and it is not expected that the pest would result in a complete loss of markets, rather for increased costs to treat and inspect for the pest.
Environmental and non-commercial	**Impact score:** B – Minor significance at the local level. Additional pre-harvest pesticide applications would be required to contain and/or eradicate the pest and control them on susceptible crops. However, this is unlikely to impact on the environment to any greater extent than already occurs from run-off into waterways from commercial crops due to control measures for other pests.

4.1.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Tetranychus kanzawai*	
Overall probability of entry, establishment and spread	**Low**
Consequences	**Moderate**
Unrestricted risk	**Low**

As indicated, the unrestricted risk estimate for *T. kanzawai* of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.2 Harlequin ladybird

Harmonia axyridis

Harmonia axyridis, known as the harlequin ladybird, is a relatively large lady beetle (5-8mm long) with characteristic oval convex shape. Patterning is highly variable, the elytra can be light orange, red to black and marked with 0 to 19 spots (Komai and Chino 1969; Ker and Carter 2004). Pronotum of the adult is often marked with a black 'W" or 'M' (Ker and Carter 2004).

The natural range of *H. axyridis* includes China from the northeast to the Himalayas, Japan, Korea and eastern Russia (Siberia) (Komai and Chino 1969; Koch 2003; Su *et al.* 2009). *Harmonia axyridis* is associated with a wide range of arboreal (broadleaf and conifer) and herbaceous habitats (Ker and Carter 2004; Koch *et al.* 2006).

Harmonia axyridis is a voracious predator of plant pests, especially aphids and other soft bodied insects and has been released as a classical bio-control agent in North America (Koch 2003) and Europe (Brown *et al.* 2008a). It has become established in many countries indicating its potential as an invasive species. These include USA, Canada and Mexico (Koch *et al.* 2006), Argentina and Brazil in South America (de Almeida and da Silva 2002), and Austria, Belgium, France, Netherlands, Germany, Greece, Italy, Luxemburg, Switzerland, United Kingdom in Europe (Roy and Roy 2008; Brown *et al.* 2008a). It is also spreading eastwards, and is now present in Poland, Serbia, Hungary, Romania, Slovakia and the Ukraine (EPPO 2009). It is thought by some that founders of the established populations of *H. axyridis* in North America came on a ship from Japan (Potter *et al.* 2005).

Life history of *H. axyridis* is typical of coccinelids. It consists of the egg stage, four larval instars, pupae and adult. Eggs are oval, 1.2 mm long, yellow and are laid in clusters of about 20 on leaves or stems of host plants. A female can lay up to 3000 eggs at a rate of about 25 a day. Eggs hatch in 3 days at 26 °C, larvae are initially black, elongate with tubercles, and as they grow the tubercles get more marked with orange. Larvae are 2 mm long at hatching and 7.5 to 11 mm long when fully grown. At 26 °C, the larval stage lasts about 14 days. Larvae pupate exposed on a leaf or stem. Adults can live for up to 3 years (Koch 2003). In much of Asia, Europe and America, *H. axyridis* has two generations a year, but four or five are possible (Koch 2003).

Harmonia axyridis overwinters as an adult. In response to temperature, day-length and food availability, adults migrate to hibernation sites, which include natural sites such as cracks in rock faces and man-made sites such as buildings (Koch 2003; Potter *et al.* 2005; Koch and Smith 2008; Huelsman *et al.* 2010). In the autumn, buildings can be invaded by large numbers of beetles, causing distress and inconvenience to occupants (Potter *et al.* 2005). Exposure to these beetles can cause a range of allergenic responses (Sharma *et al.* 2006; Goetz 2009). In spring, beetles mate and disperse to feeding sites in search of prey (Koch 2003).

In the USA in autumn, *H. axyridis* adults are reported to congregate in large numbers on late season fruit (e.g. apples, pears, grapes, raspberries) to feed, especially on damaged fruit as invertebrate food becomes scarce (Kovach 2004; Galvan *et al.* 2006; Koch and Smith 2008). It is recognised as a pest of fruit including grapes (Kovach 2004; Galvan *et al.* 2006). They can move deep into bunches of grapes and burrow into individual grapes, from which they are difficult to remove (Koch 2003; Roy and Roy 2008). This is a particular concern in vineyards for producing wine grapes as beetles may be crushed along with grapes during processing.

The contamination produces an undesirable taint known as 'ladybug taint', which is bottle stable and resistant to common wine fining agents (Pickering *et al.* 2006; Pickering *et al.* 2008).

The risk scenario of concern for *H. axyridis* is the transportation of adult and possibly larvae and pupae in bunches of table grapes.

4.2.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Probability of importation

The likelihood that *H. axyridis* will arrive in Australia with the importation of table grapes from China is: **HIGH**.

Supporting information for this assessment is provided below:

- *Harmonia axyridis* appears to be widely distributed in China. In northern China, it is recorded from a wide range of habitats, including orchards, natural forests and vegetable gardens (Su *et al.* 2009).
- Adult *H. axyridis* can live up to 3 years (Koch 2003; Weeden 2009) and are likely to survive journey times from China, even if these are extended.
- *Harmonia axyridis* overwinters as adults and is able to survive severe winters of northeast Asia and northeast North America. In Japan, hibernating beetles are known to survive temperatures as low as -16 °C (Koch 2003; Potter *et al.* 2005). Cool conditions used in the storage and transportation of grapes will reduce beetle activity and are likely to extend the lifespan of beetles.
- Adult and larvae of *H. axyridis* will range over a grapevine in search of prey. Adults are attracted to ripe fruit and will feed on damaged grape berries in autumn as invertebrate food becomes scarce. Large numbers may be present on crops at harvest and they may also be attracted to bins of picked grapes (Kovach 2004; Galvan *et al.* 2006). Surveys of grape growers in Ohio indicated that 50% of growers had problems with *H. axyridis* feeding on grapes prior to harvest (Kovach 2004). Laboratory tests indicated that the beetle preferred to feed at sites of previous damage, though this was not exclusive (Kovach 2004).
- Commercial harvest and processing procedures mean that visibly damaged berries and obvious insects may be removed. However, the risk remains that individual beetles may remain within bunches, especially where berries are tightly packed. *Harmonia axyridis* have been reported as being difficult to remove from bunches of grapes (Koch 2003; Kovach 2004). Recommendations to harvest grapes at cool times of day and processing and packing grapes under cool conditions are likely to reduce activity of individual beetles and decrease the likelihood that they are detected.
- *Harmonia axyridis* has been recorded arriving alive in New Zealand in ya pears imported from China (MAF Biosecurity New Zealand 2009).

The wide distribution of *H. axyridis* in China, its preference for grapes and its ability to survive cold storage and transport support a risk rating for entry of 'high'.

Probability of distribution

The likelihood that *H. axyridis* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **HIGH**.

Supporting information for this assessment is provided below:

- Packed grapes are usually not processed or handled after packing until they arrive at retail outlets, as they are easily damaged. Adult beetles are long-lived and are likely to survive the transportation and storage of grapes from place of importation to retail sale. Cool conditions are likely to cause beetles to be inactive and stay with the commodity to the point of sale or consumption, where they may warm to ambient conditions and become active again. Once active, beetles may fly to find suitable habitat and prey.
- Grapes will be distributed for retail sale to the general community throughout Australia. The majority of the imported grapes are likely to be sold in metropolitan, suburban and regional centres.
- *Harmonia axyridis* is a generalist predator of soft-bodied insects such as aphids, scales, psyllids and mealybugs (Koch 2003; Koch *et al.* 2006). It is likely that suitable prey items will be available close to the point of sale and consumption of table grapes, for example plants grown in gardens (especially vegetables), street and fruit trees and weeds.
- Grapes are likely to be consumed in urban, suburban, rural and natural settings where vegetation infested by a variety of soft bodied insects (aphids etc.) that are suitable prey for *H. axyridis* are likely to be present. Lady beetles are generally seen by members of the community as beneficial insects and the presence of an individual on fresh produce such as grapes is unlikely to cause alarm or concern, and may be intentionally released if found by a consumer.

The likely distribution of the grapes throughout Australia under cold conditions and the ability of *H. axyridis* to survive and then fly to seek suitable habitats, supports a risk rating for distribution of ‘high’.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *H. axyridis* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **HIGH**.

4.2.2 Probability of establishment

The likelihood that *H. axyridis* will establish within Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **HIGH**.

Supporting information for this assessment is provided below:

- Adult *H. axyridis* are long-lived, generalist predators capable of flight and able to efficiently search for and find suitable prey. Individual females can lay up to several thousand eggs and these are laid daily in small batches over weeks or months (Koch

2003). It is possible that a viable population could develop from the progeny of a single fertilised female.

- In Europe and North America where *H. axyridis* has recently become established, it is known to out-compete and displace native coccinellids and other predatory arthropods (Ware and Majerus 2008; Koch and Galvan 2008).
- In East Asia, *H. axyridis* is native to areas with a temperate climate. It can survive in areas with warm to hot summers and cold winters, e.g. Siberia, Beijing and northeast China (Koch *et al.* 2006; Su *et al.* 2009). In North America it is established in regions with temperate (NE USA), Mediterranean (California) and sub-tropical climates (Florida) (Koch *et al.* 2006). It is widely established in temperate areas of central and western Europe and is spreading into the Mediterranean region (Brown *et al.* 2008a; EPPO 2009). Much of non-arid southern Australia has climates similar to areas where this insect has recently become established. This includes most areas where table grapes are grown and all the areas where wine grapes are grown.

The availability of pest species and the recent establishment of *H. axyridis* in countries and areas with a wide range of climates and environments support a risk rating for establishment of 'high'.

4.2.3 Probability of spread

The likelihood that *H. axyridis* will spread within Australia, based on a comparison of factors in the source and destination areas that affect the expansion of the geographic distribution of the pest, is: **HIGH**.

Supporting information for this assessment is provided below:

- Following introduction and establishment in North America and Europe, *H. axyridis* has demonstrated its ability to spread rapidly. By 1994, *H. axyridis* had become widely distributed in the continental USA following the initial discovery of established populations in Louisiana in 1988. Rate of spread was estimated to have been up to 442 km per year through a mixture of natural dispersal and human mediated movement (Koch *et al.* 2006). From its initial discovery of in northeast France in 2004, *H. axyridis* had, by 2008, spread to the Mediterranean coast, about 800 km to the south (Ternois 2009), indicating a rate of spread of up to 200 km per year. In the UK, between 2004 and 2006, *H. axyridis* spread northwards and westwards by an average of 58 km and 144 km per year, respectively (Brown *et al.* 2008b).
- *Harmonia axyridis* is a long-lived generalist predator capable of flight and self-dispersal through residential, agricultural (e.g. horticultural, viticulture, fruit trees) and forested areas. Spread may be halted or moderated in arid zones (e.g.southwest USA) where suitable prey species may be rare or patchy when compared with the well wooded northeast of the USA (Koch *et al.* 2006). Its ability to survive in natural habitats in Australia remains untested, but given its generalist nature as a predator it is highly likely it would find sufficient food in woodland, forest and rainforest in eastern and southern Australia.
- *Harmonia axyridis* is likely to be spread by the transportation of domestically produced horticultural produce. Overwintering adults are also likely to be moved about while concealed within furniture, household effects and other goods.

The evidence of rapid spread of *H. axyridis* in North America and Europe supports a risk rating for spread of 'high'.

4.2.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *H. axyridis* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **HIGH**.

4.2.5 Consequences

The consequences of the establishment of *H. axyridis* in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**E**', the overall consequences are estimated to be **MODERATE**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score:** C - Minor significance at the district level. *Harmonia axyridis* is a pest of fruit production and in autumn adults congregate on fruit trees (grapes, apples, raspberries) and will feed on ripe fruit, especially if damaged (Kovach 2004; Galvan *et al.* 2006; Koch and Galvan 2008). *Harmonia axyridis* is a predator of a wide range of hemipteran pests (aphids, scales, psyllids and mealybugs) some of which are important crop and forestry pests (Koch 2003; Koch and Galvan 2008). The likely damage to fruit on occasions is moderated by the beneficial effect of reducing the numbers of some pest species.
Other aspects of the environment	**Impact score**: D- Significant at the district level. In the USA and Europe, *H. axyridis* is thought to have a widespread undesirable impact on native biodiversity by preying upon and displacing native coccinellids, other predatory arthropods and other non target non pest biota in natural and man-made habitats. It appears to have become the main predator of aphids in the areas it has invaded (Majerus *et al.* 2006; Mizell, III 2007; Kenis *et al.* 2008; Ware and Majerus 2008; Pell *et al.* 2008).
Criterion	**Estimate and rationale**
Indirect	
Eradication, control etc.	**Impact score:** D - Significant at the district level. In Minnesota USA, estimates of the cost to eliminate *H. axyridis* from wine grapes at harvest range from US$50/acre (US$123/ha) for an IPM program comprising spraying with carbaryl, sampling and physical removal of remaining beetles, to US$270/acre (US$667/ha) for washing of all grapes with no other measures. The figures represent a 2 to 11% addition to production costs (Galvan *et al.* 2006). *Harmonia axyridis* is a generalist predator and has the potential to become widely established in a wide range of habitats including plantations and natural forest. If this was to happen, it is unlikely that control or eradication would be possible. Eradication of a small incursion may be possible using appropriate control measures and quarantine and would likely be costly and disruptive.

Criterion	Estimate and rationale
Domestic trade	**Impact score:** E - Significant at the regional level. *Harmonia axyridis* could become an important contaminating pest of wine grapes harvested in Australia as it has become in parts of the USA. Adult *H. axyridis* harvested along with grapes can be crushed. Contaminated juice is tainted by the chemical 2-isopropyl-3-methoxypyrazine, which is produced by the beetle as an alerting signal and an aggregation pheromone. The taint, known commercially as 'ladybug taint', is bottle stable and is resistant to common wine fining agents (Pickering *et al.* 2006; Pickering *et al.* 2008). In the USA, untrained tasting panels indicate that consumers can detect and will reject lady beetle tainted wine over untainted wine (Ross and Weller 2007). The impact of such rejection on the value of wine, especially in 'premium' products, would be considerable. In eastern USA and southern Canada, the taint is thought to have done 'millions of dollars' of damage to wine production (Galvan *et al.* 2006). The value of Australian wine produced in the 2007/08 season was $4.77 billion (ABS 2009c), of which $2.1billion was sold locally. Even a small reduction in value of domestically consumed product could have a significant impact. For example, a 3% reduction on average returns could equate to a $60 million reduction in domestic earnings. This figure does not include knock-on effects on related sectors such as tourism and hospitality. The presence of *H. axyridis* on grapes, other fruit and horticultural produce in general may result in interstate restrictions being placed on the movement of such goods resulting in loss of markets.
International trade	**Impact score:** D - Significant at the district level. The presence of *H. axyridis* on grapes, other fruit and horticultural produce may limit or restrict access of such goods into overseas markets and/or require additional measures to be undertaken. The international reputation of Australian wines could be affected as a result of the presence of 'ladybug taint' and export earnings could be reduced. In 2007/08, the value of exports of Australian wine was $2.68 billion (ABS 2009c). Even a small reduction in value of exported product due to taint could have a significant impact on export earnings. For example, a 3% reduction on average returns could equate to an $80 million reduction in export earnings.
Environmental and non-commercial	**Impact score:** E - Significant at the regional level. Additional pesticide applications may be required to control *H. axyridis* in vineyards and other fruit crops. This is problematic, as applications will need to occur close to harvest and issues could arise with meeting maximum residue limits and customer contracts. In autumn, *H. axyridis* invades buildings, including domestic residences in large numbers to find a place to overwinter. In parts of the USA, householders have reported that they are unable to leave properties without being covered with beetles (Koch and Galvan 2008; USDA 2009c; Huelsman *et al.* 2010). In Ohio USA, individual houses have become the preferred overwintering sites for *H. axyridis* (Huelsman *et al.* 2010). This invasion of large number of beetles causes distress and disruption, in addition to costs and inconvenience associated with entry, prevention, pest control and cleaning. The problem is worst during autumn at the time of invasion and in the spring when insects become active again (Huelsman *et al.* 2010). In addition, they are known to be a nuisance at outdoor catering events, sometimes swarming over people and food (Weeden 2009; Huelsman *et al.* 2010). Adult *H. axyridis* are known to bite and scratch when handled. Tests show that the bite is sufficiently strong to pierce the skin (Kovach 2004) and the beetles are attracted to blood or wounds. Adult *H. axyridis* can, if handled, crushed or alarmed, exude a foul smelling yellow orange body fluid. If the beetles are present in buildings during cooler months, these secretions can permanently stain curtains, furnishings and other personal items (Potter *et al.* 2005; USDA 2009c). Foul odour, staining, biting and food contamination were issues of most concern to affected Ohio residents (Huelsman *et al.* 2010). Exposure to this body fluid and beetles can cause a range of allergenic responses in some individuals, including allergic rhinoconjunctivitis, asthma, pruritus, urticaria, angioderma and anaphylaxis (Sharma *et al.* 2006; Goetz 2009). In a survey of allergy prevalence in West Virginia, USA, it was estimated that 10% of respondents had experienced 'ladybug allergy' (Goetz 2009). In Ohio, USA a survey of property owners affected by this insect saw 13% of respondents report allergic reactions with 6% confirmed by a doctor (Huelsman *et al.* 2010). Some cases reported in children have been severe and have required emergency department management (Davis *et al.* 2006). In addition, acute corrosion of oral mucosa has been caused in domestic dogs that had eaten adult *H. axyridis* (Stocks and Lindsey 2008). Overwintering *H. axyridis* can invade beehives where they can be a nuisance to bee keepers but they are not known to be harmful to the bees (Koch 2003).

4.2.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Harmonia axyridis*	
Overall probability of entry, establishment and spread	**High**
Consequences	**Moderate**
Unrestricted risk	**Moderate**

As indicated, the unrestricted risk estimate for *H. axyridis* of 'moderate' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.3 Grape berry weevil

Merhynchites sp.

Merhynchites sp., the grape berry weevil (Li 2004), has not yet been named. It belongs to the tooth–nosed snout weevil family, Rhynchitidae, which can be distinguished from other beetles by its long proboscis, called a snout, and mouth parts modified to allow it to chew into flower heads. Rhynchitidae are also known as leaf and bud weevils, as some species lay eggs in young fruit or buds of trees, which are then destroyed during larval feeding; other species feed on blossoms or foliage (McNamara 1991).

This *Merhynchites* sp. has only been recorded in north Shanxi province in China (Li 2004; AQSIQ 2009b) and table grapes (*Vitis vinifera*) and Amur grapes (*Vitis amurensis*) are the only known hosts of this weevil (Li 2004; AQSIQ 2009b).

Merhynchites sp. has four life stages; egg, larva, pupa and adult. Adults and larvae damage the fruit and young seeds of grapes. Adults are 3.4–4 mm long and 1.72 mm wide and emerge from the soil from June to late August. After emergence, adults feed on the skin and pulp of grapes for a period of time before mating. Eggs are laid in the grape seeds at a rate of one egg per seed. The eggs are oval and 0.5 mm long and 0.3 mm wide. The egg-laying hole on the fruit is covered by a brown secretion above the surface of the fruit. Eggs hatch after 5–7 days and larvae feed on the young grape seed. The larvae are 4–5 mm long and without legs (Li 2004; AQSIQ 2009b). When disturbed, adults either pretend to be dead and fall onto the ground or during the warm weather they fly away (Li 2004).

From mid-July to mid-September, mature larvae chew through the grape pulp and skin and leave the berries (Li 2004). This occurs mainly at night and the larval emergence hole is clearly visible on the berry. Larvae normally leave the fruit before the fruit is ripe (AQSIQ 2009b). Mature larvae fall to the ground and burrow 10–20 mm deep into the soil. If the soil is dry, larvae may burrow deeper. Larvae overwinter in an underground cell (Cranshaw *et al.* 1994; AQSIQ 2007). From early or mid-June onwards, they form pupae 3.4–4 mm long. Pupation last 9–12 days and early emerged adults will temporarily stay in the soil and wait until grapevines flower. Adults then gradually emerge. *Merhynchites* sp. has one generation per year (Li 2004; AQSIQ 2007; AQSIQ 2009b).

The risk scenario of concern for *Merhynchites* sp. is the presence of developing larvae in seeded grapes.

4.3.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Probability of importation

The likelihood that *Merhynchites* sp. will arrive in Australia with the importation of table grapes from China is: **LOW**.

Supporting information for this assessment is provided below:

- The grape berry weevil, *Merhynchites* sp., is only found in a small area in the north of Shanxi province in China (Li 2004; AQSIQ 2007; AQSIQ 2009b). There is no evidence of official control measures in place to prevent its spread to other provinces.
- Most Chinese table grapes for export are likely to be sourced from Xinjiang (38.5% production area) and Shandong (16.2% production area) (AQSIQ 2006; AQSIQ 2009b).
- In Shanxi, adult grape berry weevil adults emerge from the soil from June to late August and are 3.4–4 mm in length and visible to the naked eye (Li 2004).
- Adults feed for a period of time before mating. They feed on the skin and pulp of grapes by chewing a hole in the surface of young grape berries, which turns dark brown and areas near the hole become slightly concave. The grapes shrivel when infested (Li 2004).
- When disturbed, adults either pretend to be dead and fall to the ground, or fly away in warm weather. (Li 2004).
- Adult females lay their eggs in young grape seeds at a rate of one egg per seed. The total number of eggs each female can lay is unknown. The egg laying hole on the fruit is sealed by a brown secretion that is visible above the surface of the fruit (AQSIQ 2009b). Larvae emerge after 5–7 days (Li 2004; AQSIQ 2007).
- AQSIQ (2008; 2009b) reported that *Merhynchites* sp. larvae feed and damage young seeds (i.e. seeds which are not lignified) inside the grape berry and that *Merhynchites* sp. larvae are not common in ripe grapes.
- In grapes, lignification occurs in seeds after the seeds have released abscisic acid to initiate berry ripening (Cooperative Research Centre for Viticulture 2005). As berries start to ripen, the seeds become lignified and hard. *Merhynchites* sp. larvae may be uncommon in ripening and ripe grapes as they are unable to feed on the harder, older seeds.
- The grapes infested with larvae remain small and are inedible (AQSIQ 2009b). Serious larval damage results in the grape berries falling from the vine (Li 2004).
- In China, table grapes for export are harvested and exported usually between August and October each year depending on the cultivar and geographical location (AQSIQ 2008). In Shanxi, late developing larvae may be in harvested grapes during this time. However, in 2006, only 1.4% of China's total grape production came from Shanxi (USDA 2006).
- Defective (e.g. diseased, blemished, infested, small, damaged) grapes may be downgraded and removed by pickers/trimmers and packing house staff during harvesting, sorting and grading, and before packing for export.
- Late developing larvae inside table grapes may be able to survive cold storage before and during transportation as *Merhynchites* sp. overwinter as larvae (AQSIQ 2007).

The larvae mainly feeding on young grape seeds in immature fruit, leading to conspicuous berry damage that results in removal of infested fruit from the pathway and the distribution of this species restricted to northern Shanxi, support a risk rating for importation of 'low'.

Probability of distribution

The likelihood that *Merhynchites* sp. will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **LOW**.

Supporting information for this assessment is provided below:

- Packed grapes are usually not processed or handled again until they arrive at the retailers as grapes are easily damaged through rough handling and impacts due to their thin skins (Mencarelli and Bellincontro 2005). Therefore, any pests or pathogens in the packed grapes are unlikely to be detected during transportation and distribution to retailers.
- Since *Merhynchites* sp. larvae are found within the grape berry, packed grapes infested with *Merhynchites* sp. larvae are likely to travel to their destination without being detected. This pest may enter the environment as larvae discarded with infested grapes.
- Grapes will be stored at optimum temperature and relative humidity conditions to ensure quality is maintained.
- Larvae inside table grapes may be able to survive cold storage before and during transportation and distribution as *Merhynchites* sp. overwinter as larvae in Shanxi. This suggests that temporary cold storage may not be effective in killing larvae inside grapes.
- The majority of cold store facilities, grape retailers and consumers are located in metropolitan and suburban areas. Grapes will be distributed to these areas in Australia for retail sale as the intended use is human consumption. Individual consumers may distribute small quantities of grapes to urban, rural and wild environments where they will be consumed or disposed of.
- Grapes infested with larvae remain small and inedible (AQSIQ 2009b). It is expected that during commercial transport, storage and distribution some table grapes will be discarded as waste. Some discarded grapes may end up close to the soil.
- In China, mature larvae leave grapes, fall to the ground and burrow 10–20 mm deep into the soil between late summer to early autumn and overwinter. If the soil is dry, larvae may burrow deeper. Larvae need to pupate for 9–12 days in the spring before emerging as adults (Cranshaw *et al.* 1994; AQSIQ 2007). The adults need to feed on flowers and fruit of grapes before finding a mate to reproduce (Li 2004).
- As importation into Australia is likely to occur in August to October, which is late winter to early-summer, it is unknown whether *Merhynchites* sp. larvae would be able to burrow into the soil and survive Australia's summer in the soil or whether *Merhynchites* sp. adults would emerge during the summer period. These issues may affect the chance of *Merhynchites* sp. completing its life cycle.
- Table grapes (*Vitis vinifera*) and Amur grapes (*Vitis amurensis*) are the only known hosts of this pest (Li 2004). Grapevines are widely but sporadically distributed throughout Australia including in domestic and commercial environments and abandoned vineyards in temperate regions of Australia.
- Emerging adults require fruiting grapevines for feeding and then egg-laying. Locating a suitable host may affect the chance of *Merhynchites* sp. completing its life cycle. It is unknown how *Merhynchites* sp. adults locate their host plants.

Evidence that *Merhynchites* sp. larva may reside unnoticed within the fruit increasing the chance of dispersal and the ability of the larva to survive cold periods by overwintering, moderated by the need to complete its development and find a mate for sexual reproduction, supports a risk rating for distribution of 'low'.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *Merhynchites* sp. will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **VERY LOW**.

4.3.2 Probability of establishment

The likelihood that *Merhynchites* sp. will establish within Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **VERY LOW**.

Supporting information for this assessment is provided below:

- For establishment, adult weevils need to disperse in sufficient numbers and in proximity to susceptible hosts to ensure adults feed, then females can locate a male to mate with and then find a susceptible host on which to lay their eggs. Environmental conditions need to be suitable for population development.
- *Merhynchites* sp. has one generation per year (Li 2004; AQSIQ 2007; AQSIQ 2009b) and reproduces sexually. Successful mating between a male and a female must occur before viable eggs are produced (Li 2004; AQSIQ 2007; AQSIQ 2009b). It is unknown how *Merhynchites* sp. adults initially locate their mate.
- There may be more than one larva of *Merhynchites* sp. present in each infested grape dependent on the number of seeds in the grape (Li 2004). More than one larva in a grape could increase the chance of sexual reproduction as males and females need to find each other before reproduction.
- *Merhynchites* sp. has a limited distribution and has only been reported in northern Shanxi which has a continental climate with distinctive seasons of cold winters but mild summers, with a mean annual temperature of 6–14 °C. Most of the province has a mean annual precipitation of 400–650 mm (Ministry of Culture 2003). Similar climatic conditions exist in temperate parts of Australia that may be suitable for this species' establishment.
- European grapes (*Vitis vinifera*) and Amur grapes (*Vitis amurensis*) are the only recorded hosts of *Merhynchites* sp. No other plant hosts have been recorded (Li 2004; AQSIQ 2009b). Only European grapes (wine and table grapes) are found in Australia (USDA 2010a). *Merhynchites* sp. adult females require young grape berries with seeds to lay eggs in as larvae feed on young grape seeds (Li 2004; AQSIQ 2007; AQSIQ 2009b). Based on this, *Merhynchites* sp. would not be expected to occur in seedless grapes.
- Finding suitable egg-laying sites (i.e. fruiting grapevines) may be difficult as grapevines are widely but sporadically distributed throughout Australia. They are found in domestic and commercial environments and abandoned vineyards in temperate regions of Australia where climatic conditions may be less severe than in northern China and maybe more amenable for *Merhynchites* sp. to establish.

- *Merhynchites* sp. are capable of flight but it is unknown if they are strong or poor fliers. This may affect their ability to locate a host plant and mate to complete their life cycle.
- Existing control programs in Australia, such as broad spectrum pesticide application, may be effective in preventing *Merhynchites* sp. establishing on commercial grapes, but these are not routinely applied to home grown grapes, or would not be applied to abandoned vineyards.

The wide but sporadic availability of a single host species in Australia, limited distribution in its native environment in China, moderated by the necessity to find a mate for sexual reproduction, the unknown fecundity of female *Merhynchites* sp. adults and a single generation per year, support a risk rating for establishment of 'very low'.

4.3.3 Probability of spread

The likelihood that *Merhynchites* sp. will spread within Australia, based on a comparison of factors in the source and destination areas that affect the expansion of the geographic distribution of the pest, is: **LOW**.

Supporting information for this assessment is provided below:

- *Merhynchites* sp. weevils require fruiting grapevines that produce seeded grapes to continue their life cycle (Li 2004). Grapevines are distributed throughout Australia, including in domestic and commercial environments and abandoned vineyards in temperate regions of Australia where climatic conditions may be less severe than in northern China and maybe more amenable for *Merhynchites* sp. to establish.
- *Merhynchites* sp. are capable of flight but it is unknown if they are strong or poor fliers. This may affect their ability to locate a host plant and mate to complete their life cycle.
- Natural barriers such as arid areas, climate differences and long distances, exist in Australia and may limit the natural spread of *Merhynchites* sp.
- Dispersal of this pest to previously uninfested areas may occur by transport of fruit infested with *Merhynchites* sp. larvae.
- Large volumes of wine and table grapes are transported across vast distances throughout Australia. If infested grapes from Australian vineyards where *Merhynchites* sp. become established are transported and sold on the domestic market, this could increase opportunities for the species to spread and establish in other areas in the same manner as the initial introduction (e.g. disposal of infested grapes intended for human consumption).
- However, official state legislation controls the movement of wine and table grapes to ensure pests and diseases are not introduced into new areas in Australia (QDPIF 2008). This may reduce the spread of *Merhynchites* sp. in Australia.

The limited host range, lack of a natural mechanism for long distance dispersal, only one generation per year and natural barriers and official control measures that exist in Australia between areas where grapevines occur support a risk rating for spread of 'low'.

4.3.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *Merhynchites* sp. will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **EXTREMELY LOW**.

4.3.5 Consequences

The consequences of the establishment of *Merhynchites* sp. in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**D**', the overall consequences are estimated to be **LOW**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score:** D – Significant at the district level. In China, *Merhynchites* sp. weevil only attacks European grapes (i.e. wine and table) (*Vitis vinifera*) and Amur grapes (*Vitis amurensis*) (Li 2004) and is found in a small part of northern Shanxi in China. External symptoms of attack by *Merhynchites* sp. weevils are readily visible on infested fruits and yields may be affected, since the larvae feed on grape seeds and chew through the pulp to exit the fruit when they are ready to overwinter (Li 2004). The main damage includes the egg-laying holes in the surface of the grapes and larval feeding within the berries making the grapes unfit for human consumption or unmarketable (AQSIQ 2009b). The pest's impact on Australian native Vitaceae (e.g. *Cayratia clematidea, Cissus hypoglauca* and *Cissus sterculiifolia* (Harden 2009; Herbison-Evans and Ashe 2009), some of which are found in rainforest areas (Arnold and Rossetto 2002) is unknown. Legalov (2005) states that the majority of Rhynchites develop on species of a single host, therefore it is unlikely that *Merhynchites* sp. will attack plants that do not belong to the *Vitis* genus.
Other aspects of the environment	**Impact score:** A – Indiscernible at the local level. There are no known direct consequences of this pest on other aspects of the environment.
Indirect	
Eradication, control etc.	**Impact score:** C – Significant at the local level. Strict pest management programs are already in place for commercial table and wine grapes in Australia and *Merhynchites* sp. may be controlled by these programs. For example, synthetic pyrethroids are already registered for and used in Australian vineyards to control other weevil species (Bailey and Furness 1994). Therefore, an additional control program may not have to be implemented in infested vineyards to reduce fruit damage and yield losses, so production costs may not be greatly affected. However, in organic vineyards, home gardens and abandoned vineyards and grapevines, where strict pest control programs may not occur, *Merhynchites* sp. may become a pest and require pesticide applications.
Domestic trade	**Impact score:** D – Significant at the district level. The presence of *Merhynchites* sp. in commercial production areas may result in interstate trade restrictions on table and wine grapes. These restrictions may lead to a loss of markets.
International trade	**Impact score:** D – Significant at the district level. The presence of *Merhynchites* sp. in commercial table grape production areas could have impacts on the export of Australia's table grape to countries where this pest is not present.
Environmental and non-commercial	**Impact score:** A – Indiscernible at the local level. Additional pesticide application and other measures to control *Merhynchites* sp. could have additional effects on the environment.

4.3.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Merhynchites* sp.	
Overall probability of entry, establishment and spread	**Extremely low**
Consequences	**Low**
Unrestricted risk	**Negligible**

As indicated, the unrestricted risk estimate for *Merhynchites* sp. of 'negligible' achieves Australia's ALOP. Therefore, specific risk management measures are not required for this pest.

4.4 Japanese beetle

Popillia japonica

Popillia japonica, known as Japanese beetle, is a member of the scarab beetle family (Scarabaeidae) and the ruteline beetle tribe. The adults are 8–11 mm long, stout-bodied iridescent green beetles with copper wing covers, while the larvae are c-shaped, pale and soft-bodied. It is native to Japan and parts of the Kuril Islands within the Russian Federation. It also occurs widely in China, in the provinces of Heliojiang, Jilin, Zhejing, Gansu and Qinghai (EPPO 2006a; Gansu Academy of Agricultural Sciences 2010).

As with all beetles, *P. japonica* has four life history stages: egg, larva, pupa and adult (Fleming 1972; CSIRO 1991). Adult beetles are attracted to chemicals released from damaged leaves and fruit and form feeding aggregations, which can consist of thousands of beetles (Hammons *et al.* 2009). Females mate up to four times, using a sex pheromone to attract a mate for the first mating. All subsequent matings rely on high densities of both sexes present in feeding aggregations (Potter and Held 2002). After mating, females disperse to find suitable hosts. Eggs are laid individually in soil associated with roots of suitable grass hosts. Females lay between 40–60 eggs during their 4–6 week lifespan, which hatch in approximately two weeks. Larvae take 2–3 weeks and 3–4 weeks to pass through the first and second instars, respectively, with third instar larvae then overwintering. Development resumes in the spring once soil temperatures rise above 10 °C, with larvae taking a further 4–8 weeks to mature. After constructing a pupal chamber in the soil, larvae enter a pre-pupal stage lasting approximately 10 days. Adults emerge after spending 7–17 days as a pupa, but remain in the pupal chamber for between 2–14 days after emergence (Potter and Held 2002).

Adult *P. japonica* feed as generalists on flowers, fruits and foliage of a wide range of plants, while the larvae feed on the roots of grasses and other plants present in pastures, lawns and sports fields (Fleming 1972). Home gardens are badly affected by this species, as they provide a large range of adult and larval hosts growing in a small area (Fleming 1972). Adults graze on the fruit surface, but can become inconspicuous if they burrow into the flesh. Grapevines are especially favoured and may be heavily infested with feeding beetles, with adults opportunistically exploiting fruits as a high energy source (Hammons *et al.* 2009).

Popillia japonica is notable for being accidentally introduced to the USA prior to 1916 (Fleming 1972). In 1998, suppression of this beetle cost the USA economy approximately US$460 million dollars, while ongoing management contributes to over 3.2 million kilograms of insecticide applied to lawns in the USA alone (USDA 2004; Reding and Krause 2005).

The risk scenario of concern for *P. japonica* is the presence of adults within bunches of grapes.

4.4.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Probability of importation

The likelihood that *P. japonica* will arrive in Australia with the importation of table grapes from China is: **LOW**.

Supporting information for this assessment is provided below:

- The records of *P. japonica* in China are limited to the provinces of Jilin, Gansu and Qinghai (Gansu Academy of Agricultural Sciences 2010). Jilin is the only major grape producing province in China where this beetle is recorded (CABI-EPPO 1997c).
- Adults are present from June to October in North America (Fleming 1972).
- Temperatures at harvest time in Jilin are within the range of temperatures recorded when adult *P. japonica* are present in the USA, which suggests adults are likely to be present in China at harvest.
- *Popillia japonica* adults are attracted to volatiles released from leaves and fruit damaged by other *P. japonica*. This allows large numbers, even thousands, of adult *P. japonica* to exploit preferred food resources (Fleming 1972; Hammons *et al.* 2009).
- *Vitis vinifera* and *V. labrusca* are among the plant species that are always attacked by the beetle in the USA (Fleming 1972).
- Although *P. japonica* adults initially attack leaves of *V. vinifera* and other hosts, they opportunistically exploit sugar-rich fruits, using them as a high calorie fuel for flight (Hammons *et al.* 2009).
- *Popillia japonica* has a range of feeding behaviours, from nibbling leaves to skeletonising them and feeding on fruit until only a core or stone remains (Fleming 1972).
- An adult *P. japonica* has been found in a blueberry baked in a muffin (Gillespie 2006; APPD 2009). This demonstrates that adult beetles can remain on fruit through harvest and post-harvest processing activities and burrow into fruit.
- Beetles may be removed from grape bunches by picking, grading and packing operations because of their size (8–11 mm).
- Adults of this species are known to cling tightly to food sources (Hammons *et al.* 2009), so beetles in grape bunches may be difficult to remove.
- *Popillia japonica* is not attracted to harvested grapes in North America (Hammons *et al.* 2009).
- Adult *P. japonica* can survive temperatures as low as –20 °C without prior cold conditioning (Payne 1928). Temperatures used for fast pre-conditioning (–2 °C to 0 °C) and cold storage (0 °C to 1 °C) of grapes are unlikely to kill *P. japonica* adults.
- Cold conditions may improve the ability of *P. japonica* to survive transport to Australia by halting its movement and increasing its lifespan.

The evidence that *P. japonica* adults are attracted to grapevines, feed on grape berries, could be concealed within grape bunches and the capacity to survive cold storage, moderated by their limited distribution in grape growing areas in China and their size of 8-11 mm, supports a risk rating for importation of ‘low’.

Probability of distribution

The likelihood that *P. japonica* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **HIGH**.

Supporting information for this assessment is provided below:

- Grapes are imported for human consumption. Fruit will be distributed to many localities by wholesale and retail trade and by individual consumers. Berries may be distributed to all states in unrestricted trade.
- Most fruit waste will be discarded into managed waste systems and will be disposed of in municipal tips. Consumers will discard small quantities of fruit waste in urban, rural and natural localities. Small amounts of fruit waste will be discarded in domestic compost.
- *Popillia japonica* will survive in-transit, pre-retail and retail cold storage during distribution in Australia, as adults are capable of surviving temperatures as low as –20 °C with no pre-conditioning (Payne 1928).
- Beetles need warm temperatures in order to make any movement. Temperatures above 21 °C are sufficient for flight (Fleming 1972). Temperatures of the Australian spring and summer, corresponding to proposed grape exports from China, will allow *P. japonica* present to resume movement.
- Any *P. japonica* associated with grapes in plastic wrapped packaging will be unable to escape until the packaging is opened. Beetles imported in such packaging may be discovered and killed by the consumer, or become trapped inside houses or other buildings. Successful escapes would most likely occur if the grapes are unpacked and eaten outside.
- *Popillia japonica* adults associated with boxed grapes are likely to escape if sold directly from the packaging by retail outlets. Beetles present in grapes sold in this manner, either outside or at the entrance to such stores, could move directly to a favourable environment.
- Female *P. japonica* release pheromones to attract males and mate before feeding (Fleming 1972). Therefore, it is likely that any females arriving in Australia will be mated and will actively seek larval hosts for egg laying.
- Beetles of both sexes can fly up to 8 kilometres in one flight (Fleming 1972), which will potentially allow them to access favourable hosts in virtually any urban or agricultural area in Australia.
- Adults are attracted to host volatiles, allowing them to readily find food sources and live for up to 6 weeks (Fleming 1972).
- Urban landscapes, where the majority of grapes will be consumed, offer an abundance of larval hosts (e.g. lawn grasses) in backyards, parks and sports fields. Most *P. japonica* adults entering the Australian environment will find suitable hosts without difficulty.

The likelihood of mated females arriving, the ability of adults to withstand cold-storage of grapes, their ability to fly to find hosts and the abundance of larval hosts supports a risk rating for distribution of ‘high’.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *P. japonica* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **LOW**.

4.4.2 Probability of establishment

The likelihood that *P. japonica* will establish within Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **HIGH**.

Supporting information for this assessment is provided below:

- Female *P. japonica* release pheromones to attract males and mate before feeding (Fleming 1972) and are then guarded by their male partner until they lay eggs (Saeki *et al.* 2005). Given this is the case, any female *P. japonica* entering Australia can be expected to have mated and be capable of producing fertile eggs, and may be accompanied by her previous mate.
- *Popillia japonica* adults live for 4–6 weeks, with females capable of laying between 40–130 eggs during this time. Eggs are also deposited individually in the soil adjacent to roots of larval host plants (Fleming 1972). This is likely to assist establishment, as eggs scattered across multiple locations offer protection against likely predators and unfavourable temperatures.
- *Popillia japonica* has a wide host range, attacking some 400 species of plants as adults, including monocots, dicots, gymnosperms and ferns. Comprehensive host listings for North America are provided by Fleming (1972) and CFIA (2009) and include many species and genera that grow in Australia as garden, agriculture, forestry and amenity plants, or as weeds (e.g. *Rosa, Prunus, Malus, Pinus, Plantago, Magnolia, Ficus, Morus, Iris*).
- The larvae feed on roots of both monocots and dicots, favouring species present in turf and pasture assemblages (Fleming 1972).
- The early instar larvae of *P. japonica* require moist soil for survival. While summer drought in the USA significantly reduced beetle populations, the species is able to survive in irrigated areas and persist on non-favoured hosts (Fleming 1972). In the USA, the beetle has established in parts of Arizona, California, Texas and Utah.
- Lack of endemic natural enemies in North America is believed to have significantly increased the ability of *P. japonica* to establish there (Fleming 1972).
- There are no natural enemies of *P. japonica* native to Australia, but three exotic entomopathic nematodes effective against *P. japonica* larvae are used in Australia. Of these, *Heterorhabdis zealandica* receives limited usage on golf courses and playing fields. The other two, *H. bacteriophora* and *Steinernema carpocapsae*, are mainly used to protect ornamentals (Australian Biological Control 2009).

The evidence that *P. japonica* is likely to arrive as mated females, is moderately fecund, feeds on many plants as adults and larvae, is capable of making use of limited resources under dry conditions and lacks native natural enemies supports a risk rating of ‘high’.

4.4.3 Probability of spread

The likelihood that *P. japonica* will spread within Australia, based on a comparison of factors in the source and destination areas that affect the expansion of the geographic distribution of the pest, is: **HIGH**.

Supporting information for this assessment is provided below:

- *Popillia japonica* has successfully spread in both North America and the Azores (Fleming 1972; Martins and Simoes 1985; APHIS 2008; CFIA 2009). In the USA, *P. japonica* has spread from an initial introduction point in New Jersey to infest the eastern one-third of the country, with secondary infestations in Washington State, Oregon, California, Utah, Arizona, New Mexico and Texas (NAPIS 2008).
- Its ability to spread is attributed to the abundance of suitable hosts and habitat (grasslands/turf adjacent to broad-leaved plants) in contemporary suburban and agricultural landscapes, and the lack of natural enemies (Fleming 1972).
- The majority of spread in *P. japonica* is achieved by the adults, which are strong fliers capable of flying up to 8 km in one flight. *Popillia japonica* has spread up to 24 km (15 miles) per year in the USA.
- *Popillia japonica* will fly in swarms, often consisting of millions of individuals. There is evidence that such flights may be wind assisted (Fleming 1972), which is likely to increase their flight range (Pedgley 1982).
- Adults and larvae are transported long distances with infested produce, nursery stock and soil (Fleming 1972). There is evidence of human-assisted spread via road, rail and air (Fleming 1972), which has enabled *P. japonica* to become established in parts of the USA that are thousands of kilometres from the nearest infestation (NAPIS 2008).
- Suitable hosts (Fleming 1972) are widely distributed in Australia. It is likely that dispersing beetles will find suitable adult and larval hosts in many parts of Australia.
- The early instar larvae of *P. japonica* require moist soil for survival. While summer drought in the USA significantly reduced beetle populations, the species is able to survive in irrigated areas and persist on non-favoured hosts (Fleming 1972).
- *Popillia japonica* is likely to thrive in areas with summer rainfall greater than 250 mm (Fleming 1972), the majority of which are located to the east of the Great Dividing Range in Australia (Bureau of Meteorology 2009). Establishment in drier areas will likely be facilitated by agricultural and amenity irrigation.
- Although entomopathic nematodes (*Heterorhabdis zealandica*, *H. bacteriophora* and *Steinernema carpocapsae*) effective against *P. japonica* larvae are used in Australian horticulture, they are unlikely to slow its spread because their use is limited to horticulture and commercial turf (e.g. professional playing fields) (Australian Biological Control 2009). As nematodes are unlikely to be present in all habitats suitable for *P. japonica* larvae, they are unlikely to act as an efficient barrier against its spread in Australia.

The evidence that *P. japonica* is a successful invasive species elsewhere, is capable of active and passive spread over short and long distance, lacks natural enemies and has a wide availability of hosts supports a risk rating of ‘high’.

4.4.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *P. japonica* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **LOW**.

4.4.5 Consequences

The consequences of the establishment of *P. japonica* in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**E**', the overall consequences are estimated to be **MODERATE**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: E - Significant at the regional level. Adults of *P. japonica* cause economic damage by attacking foliage, flowers and fruit of more than 300 plant species (Potter and Held 2002). In the USA, the annual cost of controlling adults and larvae of *P. japonica* is approximately US$226 and US$234 million, respectively (USDA 2004). All sectors of the Australian horticulture industry are vulnerable to damage by adult *P. japonica*, especially those producing fruit and ornamental plants. Grapes, apples and peaches are always attacked by the beetle in the USA. When present in large numbers, entire trees and vines can be skeletonised and fruits eaten back to the core or stone (Fleming 1972). Flowers, especially roses, are also targeted, with adults eating petals into irregular shapes; other flowers may be skeletonised. Adults also attack a range of deciduous tree species while in leaf (e.g. Japanese maples, American elm, English elm) (Fleming 1972). Large plantings of these species for autumn displays may be damaged, impacting on tourism. *Popillia japonica* larvae are also likely to cause severe damage to managed turf in Australia, including turf in gardens, parks and sports facilities. Pastures would also be badly affected in moderate to high rainfall areas. Grass and pasture monocultures affected by *P. japonica* are also more susceptible to invasion by weedy broad-leaved plants (e.g. dandelion, *Taraxacum officinale*) (Richmond *et al.* 2004). In the US, control measures for *P. japonica* on turf amount to US$78 million (USDA 2004) and some US$156 million per year is spent on replacement turf (USDA 2004). Control programs in place in Australia for other pests in orchards and vineyards and in managed turf would reduce the impact of this pest.
Other aspects of the environment	**Impact score**: E - Significant at regional level. *Popillia japonica* may be capable of exploiting native grassland in Australia via the larval stage. Six grassland biomes are regarded as threatened ecological communities in Australia, all of which contain many threatened species of flora and fauna, especially herbivores (DEWHA 2009).
Indirect	
Eradication, control etc.	**Impact score**: E - Significant at the regional level. If there was an incursion of *P. japonica* in Australia, eradication would be costly and would only be feasible if the beetle was detected soon after establishment. In the USA, control of this beetle costs approximately US$460 million per year (USDA 2004). Although two nematode agents used against *P. japonica* in the USA (*Heterorhabditis bacteriophora* and *Steinernema carpocapsae*) (Campbell *et al.* 1998) are commercially available in Australia, control would likely rely on pesticides. This is the case in the USA, where nearly 3.2 million kilograms of pesticides are used on turf annually, largely for *P. japonica* in the eastern states (Reding and Krause 2005). The cost of maintaining home gardens and turf would probably increase. Control programs already in place in Australia for other pests in orchards and vineyards and in managed turf should provide some control of this pest.
Domestic trade	**Impact score**: D – Minor significance at the regional level. The presence of *P. japonica* in horticultural areas may result in interstate trade restrictions on movement of some fruit and field crops and nursery stock, resulting in additional costs to producers. In the USA, additional quarantine procedures have been put in place in airports to prevent the spread of the beetle (USDA 2010b).

Criterion	Estimate and rationale
International trade	**Impact score**: C - Significant at the local level. Measures may be required to reduce the risk of entry of *P. japonica* into countries free of this pest, resulting in additional costs to producers and exporters.
Environmental and non-commercial	**Impact score**: D – Minor significance at the regional level. Additional pesticide use to control *P. japonica* may affect the environment. Pesticides from turf may leach into waterways. Insect predators may be affected by ingesting poisoned insects. Swarms of beetles in gardens are likely to concern to the general public, as is currently the case in parts of the USA (USDA 2004).

4.4.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Popillia japonica*	
Overall probability of entry, establishment and spread	**Low**
Consequences	**Moderate**
Unrestricted risk	**Low**

As indicated, the unrestricted risk estimate for *P. japonica* of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.5 Ruteline beetles (other than Japanese beetle)

Popillia mutans [EP], *P. quadriguttata* [EP]

Popillia mutans and *P. quadriguttata* are members of the scarab beetle family (Scarabaeidae) and the ruteline beetle tribe. The adults are 8–11 mm long, stout-bodied iridescent beetles, while the scarabaeiform (c-shaped) larvae are pale and soft-bodied. Both species are widespread in Palaearctic Asia, occurring throughout China (including Taiwan), Russia (Amurland), Korea and Vietnam (Lee *et al.* 2007). *Popillia mutans* is also recorded from northern India. The biology and behaviour of *P. quadriguttata* is nearly identical to that of *P. japonica*; it differs only in having a smaller adult host range (Lee *et al.* 2007). The biology of *P. mutans* remains unreported.

The risk scenario of concern for *P. mutans* and *P. quadriguttata* is the presence of adults within bunches of grapes.

Popillia mutans and *P. quadriguttata* were previously assessed in the existing import policy for longan and lychee from China and Thailand (DAFF 2004a). The assessment of both *P. mutans* and *P. quadriguttata* presented here builds on the previous assessment.

The probability of importation for *P. mutans* and *P. quadriguttata* was rated as 'very low' and the probability of distribution was rated as 'moderate' in the assessment for longan and lychee from China and Thailand. However, differences in the commodities and horticultural practices make it necessary to re assess the likelihood that *P. mutans* and *P. quadriguttata* will be imported into and distributed within Australia with table grapes from China.

The probability of establishment and of spread of *P. mutans* and *P. quadriguttata* in Australia, and the consequences they may cause will be the same for any commodity in which the species are imported to Australia. Accordingly, there is no need to reassess these components.

4.5.1 Reassessment of probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Reassessment of probability of importation

The likelihood that *P. mutans* and *P. quadriguttata* will arrive in Australia with the importation of table grapes from China is: **LOW**.

Supporting information for this assessment is provided below:

- *Popillia quadriguttata* occurs in the grape producing provinces of Hebei, Shandong, Henan, Shanxi, Shaanxi and Yunnan; *P. mutans* occurs in all provinces of China (Löbl and Smetana 2006).
- Adults of both *Popillia* spp. are likely to be present at harvest time (August-October) in China. *Popillia quadriguttata* flies in July in Korea (Lee *et al.* 2007). Adults are likely to live for 4–6 weeks (as is the case with *P. japonica*) (Fleming 1972).
- Larvae are unlikely to be imported because they feed on the roots of grasses. The biology and behaviour of *P. quadriguttata* larvae is similar to that of *P. japonica* (Lee *et al.* 2007).

- *Popillia quadriguttata* adults are attracted to plant-based lures designed for *P. japonica* in South Korea (Lee *et al.* 2007). This suggests that *P. quadriguttata*, like *P. japonica*, responds to volatiles released from leaves and fruit damaged by other beetles. This adaptation may allow large numbers of beetles to exploit preferred food resources (Fleming 1972; Hammons *et al.* 2009).
- *Popillia mutans* and *P. quadriguttata* attack the leaves and fruits of *V. vinifera* and other hosts (Li 2004; Zhang 2005b; AQSIQ 2006). Sugar-rich fruit is opportunistically exploited, as adult Ruteline beetles use them as a high calorie fuel for flight (Hammons *et al.* 2009).
- Other *Popillia* spp. have a range of feeding behaviours, from nibbling leaves to skeletonising them and feeding on fruit until only a core or stone remains (Fleming 1972).
- An adult *P. japonica* has been found in a blueberry baked in a muffin (Gillespie 2006; APPD 2009). This demonstrates that adult beetles can remain on fruit through harvest and post-harvest processing activities and burrow into fruit.
- Beetles may be removed from grape bunches by picking, grading and packing operations because of their size (8–11 mm).
- *Popillia* spp. are known to cling tightly to food sources (Hammons *et al.* 2009), so beetles in grape bunches may be difficult to remove. Adults may be inconspicuous inside grape bunches.
- *Popillia* spp. are not attracted to harvested grapes in North America (Hammons *et al.* 2009).
- No reports were found indicating the tolerance of either *P. mutans* or *P. quadriguttata* of cold temperatures. However, adults of a closely related species (*P. japonica*) can survive temperatures as low as –20 °C without prior cold conditioning (Payne 1928). Temperatures used for fast pre-conditioning (–2 °C to 0 °C) and cold storage (0 °C to 1 °C) of grapes are unlikely to kill *P. japonica* adults, and may not kill either *P. mutans* or *P. quadriguttata*.
- Cold conditions may improve the ability of *Popillia* spp. to survive transport to Australia by halting their movement and increasing their lifespan.

The widespread distribution of *P. mutans* and *P. quadriguttata* in China and the likelihood that they will feed on grapes and survive cold storage, mitigated by the likely removal of beetles from grape bunches because of their size, supports a risk rating for importation of 'low'.

Reassessment of probability of distribution

The likelihood that *P. mutans* and *P. quadriguttata* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **HIGH**.

Supporting information for this assessment is provided below:

- Grapes are imported for human consumption. Fruit will be distributed to many localities by wholesale and retail trade and by individual consumers. Berries may be distributed to all states in unrestricted trade.

- Most fruit waste will be discarded into managed waste systems and will be disposed of in municipal tips. Consumers will discard small quantities of fruit waste in urban, rural and natural localities. Small amounts of fruit waste will be discarded in domestic compost.
- Adults of a closely related species from nearby parts of Asia (*P. japonica*) will survive temperatures as low as –20 °C with no pre-conditioning (Payne 1928). Given their close relationship to *P. japonica*, it is likely that *P. mutans* and *P. quadriguttata* may also survive in-transit, pre-retail and retail cold storage during distribution in Australia.
- Beetles need warm temperatures in order to make any movement. Temperatures above 21°C are sufficient for *P. japonica* to fly (Fleming 1972) and probably *P. mutans* and *P. quadriguttata*. Temperatures will be sufficient for movement of *Popillia* beetles to fly in spring and summer in southern areas of Australia (Bureau of Meteorology 2009). Beetles that survive cold storage are likely to resume movement when warmed to ambient temperatures.
- Any *P. mutans* or *P. quadriguttata* associated with grapes in plastic wrapped packaging will be unable to escape until the packaging is opened. Beetles imported in such packaging may be discovered and killed by the consumer, or become trapped inside houses or other buildings. Successful escapes would most likely occur if the grapes are unpacked and eaten outside.
- *Popillia mutans* or *P. quadriguttata* adults associated with boxed grapes are likely to escape if sold directly from the packaging by retail outlets. Beetles present in grapes sold in this manner, either outside or at the entrance to such stores, could move directly to a favourable environment.
- Female *P. quadriguttata* are similar to *P. japonica* in releasing pheromones to attract males (Fleming 1972; Lee *et al.* 2007). Like *P. japonica* (Fleming 1972), they probably mate before feeding. *Popillia mutans* probably display similar behaviours. Therefore, it is likely that any females arriving in Australia will be mated and will actively seek larval hosts for egg laying.
- No reports were found for the flight capacity of either *P. mutans* or *P. quadriguttata.* However, both sexes of *P. japonica* can fly up to 8 kilometres in one flight (Fleming 1972), which will potentially allow them to access favourable hosts in virtually any urban or agricultural area in Australia.
- Adult *Popillia* are attracted to host volatiles (Lee *et al.* 2007; Hammons *et al.* 2009), allowing them to readily find food sources. In Korea, *P. quadriguttata* are active over a 5 week period (Lee *et al.* 2007), suggesting they have a similar lifespan to that of *P. japonica* (up to 6 weeks) (Fleming 1972).
- Urban landscapes, where the majority of grapes will be consumed, offer an abundance of larval hosts (e.g. lawn grasses) in gardens, parks and sports fields (Lee *et al.* 2002; Lee *et al.* 2007). Most *P. mutans* and *P. quadriguttata* adults entering the Australian environment will find suitable hosts without difficulty.

The likelihood of mated females arriving, adults able to withstand cold-storage of grapes, the ability to fly to find hosts and the abundance of larval hosts all support a risk rating for distribution of ‘high’.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *P. mutans* and *P. quadriguttata* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **LOW**.

4.5.2 Probability of establishment and of spread

As indicated above, the probability of establishment and of spread for *P. mutans* and *P. quadriguttata* would be the same as those assessed for longan and lychee from China and Thailand (DAFF 2004a). The ratings from the previous assessments are presented below:

Probability of establishment: **HIGH**

Probability of spread: **HIGH**

4.5.3 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *P. mutans* and *P. quadriguttata* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **LOW**.

4.5.4 Consequences

The consequences of the establishment of *P. mutans* and *P. quadriguttata* in Australia have been estimated previously for longan and lychee from China and Thailand (DAFF 2004a). This estimate of impact scores is provided below expressed in the current scoring system (Table 2.3).

Plant life or health	**D**
Other aspects of the environment	**A**
Eradication, control etc.	**C**
Domestic trade	**C**
International trade	**C**
Environment	**B**

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**D**', the overall consequences are estimated to be **LOW**.

4.5.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Popillia mutans and Popillia quadriguttata*	
Overall probability of entry, establishment and spread	**Low**
Consequences	**Low**
Unrestricted risk	**Very low**

As indicated, the unrestricted risk estimate for *P. mutans* and *P. quadriguttata* of 'very low' achieves Australia's ALOP. Therefore, specific risk management measures are not required for these pests.

4.6 Oriental fruit fly

Bactrocera dorsalis [EP]

Bactrocera dorsalis, Oriental fruit fly, belongs to the fruit fly family Tephritidae which is a group considered to be among the most damaging pests of horticultural crops (White and Elson-Harris 1992). *Bactrocera dorsalis* is a serious pest of a wide range of commercial fruit crops in parts of Asia and Hawaii (White and Elson-Harris 1992).

Bactrocera dorsalis has four life stages: egg, larva, pupa and adult. Adults are predominantly black, or black and yellow. Eggs are laid below the skin of the host fruit. Hatched larvae feed within the fruit and third instar larva are 7.5–10.0 mm long and 1.5–2.0 mm wide. Pupation occurs in the soil under the host plant (CABI 2009). It can produce several generations a year, depending on the temperature (CABI 2009).

The risk scenario of concern for *B. dorsalis* is the presence of eggs and developing larvae within table grapes.

Bactrocera dorsalis was included and/or assessed in the existing import policy for pears from China (AQIS 1998b), longan and lychee from China and Thailand (DAFF 2004a), mangosteens from Thailand (DAFF 2004b), mangoes from Taiwan (Biosecurity Australia 2006d) and mangoes from India (Biosecurity Australia 2008). The assessment of *B. dorsalis* presented here builds on these previous assessments.

The probability of importation for *B. dorsalis* was rated as 'high' in the assessments for longan and lychee from China and Thailand (DAFF 2004a), mangoes from Taiwan (Biosecurity Australia 2006d) and mangoes from India (Biosecurity Australia 2008) because the species is widespread in the production regions and as 'very low' in the assessment for mangosteens from Thailand (DAFF 2004b) because mangosteen is a conditional non-host of *B. dorsalis*.

The probability of distribution for *B. dorsalis* was rated as 'high' in the assessments for longan and lychee from China and Thailand (DAFF 2004a), mangoes from Taiwan (Biosecurity Australia 2006d) and mangoes from India (Biosecurity Australia 2008) because this species can fly and has a wide host range; and 'moderate' in mangosteens from Thailand (DAFF 2004b) due to mangosteens being a conditional non-host of *B. dorsalis*. However, differences in commodities, horticultural practices and the prevalence of the pest between previous export areas (Thailand, Taiwan and India) and China, make it necessary to re assess the likelihood that *B. dorsalis* will be imported into and distributed within Australia with table grapes from China.

The probability of establishment and of spread of *B. dorsalis* in Australia, and the consequences it may cause will be the same for any commodity in which the species is imported into Australia. Accordingly, there is no need to re assess these components.

4.6.1 Reassessment of probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Reassessment of probability of importation

The likelihood that *B. dorsalis* will arrive in Australia with the importation of table grapes from China is: **LOW**.

Supporting information for this assessment is provided below:

- Yang *et al.* (1994) reported that *B. dorsalis* is found on the Xisa Islands (Parcel Islands) in the South China Sea and as far north on mainland China as 26 degrees north latitude (26°N). Recent studies indicate that the northern-most border of *B. dorsalis* distribution in China is 30 ± 2°N (Hou and Zhang 2005; Wu 2005).
- The majority of table grape production areas are located in northern China above the latitude where *B. dorsalis* does not naturally occur (Yang *et al.* 1994). In 2003, 90% of table grape production in China occurred in seven provinces (i.e. Hebei, Henan, Jilin, Liaoning Shandong, Shanxi and Xinjiang (AQSIQ 2009b), all located north of 30 ± 2°N latitude. *Bactrocera dorsalis* does not naturally occur in these areas as it would not survive the northern winter temperatures (Hou and Zhang 2005).
- The only table grape producing province being assessed where *B. dorsalis* naturally occurs, is Yunnan (AQSIQ 2009b). *Bactrocera dorsalis* is one of the major horticultural pests in Yunnan and low infestations have been recorded on table grapes in this province (Ye and Liu 2005).
- Although *B. dorsalis* will attack table and wine grapes (*Vitis vinifera*), grapes are not common hosts of this fruit fly (Chu and Tung 1996).
- *Bactrocera dorsalis* may fly into or may be introduced during the warmer summer months into table grape producing areas in the north of China through human movement of fruit fly-infested produce as there are limited official control measures in place to prevent its spread in non-commercial fruit carried by humans from southern provinces, where *B. dorsalis* is known to occur.
- Adult female *B. dorsalis* puncture and deposit eggs beneath the skin of host fruit including table grapes (White and Elson-Harris 1992). Larval feeding causes mechanical damage and plant tissue rots due to secondary infestation by microorganisms (Mau and Matin 2007).
- Table grapes for export are harvested in China and exported usually between August and October each year depending on the cultivar and geographical location (AQSIQ 2008).
- Newly infested fruit are unlikely to be detected during picking, sorting and quality inspection due to the absence of visual blemishes, bruising and damage to the skin and are likely to be present in fruit packed for export.
- In China, *B. dorsalis* adults can withstand 13 °C as a daily average temperature however they cannot survive at temperatures lower than 10 °C (Ye and Liu 2005) as the flies are not cold tolerant with a lower temperature threshold of 11.80 °C (Wu 2005).
- This pest may enter the environment as larvae in infested grapes. Packed grapes for export are transported from China at optimum temperature and relative humidity conditions to ensure quality is maintained. AQSIQ (2008; 2009b) report storage and transport temperature conditions for grapes as 0–1 °C.

- MAF Biosecurity New Zealand (2009) require cold treatment disinfestation for *B. dorsalis* in Chinese table grapes based on USDA Treatment Schedules for *B. orientalis* on other commodities (USDA 2010c). The recommended treatment schedules are 0.99 °C or below for 17 consecutive days or 1.38 °C or below for 20 consecutive days.
- Based on the above treatment schedules, it is unlikely that egg and larval life stages of *B. dorsalis* would survive in table grapes under the reported routine commercial conditions during cold storage, transportation and exportation in refrigerated containers by sea freight. However, maintenance of specific cold chain conditions cannot be guaranteed under unrestricted risk. Egg and larval life stages may survive if the cold chain is broken under sea freight and under air freight.

The evidence that larvae live inside the fruit and may be difficult to detect moderated by the fact that grapes are considered a minor host of fruit flies, including *B. dorsalis*, and that this species may not survive importation under commercial conditions, supports a risk rating for importation of 'low'.

Reassessment of probability of distribution

The likelihood that *B. dorsalis* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **LOW**.

Supporting information for this assessment is provided below:

- Packed grapes are usually not processed or handled again until they arrive at the retailers as grapes are easily damaged through rough handling and impacts due to their thin skins (Mencarelli and Bellincontro 2005). Therefore, any pests or pathogens in the packed grapes are unlikely to be detected during transportation and distribution to retailers.
- Since *B. dorsalis* eggs and larvae are found within grape berries, packed grapes infested with *B. dorsalis* are likely to travel to their destination without being detected.
- After transit by air or sea freight which could take from 1–3 weeks, table grapes from China are likely to arrive in Australia from August to October (see Section 3.5.3) (AQSIQ 2009c).
- On arrival in Australia, it is expected that during commercial transport, storage and distribution to the end destination, packed grapes will be stored at optimum temperature and relative humidity conditions to ensure quality is maintained.
- After arriving in the Australian ports, *B. dorsalis* larvae would need to complete their development, exit the fruit, pupate in a suitable substrate and emerge as adults.
- Formation of *B. dorsalis* pupae may take place in a variety of substrates including sand, soil, leaf litter, compost heaps and grass clippings. It is feasible that infested fruit may be disposed of in sites where pupation and adult emergence could occur. Inedible and unmarketable fruit would be disposed of via landfill and compost heaps or as animal feed, or discarded where it was being eaten.
- *Bactrocera dorsalis* is a tropical species (CABI-EPPO 1997a) and is not very cold tolerant. MAF Biosecurity New Zealand (2009) cold treatment disinfestation schedules are 0.99 °C or below for 17 consecutive days or 1.38 °C or below for 20 consecutive days.

- Egg and larval life stages of *B. dorsalis* may not survive in table grapes stored under commercial conditions (temperature, relative humidity and time regimes) during transport, storage and distribution as grapes may have been stored at low storage temperatures (0–2 °C) for 1–3 weeks, although this cannot be guaranteed. This period may be long enough to kill egg and larval stages.
- Availability of hosts would not be a limiting factor in the distribution of *B. dorsalis*. Suitable host plants are available in Australia regardless of the season. Host records for *B. dorsalis* include more than 150 fruit and vegetables (see Appendix B). Australia has a wide range of naturalised, commercial, home grown and ornamental plant hosts that are widely distributed around the country.

The evidence that infested fruit may go undetected until sold, the ability to complete development on discarded fruit, and the wide range of suitable plant hosts throughout Australia moderated by the fact that eggs and larvae in table grapes may not survive the longer duration and condition(s) of storage, transport and distribution, all support a risk rating for distribution of 'low'.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *B. dorsalis* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **VERY LOW**.

4.6.2 Probability of establishment and of spread

As indicated above, the probability of establishment and of spread for *B. dorsalis* would be the same as those assessed for longan and lychee from China and Thailand (DAFF 2004a), mangosteens from Thailand (DAFF 2004b), mangoes from Taiwan (Biosecurity Australia 2006d) and mangoes from India (Biosecurity Australia 2008). The ratings from the previous assessments are presented below:

Probability of establishment: **HIGH**

Probability of spread: **HIGH**

4.6.3 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *B. dorsalis* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **VERY LOW**.

4.6.4 Consequences

The consequences of the establishment of *B. dorsalis* in Australia have been estimated previously for longan and lychee from China and Thailand (DAFF 2004a), mangosteen from Thailand (DAFF 2004b), mangoes from Taiwan (Biosecurity Australia 2006d) and mangoes

from India (Biosecurity Australia 2008). This estimate of impact scores is provided below expressed in the current scoring system (Table 2.3).

Plant life or health	**E**
Other aspects of the environment	**C**
Eradication, control etc.	**F**
Domestic trade	**E**
International trade	**E**
Environment	**D**

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**F**', the overall consequences are estimated to be **HIGH**.

4.6.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Bactrocera dorsalis*	
Overall probability of entry, establishment and spread	**Very low**
Consequences	**High**
Unrestricted risk	**Low**

As indicated, the unrestricted risk estimate for *B. dorsalis* of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.7 Grape midge

Cecidomyia sp.

Cecidomyia sp. belongs to the Cecidomyiidae or gall midge family and is commonly known as the grape midge.

In China, the grape midge is a small fly (3 mm long) with wings (wingspan 6–7 mm) and long antennae (Li 2004). Grapes (*Vitis vinifera*) are the only known hosts of *Cecidomyia* sp. (Li 2004). This species occurs in four northern provinces of China (Jilin, Liaoning, Shaanxi and Shanxi) (AQSIQ 2007). It has four life stages: egg, larva (or maggot), pupa and adult (Li 2004; Zhang 2005b). There are two generations a year (Li 2004).

The following biology is taken from Li (2004), Zhang (2005b) and AQSIQ (2007; 2009b). In China, first generation adults emerge in May and are active during the daytime but have limited flight ability (Li 2004). Skuhravá (1991) reports that adult gall midges do not feed at all. They lay eggs on young grapes at a rate of one egg per berry. Adults usually lay eggs in one grape bunch and attack bunches in the middle of a vine. Some varieties of grapes are more susceptible than others. Different grape varieties exhibit different damage symptoms but in general, larvae bore into and feed on the young grapes. Infested grapes develop more rapidly than uninfested fruit and become oval in shape. Ten days after petal fall, the infested grapes are twice the size of uninfested grapes. The infested grapes stop growing when they are 4–5 times larger than uninfested berries and have reached approximately 8–10 mm in diameter. The infested fruit has a slightly concave top and is dark green and glossy. The sepals and filaments are also still attached to infested fruit. The larvae feed and become mature in about 20 days then they pupate within the berries. The pupation period is about 5–7 days. Infested berries are full of frass, making the grapes unfit for human consumption and reducing the yield.

In early July, second generation adults start emerging, with mid-July being the peak period for adult emergence. After adult emergence, part of the pupal case remains in the emergence hole in the infested fruit. The adult is active during the daytime but they are weak fliers (Li 2004). Emerging adults mate and lay eggs on grape branches and hatched larvae overwinter on the branches. The life span of adult *Cecidomyia* sp. midges is unknown; however, in general Cecidomyiidae adults are very short lived, living between a few hours to a few days, males die after mating and females after egg-laying (Skuhravá 1991).

The risk scenario of concern for *Cecidomyia* sp. is the presence of late developing first generation larvae and pupae in table grapes.

4.7.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Probability of importation

The likelihood that *Cecidomyia* sp. will arrive in Australia with the importation of table grapes from China is: **VERY LOW**.

Supporting information for this assessment is provided below:

- Only grapes sourced from Jilin, Liaoning, Shaanxi and Shanxi are likely to be infested with *Cecidomyia* sp. (Zhang 2005b; AQSIQ 2006; AQSIQ 2009b). In 2006, these provinces produced approximately 30% of the total grape production in China (USDA 2006). However, most Chinese table grapes for export are sourced from Xinjiang and Shandong (AQSIQ 2009b) where *Cecidomyia* sp. is not known to occur.
- In China, *Cecidomyia* sp. reproduces sexually and has 2 generations a year with first generation adults appearing in May (late spring). First generation adults lay eggs on young grapes in a bunch at a rate of one egg per berry (Zhang 2005b; AQSIQ 2007; AQSIQ 2009b). Larval development and pupation occur in fruit that remains on the plant.
- Larvae bore into young berries to feed, causing the infested berries to enlarge and change shape and colour. The sepals and filaments also remain on infested fruit, which do not ripen or form seeds (AQSIQ 2009b). Larvae pupate inside the deformed grapes. Infested grapes are full of frass, making the grapes unfit for human consumption and leading to a reduction in yield (Zhang 2005b; AQSIQ 2009b).
- The deformed shape, size and colour of berries infested with *Cecidomyia* sp. and the presence of frass and sepals on the infested berries (AQSIQ 2009b), may result in the detection and elimination through manual removal, trimming and sorting of damaged fruit from the export pathway.
- In China, second generation adults begin emerging in early July (AQSIQ 2007) and lay eggs on grape branches where hatched larvae overwinter until the following spring (AQSIQ 2007). There is no available information on what larval instar stage overwinters on the fruit.
- In China, table grapes for export are harvested and exported usually between August and October each year depending on the cultivar and geographical location (AQSIQ 2008). Harvest time occurs after the emergence of second generation adults from infested berries (Zhang 2005b) and AQSIQ has reported that this insect is not present in ripe fruit (AQSIQ 2007; AQSIQ 2009b).

Cecidomyia sp. larvae mainly feed on young grapes, leading to conspicuous berry damage that results in removal of infested fruit from the pathway, plus the absence of *Cecidomyia* sp. from the major table grape exporting provinces, and the emergence of adults from fruit before the main export season begins, all support a risk rating for importation of ‘very low’.

Probability of distribution

The likelihood that *Cecidomyia* sp. will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **LOW**.

Supporting information for this assessment is provided below:

- Packed grapes are usually not processed or handled again until they arrive at the retailers, as grapes are easily damaged through rough handling and impacts due to their thin skins (Mencarelli and Bellincontro 2005). Therefore, any pests in the packed grapes are unlikely to be detected during transportation and distribution to retailers.

- Larvae inside table grapes would be able to survive cold storage before and during transportation and distribution, as larvae of *Cecidomyia* sp. overwinter in China. Late developing larvae and pupae may remain in the fruit and may survive storage, transportation and distribution via wholesale or retail trade.
- Grapes will be distributed throughout Australia for retail sale as the intended use is human consumption and waste material would be generated that may contain larvae and pupae. The majority of grape retailers, processors and consumers are located in metropolitan and suburban areas.
- Since *Cecidomyia* sp. larvae and pupae are found within grape berries, infested grapes are likely to travel to their destination without being detected. This pest may enter the environment as larvae or pupae discarded with infested grapes.
- Individual consumers may distribute small quantities of grapes to urban, rural and wild environments where they will be consumed or disposed of. Infested grapes would be discarded into compost heaps or into domestic waste and end up in landfills.
- Larvae would pupate inside table grapes but adults would need to leave infested grapes to complete their life cycle.
- *Cecidomyia* sp. is only known to feed on grapevine (*V. vinifera*) (Li 2004).
- Grapevines are widely grown in vineyards and as amenity plants in Australia and imported waste material may be discarded near these plants.
- Emerging *Cecidomyia* sp. adults have wings and are active during the daytime but can only fly short distances (Li 2004), which may be a significant limiting factor in their distribution from discarded fruit waste to a grapevine.
- As importation of table grapes is likely to take place during the Australian winter/spring period, it is unknown whether adults from imported infested grapes would lay eggs on grape branches and hatched larvae overwinter on the branches, or lay eggs on young grape berries. This may affect the chance of the pest completing its life cycle.

The evidence that infested fruit may go undetected until sold and the ability of *Cecidomyia* sp. to complete larval and pupal development in discarded fruit waste, moderated by its limited host range and poor flight ability, supports a risk rating for distribution of ‘low’.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *Cecidomyia* sp. will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **VERY LOW**.

4.7.2 Probability of establishment

The likelihood that *Cecidomyia* sp. will establish within Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **LOW**.

Supporting information for this assessment is provided below:

- Grapes (*Vitis vinifera*) are the only recorded host plant of *Cecidomyia* sp. (Zhang 2005b).

- *Cecidomyia* sp. are considered to be temperate pests as they are found in the northern provinces of China (Zhang 2005b; AQSIQ 2007) and are therefore likely to establish in temperate regions with cooler climates in Australia.
- Adults need to disperse in sufficient numbers and in proximity to susceptible hosts to ensure adult females can locate a male to mate with and then find a suitable host, fruiting grapevines in this case, on which to lay their eggs. Finally, environmental conditions need to be suitable for population development. *Cecidomyia sp.* has two generations per year (Zhang 2005b; AQSIQ 2007; AQSIQ 2009b) and reproduces sexually; thus successful mating between a male and a female must occur before viable eggs are produced (Zhang 2005b; AQSIQ 2007; AQSIQ 2009b).
- There may be a number of *Cecidomyia sp.* larva or pupa present in an infested bunch of grapes (Zhang 2005b), which could improve the chance of sexual reproduction.
- Grapevines are widely but sporadically distributed in Australia and are available in domestic and commercial environments and as abandoned grapevines in temperate regions of Australia where climatic conditions may be less severe than in northern China and maybe more amenable for *Cecidomyia* sp. to establish. These grapevines could occur near the transport pathway and/or end destination of imported table grapes.
- First generation *Cecidomyia* sp. adult females require young grape berries to lay eggs in as larvae feed and pupate in grapes (Zhang 2005b; AQSIQ 2007; AQSIQ 2009b). Adult midges do not usually feed and have short life spans (Skuhravá 1991).
- Finding suitable egg-laying sites (i.e. young grapes) may be difficult as *Cecidomyia* sp. adults are not strong fliers so have limited natural dispersal mechanisms (Zhang 2005b; AQSIQ 2009b). The fact that this species can only fly short distances from discarded fruit waste to a suitable host is a significant limiting factor.
- Gall midge adults may be dispersed longer distances through wind-assistance (EPPO 2004) however, unless the wind is blowing in the direction of grapevines, it is unknown whether *Cecidomyia* sp. would land on a grapevine through wind-assistance.
- Existing control programs in Australia, such as broad spectrum pesticide application, may be effective in preventing *Cecidomyia* sp. establishing on commercial grapes, but these are not routinely applied to home grown grapes, or may not be applied to the hosts in organic or abandoned grapevines.

The limited host range, limited natural dispersal mechanisms and the short adult life span with only two generations per year, support a risk rating for establishment of ‘low’.

4.7.3 Probability of spread

The likelihood that *Cecidomyia* sp. will spread within Australia, based on a comparison of factors in the source and destination areas that affect the expansion of the geographical distribution of the pest, is: **LOW**.

Supporting information for this assessment is provided below:

- *Cecidomyia* sp. require fruiting grapevines to continue their life cycle (Zhang 2005b).
- Grapevines are widely and sporadically distributed throughout temperate regions of Australia in domestic and commercial environments and as abandoned vines where

climatic conditions may be less severe than in northern China and maybe more amenable for *Cecidomyia* sp. to establish.

- Emerging *Cecidomyia* sp. adults have wings and are active during the daytime, but with limited flight ability so they can only fly short distances from discarded fruit waste to a suitable host (Zhang 2005b). They also have short life spans which would also restrict the distance they can disperse (Skuhravá 1991).
- Gall midge adults may be dispersed longer distances through wind-assistance (EPPO 2004). However, unless the wind is blowing in the direction of suitable hosts (i.e. grapevines), it is unknown whether *Cecidomyia* sp. would land on a grapevine through wind-assistance.
- The dispersal of *Cecidomyia* sp. to previously uninfested areas may occur through transport of table and wine grapes infested with *Cecidomyia* sp. larvae.
- However, official state legislation controls the movement of wine and table grapes to ensure pests and diseases are not introduced into new areas in Australia (QDPIF 2008). This may reduce the spread of *Cecidomyia* sp. in Australia.

The limited natural dispersal mechanisms, moderated by potential human-assisted dispersal, two generations per year and limited host range which is widely but sporadically distributed in temperate Australia, support a risk rating for spread of 'low'.

4.7.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *Cecidomyia* sp. will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **VERY LOW**.

4.7.5 Consequences

The consequences of the establishment of *Cecidomyia* sp. in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are 'D', the overall consequences are estimated to be **LOW**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score:** C – Significant at the local level. *Cecidomyia* sp. only causes direct harm to grapes. The main damage caused by *Cecidomyia* sp. in Chinese table grapes is from holes in the surface of the fruit making the grapes inedible or unmarketable (Li 2004).
Other aspects of the environment	**Impact score**: A – Indiscernible at the local level. There are no known direct consequences of this pest on other aspects of the environment.

Criterion	Estimate and rationale
Indirect	
Eradication, control etc.	**Impact score:** C – Significant at the local level. Strict pest management programs are already in place for commercial table and wine grapes in Australia and *Cecidomyia* sp. may be controlled by these programs. For example, insecticides such as synthetic pyrethroids are already registered for and used in Australian vineyards to control other arthropod species (Bailey and Furness 1994). Therefore, an additional control program may not have to be implemented in infested vineyards to reduce fruit damage and yield losses, so production costs may not be greatly affected. However, in organic vineyards, home gardens and abandoned vineyards and grapevines, where strict pest control programs may not occur, *Cecidomyia* sp. may become a pest.
Domestic trade	**Impact score:** D – Significant at the district level. The presence of *Cecidomyia* sp. in commercial production areas may result in interstate trade restrictions on table and wine grapes. These restrictions may lead to a loss of markets.
International trade	**Impact score:** D – Significant at the district level. The presence of *Cecidomyia* sp. in commercial table grape production areas could have impacts on the export of Australia's table grape to countries where this pest is not present.
Environmental and non-commercial	**Impact score:** B – Minor significance at the local level. Additional pesticide applications or other control activities would be required to control this pest on organic table and wine grapes or abandoned grapevines. Any additional insecticide usage may affect the environment. However, any impact on the environment is likely to be minor at the local level.

4.7.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Cecidomyia* sp.	
Overall probability of entry, establishment and spread	**Very low**
Consequences	**Low**
Unrestricted risk	**Negligible**

As indicated, the unrestricted risk estimate for *Cecidomyia* sp. of 'negligible' achieves Australia's ALOP. Therefore, specific risk management measures are not required for this pest.

4.8 Grape whitefly

Aleurolobus taeonabe

Aleurolobus taeonabe, commonly known as the grape whitefly, is a 1.2 mm long insect (Li 2004) belonging to the whitefly family (Aleyrodidae). *Aleurolobus taeonabe* is described as *Aleyrodes taonaboe* in Li (2004). Whiteflies are tiny, white-winged moth-like insects with a fringe around the body (Blodgett 1992). They are major pests of tropical and subtropical crops and of protected crops in temperate regions (Caciagli 2007). Whitefly occur in groups and on the undersides of leaves (UC 1999).

Known hosts of *A. taeonabe* include *Mallotus japanoicus* (Euphorbiaceae), *Cercis chinensis* (Fabaceae), *Pittosporum tobira* (Pittosporaceae), *Osmanthus fragrans* (Oleaceae), *Tanabo japonica* (Theaceae) and *Vitus vinifera* (Vitaceae) (Dubey and Ko 2009). It is also reported on hawthorn (*Crataegus* spp.) (Li 2004). Given these hosts are from widely differing plant families it is likely that other, as yet unrecorded hosts, occur. Little information on the ecology of this pest appears to be available.

Aleurolobus taeonabe is known from China, Taiwan, Japan and India (Dubey and Ko 2009). In China, it is recorded from Hebei, Shandong and Shanxi provinces (Li 2004).

In China, *A. taeonabe* is reported to have three generations per year. Eggs overwinter on hawthorn bushes and hatch the following spring. First generation adults emerge in late May and leave hawthorn bushes and fly to grapevines to lay eggs on leaves. Eggs are scattered on grape leaves and hatched nymphs mostly feed on the back of grape leaves. Second generation adults emerge from late July to mid-August and also lay eggs on grapevine leaves. Adults and hatching nymphs continue to damage leaves and ripening fruit of grapevines. Third generation adults emerge in September and these lay eggs on other hosts e.g. hawthorn (*Crataegus* spp.). *Aleurolobus taeonabe* overwinters as eggs (Li 2004).

Aleurolobus taeonabe adults and nymphs suck plant juices from the leaves of grapevines. The leaves become yellow-brown and dry, then curl up and drop off the vine, leading to reduced vigour of the plant (Li 2004).

Damage to the grape bunches occurs when *A. taeonabe* adults and nymphs suck nutrients from ripening berries, leading to damage that reduces both yield and quality of the fruit (Li 2004). During the feeding process, whiteflies excrete honeydew, which can encourage the growth of sooty moulds on the plant host and may affect the quality of grape bunches (Blodgett 1992).

The risk scenario of concern for *A. taeonabe* is that second generation adults and their nymphs may be imported in table grape bunches.

4.8.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Probability of importation

The likelihood that *A. taeonabe* will arrive in Australia with the importation of table grapes from China is: **MODERATE**.

Supporting information for this assessment is provided below:

- *Aleurolobus taeonabe* has been recorded on table grapes (*Vitis vinifera*), including grape bunches (Li 2004; Dubey and Ko 2009)).
- *Aleurolobus taeonabe* has been reported in Hebei, Shandong and Shanxi in north-eastern China (Li 2004). Most Chinese table grapes for export are sourced from Xinjiang and Shandong, which account for 38.5% and 16.2% of the total table grape production area, respectively (AQSIQ 2006).
- Second generation *A. taeonabe* adults and their nymphs that appear from late July to mid-August (Li 2004) may be associated with table grapes harvested between August and October destined for export to Australia (AQSIQ 2008).
- Whilst feeding on leaves and fruit, whitefly adults and nymphs excrete honeydew on which black, sooty moulds may grow (Blodgett 1992). Grapes with high levels of infestation by whitefly adults and nymphs and/or with honeydew or sooty moulds present are unlikely to be selected for harvest.
- Inferior or defective bunches and grape berries are downgraded and removed by packing house staff during sorting and grading and before packing for export. These measures may assist in culling fruit that is not suitable for export and removing heavily infested grape bunches from the export pathway.
- It is not known if *A. taeonabe* nymphs and adults inside table grape bunches are able to survive cold storage before and during transportation and importation.

The association of adults and nymphs with grape bunches at harvest and visible sooty mould under high infestation, moderated by the poorly understood distribution and unknown incidence in table grapes in China, support a risk rating for importation of ‘moderate’.

Probability of distribution

The likelihood that *A. taeonabe* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **MODERATE**.

Supporting information for this assessment is provided below:

- Packed grapes are usually not processed or handled again until they arrive at the retailers, as they are easily damaged during handling (Mencarelli and Bellincontro 2005). Therefore, pests or pathogens in packed grapes are unlikely to be detected during transportation and distribution to retailers.
- Distribution of the commodity would be for retail sale, as the intended use of the commodity is human consumption. *Aleurolobus taeonabe* nymphs and adults present within grape bunches could potentially be distributed via wholesale and retail trade, and waste material could be generated in the form of discarded bunches or bunch stems. Transport of infested fruit is reported as the main means of dispersal of whiteflies to previously uninfested areas (Caciagli 2007).
- On arrival in Australia, it is expected that cool storage will be continued up to the point of retail sale. It is not known if *A. taeonabe* nymphs and adults can survive these conditions but cool and humid conditions may increase the longevity of individuals of this species.

- The majority of cold store facilities, grape retailers and consumers are located in metropolitan and suburban areas. Individual consumers will distribute small quantities of grapes to urban, rural and wild environments where they will be consumed or disposed of.
- Infested grape waste may be discarded into compost heaps or into domestic waste and end up in landfills. Some discarded grapes may end up close to grapevines and other potential hosts.
- *Aleurolobus taeonabe* adults may only fly short distances from discarded fruit waste searching for suitable hosts. Known hosts of *A. taeonabe* include *Mallotus japanoicus* (Euphorbiaceae), *Cercis chinensis* (Fabaceae), *Pittosporum tobira* (Pittosporaceae), *Osmanthus fragrans* (Oleaceae), *Tanabo japonica* (Theaceae) and *Vitus vinifera* (Vitaceae) (Dubey and Ko 2009). It is also reported on hawthorn (*Crataegus* spp.) (Li 2004). Adults may also be dispersed on the wind.

The association with infested fruit, moderated by the need to complete development and with limited flight ability to find a suitable host plant, supports a risk rating for distribution of 'moderate'

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *A. taeonabe* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **LOW**.

4.8.2 Probability of establishment

The likelihood that *A. taeonabe* will establish within Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **HIGH**.

Supporting information for this assessment is provided below:

- *Aleurolobus taeonabe* is reported to feed on grapevines and a range of other trees and shrubs, some of which are grown as ornamental and hedging plants in Australia. For example, *Pittosporum* spp. are widely used as hedging plants in temperate parts of Australia. Species of *Mallotus* and *Pittosporum* are native to Australia (Coleman 2008b; PlantNet 2009; ANPSA 2010; Florabank 2010). It is likely that suitable hosts for this pest will be available close to point of consumption as garden and hedging plants.
- This whitefly is recorded from China, Japan, India and Taiwan (Dubey and Ko 2009). The environment and climate in sub-tropical and more humid temperate regions of Australia, including irrigated areas in inland southern Australia, are likely to be suitable for establishment of *A. taeonabe*.
- It is likely that adult females will be mated and able to lay fertile eggs when they locate a host.
- In China, *A. taeonabe* is reported to have three generations per year on *V. vinifera* (Li 2004), which is a deciduous species in China and southern Australia. In Australia, this whitefly may continue to multiply on evergreen species such as *Mallotus* and *Pittosporum* species.

- *Aleurolobus taeonabe* can overwinter as eggs (Li 2004).
- Integrated pest management programs are used in grape production in Australia (Nicholas *et al.* 1994; UCANR 2008b) but are unlikely to prevent the establishment of *A. taeonabe.*
- Systematic control measures will not be in place for populations in suburban and natural environment or in abandoned vineyards. Populations may become a self-sustaining reservoir from which this species can spread.
- Several genera and species of whitefly (*Aleurolobus* spp., *Aleyrodes* spp. and *Aleurodicus* spp.) (Martin and Gillespie 2001) are present in Australia, demonstrating the suitability of conditions for their survival.

The fact that hosts of *A. taeonabe* are widely grown in Australia in suburban and urban environments where environmental conditions are suitable for its reproduction supports a risk rating for establishment of 'high'.

4.8.3 Probability of spread

The likelihood that *A. taeonabe* will spread within Australia, based on a comparison of factors in source and destination areas that affect the expansion of the geographic distribution of the pest, is: **HIGH**.

Supporting information for this assessment is provided below:

- Adult *A. taeonabe* are poor fliers (Caciagli 2007) but they may also be dispersed on the wind.
- Eggs and nymphs may be transported longer distances with infested plant material.
- Likely hosts of *A. taeonabe* (*Crataegus*, *Cercis*, *Mallotus*, *Pittosporum*, *Osmanthus*, *Tanabo* and *Vitus*) are widely grown in Australia as crops, ornamentals and for hedging. Some, such as *Pittosporum* spp., are widely used in gardens in temperate parts of Australia. Species of *Mallotus* and *Pittosporum* are native to Australia.
- Whiteflies have many natural enemies including predators, parasites and pathogens (Martin 1999) which may slow the spread of *A. taeonabe*.

The presence of host plants species that are widely distributed in Australia and its ability to disperse on the wind and as eggs and nymphs on nursery stock support a risk rating for spread of 'high'.

4.8.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *A. taeonabe* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **LOW**.

4.8.5 Consequences

The consequences of the establishment of *A. taeonabe* in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**E**', the overall consequences are estimated to be **MODERATE**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: E – Significant at the regional level. *Aleurolobus taeonabe* causes direct harm to a range of plant hosts including grapevines and a number of genera of trees and shrubs. These include species of *Mallotus* (Euphorbiaceae), *Cercis* (Fabaceae), *Pittosporum* (Pittosporaceae), *Osmanthus* (Oleaceae), *Tanabo* (Theaceae) (Dubey and Ko 2009) and hawthorn (*Crataegus* spp.) (Li 2004). These genera are grown as ornamentals and for hedging in urban and suburban Australia, while hawthorn is a weed in south eastern Australia. Given the wide range of plant families recorded as hosts, it is likely that this species will also attack other species and families. Infestations may result in reduced vigour and growth of affected plants. No reports of *A. taeonabe* acting as a vector of viruses have been found. Control programs for other whitefly pest in Australia may reduce the impact if this pest was introduced. About 20 species of *Pittosporum* are native to Australia and some species are widely distributed (ANPSA 2010; Florabank 2010). *Mallotus* spp. are native to rainforest habitats in northern and north eastern Australia (Coleman 2008b; PlantNet 2009). Some of these species will occur in National Parks and threatened ecological communities that are protected under State and Commonwealth law.
Other aspects of the environment	**Impact score**: B – Minor significance at the local level. Establishment of this whitefly into natural environments may lead to competition with native herbivores.
Indirect	
Eradication, control etc.	**Impact score**: D – Significant at district level. Existing pest management in commercial vineyards and in the nursery industry may or may not provide effective control for this insect. If populations of this insect became established in parks, gardens and natural habitats, it is unlikely that they could be eradicated. Native biological control agents (e.g. predatory ladybirds, parasitic wasps and fungal pathogens) commonly found in Australia attack native whiteflies (Nicholas *et al.* 1994) and may assist in the control of *A. taeonabe* in the field
Domestic trade	**Impact score**: D – Significant at district level. The presence of *A. taeonabe* in commercial vineyards may result in the imposition of measures for interstate trade in table and wine grapes. Measures may also be put in place on the movement of hosts (e.g. *Pittosporum*) that are widely grown and used by the nursery and landscaping industries. Honeydew excreted forms a substrate for the growth of black, sooty moulds, fouling fruit and impairing photosynthesis, and sometimes causing premature leaf drop. Sooty mould fouling reduces the value and marketability of produce and ornamentals.
International trade	**Impact score**: C – Significant at the local level. The presence of *A. taeonabe* in Australia may increase the costs of production of commercial table grapes for export to countries where this pest is not present.
Environmental and non-commercial	**Impact score**: B – Minor significance at the local level. *Aleurolobus taeonabe* is likely to be an additional pest of parks and gardens. Depending on the severity of infestations it may reduce the amenity value provided by affected species.

4.8.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Aleurolobus taeonabe*	
Overall probability of entry, establishment and spread	**Low**
Consequences	**Moderate**
Unrestricted risk	**Low**

As indicated, the unrestricted risk estimate for *A. taeonabe* of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.9 Grape phylloxera

Daktulosphaira vitifoliae

Daktulosphaira vitifoliae is commonly known as the grape phylloxera or grapevine root-aphid and belongs to the Phylloxeriidae family. *Daktulosphaira vitifoliae* attacks the leaves and/or roots of some plants in the genus *Vitis* including those of commercial grapevines; feeding on roots of the vine will lead to death of the plant (Corrie *et al.* 2003). This pest causes considerable losses in both quality and yield of grapevines throughout many grape producing areas around the world (PGIBSA 2003; INRA 2009).

Daktulosphaira vitifoliae was first observed in China in 1892 (Sun *et al.* 2009) and is present in Liaoning, Shaanxi and Shandong provinces, where it is considered a domestic quarantine pest (AQSIQ 2009a). Sun *et al*. (2009) identified 13 clonal types belonging to two clades and related to populations in different areas of the USA and suggestive of two separate introductions into China. *Daktulosphaira vitifoliae* is also present in Australia, where it is also a domestic quarantine pest and strict quarantine restrictions have been in place since 1917 (Umina *et al.* 2007). It is under official control and restricted to parts of New South Wales and Victoria (Loch and Slack 2007).

The roots of European grapevine, *Vitis vinifera*, are extremely susceptible to attack by *D. vitifolia*e but the leaves are resistant to clones present in Australia; leaf attacking clones have been reported overseas (Botton and Walker 2009; Molnár *et al.* 2009). Populations of *D. vitifoliae* in Australia mostly feed on roots. Leaf gall formation is rare, occurring in humid conditions in late summer on leaves of American *Vitis* species or their hybrids (Loch and Slack 2007). The roots of American species *V. berlandieri, V. rupestris* and *V. riparia* are resistant to attack (Skinkis *et al.* 2009), but their resistance to leaf attack appears to vary depending on the *D. vitifolia*e genotype (Downie *et al.* 2000; Granett *et al.* 2001). The use of resistant American species as rootstock is advised for establishing new grapevines in Australia (PGIBSA 2003). However, the cost of grafted rootstocks can be a limitation for some growers (Powell 2008b).

Umina *et al.* (2007) surveyed roots and leaves in *D. vitifoliae*-infested areas of Australia and reported 83 genotypes, of which 11 occur both on leaves and roots, 23 on leaves and the remaining 49 on roots. Those that occur on leaves in Australia are mainly restricted to areas in north-eastern Victoria and are found on leaves from rootstocks other than *V. vinifera* (Thomas 2010).

The life cycle of *D. vitifoliae* has recently been reviewed by Forneck and Huber (2009) and in common with other members of the superfamily Aphidoidea the life cycle is complex (Downie 2006). During spring and summer *D. vitifoliae* reproduces parthenogenetically on the roots and/or on the leaves of susceptible plants. Wingless females 0.8–1.5 mm long, produce eggs up to 0.25–0.3 mm long and 0.18–0.2 mm wide (Forneck and Huber 2009) with approximately 50 eggs (Granett *et al.* 2001) or up to 400–600 eggs (Skinkis *et al.* 2009) produced per female. The number of parthenogenetic generations produced ranges from 3–4 (Forneck and Huber 2009) to 3–10 (Granett *et al.* 2001). These eggs hatch into the first instar (crawler stage) that can move between leaves and roots (Forneck and Huber 2009). Three typically sedentary instars occur before the adult is produced (Granett *et al.* 2001). If disturbed these later instars can relocate to another feeding site (Kingston *et al.* 2009). For populations living on roots the first instar is considered to be the overwintering stage (Granett *et al.* 2001).

During summer and autumn the wingless females living on roots produce winged sexupara (Forneck and Huber 2009) also often termed alates that move to the leaves and may fly to disperse (Granett *et al.* 2001). Downie (2006) has suggested that crowding and resource deterioration induce the formation of sexupara as much as cooler weather. Where the environment is suitable, the sexupara then go on to produce 4–8 eggs per female which hatch to produce male and female sexuals (Forneck and Huber 2009). After mating, the female lays a single sexual egg under bark. This is an overwintering stage which hatches into a fundatrix next spring. This stage produces the next round of wingless females (Forneck and Huber 2009).

On leaves during summer to late autumn, the wingless females do not produce alates and instead produce wingless sexupara and the life cycle continues as described above except that the number of sexual eggs produced by these wingless sexupara ranges between 1–63, but if they are producing asexual eggs the range is between 1–90 (Downie and Granett 1998). Based on the different data sources quoted above, the number of asexual eggs produced seems to vary between 1–600 per female. There is no explanation in the literature for such a wide ranging level of fecundity but possibly there are genotypic and climatic factors involved.

The life cycle described above is not the only mode of reproduction available to *D. vitifolia.* Forneck and Huber (2009) describe reports in earlier literature that found that wingless females on roots can also produce wingless sexupara that produce sexuals which produce eggs that hatch into a fundatrix that can feed on roots and produce wingless females.

The root gall form is more commonly found in China (Li 2004; Zhang 2005b), where there are extensive commercial plantings of European grapevines for table and wine grapes. In China, early instar nymphs overwinter on roots and become active in April (Li 2004). By June, winged adults begin to emerge from the soil and fly to the vines (Li 2004). *Daktulosphaira vitifoliae* has up to eight generations per year in China and reproduces both parthenogenetically and more rarely, sexually (Li 2004).

The risk scenario of concern for *D. vitifoliae* is that winged adults or crawlers may be imported in table grapes. *Daktulosphaira vitifolia* may become established outside of its existing limited distribution in eastern Australia. It may then spread throughout the wine, table grape and dried fruit growing regions of Australia, with potential serious consequences for these grape based industries.

4.9.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Probability of importation

The likelihood that *D. vitifoliae* will arrive in Australia with the importation of table grapes from China is: **MODERATE**.

Supporting information for this assessment is provided below:

- *Daktulosphaira vitifoliae* has been recorded on table grapes (*Vitis vinifera*) in the provinces of Shaanxi, Shandong and Liaoning in China (Li 2004). Most Chinese table grapes for export are sourced from Xinjiang and Shandong with 38.5% and 16.2% of the total table grape production area, respectively (AQSIQ 2006).

- Sun *et al.* (2009) report that *D. vitifoliae* has spread within China as no strict quarantine restrictions are implemented for the movement of grapevine seedlings. Mechanisms for preventing the spread of *D. vitifoliae* with grape products, machinery and personnel, and travel by visitors have not been identified as in place in China. As it can be several years before an outbreak is detected (Loch and Slack 2007), it is assumed that *D. vitifoliae* has the potential to establish and spread throughout the grape growing areas of China.
- In China, grapes are mostly harvested between August and October (AQSIQ 2006; AQSIQ 2009b). During this time, winged *D. vitifoliae* or crawlers may be associated with harvested grapes destined for export to Australia. The first instar crawlers are about 0.3 mm long (King and Buchanan 1986). Owing to their small size, it is unlikely that those in or on the bunches will be observed during routine field and packing house procedures. Winged adults are larger than crawlers, being about 2 mm long (Forneck and Huber 2009), but they may still be too small to be observed, particularly if they are in the bunch.
- Packed grapes for export are transported from China in cold humidified storage to ensure grape quality is maintained. AQSIQ (2008) report storage and transport conditions for grapes as 0–1 °C for temperature and 85–95% for relative humidity. It is unknown if *D. vitifoliae* will survive in table grapes under routine commercial conditions during cold storage, transportation and export. The crawlers have been reported to survive under water for six or more days (Powell 2008a) and without food for seven days at 25 °C (Kingston *et al.* 2009). For populations living on roots, the first instar is considered to be the overwintering stage (Granett *et al.* 2001). The first instar may survive temperatures associated with cold storage and transport.

The association of winged and crawler dispersal stages of *D. vitifoliae* with grape bunches, their limited capacity to be detected in normal picking and packing procedures combined with the uncertainty about survival of storage and transport conditions support a risk rating for importation of ‘moderate’.

Probability of distribution

The likelihood that *D. vitifoliae* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **MODERATE**.

Supporting information for this assessment is provided below:

- Packed grapes are usually not processed or handled again until they arrive at the retailers as grapes are easily damaged through rough handling and impacts due to their thin skins (Mencarelli and Bellincontro 2005). Therefore, any alates or crawlers of *D. vitifoliae* in the packed grapes are unlikely to be detected during transportation and distribution to retailers.
- In Australia, commercial table grapes are transported and distributed under controlled conditions (0–0.5 °C and 90–95% relative humidity) to ensure quality is maintained (Sydney Postharvest Laboratory and Food Science Australia 2001). The majority of cold store facilities, grape retailers and consumers are located in metropolitan and suburban areas.
- The first instar crawlers are the overwintering stage, for populations on roots stage (Granett *et al.* 2001) so they may have a good chance of surviving temperatures associated

with transport and storage in Australia. It is unknown whether *D. vitifoliae* will survive in table grapes under routine commercial conditions during transportation and cold storage.

- Distribution of the commodity would be for retail sale, as the intended use of the commodity is human consumption. *Daktulosphaira vitifoliae* alates or crawlers present within the fruit could potentially be distributed via wholesale and retail trade and waste material could be generated in the form of discarded bunches or bunch stems. Infested grape waste may be discarded into compost heaps or into domestic waste and end up in landfills. Individual consumers may distribute small quantities of grapes to urban, rural and wild environments where they will be consumed or discarded. Some discarded grapes may end up close to grapevine plantings.
- In the absence of any disinfestation measures, transport of infested fruit is considered to be a potential means of dispersal of *D. vitifoliae* to uninfested areas (NVHSC 2005).
- In Australia, *D. vitifoliae* feed on the roots of *Vitis vinifera* and on leaves of grapes derived from American rootstocks (Loch and Slack 2007). Grapevines are widely and sporadically distributed throughout Australia. Domestic plantings, both in a maintained and abandoned condition, occur throughout Australia in all or most Australian towns and by many farm houses.
- Domestic plantings which also include ornamental varieties are not expected to be resistant to *D. vitifoliae.* Some ornamental varieties are capable of supporting the leaf galling phase of the life cycle (NVHSC 2005).
- Table grape production occurs in the Northern Territory and all Australian states (DPIW Tasmania 1999; Australian Table Grape Association 2008),, but these states do not typically use resistant rootstocks (Thomas 2010). Extensive wine grape plantings are found across the south-eastern quarter of Australia and southwest of Western Australia (Kiri-ganai Research Pty Ltd 2006). Trethowan and Powell (2007) report that more than 80% of these plantings use ungrafted non-resistant rootstock. However, resistant rootstocks can still support populations of *D. vitifoliae* (Granett *et al.* 2005).
- Adult winged *D. vitifoliae* have been recorded flying up to 48 m (Stevenson and Jubb, Jr. 1976). However, while winged adults are part of the sexual cycle, the sexual cycle occurs very rarely in areas where *D. vitifoliae* is present in Australia and currently winged adults are believed not to be a risk factor for the commencement of a new generation (NVHSC 2005). If sexual reproduction is influenced by climatic factors, then the introduction of *D. vitifoliae* to some other regions of Australia may prompt more frequent occurrences of sexual reproduction. This could make dispersal by alates from imported grapes more of a concern.
- Crawlers may be dispersed randomly by wind. King & Buchanan (1986) reported detection of crawlers in traps up to 20 m from the nearest vine. They also found that phylloxera migrated typically 15–27 m per year in vineyards with distances up to 103 m occurring. The patterns of spread were consistent with wind dispersal. Powell (2008a) states “Phylloxera do not crawl further than a few dozen meters”. However, windblown dispersal of crawlers of at least 61 m is possible (Hawthorne and Dennehy 1991).
- *Daktulosphaira vitifoliae* feeds either on grape leaves or on roots; they do not feed in bunches. First instar nymphs can survive without food, but with access to water for seven days at 25 °C under laboratory conditions (Kingston *et al.* 2009). Since the import of

grapes is mostly expected to occur from winter to spring, environmental conditions in southern Australia may be suitable for crawler survival.

The evidence that infested fruit may go undetected until sold, is moderated by the fact that *D. vitifoliae* do not feed in bunches but need to move to grapevines to complete their development, supporting a risk rating for distribution of 'moderate'.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *D. vitifoliae* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **LOW**.

4.9.2 Probability of establishment

The likelihood that *D. vitifoliae* will establish within Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **HIGH**.

Supporting information for this assessment is provided below:

- *Vitis* species are the only recorded hosts of *D. vitifoliae* (Li 2004; Frolov and David'yan 2009). In its natural range east of the Rocky Mountains in the USA, *D. vitifoliae* attacks approximately half of the *Vitis* species examined, with the level of leaf infestation not equal across the different species attacked (Downie *et al.* 2000). *Vitis vinifera* was not a component of the flora found in the natural range of *D. vitifoliae* and has no resistance to this pest. Only *V. vinifera* grown on rootstocks derived from American species have been found to be tolerant or resistant to root feeding *D. vitifoliae.*
- Grapevines are widely and sporadically distributed throughout Australia. Domestic garden plantings, both in a maintained and abandoned condition, occur throughout Australia in all or most Australian towns and by many farm houses. Such plantings are not expected to be resistant to *D. vitifoliae.* Table grape production occurs in the Northern Territory and in all Australian states (DPIW Tasmania 1999; Australian Table Grape Association 2008), and the rootstocks that are used have been selected for vigour rather than resistance to infestation by *D. vitifoliae* (Thomas 2010). Extensive wine grape plantings are found across the south-eastern quarter of Australia and southwest of Western Australia (Kiri-ganai Research Pty Ltd 2006). Trethowan and Powell (2007) report that more than 80% of these plantings use ungrafted non-resistant rootstock.
- *Daktulosphaira vitifoliae* appears to be able to survive under most of the climatic conditions where its host is present (CABI-EPPO 1997e). While it is native to North America it is now widely distributed in many countries in Asia, Africa, North and South America and Europe (CABI-EPPO 1997e).
- *Daktulosphaira vitifoliae* need living *Vitis* species to complete their life cycle. The dispersive stages for *D. vitifoliae* are the crawlers and winged adults, the most important of which under Australian conditions where *D. vitifoliae* is presently established are the crawlers (NVHSC 2005). Because an infestation of *D. vitifoliae* can eventually lead to the death of the vine, *D. vitifoliae* will need to be capable of local movement to maintain establishment in a local area.

- *Daktulosphaira vitifoliae* is already established in small areas of Victoria and New South Wales in Australia (Loch and Slack 2007), where it is under official control (NVHSC 2005). In Australia, several generations per year develop each growing season (NVHSC 2008) and it is obligately or functionally parthenogenetic (Herbert *et al.* 2010). *Daktulosphaira vitifoliae* can produce large number of offspring with up to 600 eggs being reported (CABI-EPPO 1997e; Skinkis *et al.* 2009). The eggs develop into nymphs that establish feeding sites (Powell 2008b).

The parthenogenetic reproduction rate and number of generations developing per growing season, a wide climatic tolerance and existing presence in limited areas of Australia, all support a risk rating for establishment of 'high'.

4.9.3 Probability of spread

The likelihood that *D. vitifoliae* will spread within Australia, based on a comparison of those factors in source and destination areas that affect the expansion of the geographic distribution of the pest, is: **MODERATE**.

Supporting information for this assessment is provided below:

- *Daktulosphaira vitifoliae* is already established in small areas of New South Wales and Victoria in Australia (Loch and Slack 2007), where it is under official control (NVHSC 2005). In Victoria it is in the Nagambie, Mooroopna, Upton, north-east Victoria (Rutherglen, King Valley, Milawa, Wangaratta and Bright) and Maroondah areas. In NSW it is and the Albury/Corowa and Greater Hume areas (excluding Culcairn and Holbrook), and the Sydney area (Loch and Slack 2007). This represents 2% of Australia's total grape production area (Powell 2008a).
- The pest is found in most grape-growing areas of the world and appears to survive in all climates where grapevines are grown (CABI-EPPO 1997e). It is present in cold winter climate regions such as north China, Canada, and Austria, in hot arid regions of Africa such as Algeria and Morocco and in hot and humid regions such as Panama, Colombia and Venezuela (CABI-EPPO 1997e). Grapevines are grown in Australia from hot humid areas such as Darwin through warm and temperate areas of southern mainland Australia to cool temperate areas of the south eastern highlands and Tasmania (DPIW Tasmania 1999; Kiri-ganai Research Pty Ltd 2006; Australian Table Grape Association 2008). Grapes grown on *V. vinifera* rootstocks or *V. vinifera* hybrid rootstocks in any of these Australian production areas would be susceptible to damage.
- *Daktulosphaira vitifoliae* need *Vitis* species to complete their life cycle. Dispersal can occur naturally, including crawling of the insect from vine to vine, and by the wind or by human assisted means (NVHSC 2005).
- The dispersive stages for *D. vitifoliae* are the crawlers and winged adults, the most important of which are the crawlers (NVHSC 2005). Crawlers have been recorded being transported up to 61 m by wind (Hawthorne and Dennehy 1991) and within vineyard spread of *D. vitifoliae* (presumably by crawlers) up to 103 m in a year has been recorded (King and Buchanan 1986). Dispersal of alates has been reported to be at least 48 m (Stevenson and Jubb, Jr. 1976), but based on the apparent absence of sexual reproduction in existing populations of *D. vitifoliae* in Australia (Umina *et al.* 2007) the alates appear to have no functional role under Australian conditions where *D. vitifoliae* is established.

Buchanan (1987) was unable to detect any evidence of natural spread between vineyards 2 km apart. The potential for *D. vitifoliae* to spread by natural means seems limited.

- *Daktulosphaira vitifoliae* can also be moved by people on grapevine cuttings, prunings, rootstocks, grapes, fresh juice, fresh must, soil, other equipment and tools (NVHSC 2005; Powell 2008a).
- The movement of commercial table grapes is not considered to be a significant risk for the spread of *D. vitifoliae* between Australian vineyards (NVHSC 2005) because sulphur pads are used to disinfest cartons of transported table grapes from infested areas (NVHSC 2004).
- Infestations may not be obvious unless the roots are inspected. Loch and Slack (2007) report that yellowing of vines may not occur until 2-3 years after infestation, delaying detection. However, genotypes of *D. vitifoliae* that have low virulence may not be as readily detected. Powell (2008a) indicates one infestation went undetected for 30 years. Mature storage roots of resistant rootstocks may not support infestations but populations of *D. vitifoliae* can occur on immature and feeder roots (Granett *et al.* 2005). Human assisted movement from these sources may go unnoticed.
- It is assumed that the strict quarantine restrictions that have been in place since 1917 (Umina *et al.* 2007) have largely confined the spread of *D. vitifoliae* in Australia. However, regardless of these measures, infrequent outbreaks in Australia outside of the quarantine zone still occur such as in Victoria's Yarra Valley and Muchison in 2006 and at Macedon in 2008 (Powell 2008a). The Yarra Valley outbreak was 260 km from the nearest infestation (Powell 2008a) indicating a strong potential for spread for any populations established outside quarantine areas.
- Botha *et al.* (2007) report that more than half of existing land planted vines in Western Australia would be highly susceptible for the spread of *D. vitifoliae* based on soil types. Sandy soils seem to give some protection to vines from *D. vitifoliae* (Granett *et al.* 2001; Gale 2002).

The demonstrated potential for human assisted spread and the distribution of hosts in Australia, moderated by the limited natural dispersal mechanisms, support a risk rating for spread of 'moderate'.

4.9.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *D. vitifoliae* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **LOW**.

4.9.5 Consequences

The consequences of the establishment of *D. vitifoliae* in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**E**', the overall consequences are estimated to be **MODERATE**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: E – Significant at the regional level. *Daktulosphaira vitifoliae* only causes direct harm to grapevines (*Vitis* spp.). *Daktulosphaira vitifoliae* can form galls on the roots and leaves of susceptible plants with root feeding allowing the entry of fungi into the roots leading to decline of the plants (Granett *et al.* 2001). Most infestations of *D. vitifoliae* render vineyards uneconomic. The presence of *D. vitifoliae* in previously uninfected areas will result in control measures that require the complete removal of infested vines and their replacement with grapevines grown on phylloxera tolerant-rootstock (PGIBSA 2003). This appears to not always be the case. Herbert *et al.* (2010) indicates one infestation in the Rutherglen region of Australia on *V. vinifera* has been present for 40 years without presenting visible symptoms or causing yield loss. The reason for this is unknown. The type of *D. vitifoliae* clone present will also have an impact on the level of damage in a vineyard (Herbert *et al.* 2010). However, the assumption used in this analysis is that plants in infested vineyards will need to be replaced with resistant rootstock. There were more than 173 000 ha of Australia planted to commercial grapes in 2007 (McGrath-Kerr Business Consultants Pty Ltd 2008). Most of these plantings are for wine grapes (ABS 2009c) with >10 500 ha growing table grapes (Australian Table Grape Association 2008). Approximately 80% of these wine grape plantings are on rootstock that is not resistant to *D. vitifoliae* (Trethowan and Powell 2007). Hathaway (2009) estimated a 12 year cumulative loss of income to be $75 000 for infested vineyards that are to be replanted over seven years commencing three years after an infestation was first detected and based on a 10 ha block size, 7t/ha yield, $1500/t selling price and management costs of $7000/ha. However, this estimate is approximate as selling price is variable. For example, the price per ton for grapes in South Australia in 2006 varied from as low as $89/t at McLaren Vale to $10 000/t in the Barossa Valley (Kiri-ganai Research Pty Ltd 2006). In 2007/08 the value of the Australian wine produced was $4.77 billion of which $2.1 billion was sold locally (ABS 2009c). Very few, if any, table and dried fruit grapevines are on resistant rootstock (Thomas 2010) and therefore most, if not all, of this production would be susceptible if *D. vitifoliae* were to spread to these production areas. Annual production of table grapes is about 120 000 t (Australian Table Grape Association 2008). In 2008/09 Australia exported 70 000 t of table grapes at prices of between $2.08/kg to $3.34/kg (ABS 2009b). Dried grape production was 56 139 t in 2008 and was as high as 135 412 t in 2005 (ABS 2009c). Fruit bearing vines in home gardens are also expected to be susceptible and would need to be replaced. Ornamental vines may have some resistance, but if so, then it is likely that their leaves will develop galls and the infestation may be detected.
Other aspects of the environment	**Impact score**: A – Indiscernible at the local level. There are no known direct consequences of this species on other aspects of the environment. It is assumed that infested plants will either die and/or be pulled out, and in commercial operations replanted with resistant rootstock (see below).
Indirect	
Eradication, control etc.	**Impact score**: E – Significant at the regional level. There is no proven chemical method to eradicate *D. vitifoliae* on roots of ungrafted *V. vinifera* grapevines (Loch and Slack 2007), so additional pesticide applications would not be effective. Approximately 80% of Australia's commercial wine grapevines are ungrafted *V. vinifera* and are susceptible to *D. vitifoliae* (Trethowan and Powell 2007) and very few, if any, table and dried fruit grapevines are on resistant rootstock (Thomas 2010). The only control measure is to replant infested vineyards with rootstock that is resistant to *D. vitifoliae* (PGIBSA 2003). The costs of this procedure per hectare for grafted plants alone appear to be around $7200 (Hathaway 2010) compared to between $2500 (QDEEDI-PIF 2009) to $3500 (Strahan 2006) for ungrafted plants. In addition there may be ground preparation costs and planting costs that may add a further $1875 per hectare (Strahan 2006). Mature storage roots of resistant rootstocks may not support infestations but populations of *D. vitifoliae* can occur on immature and feeder roots (Granett *et al.* 2005). This means other measures to control any spread of the infestation from these areas would also involve additional costs. These measures include procedures for moving grape material, transport of grapes and grape products, cleaning and disinfestation of vineyard machinery and hygiene procedures for personnel and visitors (NVHSC 2004).

Criterion	Estimate and rationale
Domestic trade	**Impact score**: D – Significant at the district level. The presence of *D. vitifoliae* in commercial production areas results in movement restrictions of grapes and grape products out of infested areas (e.g. NSW Govt Plant Diseases Act 1924 Proclamation P176 (2006), and NSW Industry and Investment (2010). The restrictions may lead to a loss of markets. Such restrictions can include vineyard soil, cuttings, potted plants, unprocessed wine grapes or non-packaged table grapes (Loch and Slack 2007). However, the movement of commercial table grapes is not considered to be a significant risk for the spread of *D. vitifoliae* between Australian vineyards (NVHSC 2005). This is due to the requirement in the national phylloxera management protocol for sulphur pads in cartons of transported table grapes (NVHSC 2004). Sulphur pads are known to control phylloxera in table grapes (APVMA 2009).
International trade	**Impact score**: C – Significant at the local level. The presence of *D. vitifoliae* in wine grape areas and commercial dried fruit production areas would not have an impact on the export of these products other than loss of production. The presence of *D. vitifoliae* in commercial table grape production areas could have impacts on the export of Australia's table grapes to countries where this pest is not present. This pest is widely distributed in many countries in Asia, Africa, North and South America and Europe (CABI-EPPO 1997e). In 2008/09 Australia exported 70 000 t of table grapes; of this 62 000 t went to eight countries: 25 701 t went to Hong Kong, 8842 t to Indonesia, 8267 t to Thailand, 5429 t to Singapore, 5213 t to Malaysia, 4271 t to Vietnam, 3009 t to the United Arab Emirates, and 1937 t to New Zealand (ABS 2009b). *Daktulosphaira vitifoliae* does not appear to be present in six of the major eight export destinations: Hong Kong, Thailand, Singapore, Malaysia, Vietnam or the United Arab Emirates (CABI-EPPO 1997e; Botha *et al.* 2000). Sulphur pads are known to control phylloxera in table grapes (APVMA 2009) and is the method used in Australia (NVHSC 2005). While this control method is standard practice in Australia and should also be effective in export table grapes, there may be potential for some delay in getting such a method accepted outside of Australia when this pest is not present.
Environmental and non-commercial	**Impact score**: B – Minor significance at the local level. Grapevines are grown in domestic gardens for both food and amenity value as shade or ornamental features. Infested grapevines would need to be removed and the garden may lose some of its amenity value.

4.9.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Daktulosphaira vitifoliae*	
Overall probability of entry, establishment and spread	**Low**
Consequences	**Moderate**
Unrestricted risk	**Low**

As indicated, the unrestricted risk estimate for *D. vitifoliae* of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.10 Soft scales

Parthenolecanium orientalis, Parthenolecanium corni [EP, WA]

Parthenolecanium corni is not present in the state of Western Australia and is a pest of regional quarantine concern for that state.

The biology and taxonomy of these species is considered sufficiently similar to justify combining them into a single assessment. In this assessment, the term 'scales' is used to refer to these two species unless otherwise specified.

Parthenolecanium corni and *P. orientalis* belong to the scale insect family, Coccidae or soft scale insects. Soft scale insects are sessile, small and often inconspicuous and are covered with a wax secretion that covers adult females and immature males. There are three life stages; eggs, nymphs and adults. The life cycle of the female scale includes an egg stage, two nymphal stages and an adult stage. The male scale has one egg stage, four nymphal or instar stages and an adult stage which is winged (David'yan 2009). The first nymphal stage or instar is called a 'crawler' and has functional legs (David'yan 2009) and is the main dispersal stage. Crawlers may be dispersed by wind, animals and by human transport of infested material. Apart from the winged male, the other stages are mostly sedentary but once the crawlers settle and feed on leaf undersides, later instars may migrate to stems and branches on the host plant (CABI 2005).

Scales cause major problems in agricultural and ornamental ecosystems and are commonly transported on plant materials (CABI 2005). Due to their small size and habit of feeding in concealed areas, they are frequent invasive species causing billions of dollars (US) in damage annually in the USA (Miller *et al.* 2007). In the USA there are 42 introduced species of soft scales and 41 of them are pests (Miller *et al.* 2007). *Parthenolecanium* spp. soft scale nymphs produce honeydew as they feed. Sooty mould may grow on the honeydew, causing blackened areas on leaves and fruit. Ants may also be observed feeding on honeydew. When soft scales occur in abundance, they may stunt vine growth (David'yan 2009).

The main economic damage caused by soft scales is from the downgrading of fruit quality caused by sooty mould fungi growing on the honeydew produced by these insects.

Parthenolecanium corni and *P. orientalis* occur throughout China (Zhang 2005b; AQSIQ 2007). Both soft scale species have similar life cycles and both have the same number of nymphal instars and two generations a year in China (Zhang 2005b).

In spring, overwintering second instar *P. corni* nymphs emerge from grapevine leaves and cracks in grapevine branches and move to branches where they feed, producing lots of honeydew. They remain there for the rest of their life cycle. These nymphs pass through the third instar stage and mature into adults. Adult males are very small (1.7 mm long) with two wings and are rare (David'yan 2009). Adult females are small (3–6.5 mm long, 2.0–4.0 mm in width and 4.0 mm in height) and covered in a shiny brown leathery domed shell (University of California 2003). They are sessile and reproduce primarily parthenogenetically (without mating), laying 1000–3000 eggs beneath the female's body under her shell. The female then dies, leaving the eggs protected by her shell (University of California 2003).

The first generation eggs hatch at the beginning of summer (early June) and first instar nymphs or "crawlers" move out from under the shell onto grapevine shoots, leaves and fruit of the current season's growth to feed on sap. *Parthenolecanium corni* disperses as the first

instar or crawler by wind, animal vectors and movement of infested material by humans. Life stages are mostly sessile apart from the winged male (Zhang 2005b).

The nymphs pass through the instar stages and mature into second generation adults. The second generation adult females lay eggs in July. Second generation crawlers appear in early to mid-August and migrate to the undersides of leaves for feeding and also to young branches and fruit. The second generation nymphs migrate to cracks in grapevine trunks and branches in October to overwinter (Zhang 2005b).

Parthenolecanium orientalis also has one or two generations a year in China. In Shandong and Henan, it has two generations a year in locust trees and grapes, but one generation on peach trees (AQSIQ 2007). In grapes, the second generation nymphs overwinter in cracks on the stem and underside of branches, leaves and old skins (AQSIQ 2007). Nymphs start moving to branches to feed from middle to late March and develop into adults in late April. Over a period of about a month, adults lay a few hundred to a thousand eggs. These first generation eggs start hatching in the middle of May and peak in late May to early June.

First instar nymphs or crawlers appear from mid-May to early June and initially feed on the back of grape leaves. They move to the new branches and flower buds of grapevines in the middle of June. First generation adults emerge in the middle of July and lay second generation eggs. These eggs hatch from late July to early August and second generation nymphs initially feed on leaves before moving to branches to overwinter in September (Li 2004). Li (2004) reports that *P. orientalis* feeds on vines, grape bunches and berries.

Parthenolecanium orientalis attacks grapevine (*Vitis vinifera*) (Li 2004), currants (*Ribes* spp.), Chinese wisteria (*Wisteria chinensis*), plums, cherries, peaches, apricots and almonds (*Prunus* spp.) and willow (*Salix* spp.) (Ben-Dov 2006a). *Parthenolecanium corni* is highly polyphagous, attacking some 350 plant species placed in 40 families (Ben-Dov 2006a). Due to the recognised biological and economic importance of *P. corni*, it was used as the basis for this risk assessment.

The risk scenario of concern is that imported bunches of Chinese table grapes may contain feeding *P. orientalis* and *P. corni* adult females and nymphs.

Parthenolecanium corni was assessed in the existing import policy for table grapes from Chile (Biosecurity Australia 2005d). The assessment of *P. corni* and *P. orientalis* presented here builds on this previous assessment.

The probability of importation for *P. corni* was rated as ‘high’ and the probability of distribution was rated as ‘low’ in the assessment for table grapes from Chile (Biosecurity Australia 2005d). However, differences in horticultural practices, climatic conditions and the prevalence of the pests between the previous export area (Chile) and China make it necessary to re-assess the likelihood that scales *P. corni* will be imported into Australia with table grapes from China.

The probability of distribution for *P. corni* will not differ for the same commodity (table grapes) after arrival in Australia. The probability of establishment and of spread of *P. corni* in Australia, and the consequences will also be similar. Accordingly, there is no need to re-assess these components.

4.10.1 Reassessment of probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues respectively.

Reassessment of probability of importation

The likelihood that *P. corni* and *P. orientalis* will arrive in Australia with the importation of table grapes from China is: **HIGH**.

Supporting information for this assessment is provided below:

- *Parthenolecanium corni* and *P. orientalis* are found in many provinces of China, including the main table grape production provinces such as Xinjiang and Shandong (Li 2004; Zhang 2005b; AQSIQ 2007).
- Once the first instars or crawlers settle on a suitable host, grapevine in this case, subsequent nymphs and adults inside the scale covers are sessile and remain attached to their host. The small size of *P. corni* and *P. orientalis* adult females and nymphs, may make them difficult to detect, especially at low population levels. Therefore, table grape sorting, grading and packing processes may not remove them effectively from the export pathway.
- Nymphs initially feed on the undersides of leaves and new branches before moving to branches to overwinter in September. Nymphs and adults feed on grapevine leaves, bark of branches and sometimes fruit (Li 2004; Zhang 2005b; AQSIQ 2007; David'yan 2009). Scales are likely to be on table grapes during harvest time (Li 2004; Zhang 2005b).
- *Parthenolecanium corni* overwinter on grape branches as second instar nymphs (Li 2004; Zhang 2005b; AQSIQ 2007). They are likely to survive cold storage and transportation as *P. corni* have been intercepted on table grapes imported from Chile into New Zealand (MAF New Zealand 2005) and the USA has also intercepted them on grape imports from France and Chile (Gill 1988; Miller *et al.* 2007).

The small size, sessile nature of most life stages and cold tolerance, all support a risk rating for importation of ‘high’.

4.10.2 Probability of distribution, establishment and of spread

As indicated above, the probability of distribution, of establishment and of spread for these scales would be the same as those assessed for table grapes from Chile (Biosecurity Australia 2005d). The ratings from the previous assessment are presented below:

Probability of distribution: **LOW**

Probability of establishment: **HIGH**

Probability of spread: **MODERATE**

4.10.3 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *P. corni* and *P. orientalis* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **LOW**.

4.10.4 Consequences

The consequences of the establishment of *P. corni* in Australia have been estimated previously for Chilean table grapes (Biosecurity Australia 2005d). This estimate of impact scores is provided below expressed in the current scoring system (Table 2.3).

Plant life or health	**D**
Other aspects of the environment	**B**
Eradication, control etc.	**D**
Domestic trade	**C**
International trade	**C**
Environment	**B**

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**D**', the overall consequences are estimated to be **LOW**.

4.10.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Parthenolecanium orientalis* and *Parthenolecanium corni* [WA]	
Overall probability of entry, establishment and spread	**Low**
Consequences	**Low**
Unrestricted risk	**Very low**

As indicated, the unrestricted risk estimate for *P. orientalis* and *P. corni* of 'very low' achieves Australia's ALOP. Therefore, specific risk management measures are not required for these pests.

4.11 Mealybugs

Pseudococcus comstocki [EP], *Pseudococcus maritimus* [EP], *Planococcus kraunhiae* [EP]

The biology and taxonomy of these species is considered sufficiently similar to justify combining them into a single assessment. In this assessment, the term 'mealybug' is used to refer to these three species unless otherwise specified.

Pseudococcus comstocki (Comstock's mealybug), *Ps. maritimus* (grapevine mealybug) and *Planococcus kraunhiae* (Japanese mealybug) belong to the Pseudococcidae or mealybug family. Mealybugs are small, oval, soft-bodied insects that are covered with a white, cottony or mealy wax secretion that is moisture repellent and protects them against desiccation (University of Minnesota 2007). Mealybugs are sucking insects that injure plants by extracting large quantities of sap. This weakens and stunts plants, causing leaf distortion, premature leaf drop, dieback and even plant death (University of Minnesota 2007). They may also cause indirect damage by injecting toxins or plant pathogens into host plants (e.g. grapevine leafroll virus, mealybug pineapple wilt (Pfeiffer and Schultz 1986b)). Mealybugs detract from the appearance of the plant by contaminating bunches with egg sacs, nymphs and adults (Spangler and Agnello 1991). They may also deposit a waste product, 'honeydew' on the leaves and fruit as they feed. Honeydew may act as a substrate for sooty mould to grow (Spangler and Agnello 1991).

Pseudococcus comstocki and *Ps. maritimus* female and male mealybugs have different life cycles and life stages. Female mealybugs have three life stages: adult, egg and nymph. They develop from an egg through three nymphal (immature instar) stages before undergoing a final moult into the adult form (CABI 2009). Adult females are 3–4 mm long, slow-moving and oval-shaped. Male mealybugs have four life stages: egg, nymph cocoon and adult. They develop from eggs through first and second feeding instars, and third and fourth non-feeding instars in a cocoon, before moulting into tiny winged adults, which possess a pair of long wax terminal filaments (University of Minnesota 2007).

Mealybugs generally prefer warm, humid, sheltered sites away from adverse environmental conditions and natural enemies. Mealybug nymphs and adult females are very small and are often not detected as they hide in crevices and in protected spaces in grape bunches. This makes them a potentially serious pest problem in grape-growing areas. Many mealybug species pose particularly serious problems to agriculture when introduced into new areas of the world where natural enemies are not present (Miller *et al.* 2002; Moore 2004).

In China, *P. comstocki* has three generations a year in grapes. Eggs overwinter in cracks in grapevine trunks and branches. Nymphs of each generation appear in mid and late May, mid and late July and late August, respectively. Adults and nymphs eat young parts of host plants (AQSIQ 2007).

Pseudococcus maritimus also has three generations a year, and the eggs overwinter underground in cotton-like cases near the roots of grapevines. In early spring, nymphs hatch and first attack the roots before moving above ground in late June. Adults and nymphs suck stalks, young branches, vines and young roots and cause deformity to the roots (AQSIQ 2007).

Although there are records of *Planococcus kraunhiae* in China (Narai and Murai 2002), there are no records of this pest attacking grapes in China but it has been reported on table grapes in Japan (Narai and Murai 2002). *Planococcus kraunhiae* has four life stages: adult, egg, nymphs and pupa (Narai and Murai 2002). No record of the life cycle on grapes could be found but in general the biology and taxonomy of mealybugs are similar. Due to the recognised biological and economic importance of *Pseudococcus comstocki*, it was used as the basis for this risk assessment.

The risk scenario of concern is that mealybug eggs, nymphs or adult females may be present in sheltered areas on imported bunches of Chinese grapes.

Pseudococcus comstocki was included and/or assessed in the existing import policy for pears from China (AQIS 1998b; Biosecurity Australia 2005a), Fuji apples from Japan (AQIS 1998a), pears from Korea (AQIS 1999) and unshu mandarins from Japan (Biosecurity Australia 2009b).

Pseudococcus maritimus was included and/or assessed in the existing import policy for table grapes from California (AQIS 2000) and table grapes from Chile (Biosecurity Australia 2005d).

Planococcus kraunhiae was included and/or assessed in the existing import policy for unshu mandarins from Japan (Biosecurity Australia 2009b).

The assessment of *Ps. comstocki*, *Ps. maritimus* and *Planococcus kraunhiae* presented here builds on these previous assessments.

The probability of importation for both *Ps. comstocki* and *Pl. kraunhiae* was rated as 'high' in the assessment for unshu mandarins from Japan (Biosecurity Australia 2009b) and *Ps. maritimus* was rated as 'high' in the assessment for table grapes from Chile (Biosecurity Australia 2005d).

The probability of distribution for *Ps. comstocki* and *Pl. kraunhiae* was rated as 'moderate' in the assessment for unshu mandarin from Japan (Biosecurity Australia 2009b) and *Ps. maritimus* was rated as 'high' in the assessment for table grapes from Chile. However, differences in horticultural practices and climatic conditions between the previous export areas (Chile, Japan and Korea) and China make it necessary to re assess the likelihood that mealybugs will be imported into and distributed within Australia with table grapes from China.

The probability of establishment and of spread of mealybugs in Australia, and the consequences they may cause will be the same for any commodity in which these species are imported into Australia. Accordingly, there is no need to re assess these components.

4.11.1 Reassessment of probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues respectively.

Reassessment of probability of importation

The likelihood that *Ps. comstocki*, *Ps. maritimus* and *Pl. kraunhiae* will arrive in Australia with the importation of table grapes from China is: **HIGH**.

Supporting information for this assessment is provided below:

- *Pseudococcus comstocki* has been reported on table grapes in China and is present throughout the production areas and time of harvest (Li 2004; Zhang 2005b; AQSIQ 2006; AQSIQ 2007).
- *Planococcus kraunhiae* has been reported in China (Ben-Dov 2006c), however, its plant hosts are not recorded.
- *Planococcus kraunhiae* has been reported on table grapes in Korea, where it is found on leaves, branches and fruit of grapevines (NPQS 2007).
- Mealybugs are known to be associated with table grapes in many other grape-growing countries e.g. Australia (Furness and Charles 1994) and USA (University of California 1992).
- *Pseudococcus comstocki* and *Pl. kraunhiae* adult female mealybugs and nymphs (that is, immature male and female mealybugs) are small (1.4–3 mm), oval shaped, often inconspicuous, lack wings and have limited mobility (Spangler and Agnello 1991). Adult females and nymphs are covered in a white waxy substance that is moisture repellent and protects them against desiccation (Spangler and Agnello 1991).
- Once mealybugs find a suitable feeding site, they insert their stylets and suck plant sap from the fruit. This procedure anchors the mealybugs to the fruit, where they generally remain and are dislodged with difficulty (Williams 2004). Once feeding begins, they secrete a waxy mealy coating that helps to protect their bodies.
- Procedures carried out in the vineyard and at the packing house are directed towards maintaining a standard quality of fruit with regard to ripeness, blemishes, and visible splits, cracks, bruising or damage to the skin. Although all bunches are inspected, the procedures are not specifically directed towards detecting small arthropod pests in protected spaces. Therefore, mealybugs hiding on grape bunches may not be detected during routine visual quality inspection procedures in the vineyards and within packing houses in China. Fruit packed for export is therefore highly likely to contain them.
- *Pseudococcus comstocki* mealybugs overwinter on vine trunks and branches (Li 2004; Zhang 2005b) and would be likely to survive cold storage and transportation.
- No records could be found regarding overwintering sites for *Pl. kraunhiae* mealybugs on grapevines. It is unknown whether they would be likely to survive cold storage and transportation.
- There is a strong potential for viable mealybugs to be associated with grapes after storage and transportation, as live mealybugs have been intercepted on Chilean table grapes imported into New Zealand (MAF Biosecurity New Zealand 2009) and during pre-export inspection of Californian table grapes destined for Australia (APHIS 2003).

The association of mealybugs with fruit, the small size, sessile and cryptic nature of most life stages plus their previous interceptions on arrival all support a risk rating for importation of ‘high’.

Reassessment of probability of distribution

The likelihood that *Ps. comstocki*, *Ps. maritimus* and *Pl. kraunhiae* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **MODERATE**.

Supporting information for this assessment is provided below:

- Table grapes are intended for human consumption and mealybug nymphs and adults may remain on the fruit during retail distribution. The unconsumed parts of the fruit, especially stalks of infested fruit, are likely to end up in fruit waste, which may further aid distribution of viable mealybugs. Disposal of infested waste fruit is likely to be by commercial or domestic rubbish systems or discarded where the fruit is consumed. However, some fruit waste may be disposed of in the home garden which provides an opportunity for these pests to transfer to susceptible hosts in the vicinity.
- These mealybugs are highly polyphagous, attacking up to 350 plant species placed in 40 families (Ben-Dov 2006c; Ben-Dov 2006d; Ben-Dov 2007). They are sap-feeders on deciduous orchards, vines and ornamentals (Ben-Dov 2006c; Ben-Dov 2006d; Ben-Dov 2007) that are cultivated and distributed throughout Australia (ANBG 2009).
- The ability of mealybugs to disperse naturally is limited as crawlers can move small distances on the host using their functional legs. Long range dispersal of adults or nymphs may occur through wind-assistance or on infested plant material (HortResearch 2010).

The association of mealybugs with fruit, their small size, sessile and cryptic nature of most life stages and their large number of host plants all support a risk rating for distribution of 'moderate'.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *Ps. comstocki*, *Ps. maritimus* and *Pl. kraunhiae* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **MODERATE**.

4.11.2 Probability of establishment and spread

As indicated above, the probability of establishment and of spread for *Ps. comstocki*, *Ps. maritimus* and *Pl. kraunhiae* would be the same as those assessed for table grapes from Chile (Biosecurity Australia 2005d) and unshu mandarin from Japan (Biosecurity Australia 2009b). The ratings from the previous assessment are presented below:

Probability of establishment: **HIGH**

Probability of spread: **HIGH**

4.11.3 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probability of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *Ps. comstocki*, *Ps. maritimus* and *Pl. kraunhiae* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **MODERATE**.

4.11.4 Consequences

The consequences of the establishment of *Ps. comstocki*, *Ps. maritimus* and *Pl. kraunhiae* in Australia have been estimated previously for table grapes from Chile (Biosecurity Australia 2005d) and unshu mandarin from Japan (Biosecurity Australia 2009b). This estimate of impact scores is provided below, expressed in the current scoring system (Table 2.3).

Plant life or health	**D**
Other aspects of the environment	**C**
Eradication, control etc.	**D**
Domestic trade	**D**
International trade	**D**
Environment	**B**

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**D**', the overall consequences are estimated to be **LOW**.

4.11.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Pseudococcus comstocki*, *Pseudococcus maritimus* and *Planococcus kraunhiae*	
Overall probability of entry, establishment and spread	**Moderate**
Consequences	**Low**
Unrestricted risk	**Low**

As indicated, the unrestricted risk estimate for *Ps. comstocki*, *Ps. maritimus* and *Pl. kraunhiae* of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for these pests.

4.12 European grape berry moth

Eupoecilia ambiguella (Hübner, 1796)

Eupoecilia ambiguella belongs to the Tortricidae or leaf-roller family. It is commonly known as the European grapevine or grape berry moth and is a known pest of grapevines in a number of countries across the temperate zones of the Palearctic and Indo-Oriental regions, between western Europe and Russia to Japan and also the USA, Canada, Mexico and Colombia (Meijerman and Ulenberg 2000; Frolov 2009). They cause considerable losses in both quality and yield of grapevines in Germany (Ibrahim 2004). The Tortricidae family is of great economic importance, as the larvae of many species cause major damage to horticultural crops, including pome and stone fruits, citrus fruits, grapes, ornamental crops, tea, coffee, cereals and cotton (Meijerman and Ulenberg 2000). Leafroller moth larvae damage fruit by chewing large holes that usually cause fruit rot on a wide range of economic species (CABI 2009).

The larvae of *E. ambiguella* attack a number of host plants, feeding on flower buds and fruits of grapes, buckthorn, viburnum, ivy, lilac, honeysuckle, Cornelian cherries, maple, and other arboreous and fruticose plants (HYPP Zoology 1997; Frolov 2009). However, larvae seem rare on hosts other than grapes (Roehrich and Boller 1991). Although there are records of this pest in China (Frolov 2009), there are no records of this pest attacking grapes in China but it has been reported on table grapes in the former Union of Soviet Socialist Republics (USSR) (Frolov 2009) and Germany (Ibrahim 2004).

Eupoecilia ambiguella has four life stages: egg, larva, pupa and adult (HYPP Zoology 1997; Meijerman and Ulenberg 2000). *Eupoecilia ambiguella* adults are relatively small, about 10 mm long with a wingspan of 14–18 mm and with a greyish-brown head with yellow scales and yellow-brown hairs. The body is yellow and covered with shiny black scales. Mature larvae are 14 mm long (Frolov 2009).

There are two generations per year although a third generation is reported in Central Asia (Frolov 2009). First generation or spring adult moths emerge from over-wintering pupae, between spring to early summer, depending on the region and the climate (HYPP Zoology 1997; Frolov 2009). Mating occurs between midnight until early morning (Meijerman and Ulenberg 2000). First generation moths lay up to 100 eggs (Frolov 2009) on grape buds in humid sheltered sites on the grapevine, at a rate of one egg per bud (HYPP Zoology 1997). Eggs are laid in the afternoon and evening (Meijerman and Ulenberg 2000) and are slightly elliptical, light yellow and measure 0.8 mm in length (HYPP Zoology 1997). First generation larvae emerge from eggs after 6–13 days. Emergence is dependent on temperature (13 days at 15°C, 6–7 days at 19–25°C) (Frolov 2009). Larvae are light gray turning dark red or pinkish with black heads and thoracic plate (HYPP Zoology 1997). They move about on the grapevine for a few minutes before joining 2–3 flower buds together with silk threads to form a web in which they feed (HYPP Zoology 1997). As the larvae feed on grape buds and flowers, webs can become dense, leading to the complete destruction of the buds (Frolov 2009). First generation larvae feed in the evening as well as early in the morning for 8–12 days (Meijerman and Ulenberg 2000; Ibrahim 2004). Mature larvae pupate on the dried remains of the damaged buds or on leaves, sprouts or in leaf folds (Frolov 2009). First generation larval development lasts 15–25 days from egg laying to pupation (Frolov 2009).

Second generation or summer moths emerge after 14 days as pupae, approximately 2–2.5 months after the first generation moths emerge (i.e. July–August) (HYPP Zoology 1997).

They mate between midnight and early morning then lay second generation eggs on immature grapes (HYPP Zoology 1997; Meijerman and Ulenberg 2000). The lifespan of adult moths is unknown. Emerging larvae gnaw round holes and bore into unripe berries, feeding on the grape pulp and immature seeds before the seeds harden (Frolov 2009). One larva may damage 9–17 berries (Frolov 2009). Damaged grapes dry up like raisins and may become mouldy in rainy weather (Frolov 2009). Second generation larvae pupate in greyish or brownish cocoons spun under the old bark of the vine-stock or in stake-posts cracks between late summer and early autumn (HYPP Zoology 1997).

The development of *E. ambiguella* is strongly influenced by weather conditions and hot dry environments reduce percentage egg hatch (Frolov 2009). Optimum conditions for insect development are 70–90% relative humidity and air temperatures of 18–25°C (Frolov 2009).

The risk scenario of concern for *E. ambiguella* is that second generation eggs and larvae, may be imported in table grapes.

4.12.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues respectively.

Probability of importation

The likelihood that *E. ambiguella* will arrive in Australia with the importation of table grapes from China is: **LOW**.

Supporting information for this assessment is provided below:

- *Eupoecilia ambiguella* has been reported in the southern coastal province of Guangdong, the central province of Sichuan and eastern coastal provinces of Jiangsu and Zhejiang in China (CABI 2009; Frolov 2009).
- Table grapes are mainly grown in the northern provinces of China and most Chinese table grapes for export are likely to be sourced from Xinjiang (38.5% production area) and Shandong (16.2% production area) (AQSIQ 2006; AQSIQ 2009b).
- There are no records of *E .ambiguella* on grapes in China but this pest has been reported on table grapes in the former USSR (Frolov 2009) and Germany (Ibrahim 2004).
- Second generation *E. ambiguella* moths emerge in summer between July–August, they mate, then lay up to 100 eggs on immature grapes (Frolov 2009).
- Larvae emerge after 8–12 days and gnaw round holes and bore into unripe berries, feeding on the grape pulp and immature seeds before the seeds harden. One larva may damage 9–12 berries and damaged grapes rot and dry up like raisins and may become mouldy in rainy weather (Frolov 2009). Damaged grapes eventually fall from the grape bunch 3–5 days after infestation. Larvae move to damage another grape before the first damaged grape drops (HYPP Zoology 1997; Frolov 2009).
- In China, grapes are harvested between August and October (AQSIQ 2008) when late developing second generation *E. ambiguella* eggs and larvae may be present in grape bunches.

- Adult moths are winged and good fliers but are mainly active from late night to early morning so are unlikely to remain on the fruit during picking, sorting and packing, in contrast to the egg and larval development stages.
- Damaged grapes may be conspicuous due to their abnormal shape and larval entry holes although they fall off the bunch 3–5 days after initial infestation (Frolov 2009). During harvesting, processing, packing and inspection procedures, table grapes infested by *E. ambiguella* may be identified and removed from the export pathway.

The distribution of this pest in China, the fact that eggs and larvae are not usually associated with mature grapes and fruit damage that may result in removal of infested fruit before the larvae emerge, all support a risk rating for importation of 'low'.

Probability of distribution

The likelihood that *E. ambiguella* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **MODERATE**.

Supporting information for this assessment is provided below:

- Packed grapes for export from China will be stored at temperature and relative humidity conditions to ensure quality is maintained.
- Packed grapes are usually not processed or handled again until they arrive at the retailers as grapes are easily damaged through rough handling and impacts due to their thin skins (Mencarelli and Bellincontro 2005). Therefore, any pests or pathogens in the packed grapes are unlikely to be detected during transportation and distribution to retailers.
- It was reported that *E. ambiguella* overwinter as pupae (HYPP Zoology 1997; Frolov 2009) and have a lower threshold of development of about 7 °C (Frolov 2009). It is unknown whether *E. ambiguella* eggs and larvae would survive the post-harvest processes and the long period of cold temperature during cold storage and during transportation of table grapes in China and to Australian markets but cool and humid conditions may increase the longevity of individuals of this species.
- *Eupoecilia ambiguella* has a wide host range and infests grapes and a number of commercial plants (lemons, plums), wild hosts: ivy, blackthorn (*Prunus spinosa*), yellow bedstraw (*Galium* spp), *Viburnum lantana*, privet (*Ligustrum* spp.), tin-laurel (*Viburnum tinus*), ash (*Fraxinus* spp.) and *Shizandra* spp. (INRA 1997; Frolov 2009), facilitating its transfer to new areas. These plants are widely and sporadically distributed throughout Australia, including in domestic and commercial environments and abandoned grapevines in temperate regions of Australia. They could occur near the transport pathway and/or end destination of imported table grapes (Baker *et al.* 1994; ANBG 2009).
- Table grapes are intended for human consumption and *E. ambiguella* larvae may remain on the fruit and may enter into the endangered area through distribution of fruit. The disposal of fruit waste (e.g. vegetative parts of the bunch and discarded berries) may further aid distribution of viable *E. ambiguella* as waste may be discarded into compost heaps or into domestic waste and end up in landfills. Some discarded grapes may end up close to suitable hosts.

The association of eggs and larvae with grapes, its wide host range, ability to disperse, find a mate then a host for egg-laying, moderated by the possible impact of cold storage and need to complete their life cycle before mating, support a risk rating for distribution of 'moderate'.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.4.

The likelihood that *E. ambiguella* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **LOW**.

4.12.2 Probability of establishment

The likelihood that *E. ambiguella* will establish within Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **MODERATE**.

Supporting information for this assessment is provided below:

- *Eupoecilia ambiguella* is established in China (INRA 1997; Frolov 2009). It has a wide distribution in temperate zones from western Europe (e.g. Spain, United Kingdom) to Asia as far east as Korea and Japan (CABI 2009; Frolov 2009). Climatic conditions in temperate parts of Australia are similar to those in these countries.
- *Eupoecilia ambiguella* has a wide host range and infests grapes and a number of commercial and wild host plants (INRA 1997; Frolov 2009), facilitating its transfer to new areas. These plants are widely and sporadically distributed throughout Australia (Baker *et al.* 1994; ANBG 2009), including in domestic, commercial and wild environments and abandoned grapevines in temperate regions of Australia. Some of these areas are not very far away from residential areas and could occur near the transport pathway and/or end destination of imported table grapes.
- *Eupoecilia ambiguella* requires both males and females for reproduction so may need to locate a mate within a relatively short time frame after adult emergence. The duration of the adult stage is unknown.
- After mating, each *E. ambiguella* female locates a suitable host plant and lays up to 100 eggs laid individually either on buds and flowers for first generation in the spring or immature fruit for second generation in the summer (INRA 1997).
- Integrated Pest Management (IPM) programs are practiced in the production of table and wine grapes in Australia (Bailey *et al.* 1994). The measures taken against arthropod pests, for example *Epiphyas postvittana* (light brown apple moth) (Baker *et al.* 1994), in commercial vineyard and orchard production areas may have some impact on the establishment of *E. ambiguella*. However, there are no control measures in place for abandoned grapevines, and in domestic and wild environments.

The wide host range and extensive temperate distribution, ability to disperse to find a mate for sexual reproduction and egg-laying, support a risk rating for establishment of 'moderate'.

4.12.3 Probability of spread

The likelihood that *E. ambiguella* will spread within Australia, based on a comparison of those factors in source and destination areas that affect the expansion of the geographic distribution of the pest, is: **MODERATE**.

Supporting information for this assessment is provided below:

- Dependant on climatic conditions, *E. ambiguella* produces one or two generations a year (Frolov 2009).
- *Eupoecilia ambiguella* has a wide distribution in temperate zones from western Europe to east Asia (INRA 1997; CABI 2009; Frolov 2009), suggesting that climatic conditions in many parts of temperate Australia may be suitable for the survival and spread of this moth.
- The wide range of plants recorded as hosts of *E. ambiguella*, are grown in many parts of Australia (Baker *et al.* 1994; ANBG 2009). Table grapes for human consumption and grapes for wine production, lemons, currants and plums may be transported vast distances around the country, aiding the spread of these insects on infested fruit.
- *Eupoecilia ambiguella* adults have wingspans of 14–18 mm and can spread through flight for sexual reproduction and egg-laying (Frolov 2009).

The wide distribution suggesting an ability to adapt to various temperate conditions, wide host range and the ability to disperse to find a mate for sexual reproduction and egg-laying, support a risk rating for establishment of ‘moderate’.

4.12.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread

The likelihood that *E. ambiguella* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **LOW**.

4.12.5 Consequences

The consequences of the establishment of *E. ambiguella* in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are ‘**D**’, the overall consequences are estimated to be **LOW**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: D – Significance at the district level. *Eupoecilia ambiguella* larvae cause damage to the flowers, buds, leaves, and fruit, stem of number of commercial and wild host plants (Frolov 2009; Meijerman and Ulenberg 2009a). However, in grape-growing areas, *E. ambiguella* appears to be restricted to the grapevine (Meijerman and Ulenberg 2009a). A first generation larva can damage up to 30 buds and single second generation larva up to 17 grape berries. The direct consequences of this pest on native Vitaceae (e.g. *Cissus hypoglauca* and *Cissus sterculiifolia* found in rainforest areas (Arnold and Rossetto 2002)) are unknown.
Other aspects of the environment	**Impact score**: A – Indiscernible at the local level. There are no known direct consequences of this pest on other aspects of the environment.
Indirect	
Eradication, control etc.	**Impact score**: B – Minor significance at the local level. Existing control strategies in place for other economically important moth species may have impacts on *E. ambiguella* in Australia. An integrated approach using chemicals, biological control and orchard management has been reported to be effective in controlling *E. ambiguella* (Frolov 2009).
Domestic trade	**Impact score**: C – Significant at the local level. The presence of *E. ambiguella* in commercial table grape production areas may result in interstate trade restrictions on commercial fruit, including lemons, plums, table and wine grapes. These restrictions may lead to a loss of markets.
International trade	**Impact score**: C – Significant at the local level. The presence of *E. ambiguella* in commercial table grape production areas may limit access to overseas markets which lack this pest. *Eupoecilia ambiguella* is present in Europe and Asia including China, India and Japan.
Environmental and non-commercial	**Impact score**: B – Minor significance at the local level. Additional pesticide application and other measures, including biological control, to control *E. ambiguella* could have additional effects on the environment. It is noted that biological control agents such as *Trichogramma* spp. wasps are already registered for and used in Australian vineyards to control other lepidopteran species (Baker *et al.* 1994).

4.12.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Eupoecilia ambiguella*	
Overall probability of entry, establishment and spread	**Low**
Consequences	**Low**
Unrestricted risk	**Very low**

As indicated, the unrestricted risk estimate for *E. ambiguella* of 'very low' achieves Australia's ALOP. Therefore, specific risk management measures are not required for this pest.

4.13 Grape plume moth

Nippoptilia vitis

Nippoptilia vitis, belongs to the Pterophoridae or plume moth family and is known as the grape plume moth (Li 2004). Most adult species of Pterophoridae have wings divided into narrow lobes that resemble feathers or "plumes" because of the long fringe scales along the lobe margins (Herbison-Evans *et al.* 2009).

Grapes (*Vitis vinifera*) are the only recorded hosts of *N. vitis* (Li 2004).

Nippoptilia vitis has four life stages: egg, larva, pupa and adult. *Nippoptilia vitis* adults are 9–10 mm long with a wingspan of 17–19 mm with a greyish-brown head with yellow scales and yellow-brown hairs. The body is yellow and covered with shiny black scales.

Nippoptilia vitis has two or three overlapping generations a year, depending on whether it is in northern (Jilin) (AQSIQ 2007; BAIRC 2007) or southern (Guizhou) (BAIRC 2007) China, respectively. In Guizhou, there are three generations of *N. vitis* and the mature larvae overwinter in leaf litter and infested branches (BAIRC 2007). Guizhou has a humid, sub-tropical monsoonal climate with warm winters, mild summers and unclear seasonal contrasts and a mean annual temperature of 14–16 °C (China Maps 2007).

Nippoptilia vitis overwinters as an adult (Li 2004; Zhang 2005b; AQSIQ 2007) in the north and as mature larvae in the south (Li 2004; BAIRC 2007). As most table grapes are grown in the northern part of China, the life cycle where *N. vitis* overwinters as an adult, is described below.

Nippoptilia vitis adults overwinter in grasses or cracks in the soil or in dead branches or leaf folds. Adult *N. vitis* can live from 2–12 days after overwintering, most of them live 3–4 days, they are active at night and lay eggs at night. (BAIRC 2007). Females lay 39–98 eggs with an average of 71 eggs (BAIRC 2007). Eggs are mainly laid on grape flowers and tendrils during early vine growth stage and then on pedicels and the base of fruit as the fruit develop. Each individual egg is laid and located separately. Eggs are ovoid, 0.8 mm in diameter, light yellow initially but turning brown before larval hatching (Li 2004; Zhang 2005b; BAIRC 2007). The full lifespan of this pest is unknown.

Larvae bore into the fruit from the stem end. They usually attack immature fruit but also cause damage to the grape leaves and stem (United States Environmental Protection Agency 2004) and feed on the pulp and seeds of grapes, usually causing the young fruit to drop to the ground (AQSIQ 2007). Larvae produce frass while they bore into fruits and the frass forms curved lines on the fruit surface and also accumulates around the entry holes or on grape stalks (Li 2004; Zhang 2005b; BAIRC 2007).

Every larva can attack more than 10 grapes with the larva moving to a new grape before fruit drop of the previous infested grape. The entry holes are very small and hard to detect but the exit holes on the dropped fruits are bigger and visible. Some of the infested fruit shrink and dry and remain on the fruit bunch but most of the damaged fruit will fall to the ground after 3–5 days causing a decrease in yield. The mature larva is 9–12 mm long and yellow-green with a light yellow head with two black spots on the front and dark brown-yellow stripes on the sides of the body (Li 2004; Zhang 2005b).

The peak damage periods are early-mid July and mid-late August and the most severe damage occurs between late July and mid-August as during this period two generations overlap and damage grapes at the same time (BAIRC 2007). Fruit drops start to occur from early-mid July. The damage is less severe after late-August and no more damage occurs after mid-September. Mature larvae pupate on the grape stems. Pupae are about 9 mm long, green initially but turning yellow-green then brown. In early-mid September, adults emerge and overwinter as adults. After adult emergence the pupal shell usually remains on the fruit bunch and is clearly visible after mid-September. Damaged grapes remaining on the bunch are conspicuous due to their abnormal shape and visible larval exit holes (Li 2004).

The risk scenario of concern for *N. vitis* is that first and second generation eggs, larvae and pupae, may be imported in table grapes.

4.13.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues respectively.

Probability of importation

The likelihood that *N. vitis* will arrive in Australia with the importation of table grapes from China is: **MODERATE**.

Supporting information for this assessment is provided below:

- *Nippoptilia vitis* has been reported on table grapes in Guangxi, Guizhou, Hebei, Henan, Jilin and Taiwan in China (Li 2004; Zhang 2005b; AQSIQ 2006).
- In the northern provinces, (e.g. Jilin), *N. vitis* overwinters as adults in grasses or cracks in the soil or in dead branches or leaf folds (Li 2004) and is unlikely to be present on grape bunches imported from the northern provinces. It is unknown whether the egg, larval and pupal stages are as cold tolerant as the adult stage. In the southern provinces (e.g. Guizhou), it was reported that *N. vitis* overwinter as mature larvae (Zheng *et al.* 1993). Guizhou has warm winters (Ministry of Culture 2003), suggesting that mature larvae may remain in harvested grape bunches but may not survive cold temperatures during cold storage and during transportation.
- In China, table grapes for export are harvested and exported usually between August and October each year depending on the cultivar and geographical location (AQSIQ 2008). Table grape varieties with different harvesting times show a variation in *N. vitis* damage. BAIRC (2007) reported that in vineyards which grow multiple varieties, 1.1% of fruit from early season varieties are damaged by *N. vitis* whilst up to 60% of fruit are damaged in late season varieties. However, in single variety vineyards serious damage can occur any time whether the variety being grown is harvested early or late (BAIRC 2007). It is unknown whether the vineyards discussed were commercial or not.
- Larvae of *N. vitis* can feed in grape bunches from early-July to mid-September (BAIRC 2007). The larvae bore into the young grape, mainly from the stem end but some enter around the calyx end. Frass is extruded from the infested grape. During its development, one larva can damage over 10 grapes. After larvae have fed, damaged grapes shrink and eventually fall from the grape bunch in 3–5 days (BAIRC 2007).

- Pupae of *N. vitis* may be present in the harvested grape bunches, as larvae tend to pupate on grape stalks within the grape bunch (Li 2004). Pupae are about 9 mm long, initially green but turning yellow-green then brown. (Li 2004; Zhang 2005b).
- Table grapes infested by *N. vitis* may be identified and removed from the export pathway during harvesting, processing and packing, due to their abnormal shape, the presence of frass, visible larval exit holes and the presence of the pupae attached to the stalks of grape bunches (Li 2004).
- Pupae may also survive the post-harvest processes and the cold temperature during storage and transportation, but no information appears to be available for pupal survival under these conditions.

The association of larvae and pupae with the fruit, moderated by conspicuous fruit damage that may result in removal of infested fruit, support a risk rating for importation of 'moderate'.

Probability of distribution

The likelihood that *N. vitis* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **LOW**.

Supporting information for this assessment is provided below:

- Packed grapes are usually not processed or handled again until they arrive at the retailers as grapes are easily damaged through rough handling and impacts due to their thin skins (Mencarelli and Bellincontro 2005). Therefore, any pests or pathogens in the packed grapes are unlikely to be detected during transportation and distribution to retailers.
- The cold tolerance of *N. vitis* is unknown and it is unknown whether larvae inside table grapes would be able to survive cold storage before and during transportation and distribution as *N. vitis* adults overwinter in northern China. Late developing larvae and pupae may remain in the fruit and may survive storage, transportation and distribution via wholesale or retail trade and be associated with infested waste.
- Table grapes are intended for human consumption and *N. vitis* may remain on the fruit and may enter into the endangered area through distribution of fruit. The disposal of fruit waste (e.g. vegetative parts of the bunch and discarded berries) may further aid distribution of viable *N. vitis* as waste may be discarded into compost heaps or into domestic waste and end up in landfills. Some discarded grapes may end up close to grapevines.
- *Nippoptilia vitis* has a very restricted host range and only infests grapes (*Vitis vinifera*) (Zhang 2005b). However, grapevines are widely and sporadically distributed throughout Australia, including in domestic and commercial environments and abandoned grapevines in temperate regions of Australia. These grapevines could occur near the transport pathway and/or end destination of imported table grapes (ANBG 2009).
- Adult *N. vitis* have wingspans of almost 20 mm which enable them to fly to find a mate and also fly to suitable hosts to lay eggs (Li 2004). *Nippoptilia vitis* can enter the endangered area through flight of adults that would emerge from pupae developed from larvae. However, after overwintering, active adults can live from 2–12 days but most of them live 3–4 days (BAIRC 2007) and plume moths are poor fliers (OzAnimals 2009a).

The association of eggs, larvae and pupae with grapes, moderated by the possible impact of cold storage, the need to disperse and find a grapevine in a short time period, supports a risk rating for distribution of 'low'.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *N. vitis* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **LOW**.

4.13.2 Probability of establishment

The likelihood that *N. vitis* will establish within Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **LOW**.

Supporting information for this assessment is provided below:

- *Nippoptilia vitis* is established in China in the provinces of Guangxi, Guizhou, Hebei, Henan, Jilin and Taiwan (Zheng *et al.* 1993; Wu and Li 1998; Li 2004; Zhang 2005b; AQSIQ 2006; BAIRC 2007). It has also been recorded from Japan and Korea (BAIRC 2007). Climatic conditions in temperate parts of Australia are similar to those in these countries.
- *Nippoptilia vitis* has a very restricted host range. It was reported that this species only infests grapes (*Vitis vinifera* and other *Vitis* spp.) (Li 2004; Zhang 2005b). However, grapevines are widely and sporadically distributed throughout Australia, including in domestic and commercial environments and abandoned grapevines in temperate regions of Australia. Some of these areas are not very far away from residential areas.
- After overwintering, *N. vitis* adults can live from 2–12 days but most of them live 3–4 days (BAIRC 2007) and plume moths are poor fliers (OzAnimals 2009a). *Nippoptilia vitis* requires both males and females for reproduction so may need to locate a mate within a relatively short time frame.
- Each *N. vitis* female lays 39–98 eggs on flowers and tendrils at an early stage and then on stems and the base of fruit as fruit develop. After hatching, larvae bore into fruit (Li 2004).
- *Nippoptilia vitis* has two generations a year in Jilin in north China, overwintering as adults (Zheng *et al.* 1993). In Guizhou, in south-west China, *N. vitis* has three overlapping generations, and overwinters as mature larvae (BAIRC 2007).
- Natural enemies such as predators and parasitoids are reported as being associated with *N. vitis* (Wu and Li 1998) in Guizhou in China, but their effectiveness in Australia is difficult to assess.
- Integrated Pest Management (IPM) programs are practiced in the production of table grapes in Australia (Nicholas *et al.* 1994). Insecticides used against mealybugs, mites and light brown apple moth (*Epiphyas postvittana* (Walker)) in Australian commercial vineyards may have some impact on the establishment of this pest. An integrated approach using chemicals and vineyard management has been reported to be effective in controlling *N. vitis* in Jilin and Guizhou (Zheng *et al.* 1993; Li 2004; Zhang 2005b).

- However, there are no control measures in place for abandoned grapevines and in domestic environments.

The limited and sporadically distributed host range, a weak dispersal capacity and the need to find a mate for sexual reproduction in a short time frame, support a risk rating for establishment of 'low'.

4.13.3 Probability of spread

The likelihood that *N. vitis* will spread within Australia, based on a comparison of those factors in source and destination areas that affect the expansion of the geographic distribution of the pest, is: **LOW**.

Supporting information for this assessment is provided below:

- *Nippoptilia vitis* has been reported in both northern and southern China, north and south Korea and Japan (APHIS 2002), suggesting that climatic conditions in many parts of temperate Australia may be suitable for the survival and spread of this moth.
- Grapes, the only recorded host of *N. vitis*, are grown in many parts of Australia. Table grapes for human consumption and grapes for wine production may be distributed vast distances around the country, aiding the spread of these insects on infested fruit.
- Adult *N. vitis* have a 17–19 mm wingspan however they are considered weak fliers (OzAnimals 2009a) and although they can live from 2–12 days after overwintering, most of them live 3–4 days (BAIRC 2007) which may greatly limit their natural spread.

The limited and sporadically distributed host range, weak dispersal capacity and the short adult life span, support a risk rating for spread of 'low'.

4.13.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *N. vitis* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **VERY LOW**.

4.13.5 Consequences

The consequences of the establishment of *N. vitis* in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**D**', the overall consequences are estimated to be **LOW**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: D – Significant at the district level. *Nippoptilia vitis* larvae cause damage to the flowers, leaves, fruit, and stem of grapes. In Jilin province, China, *N. vitis* is one of the most significant grape pests (Zheng *et al.* 1993). In recent years *N.* vitis has become a common pest in mountainous areas and backyard vineyards in Jilin region in China where it can cause serious yield reductions (BAIRC 2007). It was reported that in poorly-managed vineyards, up to 100% plants were infested, and 30-100% of fruit were damaged, causing significant decline in yield and fruit quality (Zheng *et al.* 1993). The pest's impact on native Vitaceae (e.g. *Cissus hypoglauca* and *Cissus sterculiifolia* found in rainforest areas (Arnold and Rossetto 2002)) are unknown.
Other aspects of the environment	**Impact score**: A – Indiscernible at the local level. There are no known direct consequences of this pest on other aspects of the environment.
Indirect	
Eradication, control etc.	**Impact score**: B – Minor significance at the local level Existing control strategies, in place for other economically important moth species, may have impacts on *N. vitis* in Australia. For example, insecticides such as synthetic pyrethroids are already registered for and used in Australian vineyards to control other lepidopteran species (Bailey and Furness 1994). An integrated approach using chemicals and orchard management has been reported to be effective in controlling *N. vitis* in Jilin and Guizhou (Li 2004).
Domestic trade	**Impact score**: C – Significant at the local level. The presence of *N. vitis* in commercial table grape production areas may result in interstate trade restrictions on table and wine grapes. These restrictions may lead to a loss of markets.
International trade	**Impact score**: C – Significant at the local level. The presence of *N. vitis* in commercial table grape production areas may limit access to overseas markets which lack this pest. *Nippoptilia vitis* is present in Japan and Korea.
Environmental and non-commercial	**Impact score**: B – Minor significance at the local level. Additional pesticide application and other measures to control *N. vitis* could have additional effects on the environment.

4.13.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Nippoptilia vitis*	
Overall probability of entry, establishment and spread	**Very low**
Consequences	**Low**
Unrestricted risk	**Negligible**

As indicated, the unrestricted risk estimate for *N. vitis* of 'negligible' achieves Australia's ALOP. Therefore, specific risk management measures are not required for this pest.

4.14 Apple heliodinid

Stathmopoda auriferella [EP]

Stathmopoda auriferella belongs to the family Oecophoridae and is commonly known as the apple heliodinid. This lepidopteran family includes other pest species of fruit, such as *Stathmopoda masinissa*, the persimmon fruit moth.

Stathmopoda auriferella has four life stages: egg, larva, pupa and adult. Adults are small, with an average wingspan of 12.3 mm. Eggs are about 0.12 mm. Mature larvae are 9.8 mm in length. Pupae are 5.9 mm long. This species appears to have two generations per year on kiwifruit in Korea (Park *et al.* 2001).

While *S. auriferella* has been found on table grapes (APHIS 2002; NPQS 2007), the biology of this species on table grapes has not been reported in detail. Therefore, available information of its biology on other fruits (e.g. kiwifruit) is used for the risk assessment.

The risk scenario of concern for *S. auriferella* is the potential for eggs to be laid on and larvae burrowing into grape bunches.

Stathmopoda auriferella was included and/or assessed in the review under existing import policy for citrus from Egypt (Biosecurity Australia 2002) and in the existing import policy for Fuji apples from Japan (AQIS 1998a) and unshu mandarin from Japan (Biosecurity Australia 2009b). The assessment of *S. auriferella* presented here builds on these previous assessments.

The probability of importation for *S. auriferella* was rated as 'moderate' and the probability of distribution was rated as 'high' in the assessment for unshu mandarin from Japan (Biosecurity Australia 2009b). However, differences in commodities, horticultural practices, climatic conditions and the prevalence of the pest between previous export areas (Egypt and Japan) and China make it necessary to reassess the likelihood that *S. auriferella* will be imported into and distributed within Australia with table grapes from China.

The probability of establishment and of spread of *S. auriferella* in Australia, and the consequences it may cause will be the same for any commodity in which the species is imported into Australia. Accordingly, there is no need to reassess these components.

4.14.1 Reassessment of probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues respectively.

Reassessment of probability of importation

The likelihood that *S. auriferella* will arrive in Australia with the importation of table grapes from China is: **LOW**.

Supporting information for this assessment is provided below:

- *Stathmopoda auriferella* is reported from China (Hiramatsu *et al.* 2001; Shanghai Insect Science Network 2009; Pathania *et al.* 2009).
- *Stathmopoda auriferella* is associated with fruit of table grapes in South Korea (NPQS 2007) and is identified as a quarantine pest for Korean table grapes to the US (APHIS

2002; APHIS 2004a). It has not been reported on table grapes in China. This pest usually infests kiwifruit, stonefruit and apples (Biosecurity Australia 2002).

- *Stathmopoda auriferella* appears to have two generations per year on kiwifruit (Park *et al.* 1994). In Korea, adults occur from late May to mid-July and again from mid-August to early September, with peaks in early to mid-June and late August, respectively. Larvae are commonly found throughout July, whereas pupae start to appear in mid-July, and are commonly found in August (Park *et al.* 1994). No information is available on where they pupate.
- *Stathmopoda auriferella* larvae cause webbing of the flower buds and newly set fruit, often causing affected plant parts to drop from the grapevine.
- Larvae burrow into the green berries, which may split, shrivel, or fall off when damaged (APHIS 2004a).
- On kiwifruit, 70% of the damage by *S. auriferella* occurred on the fruit apex, and 11.1% on the fruit stalk which is on the fruit surface (Park *et al.* 1994). This may also be true for damage on table grapes.
- Packing house procedure would be able to eliminate the split and shrivelled fruit but may not remove the internally damaged fruit with larvae.
- Eggs are very small (0.10–0.13 mm) (Park *et al.* 1994), and they are unlikely to be detected on infested fruit. Data obtained from the related species *Stathmopoda masinissa* suggests that egg numbers laid per female are relatively small from 10–25 per female at different temperatures (Park *et al.* 2001).
- Adult moths are unlikely to stay on the fruit during picking, sorting and packing, in contrast to the egg and larval development stages.

The potential presence of eggs on and the association of larvae with fruit of table grapes, moderated by no report of *S. auriferella* from table grapes in China, support a risk rating for importation of ‘low’.

Reassessment of probability of distribution

The likelihood that *S. auriferella* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **HIGH**.

Supporting information for this assessment is provided below:

- Fruit infested with eggs and larvae may be distributed throughout Australia for retail sale.
- Human consumption is the intended use for the commodity in Australia. Individual consumers will distribute small quantities of table grapes to a variety of urban, rural and wild environments, where infested fruit could be disposed of in close proximity to a suitable host.
- Commercial waste will also be discarded in Australia prior to retail sale for human consumption. *Stathmopoda auriferella* is able to survive and develop in table grapes and other organic material. Commercial waste material may contain *S. auriferella* and may be deposited near suitable hosts.

- Adult moths are winged and good fliers. On average, adults live for 29.3 days at 20°C, 8.6 days at 25°C and 7 days at 30°C (Park *et al.* 2001).
- As the cold tolerance of *S. auriferella* is unknown, it is possible that *S. auriferella* pupae may survive the post-harvest processes and the period of cold temperature during storage, transportation and distribution.
- *Stathmopoda auriferella* has a wide host range, reported from at least 20 species host plants in 14 genera and 10 families, including commercial fruit producing species such as citrus, mango, avocado, peach, grapes (Yamazaki and Sugiura 2003; Robinson *et al.* 2007b; CABI 2009).

The evidence of the ability of the adult to fly with their wide host range support a risk rating for distribution of 'high'.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *S. auriferella* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **LOW**.

4.14.2 Probability of establishment and spread

As indicated above, the probability of establishment and of spread for *S. auriferella* would be the same as those assessed for unshu mandarin from Japan (Biosecurity Australia 2009b). The ratings from the previous assessment are presented below:

Probability of establishment: **HIGH**

Probability of spread: **HIGH**

4.14.3 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *S. auriferella* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **LOW**.

4.14.4 Consequences

The consequences of the establishment of *S. auriferella* in Australia have been estimated previously for unshu mandarin from Japan (Biosecurity Australia 2009b). This estimate of impact score is provided below.

Plant life or health	**C**
Other aspects of the environment	**B**
Eradication, control etc.	**C**

Domestic trade	**D**
International trade	**D**
Environment	**B**

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**D**', the overall consequences are estimated to be **LOW**.

4.14.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the estimate of consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Stathmopoda auriferella*	
Overall probability of entry, establishment and spread	**Low**
Consequences	**Low**
Unrestricted risk	**Very low**

As indicated, the unrestricted risk estimate for *S. auriferella* of 'very low' achieves Australia's ALOP. Therefore, specific risk management measures are not required for this pest.

4.15 Thrips

Frankliniella occidentalis [EP, NT, Tas.], *Rhipiphorothrips cruentatus* [EP]

Frankliniella occidentalis is not present in the Northern Territory and Tasmania and is a pest of regional quarantine concern for these states.

The thrips considered in this import risk assessment are *Frankliniella occidentalis* and *Rhipiphorothrips cruentatus*. They belong to the Thripidae family and are known as the western flower thrips (WFT) and grapevine thrips, respectively. The thrips species assessed here have been grouped together because of their related biology and taxonomy, and they are predicted to pose a similar risk. Unless explicitly stated, the term 'thrips' is used to refer to these two species and the information presented is considered as applicable to both species.

Frankliniella occidentalis is considered the most harmful thrips in viticulture (Roditakis and Roditakis 2007). *Frankliniella occidentalis* is also a vector of several tospoviruses, including tomato spotted wilt virus (TSWV) and Impatiens necrotic spot virus (INSV) (Morse and Hoddle 2006). Tospoviruses are persistently transmitted by *F. occidentalis*, i.e. once the thrips has acquired the virus, it remains infective for life. Tospoviruses are not passed on to the next generation. *Frankliniella occidentalis* nymphs are also known vectors of tobacco streak ilarvirus (TSV) (Roques 2006).

In India, *R. cruentatus* is a widespread and serious pest of vines in all major production areas (Kulkarni *et al.* 2007; NHB 2009; NRC 2009). There is no information available on its status as a vector.

Adult thrips are very small (less than 2 mm long), narrow-bodied insects with four narrow wings. They are commonly found feeding on leaves, stems, flowers and fruit of grapevines (Rahman and Bhardwaj 1937; Roques 2006; Roditakis and Roditakis 2007).

Adult thrips reproduce sexually and parthenogenetically and both types of reproduction occur simultaneously in the field (Rahman and Bhardwaj 1937; Kulkarni *et al.* 2007). Both species only produce males through parthenogenesis (Rahman and Bhardwaj 1937; Roques 2006).

Frankliniella occidentalis has four life stages: egg, nymph, pupa and adult (Roques 2006). Adult females lay between 20–40 eggs. Eggs are laid in leaves, flower tissue and fruits (Roques 2006). Eggs hatch into nymphs, which are found on leaves, buds, flowers and fruits. Thrips are present throughout the year and their life cycle and development is dependent on optimum temperature and relative humidity conditions (Mau and Kessing 1993). The overall life cycle for *F. occidentalis* lasts from 44.1 days at 15 °C to 15 days at 30 °C (Roques 2006). Roditakis and Roditakis (2007) report that in the laboratory, *F. occidentalis* took 10 days to develop from nymph to adult on ripe grape berries at 25 °C.

Rahman (Rahman and Bhardwaj 1937) reported the following life cycle for *R. cruentatus* in India. *Rhipiphorothrips cruentatus* also has four life stages: egg, nymph, pupa and adult. There are four immature stages, first instar nymphs, second instar nymphs, prepupa and pupa (Rahman and Bhardwaj 1937).

In India, *R. cruentatus* adults emerge from overwintering pupae in March. Two to ten days after emergence, adults mate then begin feeding. Males die two to seven days after mating. Females lay 15–50 eggs singly in slits on the underside of grapevine leaves at a rate of 2–6 eggs a day (Rahman and Bhardwaj 1937). Eggs hatch into nymphs, which are whitish-yellow

colour and without wings (Rahman and Bhardwaj 1937). Mature adults are dark brown in colour (Rahman and Bhardwaj 1937). All stages of *R. cruentatus* are present between March and October. The adults die off in November and from November to March only pupae are found overwintering in the soil. The grapevine thrips life cycle and development are dependent on optimum temperature and relative humidity conditions (Rahman and Bhardwaj 1937; Kulkarni *et al.* 2007).The overall life cycle for *R. cruentatus* lasts from 33 days at 15 °C to 14 days at 30 °C and there are five to eight generations per year (Rahman and Bhardwaj 1937).

Frankliniella occidentalis and *Rhipiphorothrips cruentatus* are important pest species due to the significant cosmetic damage they cause feeding on developing flowers, leaves and fruit of grapes and a number of commercial and wild host plants (2007). In general, thrips, are a minor problem on wine and raisin grapes, however, table grapes are susceptible to thrips damage (PlantPro 2005). Thrips mouthparts are used to rupture and suck sap from plant cells, causing silvering effect on leaves or corky layer on fruit that can reduce crop yield, productivity and marketability (Mau and Kessing 1993; Kulkarni *et al.* 2007). They can also transmit pathogens while feeding (Roques 2006; Roditakis and Roditakis 2007).

The risk scenario of concern for thrips is the presence of eggs, nymphs and adults in table grape bunches.

Rhipiphorothrips cruentatus is absent from Australia. *Frankliniella occidentalis* is absent from the Northern Territory (DPINT 2008), and interstate restrictions on the movement of host material exist in Australia (DPINT 2008; DPIW Tasmania 2009). In Tasmania, *F. occidentalis* is an 'A List Pest' under the Plant Quarantine Act 1997 (DPIW Tasmania 2009). There are controls on host produce entering Tasmania, and there are active monitoring and control practices in the state.

Frankliniella occidentalis was assessed in the existing import policy for tomatoes from the Netherlands (Biosecurity Australia 2003), table grapes from Chile (Biosecurity Australia 2005d), oranges from Italy (Biosecurity Australia 2005c), stonefruit from New Zealand (Biosecurity Australia 2006b); unshu mandarin from Japan (Biosecurity Australia 2009b) and capsicum from Korea (Biosecurity Australia 2009a).

Rhipiphorothrips cruentatus was assessed in the existing import policy for mangoes from Taiwan (Biosecurity Australia 2006d).

The assessment of *F. occidentalis* and *R. cruentatus* presented here builds on these previous assessments.

The probability of importation for *F. occidentalis* was rated as 'low' in the assessment for table grapes from Chile (Biosecurity Australia 2005d), 'moderate' in the assessment for tomatoes from the Netherlands (Biosecurity Australia 2003) and 'high' in the assessments for oranges from Italy (Biosecurity Australia 2005c), stonefruit from New Zealand (Biosecurity Australia 2006b), unshu mandarin from Japan (Biosecurity Australia 2009b) and capsicum from Korea (Biosecurity Australia 2009a). The probability of importation for *R. cruentatus* was rated as 'moderate' in the assessment for mangoes from Taiwan (Biosecurity Australia 2006d).

The probability of distribution for *F. occidentalis* was rated as 'moderate' in the assessments for oranges from Italy (Biosecurity Australia 2005c), table grapes from Chile (Biosecurity Australia 2005d), stonefruit from New Zealand (Biosecurity Australia 2006b), unshu mandarin from Japan (Biosecurity Australia 2009b) and capsicum from Korea (Biosecurity

Australia 2009a) and 'high' in the assessment for tomatoes from the Netherlands (Biosecurity Australia 2003). The probability of distribution for *R. cruentatus* was also rated as 'moderate' in the assessment for mangoes from Taiwan (Biosecurity Australia 2006d).

However, differences in commodities, horticultural practices, climatic conditions and prevalence of the pests between the previous export areas (Chile, Italy, Japan, Korea, New Zealand, the Netherlands and Taiwan) and China make it necessary to re-assess the likelihood that thrips will be imported into and distributed within Australia with table grapes from China.

The probability of establishment and of spread of thrips in Australia, and the consequences they may cause will be the same for any commodity in which these species are imported into Australia. Accordingly, there is no need to re-assess these components.

4.15.1 Reassessment of probability of entry

Reassessment of probability of importation

The likelihood that the *F. occidentalis* and *R. cruentatus* will arrive in Australia with the importation of table grapes from China is: **HIGH**.

Supporting information for this assessment is provided below:

- Both *F. occidentalis* and *R. cruentatus* are recorded in China (Lu *et al.* 2007; CABI 2009). *Frankliniella occidentalis* is only found in Beijing and Yunnan (Ren 2006; Wu *et al.* 2009). *Rhipiphorothrips cruentatus* is found in the southern provinces of Guanxi, Hainan and Guangdong (CABI 2009).
- *Frankliniella occidentalis* is associated with table grapes in Korea (NPQS 2007) and *Rhipiphorothrips cruentatus* is associated with table grapes in India (Rahman and Bhardwaj 1937; Kulkarni *et al.* 2007).
- Both thrips can scar berries with their feeding which may appear as silvering or corky scabs on the fruit, which renders certain varieties unmarketable (Lopes *et al.* 2002; Kulkarni *et al.* 2007; FICCI 2009). Table grapes with such symptoms may be detected during sorting and packing processes but at low levels of infestation may be difficult to detect.
- Nymph and adult thrips are very small (less than 2 mm) (Kulkarni *et al.* 2007; CABI 2009) and inconspicuous. Thrips prefer cryptic habitats i.e. small crevices and tightly closed plant parts. Adults and immature forms may hide within bunches (i.e. in crevices on grape stalks and stems).
- Female *F. occidentalis* and *R. cruentatus* thrips can produce 20–100 (Mau and Martin-Kessing 1993) and 15–50 eggs (Rahman and Bhardwaj 1937), respectively. The eggs are very small and may be laid on, or inserted under the skin of fruit or leaves (Mau and Martin-Kessing 1993; Kulkarni *et al.* 2007).
- Adults, eggs and nymphs may escape detection, particularly when present in low numbers.
- *Frankliniella occidentalis* is opportunistic, well adapted to surviving difficult conditions, and first instar nymphs are capable of tolerating temperatures below freezing over extended periods (McDonald *et al.* 1997). *Rhipiphorothrips cruentatus* appears to be less tolerant of cold, as adults do not appear to survive 4 °C for more than 5 hours (Rahman and Bhardwaj 1937).

- However, thrips have been recorded on produce entering the Netherlands from 30 different countries over a thirteen-year period (1980-1993), and approximately 1000 thrips specimens are intercepted by US border inspectors annually (Morse and Hoddle 2006). Therefore, thrips appear to be capable of surviving packing house procedures, cold storage and transport conditions.

The small size and cryptic nature of thrips, their cold tolerance and the association of several life stages with table grape bunches, all support a risk rating for importation of 'high'.

Reassessment of probability of distribution

The likelihood that *F. occidentalis* and *R. cruentatus* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **MODERATE**.

Supporting information for this assessment is provided below:

- Adults, eggs and nymphs may hide within bunches (for example, in crevices on the fruit stems) and therefore remain with the table grapes during distribution via wholesale or retail sale.
- The commodity may be distributed throughout Australia for retail sale. The intended use of the commodity is human consumption but waste material would be generated (e.g. vegetative parts of the bunch and discarded berries).
- These thrips could enter the environment directly from purchased fruit, from fruit at the point of sale, or through eggs that have hatched in discarded fruit or fruit waste before the fruit desiccates or decays.
- Both thrips species are poor fliers and are mainly dependent on wind-assisted flight for dispersal (Rahman and Bhardwaj 1937; Mau and Martin-Kessing 1993; Roques 2006; CABI 2009). They can be dispersed long distances by strong winds but may only leap from leaf to leaf through natural dispersal (Rahman and Bhardwaj 1937). Thrips may also be dispersed on clothing, equipment, containers or planting material (Roques 2006).
- *Frankliniella occidentalis* is highly polyphagous with a broad host range of more than 500 species in 50 plant families including many cultivated crops and ornamentals (Mau and Martin-Kessing 1993). *Rhipiphorothrips cruentatus* is also polyphagous but has a smaller host range which also include commercial fruit (CABI 2009). Many of these host plants are widely distributed in Australia, including the Northern Territory and Tasmania, allowing for the potential distribution of this pest.

The small size, cryptic behaviour, oviposition in protected plant parts, tendency to infiltrate tight spaces, wide host range, wind-assisted dispersive capacity of thrips, moderated by its weak directional flying ability, support a risk rating for distribution of 'moderate'.

Overall probability of entry

The overall probability of entry is determined by combining the probabilities of importation and of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *F. occidentalis* and *R. cruentatus* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **MODERATE**.

4.15.2 Probability of establishment and spread

As indicated above, the probability of establishment and of spread for *F. occidentalis* and *R. cruentatus* would be the same as those assessed tomatoes from the Netherlands (Biosecurity Australia 2003), table grapes from Chile (Biosecurity Australia 2005d), oranges from Italy (Biosecurity Australia 2005c), stonefruit from New Zealand (Biosecurity Australia 2006b); unshu mandarin from Japan (Biosecurity Australia 2009b), capsicum from Korea (Biosecurity Australia 2009a) and mangoes from Taiwan (Biosecurity Australia 2006d). The ratings from the previous assessments are presented below:

Probability of establishment: **HIGH**

Probability of spread: **HIGH**

4.15.3 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *F. occidentalis* and *R. cruentatus* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **MODERATE**.

4.15.4 Consequences

The consequences of the establishment of *F. occidentalis* in Australia has been estimated previously for tomatoes from the Netherlands (Biosecurity Australia 2003), table grapes from Chile (Biosecurity Australia 2005d), oranges from Italy (Biosecurity Australia 2005c), stonefruit from New Zealand (Biosecurity Australia 2006b); unshu mandarin from Japan (Biosecurity Australia 2009b) and capsicum from Korea (Biosecurity Australia 2009a). This estimate of impact score is provided below expressed in the current system (Table 2.3).

Plant life or health	**D**
Other aspects of the environment	**B**
Eradication, control etc.	**D**
Domestic trade	**D**
International trade	**D**
Environment	**B**

The consequences of the establishment of *R. cruentatus* in Australia have been estimated previously for mangoes from Taiwan (Biosecurity Australia 2006d). This estimate of impact score is provided below expressed in the current system (Table 2.3).

Plant life or health	**D**
Other aspects of the environment	**B**
Eradication, control etc.	**C**
Domestic trade	**C**
International trade	**D**
Environment	**B**

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**D**', the overall consequences for both thrips species are estimated to be: **LOW**.

4.15.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Frankliniella occidentalis* and *Rhipiphorothrips cruentatus*	
Overall probability of entry, establishment and spread	**Moderate**
Consequences	**Low**
Unrestricted risk	**Low**

The unrestricted risk estimate for *F. occidentalis* and *R. cruentatus* of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for these pests.

4.16 Grape cluster black rot

Physalospora baccae

Grape cluster black rot, or axle blotch as it is also called, is an important fungal disease of grapes in China caused by *Physalospora baccae* (Li 2001; Zhang 2005b). There has been some debate about the nomenclature of the organism. The name *Physalospora baccae* Cavara is a *nomen dubium* of unknown application. It is not known if the grape pathogen to which this name is applied in Japan and Korea is the same as the original European pathogen. The grape pathogen should be designated as '*Physalospora baccae* sensu Asian authors' (Pennycook 2009). '*Physalospora baccae* sensu Nishikado non Cavara' is listed in the National Institute of Agrobiological Sciences Genbank Database of Plant Diseases in Japan. In China, *Physalospora baccae* Cavara has been considered to be a synonym of *Guignardia baccae* (Cav.) Jacz. (Tai 1979; Qi *et al.* 2007), which is not a valid name. *Guignardia baccae* (Cav.) Jacz. was included in the pest list provided by AQSIQ (2006). The pycnidial stage of the fungus is identical with *Macrophoma reniformis* (Viala & Ravaz) Cavara (Nishikado 1921).

Little information is formally published on *Physalospora baccae*, grape cluster black rot or axle blotch disease. A number of scientific publications, along with two Chinese websites that do not appear to be refereed (BAIKE 2009; NYZSW 2009), were used to develop this assessment.

Physalospora baccae infects grape berries, leaves, pedicels and peduncles (Zhang 2005b). Wind, rain and insects spread the conidia and ascospores in May and June with the peak disease period being from July to September when the weather is warm and humid. Fruit are likely to develop disease symptoms from when they start to ripen up until harvest.

The risk scenario of concern for *Physalospora baccae* is that the fungus will be present on or in the harvested grape bunches, infected bunches will be imported and the pathogen will establish in Australia.

4.16.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Probability of importation

The likelihood that *P. baccae* will arrive in Australia with the importation of table grapes from China is: **HIGH**.

Supporting information for this assessment is provided below:

- *Physalospora baccae* is present across the major grape growing regions of China (Li 2001) including the provinces: Liaoning, Hebei, Henan, Shandong, Anhui, Jiangsu and Zhejiang (AQSIQ 2009c). It generally only causes serious damage in areas with poor horticultural practices in seasons that are warm and wet (Zhang 2005b; BAIKE 2009; NYZSW 2009). Grapes may be sourced and exported from any region in China.
- *Physalospora baccae* overwinters as pycnidia and perithecia on infected peduncles, pedicels and fruit as well as on fallen leaves and trash within the vineyards. It can also

overwinter as mycelia in the infected tissues and produce perithecia the next spring (BAIKE 2009; NYZSW 2009).

- During periods of wet weather in spring when temperatures rise, overwintered pycnidia and perithecia of *P. baccae* release conidia and ascospores (BAIKE 2009; NYZSW 2009). Wind, rain and insects spread the conidia and ascospores to infect grape clusters in May and June (Zhang 2005b). Symptoms start to appear in July, with the peak disease period from July to September when the weather is warm and humid. Fruit are likely to develop disease from when they start to ripen until harvest.
- The reported timing suggests a period of symptomless infection of two months or more, i.e. from May until July. No other information was found concerning symptomless infection, but it was considered that it might occur after July. Fungicide applications may delay and modify or mask symptom expression.
- Infected pedicels develop light brown spots around the junction with the fruit (Zhang 2005b; NYZSW 2009). Pedicels dry and shrink when the brown spots encircle them and infections then spread to the fruit and peduncles.
- After infection, peduncles develop brown spots that slowly turn black and enlarge and then the peduncles dry out (Zhang 2005b; NYZSW 2009).
- Infected berries develop irregular brown spots that spread to cover the whole fruit (Zhang 2005b; NYZSW 2009). Infected berries then turn purple or black and dry out. Small black spots (pycnidia) develop on their surface. The infected mummified berries remain in the grape cluster on the vine and do not drop off.
- The reported information suggests pycnidia may release conidia during summer and autumn, allowing spores to contaminate the surfaces of grape clusters.
- During commercial harvesting procedures, pickers select and harvest bunches of normal fruit, discarding inferior, diseased, small and damaged bunches. Inferior berries are likely to be trimmed from bunches during harvest (AQSIQ 2008).
- In the packing house during routine commercial post-harvest procedures, e.g. sorting, grading, packing and quality inspection and control, inferior or defective grape berries are likely to be removed from bunches before packing (AQSIQ 2008). This will not remove fruit with symptomless infection and is unlikely to remove all mummified fruit.
- Pycnidia, perithecia and mycelia of the pathogen survive through winter in dead plant matter (Zhang 2005b; NYZSW 2009). Fruiting structures, spores and mycelia of the pathogen are likely to survive cold storage and transport.

The wide distribution of this pathogen in China, the potential for infected grape clusters to be symptomless and the likelihood that the pathogen will survive storage and transport, all support a risk rating for importation of ‘high’.

Probability of distribution

The likelihood that *P. baccae* will be distributed within Australia as a result of processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **MODERATE**.

Supporting information for this assessment is provided below:

- Pycnidia, perithecia and mycelia of *P. baccae* survive through winter in dead plant matter (Zhang 2005b; NYZSW 2009). Pycnidia, perithecia, spores and mycelia of the pathogen are likely to survive cold storage and transport.
- Imported fruit are intended for human consumption. Fruit will be distributed to many localities by wholesale and retail trade and by individual consumers. Grape clusters may be distributed to all states in unrestricted trade.
- Most fruit waste, berries, clusters and stalks, will be discarded into managed waste systems and will be disposed of in municipal tips. Consumers will discard small quantities of fruit waste in urban, rural and natural localities. Small amounts of fruit waste will be discarded in domestic compost.
- Fruit waste may be discarded near host plants.
- Spores may be spread by wind, rain or insects (NYZSW 2009) from discarded fruit waste to a host plant.
- *Physalospora baccae* is only known to infect *Vitis* spp. (Zhang 2005b; NYZSW 2009).
- Grapevines are sporadically but widely distributed throughout Australia. Domestic garden plantings, both maintained and abandoned, occur in all or most Australian towns and cities and by many farmhouses. Table grape production occurs in all Australian states and NT (DPIW Tasmania 1999; Australian Table Grape Association 2008). Extensive wine grape plantings are found across the south-eastern quarter of Australia and the southwest of WA (Kiri-ganai Research Pty Ltd 2006).

The likely survival of the pathogen through cold storage and transport, moderated by the limited host range, supports a risk rating for distribution of ‘moderate’.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *P. baccae* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **MODERATE**.

4.16.2 Probability of establishment

The likelihood that *P. baccae* will establish within Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **HIGH**.

Supporting information for this assessment is provided below:

- *Physalospora baccae* is present across the major grape growing regions of China (Li 2001). It is also present in Japan and South Korea (Nishikado 1921; Shin *et al.* 1984). The climates of these regions vary considerably.
- Other *Physalospora* species are established in Australia (APPD 2009).
- *Physalospora baccae* is only known to infect *Vitis* spp. (Zhang 2005b; NYZSW 2009). Commonly grown *V. vinifera* cultivars are susceptible.
- Grapevines are widely distributed throughout Australia, growing in domestic gardens in all cities and most towns. Table grapes are grown in all Australian states and territories

(DPIW Tasmania 1999; Australian Table Grape Association 2008). Wine grapes are grown across the south-eastern quarter of Australia and the southwest of WA (Kiri-ganai Research Pty Ltd 2006).

- Hot and wet weather promotes development of the fungus and infection of host tissues by spores (Zhang 2005b; NYZSW 2009).
- Conidia germinate in 4 hrs at 24–28 ºC and ascospores germinate in 5 hrs at 25 ºC (BAIKE 2009; NYZSW 2009). Mycelia grow at a wide range of temperatures (5–40 ºC) with the optimum being about 25 ºC on artificial media (Liu *et al.* 2006a). An optimum temperature range of 24–28 ºC is reported for symptom development on fruit.
- Temperatures and humidity in areas of Australia where grapes are grown are likely to be suitable for *P. baccae* to become established.

Suitability of the Australian climate and spore dispersal by wind, rain and insects support a risk rating for establishment of 'high'.

4.16.3 Probability of spread

The likelihood that *Physalospora baccae* will spread within Australia, based on a comparison of factors in the source and destination areas that affect the expansion of the geographic distribution of the pest, is: **HIGH**.

Supporting information for this assessment is provided below:

- During periods of wet weather when temperatures rise in spring, overwintered pycnidia and perithecia of *Physalospora baccae* release conidia and ascospores (BAIKE 2009; NYZSW 2009).
- Wind, rain and insects spread the conidia and ascospores to infect grape clusters in spring and early summer.
- Australian grown grapes are distributed to many localities by wholesale and retail trade and by individual consumers. If infected, movement of Australian grape clusters and grapevines may contribute to spreading the pathogen.
- *Physalospora baccae* is only known to infect *Vitis* spp. (Zhang 2005b; NYZSW 2009). Commonly grown *V. vinifera* cultivars are susceptible.
- Table grapes are grown in all Australian states and territories (DPIW Tasmania 1999; Australian Table Grape Association 2008) and wine grapes are grown across the south-eastern quarter of Australia and the southwest of WA (Kiri-ganai Research Pty Ltd 2006). Grapevines are also grown in domestic gardens.
- *Physalospora baccae* is present across the major grape growing regions of China (Li 2001) indicating a capacity to spread.
- In China, *P. baccae* is controlled by vineyard sanitation and chemical sprays between flower drop and the young fruit stage (Zhang 2005b). Copper fungicides are reported to provide effective control of the fungus (BAIKE 2009; NYZSW 2009).
- Existing disease control programs in Australian vineyards may reduce the ability of *P. baccae* to spread and initiate disease outbreaks, although there are currently no specific

control recommendations or precautions in place (Quirk and Somers 2009; DAFWA 2009b).

Suitability of the Australian climate, spore dispersal by wind, rain and insects and the potential for distribution with infected grape clusters support a risk rating for spread of 'high'.

4.16.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *P. baccae* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **MODERATE**.

4.16.5 Consequences

The consequences of the establishment of *P. baccae* in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**E**', the overall consequences are estimated to be **MODERATE**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: E – Significant at the regional level. The Australian grape crop in the 2007/08 season was estimated to have a gross value of $1.693 billion (ABS 2009c). The value of Australian wine produced in the 2007/08 season was estimated to be $4.77 billion (ABS 2009c) of which $2.1 billion was sold locally. Annual production of table grapes is about 120 000 t (Australian Table Grape Association 2008). In 2008/9 Australia exported 70 000 t of table grapes at prices of between $2.08/kg to $3.34/kg (ABS 2009b). Dried grape production was 56 139 t in 2008 and was as high as 135 412 t in 2005 (ABS 2009c). Table grape production occurs in all Australian states and NT (DPIW Tasmania 1999; Australian Table Grape Association 2008). Extensive wine grape plantings are found across the south-eastern quarter of Australia and the southwest of WA (Kiri-ganai Research Pty Ltd 2006). *Physalospora baccae* infects grape berries, leaves, pedicels and peduncles (BAIKE 2009; NYZSW 2009). It also infects grapevine leaves when the disease is serious. It is reported that the pathogen only causes serious damage in areas with poor horticultural practices in seasons with appropriate temperatures and humidity. The incidence of disease is high in years with hot and humid weather in summer and early autumn in vineyards that are not well managed. High disease incidences, with a fruit infection rate of about 30% have been reported in vineyards in the provinces of Hunan, Fujian and Shanxi (Hu and Lin 1993; Gao *et al.* 1999) and up to 75% of fruit were infected in a vineyard in Jiangxi province (Li 1984). *Vitis vinifera* cultivars are more susceptible to disease than American grape cultivars (NYZSW 2009). Estimates of yield losses were not found but may be consistent with incidence levels.
Other aspects of the environment	**Impact score**: A – Indiscernible at the local level. There are no known direct consequences of this fungus on other aspects of the environment.

Criterion	Estimate and rationale
Indirect	
Eradication, control etc.	**Impact score**: E – Significant at the regional level. In China, *P. baccae* is controlled by vineyard sanitation and chemical sprays between flower drop and the young fruit stage (Zhang 2005b). Vines are sprayed with fungicide from June to August every two weeks. Copper fungicides are effective in controlling the fungus (BAIKE 2009; NYZSW 2009). In Australia, control of the pathogen may require additional fungicide applications, which would have a cost and may disrupt the existing integrated disease management programs. Australian vineyards are managed with cultural methods that would probably help control this fungus (Nicholas *et al.* 1994; Quirk and Somers 2009; DAFWA 2009b) but it is likely that any initial outbreaks would be both damaging and costly. A single incursion may lead to a rapid regional spread to susceptible grape hosts with state and regional restrictions likely in the short term.
Domestic trade	**Impact score**: E – Significant at the regional level. Trade restrictions would be applied by states that lack the pathogen against states where the pathogen exists. Yield reduction would reduce the amount of fruit available for domestic supply from states/territories with this fungus.
International trade	**Impact score**: D – Significant at the district level. The presence of *P. baccae* in commercial production areas of Australia would have an impact on the export of Australian table grapes to countries where this pathogen is not present, such as New Zealand and USA. Yield reduction might reduce the amount of fruit exported.
Environmental and non-commercial	**Impact score**: B – Minor significance at the local level. Additional fungicide applications or other control measures may be required to control this disease on susceptible hosts and these may have minor impact on the environment.

4.16.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Physalospora baccae*	
Overall probability of entry, establishment and spread	**Moderate**
Consequences	**Moderate**
Unrestricted risk	**Moderate**

As indicated, the unrestricted risk estimate for *Physalospora baccae* of 'moderate' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.17 Bitter rot

Greeneria uvicola [WA]

Greeneria uvicola is not present in the State of Western Australia and is a pest of quarantine concern for that state.

Bitter rot of grapevine is caused by the fungus *Greeneria uvicola* (Berkley & M.A. Curtis) Punithalingam (Sutton and Gibson 1977; McGrew 1988). It is a weakly pathogenic fungus that attacks damaged or near-senescent tissues under warm and humid conditions (McGrew 1988).

Greeneria uvicola overwinters on pedicels, fruit spurs and mummified berries (Kummuang *et al.* 1996a; Kummuang *et al.* 1996b). The sexual state of this fungus is not known to occur (Farr *et al.* 2001) and the mode of spread is through air-bone conidia (Momol *et al.* 2007). It may also be transmitted in infected stem internodes (Sutton and Gibson 1977). There are no reports of disease transmission via seed or soil, unless accompanied by infected plant parts.

Greeneria uvicola attacks many species of grape, including *Vitis vinifera* (European grape), *V. labrusca* (fox grape) and *V. rotundifolia* (muscadine grape) (Sutton and Gibson 1977; Farr *et al.* 2001). Infection occurs from 12 °C to an optimum of 28–30 °C. Mycelial growth is inhibited above 36 °C (McGrew 1988). *Greeneria uvicola* has also been reported on mature fruit of apple, cherry, strawberry, peach and banana under experimental conditions (Ridings and Clayton 1970; McGrew 1988).

The fungus causes flecking or russetting in leaves, stems, flowers and berries (Ridings and Clayton 1970; McGrew 1988). *Greeneria uvicola* usually infects berries via the pedicel (Ridings and Clayton 1970; McGrew 1988). Berry discolouration and russetting spreads until eventually progressing into typical bitter rot symptoms (Ridings and Clayton 1970; McGrew 1988; Kummuang *et al.* 1996a; Momol *et al.* 2007). Infected berries soften and become dark coloured with concentric rings of fruiting bodies known as acervuli. The underlying tissue becomes necrotic (Ridings and Clayton 1970; McGrew 1988; Kummuang *et al.* 1996a) and within a few days berries soften and are bitter to taste. Some berries are easily detached (Ridings and Clayton 1970; McGrew 1988) while others shrivel and mummify (McGrew 1988; Momol *et al.* 2007).

Greeneria uvicola has been recorded in the southern part of Jiangsu province (Yan *et al.* 1998). In Australia, *G. uvicola* has been reported from north-eastern New South Wales in the Hunter Valley and Hastings Valley on wine grapes, and on table grapes at Mundubbera in Queensland (Castillo-Pando *et al.* 1999; Sergeeva *et al.* 2001).

The risk scenario of concern for *G. uvicola* is that conidia could be present on the surface of uninfected grapes and asymptomatic infected grapes may be harvested and packed for export.

4.17.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Probability of importation

The likelihood that *G. uvicola* will arrive in Western Australia with the importation of table grapes from China is: **LOW**.

Supporting information for this assessment is provided below:

- *Greeneria uvicola* has been recorded only in the southern part of Jiangsu province (Yan *et al.* 1998) in China, which is not a major commercial grape production area.
- Bitter rot can affect young shoots, stems of fruit bunches, pedicels and berries. *Greeneria uvicola* usually attacks berries via the pedicel. Within a few days of infection, berries soften and are bitter to taste; some are easily detached while others shrivel and mummify (McGrew 1988; Momol *et al.* 2007).
- Maturing berries become soft and show water-soaked symptoms accompanied by brown lesions, which are completely covered by concentric rings of fruiting bodies and can cause the epidermis and cuticle to rupture. Some infected berries may abscise, or dry into mummies and stay firmly attached (McGrew 1988; Momol *et al.* 2007). Symptoms on infected fruit are easily recognisable, so the infected fruit is unlikely to be picked for export. If infected berries were harvested they are likely to be removed during trimming, sorting, grading and processing in the field and packing houses before export.
- Conidia may be present on the surface of the grapes if transmitted from infected grapes or vines nearby. Undamaged fruit could therefore carry *G. uvicola* spores without visually obvious symptoms. There may be a delay between the time of infection and the time when symptoms are visually obvious which may result in postharvest decay (Ullasa and Rawal 1986). Therefore, inspection during harvesting and packing may not prevent infection of *G. uvicola* in a shipment.
- Any latent infection may be detected during the inspection at arrival for sea freighted table grapes as the time from harvesting to entry into Western Australia would exceed the time needed to show symptoms of infection. It takes 8–11 days for a container ship to travel from Shanghai to Perth excluding the loading and unloading time (World News Network 2009). But for air freighted table grapes, conidia on the surface of uninfected grapes could enter Western Australia and the grapes would not show visual symptoms upon entry.

The very limited distribution of this fungus in China, the short symptom development period and the fact that the symptoms are obvious, all support a risk rating for importation of ‘low’.

Probability of distribution

The likelihood that *G. uvicola* will be distributed within Western Australia as a result of processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **HIGH**.

Supporting information for this assessment is provided below:

- Distribution of the commodity in Australia would be for retail sale, as the intended use of the commodity is human consumption. Waste material could be generated in the form of discarded bunches or stalks.
- Infected table grapes (pedicels, fruit spurs or berries) and waste material could be discarded where eaten or in compost heaps or into domestic waste and could act as a

source of disease inoculum. *Greeneria uvicola* could then be transmitted by air-borne conidia to host species (Momol *et al.* 2007).

- The primary host of *G. uvicola* is the muscadine grape, *Vitis rotundifolia*, but other *Vitis* spp. are also susceptible, including *V. vinifera*, *V. bourquiniana*, *V. labrusca*, *V. munsoniana*. No other natural hosts are known but *G. uvicola* can infect a number of other fruits including apple, cherry, strawberry, peach and banana under experimental conditions (Ridings and Clayton 1970; McGrew 1988).
- Conidia on the surface of uninfected grapes could enter Australia. However, without actual fungal infection, growth and reproduction, it is likely that there would be insufficient conidia on uninfected grapes for a reasonable chance of transmission to a suitable host.

The availability of *Vitis* hosts, distribution of infected fruit and the air-borne nature of conidia, all support a risk rating for distribution of 'high'.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *G. uvicola* will enter Western Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **LOW**.

4.17.2 Probability of establishment

The likelihood that *G. uvicola* will establish in Western Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **HIGH**.

Supporting information for this assessment is provided below:

- The primary host of *G. uvicola* is the muscadine grape, *Vitis rotundifolia*, but other *Vitis* spp. are also susceptible, including *V. vinifera*, *V. bourquiniana*, *V. labrusca*, *V. munsoniana*. No other natural hosts are known but *G. uvicola* can infect a number of other fruits including apple, cherry, strawberry, peach and banana under experimental conditions (Ridings and Clayton 1970; McGrew 1988).
- *Greeneria uvicola* in culture has an optimum temperature of 28 °C but can grow at 8 °C and germinate to produce conidia above 12 °C (Ridings and Clayton 1970; McGrew 1988).
- *Greeneria uvicola* is present in Australia, Brazil, China, Costa Rica, Greece, India, South Africa and USA (Sutton and Gibson 1977; Ullasa and Rawal 1986; Kummuang *et al.* 1996b; Yan *et al.* 1998; Steel 2007) indicating it can establish across a range of climatic conditions.
- In Australia, *G. uvicola* has been reported in north-eastern New South Wales in the Hunter Valley and Hastings Valley on wine grapes and at Mundubbera in Queensland on table grapes (Castillo-Pando *et al.* 1999; Sergeeva *et al.* 2001). It does not appear to cause damage in other grape growing areas of eastern Australia. The distribution of the pathogen is generally limited to warmer climatic regions with high summer and autumn rainfall. Environments with warm temperatures exist in various parts of Western Australia

although the climate is predominantly Mediterranean with winter rainfall in the south, suggesting that *G. uvicola* may have some potential to establish in Western Australia.

The establishment of *G. uvicola* in eastern states in warm areas with high summer rainfall, the occurrence of suitable climatic conditions in Western Australia and the availability of hosts all support a risk rating for establishment of 'high'.

4.17.3 Probability of spread

The likelihood that *G. uvicola* will spread in Western Australia, based on a comparison of factors in the source and destination areas that affect the expansion of the geographic distribution of the pest, is: **HIGH**.

Supporting information for this assessment is provided below:

- Infected grape clusters may be distributed throughout Western Australia for human consumption and the movement of infected nursery stocks may contribute to spreading the fungus to new areas.
- The primary host of *G. uvicola* is the muscadine grape, *Vitis rotundifolia*, but other *Vitis* spp. are also susceptible, including *V. vinifera*, *V. bourquiniana*, *V. labrusca*, *V. munsoniana*. No other natural hosts are known but *G. uvicola* can infect a number of other fruits including apple, cherry, strawberry, peach and banana under experimental conditions (Ridings and Clayton 1970; McGrew 1988). All of these hosts are cultivated in Western Australia.
- Air-borne conidia of *G. uvicola* enable the long-distance spread of this fungus (Ridings and Clayton 1970). It can also be transmitted in infected stem internodes (Sutton and Gibson 1977).
- Infection occurs from 12 °C to an optimum of 28–30 °C. Mycelial growth is inhibited above 36 °C (McGrew 1988).
- *Greeneria uvicola* is present in Australia, Brazil, China, Costa Rica, India, South Africa and USA (Sutton and Gibson 1977; Ullasa and Rawal 1986; Kummuang *et al.* 1996b; Yan *et al.* 1998; Steel 2007). Environments with climates similar to these regions exist in various parts of Western Australia suggesting that *G. uvicola* may have the potential to spread in Western Australia despite predominantly winter rainfall in the south.
- In Australia, *G. uvicola* has been reported from north-eastern New South Wales in the Hunter Valley and Hastings Valley on wine grapes and on table grapes at Mundubbera in Queensland (Castillo-Pando *et al.* 1999; Sergeeva *et al.* 2001).

The spread of this fungus in parts of the eastern states and the long-distance spread of air-borne conidia by wind, support a risk rating for spread of 'high'.

4.17.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The overall likelihood that *G. uvicola* will enter Western Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Western Australia and subsequently spread within Western Australia is: **LOW**.

4.17.5 Consequences

The consequences of the establishment of *G. uvicola* in Western Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**E**', the overall consequences are estimated to be **MODERATE**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: E – Significant at the regional level. *Greeneria uvicola* infects many species of grape, including *Vitis vinifera* (European grape), *V. labrusca* (fox grape) and *V. rotundifolia* (muscadine grape) (Sutton and Gibson 1977; Farr *et al.* 2001). *Greeneria uvicola* usually infects berries via the pedicel, resulting within two days in shrivelling, rotting, and leaving soft, bitter-tasting and easily detached berries (Pearson and Goheen 1988). At worst, *G. uvicola* can kill the grapevine through girdling. *Greeneria uvicola* has also been reported on mature fruit of apple, cherry, strawberry, peach and banana under experimental conditions (Ridings and Clayton 1970).
Other aspects of the environment	**Impact score**: A – Indiscernible at the local level. There are no known direct consequences of this fungus on other aspects of the natural environment.
Indirect	
Eradication, control etc.	**Impact score**: D – Significant at the district level. In China, *G. uvicola* is controlled by cultivation measures and chemical sprays (Yan *et al.* 1998). In Australia, management measures to increase aeration of canopies tend to decrease the incidence of bitter rot of berries (Emmett 2006) and chemical control measures are being developed to control bitter rot in affected regions (Steel 2007). The incidence of *G. uvicola* in warm wet regions in Australia has been reduced by avoiding the planting of late-maturing grape varieties. Management measures to increase aeration of canopies tend to decrease the incidence of bitter rot of berries (Emmett 2006). Chemical control measures are being developed to control bitter rot in these regions (Steel 2007). Control and eradication of infected plants may disrupt the existing IDM programs and require additional fungicide applications, which would have a cost associated with it.
Domestic trade	**Impact score**: A – Indiscernible at the local level. There would be no trade restrictions applied by other states as this fungus is present and there are no existing planting material controls for this pathogen.
International trade	**Impact score**: E – Significant at the regional level. Its presence in commercial production areas of grapes in Western Australia would have impacts on the export of Australia's fresh grapes, apple, cherry, strawberry, peach and banana to countries where this pathogen is not present, such as Japan, New Zealand and South Korea. However, it is present in USA and, although the pathogen has a limited presence in China, it is a quarantine pest of concern to China.
Environmental and non-commercial	**Impact score**: B – Minor significance at the local level. Additional fungicide applications or other control measures would be required to control this disease on susceptible hosts and these may have minor impact on the environment.

4.17.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Greeneria uvicola*	
Overall probability of entry, establishment and spread	**Low**
Consequences	**Moderate**
Unrestricted risk	**Low**

As indicated, the unrestricted risk estimate for *Greeneria uvicola* of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.18 Black rot

Guignardia bidwellii

Black rot of grapevines is caused by the fungus *Guignardia bidwellii*, which has an almost cosmopolitan distribution except for Australasia, western North America and Scandinavia (Farr and Rossman 2009). *Guignardia bidwellii* causes an important disease of grapes affecting the foliage, petioles, shoots, tendrils, cluster stems and fruit, (University of Illinois 2001; Ellis 2008b; Ullrich *et al.* 2009) that causes substantial economic loss (Ramsdell and Milholland 1988; Wilcox 2003).

Guignardia bidwellii overwinters in infected canes, tendrils, fallen leaves and in mummified fruit on the vine or on the ground (Ferrin and Ramsdell 1977; Kummuang *et al.* 1996a; Hartman and Hershman 1999; Ellis 2008b). Spring rains trigger the release of ascospores from pseudothecia, which are wind-borne and disperse moderate distances, and conidia from pycnidia, which are splash-dispersed short distances (centimetres to a metre). Mummified fruit on the ground release ascospores early and mummified fruit in the vine release spores up until the beginning of ripening of the new crop (Ferrin and Ramsdell 1977; Ferrin and Ramsdell 1978; Wilcox 2003).

Infection occurs when the spores land on young, immature tissues and these remain wet for a period of time (Spotts 1977). It can take one to five weeks for symptoms to appear after infection depending on the plant part, time of infection and climatic conditions (Spotts 1980; Wilcox 2003). Once the fungus has become established in susceptible tissues, the anamorph, *Phyllosticta ampelicida*, is formed and production of conidia commences (Hartman and Hershman 1999). Conidia are splash-dispersed (Ferrin and Ramsdell 1978; University of Illinois 2001). Conidia are released in large quantities and can cause rapid spread of the disease (Ferrin and Ramsdell 1978). This cycle of conidial production and infection of susceptible hosts continues for the rest of the season, except when the environment becomes limiting (Hartman and Hershman 1999).

On leaves, symptoms start as small, brown, circular lesions that produce pycnidia in a few days (Spotts 1980; Wilcox 2003). On petioles, symptoms are elongated black lesions. On shoots, symptoms are large black elliptical lesions. On fruit, symptoms initially show as small whitish dots (Eyres *et al.* 2006), which expand to encompass the whole berry and become light or chocolate brown. The berries then turn darker brown, produce pycnidia, then shrivel and turn into hard black mummified fruit (Wilcox 2003). The pycnidia, which are small, black fruiting bodies, appear as dots on the surface of infected tissue (Eyres *et al.* 2006).

Fruit is very susceptible to infection for the first 2 to 3 weeks after cap fall and berries of *V. vinifera* cultivars remain susceptible at a reduced level until 6 to 7 weeks after bloom (Wilcox 2003). Fruit generally starts showing symptoms about 2 weeks after it becomes infected but berries infected near the end of their period of susceptibility do not show symptoms until at least 3 weeks later and do not begin to rot until 4 to 5 weeks after the infection event (Wilcox 2003).

The risk scenario of concern for *G. bidwellii* is that low levels of berry infection, especially berries infected near the end of their period of susceptibility, may escape detection during picking and packing of grape bunches, resulting in the fungus being imported into Australia.

Guignardia bidwellii was included in the existing import policy for table grapes from California (AQIS 2000). No risk assessment was undertaken because California has pest free area status for this pathogen.

4.18.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Probability of importation

The likelihood that *G. bidwellii* will arrive in Australia with the importation of table grapes from China is: **HIGH**.

Supporting information for this assessment is provided below:

- *Guignardia bidwellii* has been reported from the table grape producing provinces of Henan, Jiangsu, Liaoning, Shandong, Sichuan and Xinjiang (AQSIQ 2007).
- *Guignardia bidwellii* is an important disease of grapes. In areas with warm, humid climates, it can cause severe crop loss (Wilcox 2003). In China, 38.5% of table grapes are grown in Xinjiang, which has a warm, dry climate that is not favourable for *G. bidwellii* (FCC 1997; AQSIQ 2006; AQSIQ 2009b). The percentage of grapes grown in China where the symptoms or crop loss would be severe is unknown.
- There is variability in the susceptibility of *V. vinifera* cultivars to *G. bidwellii* (University of Illinois 2001).
- There is variation in the pathogen and several forms have been described (Luttrell 1946; Kummuang *et al.* 1996b; AQIS 2000).
- All young green tissues of the vine are susceptible to infection by *G. bidwellii* and the fungus infects the cluster stems and berries (University of Illinois 2001; Ellis 2008b; Ullrich *et al.* 2009).
- *Vitis vinifera* wine grape cultivars ‘Riesling’ and ‘Chardonnay’ are highly susceptible for 4 to 5 weeks from mid-bloom (Hoffman *et al.* 2002) and then maintain a reduced level of susceptibility until 6 or 7 weeks after the flowers open, depending on the season. Age related resistance develops more quickly in warm seasons (Wilcox 2003).
- On the fruit, symptoms start as light brown, soft spots that rapidly enlarge to cover the entire berry. These symptoms are easily visible. Affected berries, covered with pycnidia, shrivel into black, wrinkled mummified fruit which either drop to the ground or remain in clusters (Hartman and Hershman 1999).
- Symptoms take one to five weeks to appear after infection, depending on the plant part, time of infection and climatic conditions (Spotts 1980; Hoffman *et al.* 2002; Wilcox 2003).
- The proportion of berry infection in a vineyard ranged from 5–58% in the USA (Spotts 1980).
- During commercial harvesting procedures undertaken in the vineyard, pickers select and harvest only bunches of sound fruit. Inferior, diseased, small and damaged bunches are

unlikely to be selected for harvest. Inferior berries are likely to be trimmed from bunches during harvesting (AQSIQ 2008).

- In the packing house during routine commercial post-harvest procedures (e.g. sorting, grading, packing and quality inspection and control), most inferior or defective grapes are likely to be trimmed and removed from bunches of table grapes before packing (AQSIQ 2008). However, it is likely that some infected berries would escape detection in bunches, especially berries infected late in the period of susceptibility when infections develop more slowly.

The susceptibility of all commercial cultivars of *V. vinifera* to infection and the difficulty of removing all infected berries from within grape bunches support a risk rating for importation of 'high'.

Probability of distribution

The likelihood that *G. bidwellii* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **MODERATE**.

Supporting information for this assessment is provided below:

- *Guignardia bidwellii* lasts through the winter in fallen leaves and stem lesions and in mummified fruit on vines and on the ground (Hartman and Hershman 1999). Therefore, the pathogen could survive cold storage.
- Imported grapes are intended for human consumption. Fruit will be distributed to many localities by wholesale and retail trade and by individual consumers. Berries may be distributed to all states in unrestricted trade.
- Most fruit waste will be discarded into managed waste systems and will be disposed of in municipal tips. Consumers will discard small quantities of fruit waste in urban, rural and natural localities. Small amounts of fruit waste will be discarded in domestic compost.
- Fruit waste may be discarded near host plants.
- *Guignardia bidwellii* has a host range of *Ampelopsis* spp., *Cissus* spp., *Citrus* spp., *Parthenocissus* spp., *Psedera* spp., *Vitis* spp., *Arachis hypogaea* (peanut), *Asplenium nidus* (bird's nest fern), *Canthium umbellatum* (kaari), *Heptapleurum venulosum* and *Salvadora oleoides* (Eyres *et al.* 2006; CABI 2009; Farr and Rossman 2009). Some of these hosts are widely distributed in home gardens, nurseries and orchards in Australia.
- Waste fruit may contain mummified fruit, which may release ascospores and conidia if it rains. Ascospores are wind-borne and conidia are splash-dispersed (Ferrin and Ramsdell 1977; Ferrin and Ramsdell 1978; Wilcox 2003). Wind-borne ascospores can be dispersed considerable distances (Ellis 2008b).
- The fungus can cause infections of fruit and rachises (Spotts 1980; Wilcox 2003). The fungus is adapted to mummification of berries and desiccation (Wilcox 2003).

The ability of the fungus to survive cold storage and release spores from mummified fruit and the wide distribution in Australia of hosts, support a risk rating for distribution of 'moderate'.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *G. bidwellii* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host, is: **MODERATE**.

4.18.2 Probability of establishment

The likelihood that *G. bidwellii* will establish within Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **MODERATE**.

Supporting information for this assessment is provided below:

- *Guignardia bidwellii* is present in Argentina, Austria, Barbados, Brazil, Bulgaria, Canada, Chile, Cuba, Cyprus, El Salvador, Former Yugoslavia, France, Germany, Guyana, Haiti, India, Iran, Italy, Jamaica, Japan, Korea, Martinique, Mexico, Morocco, Mozambique, Pakistan, Panama, Philippines, Romania, Russian Federation, Slovakia, Sudan, Switzerland, Turkey, Ukraine, Virgin Islands (US), Uruguay, USA and Venezuela (CABI 2009), indicating that it can establish across a wide range of environments.
- *Guignardia bidwellii* has a host range of *Ampelopsis* spp., *Cissus* spp., *Citrus* spp., *Parthenocissus* spp., *Psedera* spp., *Vitis* spp., *Arachis hypogaea* (peanut), *Asplenium nidus* (bird's nest fern), *Canthium umbellatum* (kaari), *Heptapleurum venulosum* and *Salvadora oleoides* (Eyres *et al.* 2006; CABI 2009; Farr and Rossman 2009). Some of these hosts are widely distributed in home gardens, nurseries and orchards in Australia.
- Infection takes place if plant surfaces stay wet long enough for ascospores or conidia to germinate and penetrate host tissues (Hartman and Hershman 1999; Schilder 2006). Free water is required for infection (Hoffman and Wilcox 2002).
- The optimum temperature for disease development is 27 °C (range is 10–32 °C). At this temperature, the period that the plant part is required to remain wet for infection is six hours (Spotts 1977; Schilder 2006). The period of wetness required for infection increases to 24 hours at 10 °C and 12 hours at 32 °C (Spotts 1977; Schilder 2006).
- Temperatures and humidity in high rainfall areas of Australia where grapes are grown are suitable for *G. bidwellii* to infect.
- Only young tissues are infected by *G. bidwellii*. Young leaves are highly susceptible to infection as they unfold but become resistant about the time they finish expanding, while berries of *V. vinifera* remain susceptible until 6–7 weeks after bloom (Wilcox 2003).
- After infection, symptoms generally take one to five weeks to develop (Spotts 1980; Hoffman *et al.* 2002; Wilcox 2003). Once the fungus has become established in susceptible tissues, conidial production commences (Hartman and Hershman 1999).
- The fungus is homothallic so that an infection by a single spore could result in both sexual and asexual reproduction (Jailloux 1992).
- The fungus survives through the winter in fallen leaves and stem lesions and in mummified fruit on vines and on the ground (Hartman and Hershman 1999).

Suitable temperatures and relative humidities for infection in some grape growing regions of Australia and the wide distribution of some hosts in Australia, mitigated by the resistance of mature tissues, support a risk rating for establishment of 'moderate'.

4.18.3 Probability of spread

The likelihood that *G. bidwellii* will spread within Australia, based on a comparison of factors in source and destination areas that affect the expansion of the geographic distribution of the pest, is: **HIGH**.

Supporting information for this assessment is provided below:

- Some hosts of *Guignardia bidwellii* are widely distributed in home gardens, nurseries, vineyards and orchards in Australia. Favourable weather conditions for infection of hosts by *G. bidwellii* are present in parts of Australia with a warm, humid climate.
- Infected fruit, leaves and stems are likely to carry the fungus in the trade and transport of fruit and nursery stock (CABI 2009; Ullrich *et al.* 2009).
- On *Vitis* species, infections usually progress from leaves, petioles and canes to fruit (Ferrin and Ramsdell 1977; Spotts 1980; Kummuang *et al.* 1996a).
- The majority of ascospores from overwintering mummified fruit on the ground are discharged during the period when shoots are growing in spring. If mummified fruit are allowed to hang on the trellis, they can discharge ascospores and conidia throughout the growing season (Hartman and Hershman 1999).
- Spore production starts in the spring as temperatures increase and wet weather prevails (Hartman and Hershman 1999). Spring rain triggers the release of ascospores from pseudothecia, which are wind-borne and disperse moderate distances, and conidia from pycnidia, which are splash-dispersed short distances (centimetres to a metre) (Ferrin and Ramsdell 1977; Ferrin and Ramsdell 1978; University of Illinois 2001; Wilcox 2003). Ascospores are released after 0.3mm or more of rain (Ferrin and Ramsdell 1977). The cycle of conidial production and infection of susceptible hosts continues for the rest of the season, except when the environment becomes limiting (Hartman and Hershman 1999).
- A single ascospore or conidium can cause a leaf infection (Jailloux 1992; Hartman and Hershman 1999). Within each leaf lesion, many pycnidia may be formed, each producing numerous conidia. Each conidium has the potential to cause another secondary infection later in the season (Hartman and Hershman 1999).

The favourability of weather conditions for infection in some parts of Australia, the wide distribution of some hosts in Australia, the prolific production of conidia throughout the season and spread on infected fruit and nursery stock all support a risk rating for spread of 'high'.

4.18.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *G. bidwellii* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **LOW**.

4.18.5 Consequences

The consequences of the establishment of *G. bidwellii* in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one criterion is '**F**', the overall consequences are estimated to be **HIGH**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: F – Significant at the national level. *Guignardia bidwellii* has a host range of *Ampelopsis* spp., *Cissus* spp., *Citrus* spp., *Parthenocissus* spp., *Psedera* spp., *Vitis* spp., *Arachis hypogaea* (peanut), *Asplenium nidus* (bird's nest fern), *Canthium umbellatum* (kaari), *Heptapleurum venulosum* and *Salvadora oleoides* (Eyres *et al.* 2006; CABI 2009; Farr and Rossman 2009). The main commercial crops that are hosts are grapes, citrus and peanuts. For citrus and peanuts, there are no records of this fungus causing any damage of economic significance. *Guignardia bidwellii* causes an important disease of grapes. In areas with warm, humid climates, it can cause severe crop loss (Wilcox 2003). In Europe, crop losses can be from 80–100% (Pezet and Jermini 1989). In the USA, crop losses can be from 70–100% in years that favour the disease (Ferrin and Ramsdell 1977). There is variability in the susceptibility of *V. vinifera* cultivars (University of Illinois 2001). There can be an unpleasant taste to the wine (CABI 2009) when healthy and infected grapes are used to produce it. Table grape production occurs in all Australian states and NT (DPIW Tasmania 1999; Australian Table Grape Association 2008). Extensive wine grape plantings are found across the south-eastern quarter of Australia and southwest of WA (Kiri-ganai Research Pty Ltd 2006). Annual production of table grapes is about 120 000 t (Australian Table Grape Association 2008). In 2008/9 Australia exported 70 000 t of table grapes at prices of between $2.08/kg to $3.34/kg (ABS 2009b). Dried grape production was 56 139 t in 2008 and was as high as 135 412 t in 2005 (ABS 2009c). In 2007/8 the value of the Australian wine produced was $4.77 billion of which $2.1 billion was sold locally (ABS 2009c). There are no records of this pathogen being able to infect native species in Australia but it is likely it will, given the wide host range on Vitaceae. Also, *Asplenium nidus* is a species complex that includes *A. australasicum*, which is an Australian native fern (Yatabe and Murakami 2003).
Other aspects of the environment	**Impact score**: A – Indiscernible at the local level. There are no known direct consequences of this fungus on other aspects of the natural environment.
Indirect	
Eradication, control etc.	**Impact score**: E – Significant at the regional level. Control of *G. bidwellii* is frequently necessary to prevent crop losses. Programs to minimise the impact of *G. bidwellii* on host plants are likely to be costly and include cultural control, chemical control (Eyres *et al.* 2006), early warning systems and Integrated Pest Management (IPM) (CABI 2009). The cultural practices include maintaining an open canopy, weeding under vines, removal of mummified fruit and cultivation before bud-break to bury the fallen mummified fruit (Eyres *et al.* 2006; CABI 2009). Preventative sprays are applied between bud-burst and when the berries have 5% sugar. The chemicals that are effective are sodium bicarbonate, sodium ethylphosphite, mancozeb, captan, dichlofluanid, folpet, maneb, propineb and zineb (CABI 2009). The chemicals that are effective to use after infection are triadimefon, fenarimol, myclobutanil, hexaconizole and difenoconazole (CABI 2009). Asoxystrobine can be used to prevent or cure an infection of *G. bidwellii* (CABI 2009). Existing pest management programs may have to be changed due to possible increases in the use of fungicides.
Domestic trade	**Impact score**: D – Significant at the district level. The presence of *G. bidwellii* in commercial production areas is likely to result in interstate trade restrictions on table grapes, potential loss of markets, and significant industry adjustment at the district level. The National Viticulture Industry Biosecurity Plan identifies *G. bidwellii* as a pest risk (Plant Health Australia 2009).

Criterion	Estimate and rationale
International trade	**Impact score**: D – Significant at the district level. The presence of this pathogen in commercial production areas of table grapes could limit access to overseas markets that are free of this pathogen, such as New Zealand. This pathogen is present in USA, EU, Japan, Korea and India (CABI 2009).
Environmental and non-commercial	**Impact score**: B – Minor significance at the local level. Additional fungicide application or other control activities may be required to contain and/or eradicate this pest and control it on susceptible crops. However, this is not considered to have significant consequences for the environment. Although *Guignardia bidwellii* does little damage to the overall health of the vine (Hoffman and Wilcox 2002), it does make the plant look unsightly, with leaf and fruit spots (Wilcox 2003). Therefore, infected grapevines and other hosts in nurseries, home gardens and amenity plantings may need control measures applied to them.

4.18.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Guignardia bidwellii*	
Overall probability of entry, establishment and spread	**Low**
Consequences	**High**
Unrestricted risk	**Moderate**

As indicated, the unrestricted risk estimate for *G. bidwellii* of 'moderate' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.19 Spike stalk brown spot

Alternaria viticola

Alternaria viticola is a newly emerged and quickly spreading pathogen in China, causing a disease known as 'spike stalk brown spot' of grapes (Ma *et al.* 2004). It is also known as brown blotch (Wang 2009), or grape rachis blotch (Zhao 2002; Zhu *et al.* 2006). Little information is available on the organism and the disease it causes. This assessment is mainly based on a small number of scientific publications that mention the organism, publications and general knowledge of other *Alternaria* spp., a book of extension advice on pests and diseases control for table grapes in China (Zhang 2005b) and a commercial Chinese source that is not refereed (Grapevinewine 2003).

Alternaria viticola overwinters on cane surfaces, tendrils and in bud scale pieces as conidia (Ma *et al.* 2004). It can also overwinter on diseased debris (Grapevinewine 2003). Spores are spread by wind and rain (Ma *et al.* 2004; Erkara *et al.* 2008).

Alternaria viticola infects young, tender rachises and stalks of bunches, with no symptoms seen in old inflorescences (AQSIQ 2007). Young stalks and berries are infected from early May to early/mid June (Ma *et al.* 2004; Qi *et al.* 2007). The optimum temperature for germination of conidia is 25–27 ºC (Ma *et al.* 2004). *Alternaria viticola* causes more serious disease when there is early spring rainfall (Zhang 2005b) and a mild, humid spring (Li 2004). Mild and wet spring weather conditions promote infection and development of the fungus (Grapevinewine 2003).

Alternaria viticola affects stems, inflorescences and berries and in these plant parts the disease development and symptoms are distinct. Infection of the stalks starts with the peduncle and spreads to the pedicels (Li 2004). Symptoms are expressed 3–5 days after infection (Grapevinewine 2003). The infected stalks go brown and dry out causing the flower buds and young fruit on the infected inflorescences to shrink, dry out and drop off (Grapevinewine 2003; Li 2004; Zhang 2005b). When the young fruits reach soybean size, the stalks become resistant to new infection (Grapevinewine 2003; Zhang 2005b). The fungus infects repeatedly on pedicels and berries within a bunch (Zhang 2005b).

Alternaria viticola also infects berries of bunches with healthy stalks. Infected berries develop dark brown or black spots up to 2 mm in diameter on the skin. These spots which probably consist of mycelium or scar tissue expand as the berries grow and then fall off when the berries reach half size. The berries apparently continue to develop normally (Zhang 2005b). However, fruit that have lost their spots are potentially infected but appear normal, i.e. asymptomatic/symptomless.

The risk scenario of concern for *Alternaria viticola* is that the fungus will be present in grape bunches.

4.19.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Probability of importation

The likelihood that *A. viticola* will arrive in Australia with the importation of table grapes from China is: **HIGH.**

Supporting information for this assessment is provided below:

- *Alternaria viticola* is present in grape growing regions of China including Anhui, Beijing Hebei, Henan, Hunan, Liaoning, Shandong, Shanghai and Xinjiang (Grapevinewine 2003; Ma *et al.* 2004; Zhang 2005b; Zhu *et al.* 2006; Qi *et al.* 2007; Wang 2009).
- *Alternaria viticola* was reported to infect 30–50% of vines in southeast Shandong, when not effectively controlled. Incidence may be reduced to 5% in areas with control measures including application of Shajunbao 300 or carbendazim (Liu *et al.* 1996; Ma *et al.* 2004; Zhu *et al.* 2006).
- The pathogen infects young fruit, rachises, stalks and leaves (Grapevinewine 2003; AQSIQ 2007) from early May to early/mid June (Ma *et al.* 2004; Zhang 2005b; Qi *et al.* 2007).
- Conidia are spread by wind and rain and can survive long periods on fruit surfaces (Ma *et al.* 2004).
- On berries, the symptoms are brown spots that are superficial and fall off as the berries reach half size (Grapevinewine 2003). The fruit apparently grows normally once the spots fall off (Zhang 2005b). However, fruit that have lost their spots are potentially infected but appear normal. Symptomless infection of fruit appears to be likely.
- Infected stalks turn brown and dry out. The flower buds and young fruits on inflorescences with infected stalks shrink, dry out and drop off (Li 2004; Zhang 2005b). Therefore if bunches have infected stems, the fruit may fail to develop and they may not be picked for export.
- Infected symptomless berries, both immature and mature, may be present in a fruit cluster.
- During commercial harvesting and packing house procedures, inferior or defective bunches and berries may be removed from the export pathway (AQSIQ 2008). A small proportion of inferior or defective berries may escape detection and not be removed.
- Conidial infection mainly occurs from early May to early/mid June (Qi *et al.* 2007). However, the spores may exist on asymptomatic grapes.
- There are differences in disease resistance between cultivars (Zhang 2005b). Red Globe is the most sensitive cultivar (Zhang 2005b), and Red Globe is a commonly grown cultivar for international trade (AQSIQ 2009c).
- The pathogen may be present as asymptomatic endophytic infections as it occurs with other species of *Alternaria* (Guo *et al.* 2004; Cota *et al.* 2008).
- *Alternaria viticola* overwinters as hyphae or conidia (Ma *et al.* 2004; Zhang 2005b) so it is probable that this fungus will survive storage and transport to Australia.

The wide distribution of the fungus in China, its capacity to survive cold conditions and the likelihood of symptomless infection and spores on fruit surfaces, all support a risk rating for importation of ‘high’.

Probability of distribution

The likelihood that *A. viticola* will be distributed within Australia as a result of processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **MODERATE**.

Supporting information for this assessment is provided below:

- Imported berries are intended for human consumption. Fruit will be distributed to many localities by wholesale and retail trade and by individual consumers. Berries may be distributed to all states in unrestricted trade.
- Most fruit waste will be discarded into managed waste systems and will be disposed of in municipal tips. Consumers will discard small quantities of fruit waste in urban, rural and natural localities. Small amounts of fruit waste will be discarded in domestic compost.
- Conidia on discarded fruit or from infected fruit and stalk waste may be spread to hosts by wind or rain (Ma *et al.* 2004; Erkara *et al.* 2008).
- *Alternaria viticola* has only been reported infecting *Vitis* spp. including some hybrid grapes (Ma *et al.* 2004; Zhang 2005b). *Vitis* species are grown commercially and in residential gardens in all states and territories (Australian Table Grape Association 2008).
- *Alternaria viticola* overwinters as hyphae or conidia (Ma *et al.* 2004; Zhang 2005b) so it is probable that this fungus will survive transport and storage in Australia.
- *Alternaria viticola* is also saprophytic (Grapevinewine 2003; Zhang 2005b), so it could survive on dying bunches that are distributed in Australia.
- *Vitis* spp. do not propagate naturally in the Australia environment. They only grow in vineyards and domestic gardens where their propagation has been advanced by cultivation.

The capacity of the fungus to survive storage and transport and the spread of spores by wind and rain, moderated by the limited host range, support a risk rating for distribution of ‘moderate’.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *A. viticola* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **MODERATE.**

4.19.2 Probability of establishment

The likelihood that *A. viticola* will establish within Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **HIGH**.

Supporting information for this assessment is provided below:

- *Alternaria viticola* has only been reported infecting *Vitis* spp. including some hybrid grapes (Ma *et al.* 2004; Zhang 2005b). *Vitis* species are grown commercially and in residential gardens in all states and territories (Australian Table Grape Association 2008).

- The optimum temperature for conidiospore germination is 25–27 ºC (Ma *et al.* 2004). *Alternaria viticola* causes more serious disease when there is early spring rainfall (Zhang 2005b) and a mild, humid spring (Li 2004).
- In general, *Alternaria* spp. spores require free water or high humidity (Ferreira and Boley 1991; Hatzipapas *et al.* 2002; Wharton and Kirk 2007) and temperatures between 1 °C and 40 °C (optimum 23 °C and 35 °C) to germinate (Ferreira and Boley 1991; Stewart-Ward *et al.* 1998; Kucharek 2000; Wharton and Kirk 2007; Uchida 2009; Funk and Gilbert 2009).
- *Alternaria viticola* is present in grape growing regions of China including Anhui, Beijing Hebei, Henan, Hunan, Liaoning, Shandong, Shanghai and Xinjiang (Grapevinewine 2003; Ma *et al.* 2004; Zhang 2005b; Zhu *et al.* 2006; Qi *et al.* 2007; Wang 2009). This suggests that this fungus can established under a wide range of climatic environments. Environments with climates similar to these regions exist in various parts of Australia suggesting that *A. viticola* has the potential to establish in Australia.
- Many other *Alternaria* species are already present and established in Australia (APPD 2009).

The presence of many other *Alternaria* spp. in Australia and the suitability of the Australian climate support a risk rating for establishment of ‘high’.

4.19.3 Probability of spread

The likelihood that *A. viticola* will spread within Australia, based on a comparison of factors in the source and destination areas that affect the expansion of the geographic distribution of the pest, is: **HIGH**.

Supporting information for this assessment is provided below:

- Infected fruit may be distributed throughout Australia for human consumption, which may contribute to spreading the fungus.
- *Alternaria viticola* has only been reported infecting *Vitis* spp. including some hybrid grapes (Ma *et al.* 2004; Zhang 2005b). *Vitis* species are grown commercially and in residential gardens in all states and territories (Australian Table Grape Association 2008).
- Conidia on discarded fruit or from infected fruit and stalk waste may be spread to hosts by wind or rain (Ma *et al.* 2004; Erkara *et al.* 2008).
- *Alternaria viticola* is present in grape growing regions of China including Anhui, Beijing Hebei, Henan, Hunan, Liaoning, Shandong, Shanghai and Xinjiang (Grapevinewine 2003; Ma *et al.* 2004; Zhang 2005b; Zhu *et al.* 2006; Qi *et al.* 2007; Wang 2009). *Alternaria viticola* has spread quickly in some areas of China. This suggests that this fungus can establish and spread under a wide range of climatic environments. Environments with climates similar to these regions exist in various parts of Australia suggesting that *A. viticola* has the potential to spread in Australia.
- Many other *Alternaria* species are already present, established and spread in Australia (APPD 2009).
- In China, *Alternaria viticola* is controlled by vineyard sanitation and chemical sprays between flower bud formation and the young fruit stage (Liu *et al.* 1996; Ma *et al.* 2004;

Zhu *et al.* 2006). Existing control programs in Australian vineyards may reduce the ability for this fungus to spread (Nicholas *et al.* 1994). Residential gardens may not be sprayed.

Suitability of the Australian climate, spore dispersal by wind and distribution with infected fruit all support a risk rating for spread of 'high'.

4.19.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *A. viticola* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **MODERATE**.

4.19.5 Consequences

The consequences of the establishment of *A. viticola* in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**E**', the overall consequences are estimated to be **MODERATE**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: E – Significant at the regional level. *Alternaria viticola* can cause serious drop off of flowers and young fruit. Grape production has been seriously damaged in some areas of China. *Alternaria viticola* spread quickly in Hami in Xinjiang, up to 10-30% of vines were infected, leading to a yield reduction of 30–40% (Ma *et al.* 2004). It was also reported to cause 30–50% yield reduction in vineyards in southeast Shandong (Zhu *et al.* 2006). However, incidence may be reduced to 5% in areas with control measures (Liu *et al.* 1996; Ma *et al.* 2004; Zhu *et al.* 2006). *Alternaria viticola* causes disease on *Vitis* species (Ma *et al.* 2004; Zhang 2005b), affecting table grape and wine grape production. Table grape production occurs in all Australian states and NT (DPIW Tasmania 1999; Australian Table Grape Association 2008). Extensive wine grape plantings are found across the south-eastern quarter of Australia and southwest of WA (Kiri-ganai Research Pty Ltd 2006). Annual production of table grapes is about 120 000 t (Australian Table Grape Association 2008). In 2008/9 Australia exported 70 000 t of table grapes at prices of between $2.08/kg to $3.34/kg (ABS 2009b). Dried grape production was 56 139 t in 2008 and was as high as 135 412 t in 2005 (ABS 2009c). In 2007/8 the value of the Australian wine produced was $4.77 billion of which $2.1 billion was sold locally (ABS 2009c).
Other aspects of the environment	**Impact score**: A – Indiscernible at the local level. There are no known direct consequences of this fungus on the natural environment.
Indirect	
Eradication, control etc.	**Impact score**: D – Significance at the district level. If *A. viticola* was introduced to Australia it is unlikely eradication would be attempted as it is likely that spores would have been widely dispersed prior to detection of the incursion. Little information on control is available. Control of *A. viticola* would probably involve additional fungicide applications, which would disrupt the existing IDM program and have a cost associated with it. Australian vineyards are already managed with cultural methods such as vineyard sanitary measures that would help control this fungus (Nicholas *et al.* 1994). An outbreak of *A. viticola* may require additional sprays at the flowering stage of growth (Ma *et al.* 2004; Zhang 2005b; Zhu *et al.* 2006). Incidence may be reduced to 5% in areas with control measures including application of Shajunbao 300 or carbendazim (Liu *et al.* 1996; Ma *et al.* 2004; Zhu *et al.* 2006).

Criterion	Estimate and rationale
Domestic trade	**Impact score**: D – Significant at the district level. There would be trade restrictions applied by states where this fungus is not present. Yield reduction would reduce the amount of fruit available for domestic supply from states/territories with this fungus.
International trade	**Impact score**: D – Significant at the district level. The presence of *A. viticola* in commercial production areas of grapes may limit access to overseas markets which are free from this pest. *Alternaria viticola* has only been reported in China. Yield reduction may reduce the amount and quality of fruit exported.
Environmental and non-commercial	**Impact score**: B – Minor significance at the local level. Additional fungicide applications or other control measures would be required to control this disease on susceptible hosts and these may have minor impact on the environment.

4.19.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Alternaria viticola*	
Overall probability of entry, establishment and spread	**Moderate**
Consequences	**Moderate**
Unrestricted risk	**Moderate**

As indicated, the unrestricted risk estimate for *A. viticola* of 'moderate' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.20 Brown rot

Monilinia fructigena [EP]

Brown rot, caused by the fungus *M. fructigena*, is common in pome and stone fruit. Grapevine has been reported as a minor host of this pathogen (CABI 2009) but information on the biology of *M. fructigena* on grapevine has not been found. There is no report of *M. fructigena* causing harm to grapes in China (AQSIQ 2007). The information used in the following risk assessment is based on the biology of *M. fructigena* on pome and stone fruit.

Monilinia fructigena is a pathogen favoured by moist conditions (rain, fog and other factors that increase humidity), especially at the beginning of the host's growth period. This fungus overwinters mainly in or on infected mummified fruit, either attached to the tree or on the ground (Byrde and Willets 1977). Mycelia can survive long periods of adverse environmental conditions within mummified fruits, twigs, cankers and other infected tissues. In spring or early summer when temperature, day length, moisture conditions and relative humidity are suitable for sporulation, sporodochia are formed on the surface of mummified fruit and other infected tissues and bear chains of conidia (Jones 1990). The conidia of *M. fructigena* are dry airborne spores, transported by wind, water or insects to young fruit (Batra 1979; Jones 1990). Initial infection is always via wounds caused by any number of causes but subsequent spread by contact between adjacent fruit is possible. Any infected tissue in which the moisture content is sufficient for sporulation may serve as a source of inoculum for secondary infection (Batra 1979).

There are only a few records of the development fruiting bodies (apothecia) of *M. fructigena*, which are produced in spring on mummified fruit that have overwintered on the ground (Byrde and Willets 1977). The liberation of ascospores from apothecia normally coincides with the emergence of young shoots and blossoms of plants. Thus a new cycle of infection is started that coincides with early spring growth of host plants (Batra 1979).

The risk scenario of concern for *M. fructigena* is the presence of latent infections and/or spores on bunches of grapes and spread to susceptible host plants.

Monilinia fructigena was included in the existing import policy for pears from China (AQIS 1998b; Biosecurity Australia 2005b) and Fuji apples from Japan (AQIS 1998a). The assessment of *M. fructigena* presented here builds on these existing policies. A complete pest risk assessment was included, as previous assessments for this pathogen used an older methodology.

4.20.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Probability of importation

The likelihood that *M. fructigena* will arrive in Australia with the importation of table grapes from China is: **LOW**.

Supporting information for this assessment is provided below:

- *Monilinia fructigena* is recorded on grapes in China (Farr and Rossman 2009). It is present in Anhui, Henan, Hubei, Hunan, Jiangsu, Liaoning, Shaanxi, Shandong, Shanxi, Sichuan, Yunnan and Zhejiang, which are grape growing provinces (CABI 2009).
- Grapevine has been reported as a minor host of *M. fructigena* (CABI 2009) but information on its biology on grapevine has not been found.
- Lack of published information on losses caused by *M. fructigena* on grapevine and advice that there is no report of *M. fructigena* causing harm to grapes in China (AQSIQ 2007) support a low likelihood that table grapes exported to Australia would be infected by this pathogen.
- Conidia are produced on infected blossoms and twigs and infect fruit as it matures (Jones 1990). Warm temperatures and wet conditions favour spore germination and infections (CABI 2009).
- Many insects, including wasps, beetles and flies, may facilitate infection by causing injuries or by transporting spores to susceptible tissue (CABI 2009).
- Visible symptoms on infected grapes are raised light brown pustules. Fruit with old infections form dark, wrinkled, mummified berries (United States Environmental Protection Agency 2004). Grape bunches showing disease symptoms may be removed from the export pathway.
- Apparently healthy fruit can be contaminated with conidia in the field or during processes in the packing house (Ma 2006).
- *Monilinia fructigena* has the ability to cause latent infections (Byrde and Willets 1977).

The minor host status of grapevine and the absence of reports of damage to grapevine in China, mitigated by the ability of the fungus to cause latent infection and for conidia to contaminate grape berries, support a risk rating for importation of ‘low’.

Probability of distribution

The likelihood that *M. fructigena* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **HIGH**.

Supporting information for this assessment is provided below:

- *Monilinia fructigena* has a wide range of hosts, including apple, apricot, hazel, nectarine, peach, pear, plum and quince (Byrde and Willets 1977; Farr and Rossman 2009), and various minor hosts, including fig, grapes, guava, persimmons, strawberry and tomato (CABI 2009). These plants are common in parks, home gardens, nurseries, along roadsides and in commercial orchards in Australia (Australian Nurseries Online 2009; Horticulture Australia Limited 2009).
- *Monilinia fructigena* has the ability to cause latent infection in fruit, developing during storage and transport, or as the fruit senesces (Byrde and Willets 1977). The infected fruit may be distributed to various areas during retail distribution.
- Imported grapes are intended for human consumption. Fruit will be distributed to many localities by wholesale and retail trade and by individual consumers. Berries may be distributed to all states in unrestricted trade.

- Most fruit waste will be discarded into managed waste systems and will be disposed of in municipal tips. Consumers will discard small quantities of fruit waste in urban, rural and natural localities. Small amounts of fruit waste will be discarded in domestic compost.
- Fruit waste may be discarded near host plants.
- Mycelia are able to survive long periods of adverse environmental conditions within mummified fruit. When conditions become favourable (after a dormant period), spores are produced on infected tissues (Jones 1990).
- Spores are disseminated by air currents and water splash (Byrde and Willets 1977) and may be dispersed from fruit waste to host plants.

The range of hosts that are widely available in Australia, the ability of infected berries to produce spores and the potential transfer of spores from the fruit waste to a host by wind and water droplets support a risk rating for distribution of 'high'.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *M. fructigena* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **LOW**.

4.20.2 Probability of establishment

The likelihood that *M. fructigena* will establish within Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **HIGH**.

Supporting information for this assessment is provided below:

- *Monilinia fructigena* is a pathogen of moist conditions, favoured by rain, fog and other factors that increase humidity especially at the beginning of the host growth period. *Monilinia fructigena* is widely distributed throughout Europe, the Middle East, China, India, North Africa and South America. In China, *M. fructigena* is established in Anhui, Henan, Hubei, Hunan, Jiangsu, Liaoning, Shaanxi, Shandong, Shanxi, Sichuan, Yunnan and Zhejiang (CABI 2009). This indicates that *M. fructigena* has the ability to survive and establish in a wide range of environments.
- *Monilinia fructigena* has a wide range of hosts, including apple, apricot, hazel, nectarine, peach, pear, plum and quince (Byrde and Willets 1977; Farr and Rossman 2009), and various minor hosts, including fig, grapes, guava, persimmons, strawberry and tomato (CABI 2009). These host plants are widely available in parks, home gardens, nurseries, along roadsides and in commercial orchards in Australia (Australian Nurseries Online 2009; Horticulture Australia Limited 2009).
- *Monilinia fructigena* overwinters in infected fruit, peduncles and twig cankers on branches (Jones 1990).
- Both conidia and ascospores are primary inoculum (Willets and Harada 1984; Batra and Harada 1986).

- A recent survey of Australian stone fruit growers showed that brown rots caused by *Monilinia fructicola* and *M. laxa* were the diseases that they had most difficulty controlling (Hetherington 2005). It is unlikely that existing management practices for these diseases would prevent the establishment of the related species *M. fructigena*.
- Infected fruit may be moved with domestic fruit trade.

The occurrence of suitable temperature and moisture conditions for spore germination and infection in fruit production areas of Australia and the wide range of hosts, support a risk rating for establishment of 'high'.

4.20.3 Probability of spread

The likelihood that *M. fructigena* will spread within Australia, based on a comparison of factors in source and destination areas that affect the expansion of the geographic distribution of the pest, is: **HIGH**.

Supporting information for this assessment is provided below:

- *Monilinia fructigena* has a wide range of hosts, including apple, apricot, hazel, nectarine, peach, pear, plum and quince (Byrde and Willets 1977; Farr and Rossman 2009), and various minor hosts, including fig, grapes, guava, persimmons, strawberry and tomato (CABI 2009). These plants are common in parks, home gardens, nurseries, along roadsides and in commercial orchards in Australia (Australian Nurseries Online 2009; Horticulture Australia Limited 2009).
- *Monilinia fructigena* can be passed from one fruit to others coming in contact with it during packing, storage and distribution (Wormald 1954), and this allows the spread of *M. fructigena* during these processes.
- The dissemination of conidia of *M. fructigena* is promoted by wind at high temperatures and low relative humidity (Jones 1990). Many regions across Australia have climates which are favourable for the spread of *M. fructigena*, especially in southern Australia.
- Spores are usually wind dispersed. The introduction of *M. fructigena* has the potential to result in an epidemic, as spores can be spread over a wide area and from one orchard to another (Jones 1990; Ma 2006).
- The spores can also be transported by water, providing potential for the spread of spores from infected trees to adjacent healthy trees via irrigation water and rain. High humidity conditions are favourable for germination (Ma 2006).
- Wounds on the fruit surface caused by birds, insects or other pathogens provide a pathway for this pathogen to infect fruit and aid the spread of *M. fructigena* (Byrde and Willets 1977).
- Animals (birds, wasps, beetles, flies) can also vector this pathogen (Lack 1989).
- Any infected tissue in which the moisture content is sufficient for sporulation may serve as a source of inoculum (Ma 2006).
- Movement of infected planting material would aid the spread of this pathogen.

The long distance dispersal of spores by wind and vectors and the potential movement of symptomless infected planting material, all support a risk rating for spread of 'high'.

4.20.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules for combining qualitative likelihood shown in Table 2.2.

The likelihood that *M. fructigena* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **LOW**.

4.20.5 Consequences

The consequences of the establishment of *M. fructigena* in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**E**', the overall consequences are estimated to be **MODERATE**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: E – Significant at the regional level. *Monilinia fructigena* can infect leaves (causing wilting, yellowing or death), growing points (dead heart), stems (internal discoloration, canker, abnormal exudates or dieback) and fruit (brown rot), resulting in reduced vigour and loss of yield (Ma 2006). *Monilinia fructigena* causes significant yield losses both before and after harvest. *Vitis vinifera* is a minor host of *M. fructigena*. Therefore the reduction of vigour and yield may not be as severe as on apple, pear, plum, peach, nectarine, apricot and quince, on which it also causes fruit rot (Batra 1991). However, if introduced on grape, it can readily spread to other hosts. On apples in Europe, losses of 7-36% were reported in individual orchards (Jones 1990). Pome and stone fruit are grown in all states and territories of Australia (Summerfruit Australia 2009; Apple and Pear Australia Limited 2010). *Monilinia fructigena* can infect a wide range of fruit crops (Ma 2006). However, it is not known if *M. fructigena* will infect native plant species or endangered species.
Other aspects of the environment	**Impact score**: A – Indiscernible at the local level. There are no known direct consequences of this pathogen on other aspects of the environment.
Indirect	
Eradication, control etc.	**Impact score**: E – Significant at the regional level. Any attempts to eradicate *M. fructigena*, should it reach Australia, would be difficult, costly and would be unlikely to be successful. *Monilinia fructigena* also infects fruit species of *Malus*, *Prunus* and *Pyrus* causing fruit rots. It would be difficult to differentiate from *M. fructicola* and *M. laxa* under field conditions. Eradication might have to encompass all three *Monilinia* species. Diverse measures would be necessary, including host eradication, chemical control, biological control, control of vectors, cultural measures, postharvest control and breeding resistant varieties to control or eradicate the fungus (Ma 2006). Fungicides used for the routine control of other diseases, such as apple scab, powdery mildew, apple rust and grey mould are effective for reducing the amount of overwintering inoculum and subsequent sporulation formed on the infected tissue (Ma 2006; CABI 2009). Examples of effective fungicides are sulphur, iprodione, benomyl and myclobutanil (CABI 2009). Control of insects that serve as vectors and/or provide wounds for subsequent infection is essential for effective control of *M. fructigena*. Applying a protectant fungicide without delay when significant injuries, caused by weather conditions such as hail storms, occur is an important measure (Byrde and Willets 1977). Measures such as cooling, a combination of cooling and fungicides, and other postharvest treatments have been suggested to control *M. fructigena* (Ma 2006).

Criterion	Estimate and rationale
Domestic trade	**Impact score**: E – Significant at the regional level. *Monilinia fructigena* causes significant losses both before and after harvest (Byrde and Willets 1977) and the pathogen poses a high potential for establishment and spread from infected orchards to uninfected orchards. Therefore, the presence of *M. fructigena* in commercial production areas is likely to result in interstate trade restrictions on grapes, apples, pears and summerfruit, as well as potential loss of markets.
International trade	**Impact score**: E – Significant at the regional level. The presence of *M. fructigena* in table grape, pome and stone fruit production areas of Australia would have impacts on the export of Australia's table grapes, pome and stone fruit to countries where this pathogen is not present such as NZ and the USA.
Environmental and non-commercial	**Impact score**: B – Minor significance at the local level. Additional fungicide applications or other control activities would be required to control this disease on susceptible crops and these may have minor impact on the environment.

4.20.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Monilinia fructigena*	
Overall probability of entry, establishment and spread	**Low**
Consequences	**Moderate**
Unrestricted risk	**Low**

As indicated, the unrestricted risk estimate for *M. fructigena* of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.21 Grapevine leaf rust

Phakopsora euvitis

The pathogen which is responsible for grapevine leaf rust in Asia is *Phakopsora euvitis* and not *P. ampelopsidis* nor *P. vitis* which are restricted to other host plants (EPPO 2002).

Before 2000, records in the literature identified the grape leaf fungus present in Asia as *Phakospora ampelopsidis*. Work by Ono (2000), in Japan, based on morphological characteristics, identified three populations differing in life cycle and host specificity as three separate species. The species occurring on grapes was described as *Phakospora euvitis*. Further work by Chatasiri and Ono (2008) using molecular phylogenetic analyses on material collected from Australia, East Timor and Japan, confirm the distinctiveness of the three species recognised by Ono (2000). The samples of *Phakospora euvitis* collected from East Timor and Australia (where an incursion has been eradicated) are genetically distinct from the Japanese collections and may represent a separate species (Chatasiri and Ono 2008). It is not known if the rust present on grapes in China has been subjected to comparative molecular analyses with samples from Japan. Therefore, for the purpose of the pest risk assessment presented here it is assumed that all records of grape leaf rust in east Asia are of *Phakospora euvitis* including the earlier literature on *Phakospora ampelopsidis* and *Phakospora vitis* when reported on a grape (*Vitis* spp.) host.

Phakopsora euvitis is heteroecious and macrocyclic. Basidiospores are formed from teliospores in overwintered *Vitis* spp. leaves and infect *Meliosma myriantha* or *M. cuneifolia* (family Sabiaceae), the alternate host (Ono 2000; Weinert *et al.* 2003). Pycnidia and aecia are formed on *M. myriantha* leaves following infection (Ono 2000). These alternate hosts are widely present in China (USDA 2009b) but do not appear to be present in Australia (Australian National Botanic Gardens and Australian National Herbarium 2008). *Phakopsora euvitis* can persist as the uredinial stage on *Vitis* spp. (Daly and Hennessy 2006).

Spores of *P. euvitis* can easily be transported by wind. Mycelium may persist in grapevine shoots during winter and then urediniospores formed on these shoots become the primary infection source (EPPO 2002; Weinert *et al.* 2003). Uredospores require water for germination and germinate at temperatures of 8–32 °C, with an optimum of 24 °C. Teliospores germinate between 10 °C and 30 °C, with an optimum range between 15 °C and 25 °C. High humidity at night is necessary for development of epidemics (Pearson and Goheen 1988).

Phakopsora euvitis usually infects leaves (Ono 2000) and also infects fruits, stems (APHIS 2002) and occasionally rachises (Pearson and Goheen 1988). The symptoms are yellowish to pale brownish spots or irregular shaped lesions, with masses of yellowish orange urediniospores on the abaxial surface of the lesion. The telia are crust-like and orange-brown, becoming dark brown or almost blackish. Heavy infection is common and can cause early senescence and leaf drop (CABI 2009). The USDA (APHIS 2002) also considered *P. euvitis* on the fresh fruit pathway for table grapes from Korea.

The risk scenario for *P. euvitis* is that the fungus and/or urediniospores will be present in grape bunches.

4.21.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Probability of importation

The likelihood that *P. euvitis* will arrive in Australia with the importation of table grapes from China is: **MODERATE**.

Supporting information for this assessment is provided below:

- *Phakopsora euvitis* is present in Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hong Kong, Hunan, Jiangxi and Sichuan in southern China and Gansu, Jiangsu, Shaanxi and Shandong in northern China. These are grape growing provinces (EPPO 2002).
- Leaves are infected between June and November (Kuo 2009). The pathogen occasionally infects rachises and fruit (Pearson and Goheen 1988; APHIS 2002) and may be present in harvested bunches.
- Harvested grapes might also be contaminated by urediniospores.
- The ability to overwinter in temperate regions (Ono 2000; Weinert *et al.* 2003; Chatasiri and Ono 2008) may indicate this fungus could survive being transported at low temperatures.

The wide distribution of this fungus in China, the possibility that this fungus will survive storage and transport and that urediniospores may be a contaminant, moderated by the fact that the fungus only occasionally infects rachises and fruit, support a risk rating for importation of ‘moderate’.

Probability of distribution

The likelihood that *P. euvitis* will be distributed within Australia as a result of processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **MODERATE**.

Supporting information for this assessment is provided below:

- Table grapes are being imported for human consumption and will be distributed throughout Australia.
- Urediniospores and teliospores may survive transport and storage because they are the stage in which this fungus overwinters (Pearson and Goheen 1988). Teliospore inoculum is not significant as the alternate hosts do not appear to be present in Australia.
- Mycelium in the grapes and rachis is likely to survive storage and continue to produce spores once the bunch comes out of cold storage (EPPO 2002).
- Urediniospores exposed to sunlight for four hours showed reduced viability (near zero) when germinated 24 and 48 hours later (Daly and Tran-Nguyen 2008).
- Infected table grapes and waste material (stalks) would be discarded in compost heaps or into domestic waste or where grapes are consumed and end up in landfills. In landfills, the waste may be covered, which would reduce the risk of distributing the fungus.

- The natural host range is *Vitis* spp. and *Meliosma myriantha* and *M. cuneifolia* (Ono 2000). *Vitis vinifera* is grown commercially in all states (Australian Table Grape Association 2008) and as well as in backyard gardens (NTG 2007). Other species of *Vitis* are present in Australia (Hnatiuk 1990; Australian National Botanic Gardens and Australian National Herbarium 2008). The two species of *Meliosma* do not appear to be present in Australia (Australian National Botanic Gardens and Australian National Herbarium 2008).
- Australian, East Timor and Japanese isolates have been shown capable of infecting native *Ampelocissus* spp. that are found in northern Australia (Daly *et al.* 2005; Daly and Hennessy 2006; Chatasiri and Ono 2008).
- Table grapes from China will be imported between August and October (AQSIQ 2008). Therefore, table grapes will be imported when grapevines in Australia will have leaves susceptible to infection.

The possibility of infected waste materials being distributed close to the hosts and the fact this fungus would survive storage and transport, moderated by the limited distribution of other hosts within Australia, support a risk rating for distribution of 'moderate'.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *P. euvitis* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **LOW**.

4.21.2 Probability of establishment

The likelihood that *P. euvitis* will establish within Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **MODERATE**.

Supporting information for this assessment is provided below:

- The natural host range is *Vitis* spp. and *Meliosma myriantha* and *M. cuneifolia* (Ono 2000). *Vitis vinifera* is grown commercially in all states (Australian Table Grape Association 2008) and as well as in backyard gardens (NTG 2007). Other species of *Vitis* are present in Australia (Hnatiuk 1990; Australian National Botanic Gardens and Australian National Herbarium 2008). The two species of *Meliosma* do not appear to be present in Australia (Australian National Botanic Gardens and Australian National Herbarium 2008).
- *Phakopsora euvitis* also infects *Ampelocissus* spp. but may not persist on these deciduous hosts in Australia because the spores do not survive on fallen leaves for very long (Daly and Hennessy 2006). However, on grapevines, which are also deciduous, the pathogen may persist as mycelium in vine buds (Weinert *et al.* 2003).
- *Phakopsora euvitis* can establish and maintain a population through reproduction as only the uredinial stage (Daly and Hennessy 2006).

- Spores of *P. euvitis* are dispersed by wind (EPPO 2002; Deacon 2005) and may be spread on clothing on humans (Weinert *et al.* 2003), rain, animals or insects. Rust pathogens are well known for their ability for long range dispersal (Nagarajan 1990; Agrios 1997).
- Temperatures between 8 °C and 32 °C (optimum 24 °C) and free water are required for urediniospore germination. Temperatures between 10 °C and 30 °C (optimum 15–25 °C) are required for teliospore germination (Pearson and Goheen 1988). However, since the alternate host *Meliosma myriantha* does not appear to be present in Australia reproduction would be by urediniospores.
- In the Northern Territory, the time between spore germination and production of urediniospores was six days (Daly and Hennessy 2006). There is a potentially rapid population increase at the initial infection site.
- *Phakopsora euvitis* is distributed in tropical, sub-tropical and temperate regions in east and southeast Asia, USA and Timor (Weinert *et al.* 2003; Chatasiri and Ono 2008). The grape growing states in Australia where it would be most likely to establish due to similar climate conditions are northern New South Wales, Northern Territory, Queensland and Western Australia.

Suitability of the Australian climate, spore dispersal by wind and extensive planting of species of *Vitis* all support a risk rating for establishment of 'moderate'.

4.21.3 Probability of spread

The likelihood that *P. euvitis* will spread within Australia, based on a comparison of factors in the source and destination areas that affect the expansion of the geographic distribution of the pest is: **HIGH**.

Supporting information for this assessment is provided below:

- This fungus would find areas within Australia with a climate suitable for spread.
- The natural host range is *Vitis* spp. and *Meliosma myriantha* and *M. cuneifolia* (Ono 2000). *Vitis vinifera* is grown commercially in all states (Australian Table Grape Association 2008) and as well as in backyard gardens (NTG 2007). Other species of *Vitis* are present in Australia (Hnatiuk 1990; Australian National Botanic Gardens and Australian National Herbarium 2008). The two species of *Meliosma* do not appear to be present in Australia (Australian National Botanic Gardens and Australian National Herbarium 2008).
- *Ampelocissus* spp. have been demonstrated as indigenous hosts. This might lead to them being considered as a pathway via which spread into commercial grape growing areas of Australia is possible (Daly *et al.* 2005). These species are distributed in Western Australia, Northern Territory and Queensland (Coleman 2008a) and die back to a tuber in the dry season (Daly and Hennessy 2006).
- In the Northern Territory, the time between spore germination and production of urediniospores was six days (Daly and Hennessy 2006). There is a potentially rapid capability to spread.
- Spores of *P. euvitis* are dispersed by wind (EPPO 2002; Deacon 2005) and may be spread on clothing on humans (Weinert *et al.* 2003), rain, animals and insects. Rust pathogens are well known for their ability for long range dispersal (Nagarajan 1990; Agrios 1997).

- Infected fruit may be distributed throughout Australia for human consumption, which will contribute to spreading the fungus.
- Sale of infected nursery stock could facilitate spread of *P. euvitis*.

Suitability of the Australian climate, spore dispersal by wind and distribution with infected fruit and nursery stock all support a risk rating for spread of 'high'.

4.21.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *P. euvitis* will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **LOW**.

4.21.5 Consequences

The consequences of the establishment of *P. euvitis* in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**E**', the overall consequences are estimated to be **MODERATE**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score** E – Significant at the regional level. *Phakopsora euvitis* can cause a serious grapevine disease (EPPO 2002). Heavy infections are common and cause early senescence and leaf drop. The disease can cause poor shoot growth, reduction of fruit quality and yield loss (EPPO 2002; CABI 2009). Native species of Vitaceae may be infected and their presence in plant communities may be reduced. Natural infection of a species of *Ampelocissus* was reported by Daly & Hennessy (2006) before the incursion in the Northern Territory was eradicated. Infection in ornamental varieties would reduce the aesthetic appeal provided by such plantings.
Other aspects of the environment	**Impact score**: A – Indiscernible at the local level. There are no known direct consequences of *P. euvitis* on other aspects of the environments.
Indirect	
Eradication, control etc.	**Impact score**: D – Significant at the district level. *Phakopsora euvitis*, should it establish in Australia, would be devastating to Australia's wine and table grape industry. An outbreak of *P. euvitis* occurred in 2001 in Darwin, Northern Territory, Australia. All infected host plants were destroyed because no fungicide was 100% effective (Moore and Daly 2009). The eradication program cost $2.3 million (NTG 2006). Increased fungicide use will affect the environment, increase production costs and compromise biodynamic and organic grape growers.
Domestic trade	**Impact score**: D – Significant at the district level. There would be trade restrictions applied by states that do not have this fungus. The wine, table grape and processing industries may be affected.
International trade	**Impact score**: D – Significant at the district level. The presence of *P. euvitis* in commercial production areas of grapes may limit access to overseas markets which are free from this pest, such as New Zealand and Europe (CABI 2009). Yield reduction would reduce the amount of fruit exported.

Criterion	Estimate and rationale
Environmental and non-commercial	**Impact score**: B – Minor significance at the local level. Additional fungicide applications or other control measures would be required to control this disease on susceptible hosts and these may have minor impact on the environment.

4.21.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Phakopsora euvitis*	
Overall probability of entry, establishment and spread	**Low**
Consequences	**Moderate**
Unrestricted risk	**Low**

As indicated, the unrestricted risk estimate for *P. euvitis* of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.22 Phomopsis cane and leaf spot

Phomopsis viticola [EP, WA]

Phomopsis viticola is not present in the State of Western Australia and is a pest of quarantine concern for that state.

Phomopsis cane and leaf spot, or dead arm, is caused by the fungus *Phomopsis viticola* and is an important disease in several viticultural regions of the world (Nair *et al.* 1994), especially where rain following bud break keeps grapevines wet for several days (Hewitt and Pearson 1988). *Phomopsis viticola* is established in New South Wales, Queensland, South Australia, Tasmania and Victoria (Mostert *et al.* 2001; APPD 2009) but is not known to be present in Western Australia. The fungus overwinters in infected canes and rachises on the vine (Ellis and Erincik 2005). Pycnidium germination and conidia production require at least 10 hours of wet with relatively low temperatures (Rawnsley and Wicks 2002). A further 8–10 hours of very high relative humidity or surface wetness is required for infection to occur (Emmett *et al.* 1992b).

Phomopsis viticola infects leaves, young shoots, rachises, petioles and fruit (Hewitt and Pearson 1988). Grapevines are susceptible throughout the growing season. After infection of juvenile fruit, symptoms do not appear until the fruit matures. On the fruit, the early symptoms are browning and shrivelling (Ellis and Erincik 2005). On rachises, the symptoms are chlorotic spots with dark centres (Hewitt and Pearson 1988). These spots enlarge to form dark brown streaks and blotches that turn black (Hewitt and Pearson 1988). Rachises may become brittle from numerous infections and break, resulting in loss of fruit (Hewitt and Pearson 1988). Pycnidia are subepidermal. Yellowish spore masses are exuded and then the berries shrivel and mummify (University of California 1992). *Phomopsis viticola* conidia are splash dispersed and usually spread only short distances, i.e. within a vine or adjacent vines. Long distance spread is usually by movement of infected or contaminated propagation material (Hewitt and Pearson 1988).

The risk scenario of concern for *P. viticola* is the presence of the fungus on mature bunches of grapes.

Phomopsis viticola was included and/or assessed in the existing import policy for table grapes from Chile (Biosecurity Australia 2005d) and table grapes from California (AQIS 2000). The assessment of *P. viticola* presented here builds on the previous assessments.

In the assessment for table grapes from Chile, the probabilities of importation and distribution for *P. viticola* were rated as ‘low’ and ‘very low’ respectively (Biosecurity Australia 2005d). The ratings depended on the rare occurrence of *P. viticola* in Chile and on the expected export of the grapes from November to April, during which Australian grapevines were considered less susceptible to infection by the pathogen. However, differences between Chile and China in the prevalence of the pathogen and in harvesting and exporting times make it necessary to reassess the likelihood that *P. viticola* will be imported into Australia and distributed within Western Australia with table grapes.

The probabilities of establishment and spread of *P. viticola* after arrival in Australia would be similar for table grapes shipped from Chile and China, as would the consequences if the pathogen were to spread. Accordingly, there is no need to reassess those components.

There is a complex of species of *Phomopsis* on *Vitis* (Merrin *et al.* 1995; Mostert *et al.* 2000). The *Phomopsis* species on *Vitis* in China have not been studied using molecular methods. It may be that when they are, reassessment may be required as the species in China may be the *Phomopsis* taxon present in Western Australia (*Diaporthe australafricana*).

4.22.1 Reassessment of probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Reassessment of probability of importation

The likelihood that *P. viticola* will arrive in Western Australia with the importation of table grapes from China is: **MODERATE**.

Supporting information for this assessment is provided below:

- *Phomopsis viticola* has been reported from China in all grape production areas and causes significant damage in some areas (Zhang 2005b).
- *Phomopsis viticola* forms splash-dispersed conidia that infect leaves, young shoots, rachises, petioles and fruit (Hewitt and Pearson 1988). The teleomorph is not known.
- Infection is favoured by 20–30 hour wet periods during flowering (Rawnsley and Wicks 2002).
- Berry infection, either direct or via infected rachis tissues (Erincik *et al.* 2002) can occur throughout the growing season, but most fruit infections occur early in the season (Erincik *et al.* 2001). Once present inside green tissues of the berry, the fungus becomes latent (Erincik *et al.* 2002) and infected berries remain without symptoms until the fruit is mature (Ellis and Erincik 2005).
- Visual symptoms first appear close to harvest when infected berries turn brown and shrivel (Ellis and Erincik 2005), and black pycnidia are produced through the skin (University of California 1992). These pycnidia exude yellowish spore masses before the berries finally shrivel and become mummified (University of California 1992). Infected berries may abscise from the pedicel, leaving a dry scar (Hewitt and Pearson 1988).
- Recently infected rachises and fruit may not display symptoms and may be packaged for export.
- *Phomopsis viticola* has not been intercepted using visual inspection on table grapes exported from Chile to New Zealand (MAF New Zealand 2005)[5] or the USA (SAG-USDA 2006)[6], or on table grapes exported to Australia from California, where this pathogen also occurs.

Infected rachises and berries remain without symptoms until they mature and the ability and susceptibility of the berries for infection throughout the growing season all support a risk rating for importation of ‘moderate’.

[5] MAF New Zealand is the New Zealand National Plant Protection Organisation (Ministry of Agriculture and Forestry New Zealand)
[6] SAG-USDA is both the Chilean and USA National Plant Protection Organisations (Secretaria de Agricultura y Ganaderia and United States Department of Agriculture)

Reassessment of probability of distribution

The likelihood that *P. viticola* will be distributed within Western Australia as a result of processing, sale or disposal of table grapes from China and subsequent transfer to a susceptible part of a host is: **LOW**

- *Phomopsis viticola* will survive transport in cold storage. The pathogen occurs in regions with cold winters and overwinters as mycelium and conidiomata in canes, spurs, dormant buds, bark and mummified fruit (Pscheidt and Pearson 1991; Ellis and Erincik 2005).
- Grapes will be distributed to many localities by wholesale and retail trade and by individual consumers. Grapes may be distributed to all states in unrestricted trade.
- Most fruit waste, berries, clusters and stalks, will be discarded into managed waste systems and will be disposed of in municipal tips, reducing the risk of distribution of a pathogen to a host. Consumers will discard small quantities of fruit waste in urban, rural and natural localities. Small amounts of fruit waste will be discarded in domestic compost.
- Fruit waste may be discarded near host plants.
- Grapevines are sporadically but widely distributed in WA (DAWA 2005). Domestic garden plantings, both maintained and abandoned, occur in Perth and in most West Australian towns and by many farmhouses. Table grape production occurs in WA (DPIW Tasmania 1999; Australian Table Grape Association 2008). Extensive wine grape plantings are found in the southwest of WA (Kiri-ganai Research Pty Ltd 2006).
- In addition to *Vitis vinifera* (Eurasian grapevine), *P. viticola* infects *Vitis rupestris* (North American grapevine); *Vitis aestivalis* (summer grape); *Vitis labrusca* (fox grape); *Vitis rotundifolia* (Muscadine grape) and *Parthenocissus quinquefolia* (Virginia creeper) (Galet and Morton 1988; Uecker 1988).
- The pathogen is likely to remain inactive until conditions become suitable for its development (Ellis and Erincik 2005).
- China will export table grapes from August to October (AQSIQ 2008), which is during spring in Australia, when there is moderate rainfall in parts of WA (Bureau of Meteorology 2010).
- Host plants are likely to be susceptible in WA from August to October. Most *P. viticola* infections of grapevines occur in spring (Ellis and Erincik 2005).
- In spring, mature conidiomata erupt from infected tissue and during rain, water-borne alpha-conidia are exuded. Alpha-conidia are mainly dispersed by water-splash and they are only moved short distances. It is reported that the disease spreads locally in vineyards, remaining close to the source of the inoculum (Hewitt and Pearson 1988). However, conidia may also be blown in water droplets or spread by insects onto young vine foliage or flower-bunches (Emmett *et al.* 1992a).
- Under Australian field conditions, at least 10 hours of rain are required for conidium production from conidiomata, and after conidium dispersal, a further 8–10 hours or more of very high relative humidity or surface wetness are required for infection (Emmett *et al.* 1992a).

The likely survival of *P. viticola* during transport and the susceptibility of host plants in the Australian spring, moderated by the likely limits on water-splash transmission of conidia, supports a risk rating of 'low' for distribution.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that *P. viticola* will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host in Western Australia is: **LOW**.

4.22.2 Probability of establishment and of spread

As indicated above, the probability of establishment and of spread for *P. viticola* would be the same as those assessed for table grapes from Chile (Biosecurity Australia 2005d). The ratings from the previous assessments are presented below:

Probability of establishment: **HIGH**

Probability of spread: **MODERATE**

4.22.3 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that *P. viticola* will enter Western Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Western Australia and subsequently spread within Western Australia is: **LOW**.

4.22.4 Consequences

The consequences of the establishment of *P. viticola* in Western Australia have been estimated previously for table grapes from Chile (Biosecurity Australia 2005d). This estimate of impact scores is provided below expressed in the current scoring system (Table 2.3).

Plant life or health	**C**
Other aspects of the environment	**A**
Eradication, control etc.	**D**
Domestic trade	**B**
International trade	**B**
Environment	**B**

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**D**', the overall consequences are estimated to be **LOW**.

4.22.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for *Phomopsis viticola*	
Overall probability of entry, establishment and spread	**Low**
Consequences	**Low**
Unrestricted risk	**Very low**

As indicated, the unrestricted risk estimate for *P. viticola* of 'very low' achieves Australia's ALOP. Therefore, specific risk management measures are not required for this pest.

4.23 Tobacco necrosis viruses

The taxonomy of 'tobacco necrosis virus' (TNV) has been revised. *Tobacco necrosis virus A* (TNV-A) and *Tobacco necrosis virus D* (TNV-D) have been recognised as distinct species in the Necrovirus genus (Meulewaeter et al. 1990; Coutts et al. 1991), as have *Chenopodium necrosis virus* (ChNV) and *Olive mild mosaic virus* (OMMV), which were previously considered TNV isolates (Tomlinson *et al.* 1983; Cardoso *et al.* 2005). TNV isolates from Nebraska and Toyama (TNV-NE and TNV-Toyama) represent another species in the genus, as yet not officially recognised (Zhang *et al.* 1993; Saeki *et al.* 2001) and molecular sequence data indicates some other necroviruses called 'tobacco necrosis virus' are also distinct species (NCBI 2009).

Necroviruses are transmitted through soil. ChNV, TNV-A and TNV-D are transmitted by the root-infecting chytrid fungus *Olpidium brassicae* (Wor.) Dang (Rochon *et al.* 2004) and at least one TNV strain is transmitted by the related chytrid *Olpidium virulentus* (Sasaya and Koganezawa 2006). Virus particles released from roots and other plant matter are acquired in soil water by fungal zoospores and transmitted when the spores infect the roots of a suitable host. TNV particles are stable and relatively long lived. Transmission probably only occurs when there is sufficient soil water for *Olpidium* zoospore activity (Uyemoto 1981; Spence 2001). TNVs cause sporadic disease in some vegetable crops, strawberry, tulip and soybean. A necrovirus serologically related to TNV-D has been detected in grapevine (Cesati and Van Regenmortel 1969). TNVs have been reported in Qld and Vic. (Finlay and Teakle 1969; Teakle 1988) but it is not known if the species or strain that infects grapevine is present in Australia. TNV was thought to be ubiquitous and have a world-wide distribution (Uyemoto 1981; Brunt and Teakle 1996), but this status has not been reviewed since the taxonomic revision of the viruses. A satellite virus replicates with some strains of TNV.

The risk scenario of concern for TNV is where the particles of a foreign TNV species or strain are released from fruit waste, acquired in soil by a vector and transmitted to suitable host plants. TNVs may enter Australia in hyacinth (*Hyacinthus* sp.), lily (*Lilium* sp.) and tulip (*Tulipa* sp.) bulbs imported for planting under current conditions (AQIS 2009a). It is not known if the necrovirus species infecting monocots also infect grapevine.

4.23.1 Probability of entry

The probability of entry is considered in two parts, the probability of importation and the probability of distribution, which consider pre-border and post-border issues, respectively.

Probability of importation

The likelihood that Tobacco necrosis viruses will arrive in Australia with the importation of table grapes from China is: **MODERATE**.

Supporting information for this assessment is provided below:

- TNVs are probably widely prevalent in China. TNVs have been isolated from melon in Xinjiang and soybean in Jiangsu (Huang *et al.* 1984; Xi *et al.* 2008). TNVs have also been isolated from mulberry, potato and tobacco growing in China (Xi *et al.* 2008).
- A strain of TNV was found naturally infecting several grapevine cultivars in South Africa (Cesati and Van Regenmortel 1969). The taxonomy, incidence and global distribution of the grapevine-infecting TNV is not known.

- Grapevines are systemically infected (Cesati and Van Regenmortel 1969) and the virus is likely to be in berries.
- Some TNV species and strains may not infect grapevine systemically and may not be in berries. Detectable systemic infection only occurs with certain combinations of host species and TNV species or strain (Uyemoto 1981; Brunt and Teakle 1996).
- No record was found indicating that infected grapevine showed symptoms.

The prevalence of TNVs in China and the likelihood of systemic infection of grapevine, combined with the uncertainty about the incidence and distribution of infections, support a risk rating for importation of 'moderate'.

Probability of distribution

The likelihood that Tobacco necrosis viruses will be distributed within Australia as a result of processing, sale or disposal of table grapes from China and subsequently transfer to a susceptible part of a host is: **MODERATE**.

Supporting information for this assessment is provided below:

- Imported berries are intended for human consumption. Fruit will be distributed to many localities by wholesale and retail trade and by individual consumers. Berries may be distributed to all states in unrestricted trade.
- Most fruit waste will be discarded into managed waste systems and will be disposed of in municipal tips. Consumers will discard small quantities of fruit waste in urban, rural and natural localities. Small amounts of fruit waste will be discarded in domestic compost.
- Fruit waste may be discarded near host plants.
- TNV particles are likely to be present in low concentrations in infected fruit and their distribution in fruit tissue may be erratic (Uyemoto and Gilmer 1972).
- TNV particles are moderately to highly stable and survive for long periods in plant debris. TNV particles survive in soil containing infected roots for up to 130 days (18.5 weeks) and remain viable in vitro at 20 °C for one to eight weeks, depending on the strain, and up to several years in vitro at -20 °C (Smith *et al.* 1969; Kassanis 1970; Gibbs and Harrison 1976; Nemeth 1986; Brunt and Teakle 1996).
- TNV particles tolerate temperatures as high as 95 °C (Brunt and Teakle 1996), so the temperatures achieved by composting and soil pasteurization may not eliminate the viruses.
- Virus particles are released from roots and plant debris (CABI 2009).
- TNVs are transmitted by the zoospores of the chytrid fungi *Olpidium brassicae* and *Olpidium virulentus* (Rochon *et al.* 2004; Sasaya and Koganezawa 2006). The chytrids probably occur throughout Australia. *Olpidium brassicae* has been recorded in NSW and WA (APPD 2009). *Olpidium virulentus* has been recorded in WA (Maccarone *et al.* 2008).
- *Olpidium brassicae* is an efficient vector of TNV-D and can acquire particles from very dilute solutions and transmit the virus to susceptible hosts in short time periods (Kassanis

and MacFarlane 1964). If infected fruit waste is discarded in areas where *Olpidium* zoospores are active, then zoospores may acquire particles and transmit the virus.

- Species of *Olpidium* form resting spores through sexual reproduction (Spence 2001; Herrera-Vasquez *et al.* 2009). Resting spores resist desiccation, are long lived and may be distributed in dust, soil and roots. They germinate to produce zoospores.
- Zoospores need water to germinate and move and they are only active when there is sufficient soil moisture (Spence 2001). During drought and dry weather, zoospores are unlikely to be active in some areas because of dry conditions.
- Only certain *Olpidium brassicae* biotypes will transmit particular TNV strains (Uyemoto 1981). Some isolates of *Olpidium brassicae* will parasitize a wide range of host plants whereas others are more specific (Campbell 1996).
- TNV strains typically have wide experimental host ranges (Uyemoto 1981). TNVs have been found collectively to naturally infect apple (*Malus pumila*), apricot (*Prunus armeniaca*), adzuki bean (*Vigna angularis*), beetroot (*Beta vulgaris*), cabbage (*Brassica oleracea*), carrot (*Daucus carota*), citrus (*Citrus* spp.), common bean (*Phaseolus vulgaris*), crab apple (*Malus sylvestris*), cucumber (*Cucumis sativus*), European pear (*Pyrus communis*), grapevine (*Vitis vinifera*), hyacinth (*Hyacinthus* sp.), lettuce (*Lactuca sativa*), lily (*Lilium* sp.), melon (*Cucumis melo*), mulberry (*Morus* sp.), olive (*Olea europaea*), passionfruit (*Passiflora edulis*), pea (*Pisum sativum*), plum (*Prunus domestica*), potato (*Solanum tuberosum*), sour cherry (*Prunus cerasus*), soybean (*Glycine max*), strawberry (*Fragaria × ananassa*), tomato (*Solanum esculentum*) tulip (*Tulipa gesneriana*) and zucchini (*Cucurbita pepo*) (Kassanis 1970; Brunt and Teakle 1996; Pham *et al.* 2007a; Pham *et al.* 2007b; Xi *et al.* 2008; CABI 2009; Zitikaite and Staniulis 2009). Commercial crops of some of these plants are grown in every Australian state and territory and others are grown commercially in several states (Horticulture Australia Limited 2004; Strawberries Australia 2009). Many of the plants are grown in domestic gardens and tulip is grown as an ornamental in Tas., Vic. and parts of NSW.
- TNVs are also found in some wild plants, weeds and forest trees including birch (*Betula* spp.), European ash (*Fraxinus excelsior*), European beech (*Fagus sylvatica*), Norway spruce (*Picea abies*), pedunculate oak (*Quercus robur*), poplar (*Populus* spp.) and potato weed (*Galinsoga parviflora*) (Hibben *et al.* 1979; Teakle 1988; Nienhaus and Castello 1989; Bos 1999b)
- It is unlikely that the TNV that infects grapevine will also infect all of the species recorded as hosts of TNVs collectively. The host ranges of many strains and the newly recognised necrovirus species are largely unknown. The TNVs were considered to be a single species when most host range studies were done (Brunt and Teakle 1996).

The presence of efficient vectors in Australia, moderated by the likely low concentration of TNV particles in berry flesh and the chance that infected fruit waste will be discarded near a plant host while vector chytrids are active, support a risk rating for distribution of ‘moderate’.

Overall probability of entry

The overall probability of entry is determined by combining the probability of importation with the probability of distribution using the matrix of rules shown in Table 2.2.

The likelihood that Tobacco necrosis viruses will enter Australia as a result of trade in table grapes from China and be distributed in a viable state to a susceptible host is: **LOW**.

4.23.2 Probability of establishment

The likelihood that Tobacco necrosis viruses will establish within Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is: **HIGH**.

Supporting information for this assessment is provided below:

- The presence of TNVs in many countries (CABI 2009) suggests these viruses can become established in places with widely differing conditions.
- TNV-NE and its close relative TNV-Toyama were isolated in Nebraska and Japan (Zhang *et al.* 1993; Saeki *et al.* 2001) and a closely related TNV has been detected in Europe (Zitikaite and Staniulis 2009).
- Viruses likely to be strains of TNV-A and TNV-D have been recorded in Vic. and at three sites in Qld (Finlay and Teakle 1969; Teakle 1988). TNV incidence in Qld varies from year to year depending on rainfall (Teakle 1988). Conditions exist in Australia that will suit other necrovirus species and strains.
- In the United Kingdom, TNVs produce greater levels of disease in glasshouse grown plants in winter than in summer (Bawden 1956a). The infectivity of TNVs present in the United Kingdom, as measured by mechanical inoculation of leaves, is reduced when plants are exposed to higher light intensities (Bawden 1956a).
- Commercial crop, ornamental plant and fruit tree hosts of TNVs are common throughout Australia.
- In general, plants that are growing vigorously are more likely to be infected by viruses (Bawden 1956a; Gibbs and Harrison 1976). In Australia, potential hosts of TNVs will be growing during most of the year depending on temperature and rainfall.
- *Olpidium brassicae* and *Olpidium virulentus*, the vectors of TNVs, probably occur throughout Australia. Evidence of the widespread nature of *Olpidium virulentus* comes from knowledge of lettuce big-vein disease that occurs throughout Australia and is caused by Mirafiori Lettuce Big-Vein Virus (MLBVV) which is transmitted by *Olpidium virulentus* (McDougall 2006; Maccarone *et al.* 2008).
- *Olpidium* zoospores acquire TNV particles within a few minutes of mixing in vitro in solution (Kassanis and MacFarlane 1964; Gibbs and Harrison 1976). Zoospores can drift and swim in films of soil water to a root surface, where they form a cyst and then penetrate the root epidermal cells and infect the plant (Gibbs and Harrison 1976).
- Transmission only occurs when there is sufficient soil water for *Olpidium* activity (Uyemoto 1981; Spence 2001). Drought and long dry spells may limit the opportunity for TNVs to establish by limiting zoospore activity, whereas high rainfall may favour TNVs as it favours zoospore activity.
- When infected by TNVs many plant species appear symptomless (Uyemoto 1981). Many hosts of TNVs appear not to be systemically infected (Bawden 1956a). TNV infections may not be detected.

The distribution of hosts and the presence of two TNV strains in Australia support an establishment risk rating of ‘high’.

4.23.3 Probability of spread

The likelihood that Tobacco necrosis viruses will spread within Australia, based on a comparison of factors in the source and destination areas that affect the expansion of the geographic distribution of the pests is: **HIGH**.

Supporting information for this assessment is provided below:

- TNVs are transmitted by the zoospores of *Olpidium brassicae* and *Olpidium virulentus*. These chytrids probably occur throughout Australia. (Rochon *et al.* 2004; McDougall 2006; Sasaya and Koganezawa 2006; Maccarone *et al.* 2008; APPD 2009).
- The viruses are transmitted to the roots of susceptible plants and to leaves that are touching the ground (Bawden 1956b; Uyemoto 1981).
- Climatic conditions that favour plant growth may increase the chance of a TNV spreading in Australia. Rainfall will favour zoospore activity, as may cool conditions because of reduced evaporation.
- No measurements of the rate at which TNV spreads through fields have been found.
- In moist soil and without physical assistance, zoospores only move very short distances (10-20 mm) (Dixon 2009). Rain splash will disperse the fungus. Sporangia and zoospores will be dispersed in runoff water, irrigation channels and waterways.
- It is not known how long *Olpidium* zoospores remain infective, but the zoospores may only live for a few days (Gibbs and Harrison 1976; Spence 2001).
- TNVs spread through soil with the movement of soil water (Smith *et al.* 1988) and can be found in waterways (Tomlinson *et al.* 1983). Drainage water from contaminated soil contains infectious TNV particles and so does runoff water. However, a report of TNV spreading from waterways has not been found.
- TNVs are spread in a glasshouse if an irrigation source is contaminated with the virus (Bawden 1956b; Harrison 1960) or viruliferous zoospores.
- *Olive latent virus 1*, another necrovirus, is probably transmitted through soil water without the aid of a vector (Lommel *et al.* 2005) and it is possible some TNVs may be transmitted in this way.
- TNV particles are probably spread in dust by wind (Harrison 1960), although drying prevents transmission. They are probably also spread by splashing.
- Root-infecting viruses are spread to new sites by movement of soil, root fragments and drainage water and by transplanting infected plants (Harrison 1977). Soil-borne viruses may be spread to new localities by the transfer of soil on agricultural implements and possible also on the boots of farm workers (Harrison 1960).

The presence of chytrid vectors in Australia and the likely spread of TNVs in soil and water support a spread risk rating of ‘high’.

4.23.4 Overall probability of entry, establishment and spread

The overall probability of entry, establishment and spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of rules shown in Table 2.2.

The likelihood that Tobacco necrosis viruses will enter Australia as a result of trade in table grapes from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **LOW**.

4.23.5 Consequences

The consequences of the establishment of Tobacco necrosis viruses in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the consequences of a pest with respect to one or more criteria are '**C**', the overall consequences are estimated to be **VERY LOW**.

Reasoning for these ratings is provided below:

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score** C – Minor significance at the district level. Among the hosts in which TNVs cause disease, carrot, potato and strawberry are the most economically important in Australia, with the production in 2008 for the carrot crop being 27 260 t, the potato crop being 1 400 206 t. The strawberry crop production in 2007/8 was 58 000 t (Horticulture Australia Limited and Strawberries Australia 2009; ABS 2009a). The sporadic diseases caused by TNVs are economically important in some vegetable and ornamental crops in some years (Kassanis 1970; Uyemoto 1981; Nemeth 1986; Smith *et al.* 1988; Zitikaite and Staniulis 2009). No reports of adverse effects on fruit trees have been found (Nemeth 1986). A deterioration disease in trembling aspen (*Populus tremuloides*) may be caused by TNVs (Hibben *et al.* 1979). TNVs cause rusty root disease of carrot, Augusta disease of tulip, stipple streak disease of common bean, necrosis diseases of cabbage, cucumber, soybean and zucchini and ABC disease of potato (Uyemoto 1981; Smith *et al.* 1988; Xi *et al.* 2008; Zitikaite and Staniulis 2009). Losses as high as 50% have been recorded in tulips and glasshouse grown cucumbers (CABI 2009). No estimates of losses in carrot, potato and strawberry have been found. Symptomless viral infections of plants, in general, may cause no yield loss, but they may cause yield losses as high as 15% (Gibbs and Harrison 1976; Bos 1999a). Naturally infected vegetable crops show a range of symptoms including spots, flecks, streaks, necrosis and stunting. In strawberry in the Czech Republic, TNV has caused dwarfing and leaf and root necrosis (Martin and Tzanetakis 2006). Stipple streak disease has been reported in Qld causing small yield losses (Teakle 1988), but no reports of TNVs causing other diseases in Australia have been found, suggesting the combinations of virus strain, vector biotype and host plant cultivar that result in disease have not occurred in Australia. Strains have been distinguished by various characteristics including the symptoms they cause, their host ranges and genetic sequences (Kassanis 1970). The diseases recorded in common bean and cucumber are probably caused by distinct TNV strains (Brunt and Teakle 1996; Zitikaite and Staniulis 2009). The TNV detected in grapevine caused lesions when inoculated to *Chenopodium quinoa* and *Gomphrena globosa* (Cesati and Van Regenmortel 1969), but no report of further investigation of their disease causing potential was found. A satellite virus replicates with some strains of TNV (Kassanis 1970; Uyemoto 1981) but no report has been found indicating greater disease when the satellite virus is present. Given the wide host range of TNVs and their chytrid vectors it is likely that some native plants will be susceptible, although no supporting evidence was found.
Other aspects of the environment	**Impact score**: A – Indiscernible at local level. There are no known consequences of TNVs on other aspects of the environment.

Criterion	Estimate and rationale
Indirect	
Eradication, control etc.	**Impact score**: C – Significant at the local level. Virus control measures in fields are limited and eradication may not be possible unless an outbreak is detected at an early stage. Resistant cultivars may be planted, if they are available, and crop rotations may be altered to reduce incidence (CABI 2009). Establishment and spread in a glasshouse may be controlled by reducing or eliminating *Olpidium* infestation of soil by chemical treatment or by heating by composting or soil pasteurization (Asjes and Blom-Barnhoorn 2002; CABI 2009). This may add significantly to costs. TNVs tolerate temperatures as high as 95°C (Brunt and Teakle 1996), so the temperatures achieved by composting and pasteurization may not eliminate the viruses. Propagation of virus free plants and careful sanitation may reduce the chance of outbreaks (Smith *et al.* 1988; CABI 2009).
Domestic trade	**Impact score**: C – Minor significance at the district level. Australian states are unlikely to set up restrictions on interstate trade if a foreign TNV becomes established unless it causes significant disease, which is unlikely.
International trade	**Impact score**: C – Minor significance at the district level. If a damaging foreign TNV became established in Australia additional restrictions might be introduced on the international trade of some vegetables or ornamentals that might lead to the loss of markets and some industry adjustment.
Environmental and non-commercial	**Impact score**: A – Indiscernible at the local level. No report was found that could indicate an effect.

4.23.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

Unrestricted risk estimate for Tobacco necrosis viruses	
Overall probability of entry, establishment and spread	**Low**
Consequences	**Very low**
Unrestricted risk	**Negligible**

As indicated, the unrestricted risk estimate for Tobacco necrosis viruses of ‘negligible’ achieves Australia’s ALOP. Therefore, specific risk management measures are not required for this pest.

4.24 Sanitary pests

Latrodectus tredecimguttatus

Latrodectus mactans[EP]

Latrodectus tredecimguttatus (European black widow spider) and *L. mactans* (black widow spider) are not plant pests and therefore are not subject to phytosanitary action. Therefore, the methodology described in this IRA for plant pests was not used for this particular risk assessment.

These spiders are considered to be potentially associated with table grapes imported from China (see Appendix A2). *Latrodectus tredecimguttatus* is recorded in Xinjiang, Yunnan, Inner Mongolia and Gansu provinces (Chief Medical Network 2006). In Xinjiang, a region that produces table grapes for export (AQSIQ 2006; Li 2008), it is widely distributed and has been recorded from more than 20 cities and counties (Chief Medical Network 2006; Yang *et al.* 2007; Yan *et al.* 2007). *Latrodectus mactans* is present in Hainan and Sichuan (Li 2008), which are not major table grape production areas. These venomous spiders are recognised as having an impact on human health and potential impacts on the environment. Applications to import these species into Australia (i.e. an importer who actively wanted to bring specimens into Australia) would, if approved, require an Import Permit and containment of the specimens in a high security quarantine facility (AQIS 2009b).

Latrodectus tredecimguttatus is found in arid and semi arid climates from southern Europe to western China (Duma 2006). It is found in open field and grassy vegetation more than forests or bushy terrain (Duma 2006). In Kazakhstan, it is widespread in pastures (Tarabaev 1991). In Xinjiang, *L. tredecimguttatus* is reported from natural hillsides, farmland and orchards (Chief Medical Network 2006). In Central Asia, densities of *L. tredecimguttatus* fluctuate considerably depending on environmental conditions. Under good conditions, spider densities of $1/m^2$ of pasture in Kazakhstan (Tarabajev 1990; Tarabaev 1991) and $3\text{-}4/m^2$ in Uzbekistan (Krasnonos *et al.* 1989) have been reported.

In Almeria, Spain between 1984 and 1994, almost all persons admitted to hospital having been bitten by this spider were undertaking agricultural work, mostly in greenhouses (Díez García *et al.* 1996). In northern Iran, bites from *L. tredecimguttatus* are common, producing sickness and the occasional death, with 56 cases admitted to a hospital in Mashhad between September 2005-2006 (Afshari *et al.* 2009). People sleeping in tents, such as nomadic pastoralists in Uzbekistan and Kazakhstan, are reported as being frequently bitten (Krasnonos *et al.* 1989; Tarabaev 1991). In Xinjiang, the majority of people bitten are farmers and pastoralists (Chief Medical Network 2006). AQSIQ (2009c) has advised that this spider has been reported from fields in Hami and Quitar in Xinjiang but has never been detected in vineyards.

The impact of spider bites on farm animals appears to be considerable at times. Media reports indicate that farmers in western Kazakhstan have lost Bactrian camels to bites of *L. tredecimguttatus* (BBC 2004). Horses and camels are reported as being very susceptible to bites from this spider (Kungrad.com 2006). Nomadic pastoralists in Kazakhstan have in the past left rich pasture due to the threat to themselves and their livestock caused by high densities of this spider (Tarabaev 1991).

Latrodectus tredecimguttatus thrives in dry and semi arid areas with a Mediterranean or temperate continental climate. Large parts of southern and central Australia have a climate similar to regions from where this spider is found. *Latrodectus tredecimguttatus* appears to thrive in pastureland and is thus a threat to cattle, horses, other domestic animals and native herbivores, especially in drier regions of Australia. It is also a potential risk to workers in horticulture and to human communities especially in inland Australia. In addition it may pose a threat to recreational activities, such as camping, given its ground living habit.

A comprehensive assessment of the association of spiders (including *Latrodectus* spp.) with table grapes, risk mitigation measures and impact on human health is provided in a series of documents produced by the New Zealand Ministry of Agriculture and Forestry and Ministry of Health and taken into consideration in the assessment of *Latrodectus mactans* in the import risk analysis for table grapes from Chile (Biosecurity Australia 2005d).

Based on the potential association of these spiders with table grapes from China, the demonstrated ability of other *Latrodectus* species to survive in Australia and the risks identified to human health, it is concluded that the unrestricted risk associated with these species is not acceptable. Therefore, specific risk management measures are required for these sanitary pests.

4.25 Pest risk assessment conclusions

Key to Table 4.2 (next page)

Genus species [EP]	pests for which policy already exists. The outcomes of previous assessments and/or reassessments in this IRA are presented in Table 4.2
Genus species [state/territory]	state/territory in which regional quarantine pests have been identified

Likelihoods for entry, establishment and spread

N	negligible
EL	extremely low
VL	very low
L	low
M	moderate
H	high
P[EES]	overall probability of entry, establishment and spread

Assessment of consequences from pest entry, establishment and spread

PLH	plant life or health
OE	other aspects of the environment
EC	eradication control etc.
DT	domestic trade
IT	international trade
ENC	environmental and non-commercial
A-G	consequence impact scores are detailed in section 2.2.3
URE	unrestricted risk estimate. This is expressed on an ascending scale from negligible to extreme.

Table 4.2 Summary of unrestricted risk estimates for quarantine pests associated with table grapes from China

Pest name	Likelihood of						Consequences							URE
	Entry			Establishment	Spread	P[EES]	direct		indirect				Overall	
	importation	distribution	Overall				PLH	OE	EC	DT	IT	ENC		
Spider mite (Thombidiformes: Tetranychidae)														
Tetranychus kanzawai [WA]	H	M	**M**	**H**	**M**	**L**	E	B	D	C	D	B	**M**	**L**
Ladybird (Coleoptera: Rhynchitidae)														
Harmonia axyridis	H	H	**H**	**H**	**H**	**H**	C	D	D	E	D	E	**M**	**M**
Weevil (Coleoptera: Rhynchitidae)														
Merhynchites sp.	L	L	**VL**	**VL**	**L**	**EL**	D	A	C	D	D	A	**L**	**N**
Beetle (Coleoptera: Scarabaeidae)														
Popillia japonica	L	H	**L**	**H**	**H**	**L**	E	E	E	D	C	D	**M**	**L**
Popillia mutans [EP]	L	H	**L**	**H**	**H**	**L**	D	A	C	C	C	B	**L**	**VL**
Popillia quadriguttata [EP]	L	H	**L**	**H**	**H**	**L**	D	A	C	C	C	B	**L**	**VL**
Fruit fly (Diptera: Tephritidae)														
Bactrocera dorsalis [EP]	L	L	**VL**	**H**	**H**	**VL**	E	C	F	E	E	D	**H**	**L**
Midge (Diptera: Cecidomyiidae)														
Cecidomyia sp.	VL	L	**VL**	**L**	**L**	**VL**	C	A	C	D	D	B	**L**	**N**
Whitefly (Hemiptera: Aleroydidae)														
Aleurolobus taeonabe	M	M	**L**	**H**	**H**	**L**	E	B	D	D	C	B	**M**	**L**
Phylloxera (Hemiptera: Phylloxeridae)														
Daktulosphaira vitifoliae	M	M	**L**	**H**	**M**	**L**	E	A	E	D	C	B	**M**	**L**

Pest name	Likelihood of						Consequences							URE
	Entry			Establishment	Spread	P[EES]								
	importation	distribution	Overall				direct		indirect				Overall	
							PLH	OE	EC	DT	IT	ENC		
Armoured scale (Hemiptera: Diaspididae)														
Parthenolecanium corni [EP, WA]	H	L	**L**	**H**	**M**	**L**	D	B	D	C	C	B	**L**	**VL**
Parthenolecanium orientalis	H	L	**L**	**H**	**M**	**L**	D	B	D	C	C	B	**L**	**VL**
Mealybugs (Hemiptera: Pseudococcidae)														
Planococcus kraunhiae [EP]	H	M	**M**	**H**	**H**	**M**	D	C	D	D	D	B	**L**	**L**
Pseudococcus comstocki [EP]	H	M	**M**	**H**	**H**	**M**	D	C	D	D	D	B	**L**	**L**
Pseudococcus maritimus [EP]	H	M	**M**	**H**	**H**	**M**	D	C	D	D	D	B	**L**	**L**
Moths (Lepidoptera: Tortricidae)														
Eupoecilia ambiguella	L	M	**L**	**M**	**M**	**L**	D	A	B	C	C	B	**L**	**VL**
Nippoptilia vitis	M	L	**L**	**L**	**L**	**VL**	D	A	B	C	C	B	**L**	**N**
Stathmopoda auriferella [EP]	L	H	**L**	**H**	**H**	**L**	C	B	C	D	D	B	**L**	**VL**
(Thysanoptera: Thripidae)														
Frankliniella occidentalis [EP, NT, Tas]	H	M	**M**	**H**	**H**	**M**	D	B	D	D	D	B	**L**	**L**
Rhipiphorothrips cruentatus	H	M	**M**	**H**	**H**	**M**	D	B	C	C	D	B	**L**	**L**
Fungi														
Physalospora baccae	H	M	**M**	**H**	**H**	**M**	E	A	E	E	D	B	**M**	**M**
Greeneria uvicola [WA]	L	H	**L**	**H**	**H**	**L**	E	A	D	A	E	B	**M**	**L**
Guignardia bidwellii	H	M	**M**	**M**	**H**	**L**	F	A	E	D	D	B	**H**	**M**
Alternaria viticola	H	M	**M**	**H**	**H**	**M**	E	A	D	D	D	B	**M**	**M**
Monilinia fructigena [EP]	L	H	**L**	**H**	**H**	**L**	E	A	E	E	E	B	**M**	**L**
Phakopsora euvitis	M	M	**L**	**M**	**H**	**L**	E	A	D	D	D	B	**M**	**L**

Pest name	Likelihood of						Consequences							URE
	Entry			Establishment	Spread	P[EES]								
	importation	distribution	Overall				direct		indirect				Overall	
							PLH	OE	EC	DT	IT	ENC		
Phomopsis viticola [EP, WA]	M	L	**L**	**H**	**M**	**L**	C	A	D	B	B	B	**L**	**VL**
Viruses														
Necrovirus Tobacco necrosis viruses	M	M	**L**	**H**	**H**	**L**	C	A	C	C	C	A	**VL**	**N**
Sanitary pests														
Latrodectus mactans [EP]	–	–	**–**	**–**	**–**	**–**	–	–	–	–	–	–	**–**	**Not accep table**
Latrodectus tredecimguttatus	–	–	**–**	**–**	**–**	**–**	–	–	–	–	–	–	**–**	**Not accep table**

5 Pest risk management

This chapter provides information on the management of quarantine pests identified with an unrestricted risk exceeding Australia's appropriate level of protection (ALOP). The proposed phytosanitary measures are described below.

5.1 Pest risk management measures and phytosanitary procedures

Pest risk management evaluates and selects options for measures to reduce the risk of entry, establishment or spread of quarantine pests for Australia where they have been assessed to have an unrestricted risk above Australia's ALOP. In calculating the unrestricted risk, existing commercial production practices in China have already been considered, as have post-harvest procedures and packing of fruit.

In addition to China's existing commercial production practices for the production of table grapes and minimum border procedures in Australia, specific pest risk management measures, including operational systems, are proposed to achieve Australia's ALOP.

In this section, Biosecurity Australia has identified risk management measures that may be applied to consignments of table grapes sourced from China. Finalisation of the quarantine conditions may be undertaken with input from AQIS and the Australian states and territories as appropriate.

China has proposed the following general framework to be considered by Australia for the management of pests and procedures for production of table grapes for export to Australia (AQSIQ 2006; AQSIQ 2008; AQSIQ 2009c):

- *Registration*: Table grapes for export to Australia must originate from vineyards and packing houses registered with the General Administration for Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ) by the regional China Entry-Exit Inspection and Quarantine Bureau (CIQ).
- *Personnel training*: CIQ will supervise the training of personnel working in registered vineyards and packing houses in sanitation and the monitoring, identification and control of pests. Each registered vineyard has detailed pest monitoring, prevention and control guidelines and CIQ is responsible for instructing and overseeing the implementation of these guidelines.
- *Pest control and monitoring*: Quarantine pests of concern to Australia are to be monitored and controlled in export vineyards. The general pest control measures are: (i) vineyard sanitation measures including deep tillage and cultivation of mulch crop between vines; (ii) monitoring and surveillance (iii) integrated pest management measures including cultivation, pest trapping, biological control and application of chemical control measures and fruit bagging.
- *Fruit fly monitoring*: AQSIQ will use the established national fruit fly trapping system in China to monitor for fruit flies of quarantine concern.
- *Pre-harvest auditing and supervision:* Before fruit is harvested, CIQ will periodically examine the records for pest monitoring, pest control, spraying, fertilising and fruit bagging. Ten to 20 days before harvesting, AQSIQ will send technicians to undertake vineyard inspections to ensure the effectiveness of field control measures.

- *Packing house management:* A sanitation program is to be carried out in packing houses to ensure they are kept clean. Windows and doors are to be insect-proof. The waste fruit is to be collected regularly for disinfection treatment. The processing line is specifically used to grade export fruit. Fruit for export to different countries and for the domestic market are prohibited from being processed in the same packing house at the same time.
- *Labelling*: New and clean cartons must be used for packing fruit. Plant derived packing materials must not be used. For the convenience of tracing the origin of any problem, all the cartons must be labelled with 'For Australia', with the registration number of vineyards and packing house, the lot number, the number of cartons in each lot, and date.
- *Storage and transport*: The storage facilities should be clean and hygienic. Fruit for different export markets should be stored separately. The packing houses are to ensure that the relevant records are kept up to date.
- *Pre-export inspection and certification*: CIQ will conduct the on-site phytosanitary inspection, and if the lot meets the requirements, issue the Phytosanitary Certificate.

Biosecurity Australia has considered the components of China's proposed general framework. Biosecurity Australia has also visited table grape production areas in China and observed and collected information related to the framework proposed by China for registration and management of vineyards and packing houses, pest management including fruit fly monitoring and storage and transport. There are general requirements to be fulfilled for table grape vineyards and packing houses and storage facilities to be eligible to register for export to any country and specific requirements to comply with the import conditions agreed between China and the importing country.

The requirements for vineyard registration include: a minimum size of 100 mu (about 6.7 ha); good water quality; service of a plant protection officer to monitor and control pests; and capacity for implementing quality management and complying with the conditions of export protocols.

Requirements for packing houses include: good general hygiene; adequate functioning and maintenance of machinery; cold storage capacity; and capability for personnel training in quarantine and food safety issues.

The registration applications received are assessed and accepted after an initial and a final verification to confirm all the requirements are fulfilled. Fruit sourced from specific vineyards and packing houses can be traced back through segregation and labelling. Training of plant protection officers and growers in the identification and management of pests and diseases, including fruit flies and relevant food safety issues, forms an important component in the export program.

The pest risk management measures proposed by Biosecurity Australia are based on the mandatory requirement for China to adhere to existing commercial practices (refer to Chapter 3).

The proposed pest risk management measures will apply to all the table grape production areas from which China intends to export table grapes to Australia. Nominated areas or provinces will be visited by Australia and their pest status verified before the commencement of trade from that area.

Consideration of alternative measures

Consistent with the principle of equivalence detailed in ISPM 11: *Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms* (FAO 2004), Biosecurity Australia will consider any alternative measure proposed by AQSIQ, providing that it achieves an equivalent level of quarantine protection. Evaluation of such measures or treatments will require a technical submission from AQSIQ that details the proposed treatment and includes data from suitable treatment trials.

5.1.1 Pest risk management for pests

The pest risk analysis identified the quarantine pests listed in Table 5.1 as having an unrestricted risk above Australia's ALOP.

Table 5.1 Phytosanitary and sanitary measures proposed for quarantine pests for table grapes from China

Pest	Common name	Measures
Arthropods		
Bactrocera dorsalis [EP]	Oriental fruit fly	Area freedom* OR Cold disinfestation
Tetranychus kanzawai [WA]	Kanzawa spider mite	Systems approach: • Vineyard control and surveillance • Fruit bagging • Visual inspection and remedial action**
Harmonia axyridis	Harlequin ladybird	
Popillia japonica	Japanese beetle	
Aleurolobus taeonabe	Grape whitefly	
Planococcus kraunhiae [EP] *Pseudococcus comstocki* [EP] *Pseudococcus maritimus* [EP]	Mealybugs	
Rhipiphorothrips cruentatus [EP] *Frankliniella occidentalis* [EP, NT, Tas.]	Thrips	
Daktulosphaira vitifoliae	Phylloxera	Area freedom* OR Sulphur pad treatment OR Pre-shipment fumigation with SO_2/CO_2
Pathogens		
Physalospora baccae	Grape cluster black rot	Area freedom*
Guignardia bidwellii [EP]	Black rot	
Alternaria viticola	Spike stalk brown spot	
Monilinia fructigena [EP]	Brown rot	Area freedom* OR Systems approach: • Vineyard control and surveillance • Fruit bagging • Visual inspection and remedial action**
Greeneria uvicola [WA]	Bitter rot	
Phakopsora euvitis	Grapevine leaf rust	

Pest	Common name	Measures
Sanitary pests		
Latrodectus mactans [EP] *Latrodectus tredecimguttatus*	Black widow spiders	Pre-shipment fumigation with SO_2/CO_2
[EP]: Species has been assessed previously and import policy already exists. *: Area freedom may include pest free areas, pest free places of production or pest free production sites. **: Remedial action (depending on the location of the inspection) may include: treatment of the consignment to ensure that the pest is no longer viable; withdrawing the consignment from export to Australia; export of the consignment from Australia; or destruction of the consignment.		

This draft IRA builds on the existing policies for the import of table grapes from California (AQIS 2000), table grapes from Chile (Biosecurity Australia 2005d) and pears from China (Biosecurity Australia 2005a), which include many of the pests identified in Table 5.1.

Considerable trade in table grapes from California has taken place since 2002. The policy for table grapes from California was reviewed and extended in 2006 (Biosecurity Australia 2006a) and 2009 (AQIS 2009a). No table grapes have been imported under the policy for table grapes from Chile.

Equivalent management measures have been considered for the same or similar pests and proposed in this draft IRA. Thus, the management options proposed are consistent with these existing policies. They include:

- area freedom or cold disinfestation for Oriental fruit fly
- a systems approach for kanzawa spider mite, harlequin ladybird, Japanese beetle, grape whitefly, mealybugs and thrips
- area freedom or sulphur pad treatment or pre-shipment fumigation with SO_2/CO_2 for phylloxera
- area freedom for grape cluster black rot, black rot and spike stalk brown spot
- area freedom or a systems approach for bitter rot, brown rot and grapevine leaf rust
- pre-shipment fumigation with SO_2/CO_2 for spiders.

Management for *Bactrocera dorsalis*

Bactrocera dorsalis (Oriental fruit fly) was assessed to have an unrestricted risk estimate that exceeds Australia's ALOP. Measures are therefore required to manage this risk. Biosecurity Australia proposes the options of area freedom or cold disinfestation as management measures.

Area freedom

Area freedom is a measure that might be applied to manage the risk posed by Oriental fruit fly. The requirements for establishing pest free areas or pest free places of production are set out in ISPM 4: *Establishment of pest free areas* (FAO 1996) and ISPM 10: *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 1999) and more specifically in ISPM 26: *Establishment of pest free areas for fruit flies (Tephritidae)* (FAO 2006).

Current requirements for the import of pears from the provinces of Hebei, Shaanxi, Shandong and Xinjiang in northern China (Biosecurity Australia 2005a) include monitoring and trapping

of fruit flies in export vineyards and packing houses. Monitoring and trapping of fruit flies in the specific table grape export vineyards and packing houses of northern China (as for current pear export) would be required.

Biosecurity Australia is currently considering China's request for recognition of northern China for area freedom for Oriental fruit fly and other economically significant fruit flies based on China's National Fruit Flies Trapping Network. If area freedom for Oriental fruit fly and other economically significant fruit flies is accepted by Biosecurity Australia for northern China, China's existing National Fruit Flies Trapping Network would be required to be maintained in all areas including production areas where table grapes are to be sourced for export to Australia. However, additional monitoring and trapping of fruit flies in the specific export vineyards and packing houses may not be required.

Under either of the two area freedom situations (i.e. monitoring and trapping of export vineyards or based on the National Fruit Flies Trapping Network), AQSIQ would be required to notify the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) of the detection of any fruit fly species (Tephritidae) of economic importance in the regions within 48 hours. DAFF would then assess the species and number of individual flies detected and the circumstances of the detection, before advising AQSIQ of the action to be taken. If fruit flies are detected at pre-clearance inspection, trade would stop immediately, pending the outcome of an investigation.

The objective of this measure is to reduce the likelihood of importation for Oriental fruit fly to at least 'very low'. The restricted risk would then be reduced to at least 'very low', which would achieve Australia's ALOP.

Cold disinfestation

Cold disinfestation efficacy trial data for *B. dorsalis* on table grapes has not been provided by China. However, treatment regimes consistent with the USDA Treatment Manual (USDA 2010c) for *B. dorsalis* on a range of commodities and those stipulated by MAF Biosecurity New Zealand (MAF Biosecurity New Zealand 2009) for disinfestation of *B. dorsalis* in table grapes imported from China could be used for treatment of table grapes sourced from regions south of 32 °N latitude (Figure 3.1) where *B. dorsalis* may be present and can survive, for example in Yunnan province in southern China. Biosecurity Australia proposes the following treatment regime:

- 0.99 °C or below for 17 days
- 1.38 °C or below for 20 days

The objective of each of these measures is to reduce the survival of Oriental fruit fly thus reducing the likelihood of importation to at least 'very low'. The restricted risk would then be reduced to at least 'very low', which would achieve Australia's ALOP.

Other potential mitigation measures

Measures for Oriental fruit fly could also include alternative cold disinfestation, fumigation, chemical or irradiation treatments, subject to the provision and acceptance of suitable efficacy data.

Management for *Tetranychus kanzawai, Harmonia axyridis, Popillia japonica, Aleurolobus taeonabe, Pseudococcus comstocki, Planococcus kraunhiae, Pseudococcus maritimus, Frankliniella occidentalis* and *Rhipiphorothrips cruentatus*

The mite, *Tetranychus kanzawai* (kanzawa spider mite); the ladybird, *Harmonia axyridis* (harlequin ladybird); the beetle, *Popillia japonica* (Japanese beetle); the whitefly, *Aleurolobus taeonabe* (grape whitefly); mealybugs, *Pseudococcus comstocki* (Comstock's mealybug), *Planococcus kraunhiae* (Japanese mealybug) and *Pseudococcus maritimus* (grapevine mealybug); and thrips *Frankliniella occidentalis* (western flower thrips) and *Rhipiphorothrips cruentatus* (grapevine thrips) were assessed to have an unrestricted risk estimate that exceeds Australia's ALOP. Measures are therefore required to manage these risks.

Biosecurity Australia proposes the following systems approach based on vineyard control and surveillance, fruit bagging and pre-export visual inspection and remedial action to reduce the risks associated with these arthropod pests to meet Australia's ALOP.

Systems approach

Vineyard control and surveillance

Registered growers would implement a vineyard control program (i.e. good agricultural practice/integrated pest management (IPM) programs for export table grapes). Programs would be approved by AQSIQ, and incorporate field sanitation and appropriate pesticide applications for the management of quarantine arthropod pests.

AQSIQ/CIQ would be responsible for ensuring that the export table grape growers are aware of pests of quarantine concern to Australia and that the export vineyards are subject to field sanitation and control measures. Registered growers would be required to keep records of control measures for auditing. Details of the arthropod pest control program would need to be provided to DAFF by AQSIQ before trade commences.

Monitoring and surveillance for pests that require vineyard management measures must be conducted regularly by AQSIQ/CIQ in vineyards registered for export to Australia to verify the effectiveness of the measures. ASQIQ/CIQ will maintain annual survey results using a standardised reporting form. These will be made available to DAFF if requested.

The objective of vineyard control and surveillance as an element of the systems approach is to reduce the number of pests in the vineyard to a low level.

Fruit bagging

AQSIQ has indicated that table grapes produced in China for export have the bunches enclosed in a bag for a period of the grape fruit development and maturation (AQSIQ 2008; AQSIQ 2009c). Fruit bagging has been shown in China to be effective in providing some protection to the developing table grapes from the sun, dust, wind, rain, hail; reducing damage by birds and arthropod pests (AQSIQ 2008; AQSIQ 2009c); and reducing chemical residues.

The bagging practices in China for table grapes appear to vary greatly, according to the grape cultivar, the climatic conditions and the geographic location of the vineyards. For example, Red Globe grapes grown in Xinjiang are usually bagged in early to mid August and the bags are removed from early to mid September (10–15 days before harvesting) (AQSIQ 2008; AQSIQ 2009c). In this situation, the grapes are only covered by the bags for one month of their development. Earlier season cultivars in Xinjiang may be bagged from 15–20 June when the berries are 8–10 mm and removed from 10–15 August, 10–15 days before harvest in late August. In Hebei, Red Globe grapes are bagged in mid-June when the berries are the size of a

soybean or peanut and removed ten days before harvest, which occurs in the last week of August or the first week of September. In these two situations the grape bunches are protected by the bags for about two months. These table grape bagging practices differ from those of pear and apple production, where the bag is put on the developing fruitlet when it reaches 2.5 cm and only removed in the packing house after harvest with pears, and 2–4 weeks before harvest with apples to allow the colour to develop.

Biosecurity Australia proposes fruit bagging of the developing and maturing grape bunches for a minimum of two months as part of the systems approach for the arthropod pests listed above. Pest control measures, including pesticide sprays, would need to be applied at the appropriate time to manage each of the quarantine pests prior to bagging to ensure that the vineyards in general, and the developing fruit in particular, are free from these pests.

AQSIQ has advised that the bags are usually removed 10–15 days before harvesting. Variations in this practice occurs in different provinces but this advice indicates the maximum length of time that the table grapes would be exposed after bag removal is 15 days. AQSIQ (2008; 2009c) states that table grapes can be harvested from August to October depending on the cultivars and region. This means that the bags would be removed starting from early August to early October. It is possible that pests, if present in the vineyard at this time, could infest the exposed physiologically mature fruit in the period between removal of the bags and harvesting the fruit.

AQSIQ would need to ensure that registered export vineyards are free of any evidence or symptoms of the pests, prior to the removal of bags. This may be achieved through monitoring and inspecting and applying appropriate treatments if necessary to the vineyards before removing the bags and maintaining the health status of the vineyard until the fruit is harvested. AQSIQ would develop the monitoring and inspection procedures to ensure that freedom of these pests is achieved during this period. These procedures would be documented and provided to DAFF for approval before trade commences. The results of monitoring and inspection and any treatment, along with the recorded dates of initial bagging of the grape bunches and removal of bags, must also be made available to DAFF for auditing purposes.

The objective of fruit bagging as an element of the systems approach is to minimise access to the developing grape bunch through the protection or physical barrier offered by the bags. Biosecurity Australia acknowledges that there is no data to support the effect the bags have on the identified target arthropod pests of table grapes. However, the bagging and the associated practices as outlined, together with the vineyard surveillance and control, are considered to further reduce the potential for the pests to be found on the fruit bunch when presented for visual inspection.

Visual inspection and remedial action

The objective of visual inspection as a component of this systems approach is to ensure that any consignments of table grapes from China infested with these pests are identified and subjected to appropriate remedial action. The remedial action will reduce the risk associated with mites, ladybirds, beetles, whiteflies, mealybugs and thrips to a very low level to meet Australia's ALOP.

Mites, ladybirds, beetles, whiteflies, mealybugs and thrips are external pests and can be detected by trained quarantine inspectors using optical enhancement where necessary. Therefore, the standard 600 unit quarantine inspection undertaken by AQIS would be effective in identifying consignments infested with these pests.

Remedial action, if required, could include any treatment known to be effective against the target pests. Currently, standard methyl bromide fumigation rates for external pests are recognised. However, Biosecurity Australia would also consider any other treatment that AQSIQ proposes, if it provides an equivalent level of protection.

The consignment would not be released from quarantine until the remedial action has been undertaken.

The objective of all these measures (a systems approach) is to reduce the likelihood of importation for these pests to at least 'very low'. The restricted risk would then be reduced to at least 'very low', which would achieve Australia's ALOP.

Management for *Daktulosphaira vitifoliae*

Daktulosphaira vitifoliae (phylloxera) was assessed to have an unrestricted risk estimate that exceeds Australia's ALOP. Measures are therefore required to manage this risk. Biosecurity Australia has considered that visual inspection of fruit alone may not be an appropriate risk management measure for *D. vitifoliae* (phylloxera) because signs of infestation may not be visible. Options proposed are area freedom or treatment with sulphur pads or pre-shipment fumigation with sulphur dioxide (SO_2) and carbon dioxide (CO_2).

Area freedom

Area freedom is a measure that might be applied to manage the risk posed by *D. vitifoliae*. The requirements for establishing pest free areas or pest free places of production are set out in ISPM 4: *Establishment of pest free areas* (FAO 1996) and ISPM 10: *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 1999). *Daktulosphaira vitifoliae* is recorded from Liaoning, Shaanxi and Shandong (CABI 2009; AQSIQ 2009b) and it is under official control and a quarantine pest for China for table grapes from other countries (including Australia) (AQSIQ 2009a). Table grapes may be able to be sourced from identified phylloxera-free production areas.

The objective of this measure is to reduce the likelihood of introduction for *D. vitifoliae* to at least 'very low'. The restricted risk would then be reduced to at least 'very low', which would achieve Australia's ALOP.

Sulphur pad treatment

Biosecurity Australia proposes that commercial sulphur pads with proven efficacy against *D. vitifoliae* could be packed in all cartons of table grapes for export to manage the risk posed by this pest. The objective of this risk management measure is to reduce the survival of *D. vitifoliae* associated with packed table grapes and packaging and the likelihood of introduction to at least 'very low'. The restricted risk would then be reduced to at least 'very low', which would achieve Australia's ALOP.

Pre-shipment fumigation with SO_2/CO_2

Commercial pre-export fumigation with a mixture of sulphur dioxide and carbon dioxide (SO_2/CO_2) proposed under 'Management of sanitary pests' at the end of section 5.1.1, would also be an effective measure against *D. vitifoliae*. Under the proposed fumigation arrangement, the table grapes would be treated with a mixture of 1% sulphur dioxide (SO_2) and 6% carbon dioxide (CO_2) for a minimum of 30 minutes, delivered using forced air at a fruit pulp temperature of 16 °C or greater.

The objective of this risk management measure is to reduce the survival of *D. vitifoliae* associated with packed table grapes or packaging, reducing the likelihood of importation to at least 'very low'. The restricted risk would then be reduced to at least 'very low', which would achieve Australia's ALOP.

Other potential measures for arthropod pests

Other potential mitigation measures for arthropod pests could include area freedom (pest free areas or pest free places of production or pest free production sites), areas of low pest prevalence, treatments using heat, cold, chemical sprays, fumigants or irradiation, or a combination of these measures.

However, development of final import conditions will be dependent on AQSIQ providing additional scientific information supporting the establishment of pest free areas, pest free production sites or areas of low pest prevalence, or efficacy of treatments against the arthropod pests that reduce the level of risk in line with Australia's ALOP.

The use of ionising treatments, such as gamma rays and x-rays for quarantine purposes is recognised as a potential mitigation measure for all arthropod pests. The ISPM 18: *Guidelines for the use of irradiation as a phytosanitary measure* (FAO 2003) outlines a number of issues for consideration in accepting irradiation as a phytosanitary measures.

The arthropod pests identified in this draft IRA include: a fruit fly, *B. dorsalis* (Oriental fruit fly); phylloxera, *D. vitifoliae* (grapevine phylloxera); a mite, *T. kanzawai* (kanzawa spider mite); a ladybird, *H. axyridis* (harlequin ladybird); a whitefly, *A. taeonabe* (grape whitefly); a beetle, *P. japonica* (Japanese beetle); three mealybugs, *Ps. comstocki* (Comstock's mealybug), *Pl. kraunhiae* (Japanese mealybug) and *Ps. maritimus* (grapevine mealybug); and two thrips, *F. occidentalis* (western flower thrips) and *R. cruentatus* (grapevine thrips). In addition there are sanitary pests – two spiders, *Latrodectus mactans* (black widow spider) and *L. tredecimguttatus* (European black widow spider) considered at the end of section 5.1.1.

FAO (2003) provides an estimated minimum absorbed dose for certain responses for selected pest groups including fruit flies, spider mites, whiteflies, scarab beetles, and thrips but not ladybirds, mealybugs, phylloxera or spiders. The minimum absorbed doses for ladybirds, mealybugs and phylloxera, and the lethal dose for spiders, would need to be confirmed and/or determined before irradiation is accepted as the treatment against these species.

Currently, irradiated grapes are not permitted to be sold in Australia due to regulations managed by the Food Standards Australia New Zealand (FSANZ). However, application may be made to FSANZ by any interested stakeholder to change the Australia New Zealand Food Standards Code to allow grapes or additional fruits treated with irradiation for phytosanitary purposes to be sold in Australia. Information on these applications can be viewed at the FSANZ web site.

Management for *Physalospora baccae, Guignardia bidwellii* and *Alternaria viticola*

Physalospora baccae (grape cluster black rot), *Guignardia bidwellii* (black rot) and *Alternaria viticola* (spike stalk brown spot) were assessed to have an unrestricted risk estimate that does not achieve Australia's ALOP. Measures are therefore required to manage this risk.

Visual inspection of fruit alone is not considered to be an appropriate management option for these pathogens as external signs of infection are not always present and there may be late developing infections or latent infections. Visual inspection of fruit cannot detect symptomless infection. If *P. baccae, G. bidwellii* and *A. viticola* were present in the export

vineyard, developing grapes could be infected prior to the bagging of the grape bunch and infected fruit would develop symptoms before the removal of the bags and the disease symptoms would become evident. However, maturing fruit exposed to infection in the vineyard in the 10–15 days after the removal of the bags before harvest may remain symptomless by harvest yet could be infected and develop during storage or could harbour latent infection.

Biosecurity Australia proposes area freedom with the options of pest free areas or pest free places of production (vineyard freedom) as management measures.

Area freedom

Pest free areas

A pest free area, as described in ISPM 4: *Requirements for the establishment of pest free areas* (FAO 1996) and ISPM 10: *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 1999), would require systems to be put in place by AQSIQ to establish, maintain and verify that *P. baccae, G. bidwellii* and *A. viticola* do not occur within that area. Freedom from these pathogens in an area would reduce the overall probability of entry to 'very low'. The restricted risk would then be reduced to at least 'very low', which achieves Australia's ALOP.

Physalospora baccae, G. bidwellii and *A. viticola* occur throughout China (Grapevinewine 2003; Ma *et al.* 2004; Zhang 2005b; CABI 2009), including the major table grape production areas. No pest free areas for these pathogens have been identified by China. Establishment and maintenance of pest free areas may not be technically feasible.

A measure to manage the risk is to source table grapes from export vineyards free of the disease; that is to establish pest free places of production as outlined in ISPM No.10: *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 1999). Biosecurity Australia proposes pest free places of production (vineyard freedom) as a suitable measure to reduce the risk associated with these pathogens to an acceptable level.

Pest free places of production (vineyard freedom)

Table grapes for export to Australia would need to be sourced from export vineyards free of the disease. This measure would require systems to be put in place for the establishment, maintenance and verification of vineyard freedom from *P. baccae, G. bidwellii* and *A. viticola* under the supervision of CIQ and responsibility of AQSIQ and be supported by the appropriate documentation. These documents should be made available to Biosecurity Australia if requested.

The inspection and monitoring of vines in the export vineyard at appropriate times to detect evidence of the pathogen must be undertaken and supported by appropriate documentation. The inspection method, including details of the timing and size of the sampling to be undertaken for each vineyard, appropriate for the pathogen and disease would be developed by AQSIQ and subject to approval by DAFF. Results of the inspections would be subsequently made available to DAFF for auditing purposes.

If *P. baccae, G. bidwellii* and *A. viticola* are detected in any export vineyard, fruit from that export vineyard will not be eligible for the export program to Australia.

To prevent any potential contamination from the processing of table grapes destined to domestic or other export markets, processing equipment in packing houses must be suitably cleaned prior to the commencement of processing and packing fruit for export to Australia.

If grape cluster black rot, black rot or spike stalk brown spot are detected on fruit for export at pre-export inspection or detected on export fruit in Australia then the fruit will be rejected and registration of the vineyard/s would be suspended, pending the outcome of an investigation.

The objective of this measure is to reduce the likelihood of importation for *P. baccae, G. bidwellii* and *A. viticola* to at least 'very low'. The restricted risk would then be reduced to 'very low', which achieves Australia's ALOP.

Management for *Greeneria uvicola* [WA], *Monilinia fructigena* and *Phakopsora euvitis*

Greeneria uvicola [WA] (bitter rot), *Monilinia fructigena* (brown rot) and *Phakopsora euvitis* (grapevine leaf rust) were assessed to have an unrestricted risk estimate that does not achieve Australia's ALOP. Measures are therefore required to manage this risk.

Visual inspection of fruit alone is not considered to be an appropriate management option for these pathogens as external signs of infection are not always present. Inspection of fruit cannot detect symptomless infection. Biosecurity Australia proposes area freedom (pest free areas, pest free places of production (vineyard freedom) as discussed above, or a systems approach based on vineyard control and surveillance, fruit bagging and pre-export visual inspection and remedial action to reduce the risk associated with these pathogens to an acceptable level.

Area freedom

Pest free areas

Greeneria uvicola was reported from the southern part of Jiangsu province in China which is not the major table grape production area (Yan *et al.* 1998). In addition, *G. uvicola* is a quarantine pest for China for the import of table grapes from other countries, including Australia (AQSIQ 2009a). Therefore, pest free areas for *G. uvicola* are likely to exist or may be established in major table grape production areas.

While the option of a pest free area is available for *G. uvicola, M. fructigena* and *P. euvitis* occur in grape production areas sporadically throughout China (EPPO 2002; Zhang 2005b; AQSIQ 2007; CABI 2009). No pest free areas have been identified by China for brown rot and grapevine leaf rust caused by these pathogens. Establishment and maintenance of pest free areas may not be technically feasible.

Pest free places of production (vineyard freedom)

A second option to manage the risk is to source table grapes from export vineyards free of these diseases, that is to establish pest free places of production, as outlined in ISPM No.10: *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 1999). These could be a pest free place of production (vineyard freedom) for which freedom from *G. uvicola, M. fructigena* and *P. euvitis* symptoms is established, maintained and verified by CIQ.

This measure would require the place of production, under the supervision of CIQ and responsibility of AQSIQ, to establish, maintain and verify freedom from *G. uvicola, M. fructigena* and *P. euvitis* supported by the appropriate documentation. These documents should be made available to Biosecurity Australia if requested.

Systems approach

As a third option, Biosecurity Australia proposes the following systems approach based on vineyard control and surveillance, and fruit bagging, in addition to pre-export visual inspection and remedial action to reduce the risk associated with these pathogens to an acceptable level.

Vineyard control and surveillance

Registered growers would implement a vineyard control program (i.e. acceptable agricultural practice and integrated disease management (IDM) program for export table grapes). Programs would need to be approved by AQSIQ, and incorporate field sanitation and appropriate fungicide applications for the management of pathogens of quarantine concern to Australia.

AQSIQ/CIQ would be responsible for ensuring that export table grape growers are aware of diseases of quarantine concern to Australia, field sanitation and control measures. Registered growers would be required to keep records of control measures for auditing purposes. Details of the pathogen control program would need to be provided by AQSIQ to DAFF for approval before trade commenced.

Vineyard control and surveillance for these pathogens and the diseases they cause would include:

- Vineyard sanitation/hygiene: the removal and destruction of infected plant parts, weed control and pruning
- Monitoring/detection surveys for *G. uvicola, M. fructigena* and *P. euvitis* to verify the effectiveness of the vineyard control measures:
  - Regular surveys of vineyards registered for export by accredited personnel would be required to ensure that they are free from symptoms of the diseases caused by these pathogens. AQSIQ/CIQ would be required to maintain annual survey results for the regular surveys, using a standard reporting format
  - Inspection of all export vineyards and adjacent properties by AQSIQ/CIQ after removal of the bags and prior to harvest, to ensure that the grapevines and bunches are free from symptoms of the diseases caused by these pathogens. The inspection method appropriate for these diseases, including details of the timing and size of the sampling to be undertaken for each vineyard, would be developed by AQSIQ. Results of the final vineyard inspections would subsequently be required to be made available to DAFF for auditing purposes.

Fruit bagging

AQSIQ has indicated that table grapes produced in China for export are bagged for a period of fruit development and maturing (AQSIQ 2008; AQSIQ 2009c). Fruit bagging has been shown in China to be effective in providing some protection to the developing table grapes from the sun, dust, wind, rain and hail; reducing damage from disease (AQSIQ 2008; AQSIQ 2009c); and reducing chemical residues.

The bagging practices in China for table grapes appear to vary greatly, according to the grape cultivar, the climatic conditions and the geographic location of the vineyards and are not in place for the full duration of the development and maturation of the grape bunches, as

discussed earlier in the chapter in relation to the proposed systems approach for arthropod pests.

Biosecurity Australia proposes fruit bagging of the developing grape bunches for a minimum of two months as part of the systems approach for *G. uvicola, M. fructigena* and *P. euvitis*. The developing grape bunches would be bagged when the berries are approximately 8-10 mm, which for some regions and varieties would take place in mid-June. The bags would remain intact on the bunches until mid-August for grapes harvested in late August. Disease control measures, including fungicide sprays, would need to be applied at the appropriate time to manage each of the quarantine pathogens prior to bagging to ensure that the vineyards in general, and the developing fruit in particular, are free from these pathogens.

AQSIQ has advised that the bags are usually removed 10–15 days before harvesting. Variations in these practices occur in different provinces but this advice indicates the maximum length of time that the table grapes would be exposed after bag removal is 15 days. AQSIQ (2008; 2009c) states that table grapes can be harvested from August to October depending on the cultivars and region. This means that the bags would be removed starting from early August to early October. It is possible that spores of *G. uvicola, M. fructigena* and *P. euvitis* may infect the exposed maturing fruit during the period between the removal of the bags and harvesting the fruit (Ullasa and Rawal 1986; Zhang 2005b) if the pathogens were present in the vineyard.

AQSIQ would need to ensure that registered export vineyards are free of any disease symptoms of the pests, especially *P. euvitis*, prior to the removal of bags. This may be achieved through monitoring and inspecting and applying appropriate treatments if necessary to the vineyards before removing the bags and maintaining the health status of the vineyard until the fruit is harvested. AQSIQ would develop the monitoring and inspection procedures to ensure that freedom of these pests is achieved during this period. These procedures would be documented and provided to DAFF for approval before trade commences. The results of monitoring and inspection and any treatment, along with the recorded dates of initial bagging of fruit and removal of bags, must also be made available to DAFF for auditing purposes.

The objective of all these measures (a systems approach) is to reduce the likelihood of importation for these pathogens to at least ‘very low’. The restricted risk would then be reduced to at least ‘very low’, which would achieve Australia’s ALOP.

Other potential measures for pathogens

Consistent with the principle of equivalence detailed in ISPM 11: *Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms* (FAO 2004), Biosecurity Australia will consider any alternative measure proposed by AQSIQ, providing that it achieves an equivalent level of quarantine protection. Evaluation of such measures or treatments will require a technical submission from AQSIQ that details the proposed measure or treatment and includes data from suitable treatment trials.

Management for sanitary pests

The spiders *Latrodectus mactans* (black widow spider) and *L. tredecimguttatus* (European black widow spider) are not plant pests and therefore phytosanitary measures cannot be applied against them. However, these spiders have been assessed to have an unacceptable unrestricted risk estimate and sanitary measures are therefore required to manage that risk.

Although the incidence of spiders in fruit packed in a packing house compared with fruit packed in the field may differ, visual inspection alone is not considered to be an appropriate

risk management option in view of the health risks for inspectors and the cryptic habit of individual spiders, which may conceal themselves within the bunch or in the carton itself.

If infested fruit was not detected at inspection, these spiders may enter, establish or spread in Australia and become a human and animal health issue. Identified options to manage risks associated with venomous spiders are either by sourcing fruit from pest free areas or using disinfestation treatments.

Area freedom

Area freedom is a measure that might be applied to manage the risk posed by *L. mactans* and *L. tredecimguttatus*. The requirements for establishing pest free areas or pest free places of production are set out in ISPM 4: *Establishment of pest free areas* (FAO 1996) and ISPM 10: *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 1999). China has not yet identified pest free areas for these spiders. However, the distribution and habitats of the spiders indicate that table grapes may be able to be sourced from production areas or vineyards free of these pests.

Pre-shipment fumigation with SO_2/CO_2

Treatment by pre-export fumigation with a mixture of sulphur dioxide (SO_2) and carbon dioxide (CO_2), SO_2/CO_2, is considered an appropriate treatment to reduce the risk of the spiders in fruit sourced from areas where these pests may be present. The efficacy of the SO_2/CO_2 treatment against *L. mactans* (black widow spider) is reported as 92 % under best conditions and 87–99 % depending on the packaging used (MAF Biosecurity New Zealand 2002). This treatment combination currently applies to table grapes imported into Australia from California (AQIS 2009a) for the treatment of *L. mactans*. There have been no rejections of Californian table grapes in Australia due to interceptions of live spiders following pre-shipment fumigation.

Efficacy of the treatment against all stages of *L. tredecimguttatus*, including juveniles and egg sacs, is not known (MAF Biosecurity New Zealand 2002). China would need to provide Biosecurity Australia with a technical submission on the measures or treatments that details the proposed treatment with SO_2/CO_2 or alternative fumigants or measures, and include efficacy data from suitable treatment trials.

If shown to be effective against both spiders, it is proposed that all shipments undergo commercial pre-export fumigation with SO_2/CO_2. Under the proposed fumigation arrangement, the table grapes would be treated as follows:

- Fumigation with SO_2/CO_2 would be carried out with a mixture of 1% SO_2 and 6% CO_2 for a minimum of 30 minutes delivered using forced air at a fruit pulp temperature of 16 °C or greater.
- The loading ratio should not exceed 30% of the chamber volume. Fruit is not to be fumigated if the grape pulp temperature is less than 16 ºC.

If field packing is used, all packaging material would be subjected to SO_2/CO_2 under the same conditions as the export table grapes and subjected to post fumigation security measures necessary to prevent infestation with the spiders. Otherwise, packaging material would be subject to security measures to prevent infestation with spiders from manufacture until the time of export.

The objective of this risk management measure is to reduce the survival of *L. mactans* and *L. tredecimguttatus* spiders associated with packed table grapes or packaging to a very low level.

5.1.2 Operational systems for maintenance and verification of phytosanitary status

A system of operational procedures is necessary to maintain and verify the phytosanitary status of table grapes from China. This is to ensure that the proposed risk management measures have been met and are maintained.

It is proposed that China's AQSIQ or other relevant agency such as CIQ nominated by AQSIQ, prepare a documented work plan for approval by Biosecurity Australia/AQIS that describes the phytosanitary procedures for the pests of quarantine concern for Australia and the various responsibilities of all parties involved in meeting this requirement.

Details of the operational system, or equivalent, will be determined by agreement between Biosecurity Australia and AQSIQ.

Provisions for traceability

Registration of export vineyards

The objectives of this proposed procedure are to ensure that:

- table grapes are sourced from AQSIQ-registered export vineyards producing export quality fruit, as the pest risk assessments are based on existing commercial production practices
- export vineyards from which table grapes are sourced can be identified so investigation and corrective action can be targeted rather than applying it to all contributing export vineyards in the event that live pests are regularly intercepted during pre-clearance inspection.

Registration of packing houses and treatment facilities and auditing of procedures

The objectives of this proposed procedure are to ensure that:

- table grapes are sourced only from AQSIQ-registered packing houses, processing export quality fruit, as the pest risk assessments are based on existing commercial packing activities
- reference to the packing house and the vineyard source (by name or a number code) are clearly stated on cartons destined for export of table grapes to Australia for trace back and auditing purposes.

It is proposed that AQSIQ registers the packing houses before commencement of harvest each season. The list of registered packing houses must be kept by AQSIQ and provided to AQIS prior to exports commencing, with updates provided if packing houses are added or removed from the list.

Registration of packing houses and treatment facilities in the initial export season would include an audit program conducted jointly by AQIS and AQSIQ before exports commence. After the initial approval, AQSIQ would be required to audit facilities at the beginning of each season to ensure that packing houses and treatment facilities are suitably equipped to carry out

the specified phytosanitary tasks and treatments. Records of AQSIQ audits would be made available to AQIS on request.

Packing houses will be required to identify individual vineyards with a unique identifying system and identify fruit from individual vineyards by marking cartons or pallets (i.e. one vineyard per pallet) with a unique vineyard number or identification provided by AQSIQ.

Where table grapes undergo cold disinfestation or fumigation prior to export, this process could only be undertaken in facilities that have been registered with and audited by AQSIQ for that purpose. AQSIQ would be required to register all treatment facilities before export activity commences.

Packaging and labelling

The objectives of this proposed procedure are to ensure that:

- table grapes proposed for export to Australia are not contaminated by quarantine pests or regulated articles (e.g. trash, soil and weed seeds)
- unprocessed packing material (which may vector pests not identified as being on the pathway) is not imported with table grapes
- all wood material used in packaging of the commodity complies with AQIS conditions (see AQIS publication ‘Cargo Containers: Quarantine aspects and procedures’)
- secure packaging is used if consignments are not transported in sealed containers directly to Australia
- the packaged table grapes are labelled with the vineyard registration number for the purposes of trace back to registered vineyards
- the pre-cleared status of table grapes is clearly identified.

Specific conditions for storage and movement

The objectives of this proposed procedure are to ensure that:

- product for export to Australia that has been treated and/or inspected are kept secure and segregated at all times from any fruit for domestic or other markets, untreated/non pre-cleared product, to prevent product mixing or cross-contamination
- the quarantine integrity of the commodity during storage and transport is maintained.

Freedom from trash

All table grapes for export must be free from pests of quarantine concern to Australia or regulated articles. Regulated articles are defined as any items other than the grape bunch. This may include leaf material, woody plant material, weeds, weed seeds, or any other contaminant, often referred as to as ‘trash’. Freedom from trash will be confirmed by the inspection procedures. AQSIQ/CIQ must provide details of how inspection for trash will occur before trade commences.

Pre-export phytosanitary inspection and certification

The objectives of this proposed procedure are to ensure that:

- all consignments are inspected by CIQ in accordance with official procedures for all visually detectable quarantine pests and other regulated articles (including soil, animal and plant debris) at a standard 600 unit sampling rate per lot whereby one unit is one bunch of table grapes
- an international phytosanitary certificate (IPC) is issued for each consignment upon completion of pre-export inspection and treatment to verify that the relevant measures have been undertaken offshore
- each IPC includes:
  - a description of the consignment (including vineyard number and packing house details)

  and

  - an additional declaration that '*The fruit in this consignment has been produced in the People's Republic of China in accordance with the conditions governing entry of table grapes to Australia and inspected and found free of quarantine pests*'.

Requirement for pre-clearance

The objectives of the proposed requirement for pre-clearance are to ensure that:

- the proposed quarantine measures, including vineyard control and surveillance, product identification, AQIS inspection requirements, product security and documentation are met
- all lots are inspected by AQIS and CIQ in accordance with official procedures for all visually detectable quarantine pests and other regulated articles (including soil, animal and plant debris) at a standard 600 unit sampling rate per lot whereby one unit is one bunch of table grapes
- the detection of live quarantine pests will result in the rejection of the inspection lot and remedial action may be required.

Under pre-clearance arrangements, AQIS officers would be involved in vineyard inspections for pests of quarantine concern to Australia, in the direct verification of packing house procedures, treatments and in joint fruit inspection. It would further include their involvement in auditing of other arrangements including registration procedures, existing commercial practice, traceability, and handling of export fruit in a secure manner.

The pre-clearance arrangement is to be used at least for initial trade. Subsequently, subject to a review of the trade and agreement by DAFF and AQSIQ on a region by region basis, pre-clearance of lots in China might not be undertaken in the future and in this case AQIS will conduct the quarantine inspection on arrival in Australia.

Pre-clearance and on-arrival phytosanitary inspection by AQIS

A phytosanitary inspection of lots covered by each phytosanitary certificate issued by AQSIQ will be undertaken by AQIS either in the country of origin (mandatory or voluntary) as a pre-clearance, or on arrival of the consignment in Australia, as determined by DAFF. The inspection will be conducted using the standard AQIS inspection protocol for table grapes, using optical enhancement where necessary.

Action for non-compliance

The objectives of the proposed requirements for remedial action(s) for non-compliance are to ensure that:

- any quarantine risk is addressed by remedial action, as appropriate
- non-compliance with import requirements is addressed, as appropriate.

The detection of live quarantine pests or regulated articles during an inspection will result in the failure of the inspection lots during pre-clearance inspection and the entire consignment during on arrival inspection.

Where inspection lots are found to be non-compliant with Australian requirements, remedial action must be taken. The remedial actions for consignments (subject to pre-clearance or on-arrival inspection) where quarantine pests are detected will depend on the type of pest and the mitigation measure that the risk assessment has determined for that specific pest.

Remedial actions could include:

- withdrawing the consignment from export (if quarantine pests are detected during pre-clearance inspection)
- export of the consignment (if quarantine pests are detected during on-arrival inspection)
- destruction of the consignment (if quarantine pests are detected during on-arrival inspection)

or

- treatment of the consignment and re-inspection to ensure that the pest risk has been addressed (if quarantine pests are detected during either pre-clearance or on-arrival inspection).

Separate to the corrective measures mentioned above, there may be other breach actions necessary depending on the specific pest intercepted and the risk management strategy put in place against that pest in the protocol.

If product continually fails inspection, Biosecurity Australia/AQIS reserves the right to suspend the export program and conduct an audit of the risk management systems in China. The program will recommence only after Biosecurity Australia/AQIS (in consultation with the relevant state departments if required) is satisfied that appropriate corrective action has been taken.

Verification of documents and inspection on arrival where pre-clearance is not used

The objectives of this proposed procedure are to ensure that:

- consignments that have not been inspected under pre-clearance arrangements undergo appropriate quarantine inspection on arrival in Australia.

As proposed in the section ‘Requirement for pre-clearance’, it is recommended that the pre-clearance arrangement is to be used at least for initial trade. However, it is possible that this requirement may change in the future. This section sets out the provisions that would apply to shipments that do not undergo pre-clearance.

AQIS will undertake a documentation-compliance examination for consignment verification purposes, followed by inspection, before release from quarantine.

5.2 Responsibility of competent authority

The General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ) together with China's Ministry of Agriculture, is the designated NPPO under the International Plant Protection Convention (IPPC).

The NPPO's responsibilities include:

- inspecting plants and plant products moving in international trade
- issuing certificates relating to phytosanitary condition and origin of consignments of plants and plant products
- ensuring that all relevant agencies participating in this program meet the proposed service and certification standards and proposed work plan procedures
- ensuring that administrative processes are established to meet the requirements of the program.

5.2.1 Use of accredited personnel

Operational components and the development of risk management procedures may be delegated by AQSIQ to an accredited agent under an agency arrangement as appropriate. This delegation must be approved by AQIS and will be subject to the requirements of the pre-clearance system. AQSIQ is responsible for auditing all delegated risk management procedures.

Vineyard inspections must be undertaken by AQSIQ or persons accredited by AQSIQ. Accredited persons must be assessed and audited as being competent in the recognition of disease symptoms of concern in the field. Accredited persons may include AQSIQ officers, CIQ officers, agency staff, entomologists, plant pathologists, commercial crop monitors/scouts, or other accredited persons. The accrediting authority must provide AQSIQ with the documented criteria upon which accreditation is based and this must be available for audit by AQSIQ and AQIS. AQIS will audit these systems before commencement of trade.

5.3 Review of processes

5.3.1 Audit of protocol

The objectives of the proposed requirement for audit and verification are to ensure that:

- an effective approved documented system is in operation for the vineyard, the packing house and during transport.

The phytosanitary system for table grape export production, certification of export vineyards, pre-export inspection and certification is subject to audit by AQIS. Audits may be conducted at the discretion of AQIS during the entire production cycle and as a component of any pre-clearance arrangement.

AQIS vineyard audits will measure compliance with vineyard registration and identification, pest/disease management including maintenance of vineyard control and crop monitoring, records, the administration and verification of area freedom status of the export areas for Oriental fruit fly, grape cluster black rot, black rot and spike stalk brown spot, and any other relevant pests, if accepted by Australia.

AQIS packing house audits of participants involved in pre-clearance arrangements will include the verification of compliance with packing house responsibilities, traceability, labelling, segregation and product security, and the AQSIQ/CIQ certification processes.

Prior to the first season of trade, a representative from Biosecurity Australia and AQIS will visit areas in China that produce table grapes for export to Australia. They will audit the implementation of agreed import conditions and measures including registration, operational procedures and treatment facilities.

5.3.2 Review of policy

Biosecurity Australia reserves the right to review the import policy after the first year of trade or when there is reason to believe that the pest and phytosanitary status in China has changed. The pre-clearance arrangement requirement may be reviewed after initial substantial trade.

AQSIQ must inform Biosecurity Australia/AQIS immediately on detection in China of any new pests of table grapes that are of potential quarantine concern to Australia. For example, should area freedom from economically significant fruit flies be recognised for the areas exporting table grapes to Australia, AQSIQ must immediately advise Biosecurity Australia and AQIS if any economically significant fruit flies are detected in the exporting provinces.

5.4 Uncategorised pests

If an organism is detected on table grapes, either in China or on-arrival in Australia, that has not been categorised, it will require assessment by Biosecurity Australia to determine its quarantine status and if phytosanitary action is required. Assessment is also required if the detected species was categorised as not likely to be on the import pathway. If the detected species was categorised as on the pathway but assessed as having an unrestricted risk that achieves Australia's ALOP due to the rating for likelihood of importation, then it would require reassessment. The detection of any pests of quarantine concern not already identified in the analysis may result in remedial action and/or temporary suspension of trade while a review is conducted to ensure that existing measures continue to provide the appropriate level of protection for Australia.

6 Conclusion

The findings of this draft IRA report are based on a comprehensive analysis of relevant scientific literature. Biosecurity Australia considers that the risk management measures proposed in this draft IRA report will provide an appropriate level of protection against the pests identified in this risk analysis. A range of risk management measures may be suitable to manage the risks associated with table grapes from China. Biosecurity Australia will consider any other measures suggested by stakeholders that provide an equivalent level of phytosanitary protection.

Appendixes

Appendix A1 Initiation and categorisation for quarantine pests of table grapes from China[7]

Initiation (columns 1 – 3) identifies the pests of commodity that have the potential to be on table grapes produced in China using commercial production and packing procedures.

Pest categorisation (columns 4 - 7) identifies which of the pests with the potential to be on table grapes are quarantine pests for Australia and require pest risk assessment.

The steps in the initiation and categorisation processes are considered sequentially, with the assessment terminating at the first 'No' for columns 3, 5 or 6 or 'Yes' for column 4.

Details of the method used in this IRA are given in Section 2: Method for pest risk analysis.

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
DOMAIN BACTERIA						
Class Alphaproteobacteria						
Order Rhizobiales (Agrobacterium, Rhizobium)						
Rhizobium radiobacter (Beijerinck & van Delden) Young *et al.* 2001 As *Agrobacterium tumefaciens* Conn in AQSIQ (2006) [Rhizobiales: Rhizobiaceae] Crown gall	Yes (AQSIQ 2006)	No Causes crown gall disease (Bradbury 1986; Ellis 2008a).	Not assessed	Not assessed	Not assessed	No
Rhizobium vitis (Ophel & Kerr 1990) Young *et al.* 2001 [Rhizobiales: Rhizobiaceae] Crown gall of grapevine	Yes (CABI 2009)	No This bacteria is found in the soil, roots and near the base of the vine (Nicholas *et al.* 1994).	Not assessed	Not assessed	Not assessed	No
Class Gammaproteobacteria						
Order Enterobacteriaceae (Xanthomonas, Xylella)						
Pantoea agglomerans (Beijerinck 1888) Gavini *et al.* 1989 Synonym: *Erwinia herbicola* (Lohnis 1911) Dye 1964 [Enterobacteriales: Enterobacteriaceae] Bacterial grapevine blight	Yes (CABI 2009)	Yes Detected on mature grape skins (MacFarlane 1947).	Yes ACT, Qld (CABI 2009); NSW, Vic., WA (APPD 2009)	Not assessed	Not assessed	No

[7] This pest categorisation table does not represent a comprehensive list of all the pests associated with the entire plant of an imported commodity. Reference to soilborne nematodes, soilborne pathogens, wood borer pests, root pests or pathogens, and secondary pests have not been listed or have been deleted from the table, as they are not directly related to the export pathway of table grapes and would be addressed by Australia's current approach to contaminating pests.

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Order Pseudomonadales (Pseudomonas)						
Pseudomonas syringae pv. *syringae* van Hall 1902 [Pseudomonadales: Pseudomonoadaceae] Bacterial canker	Yes (CABI 2009)	Yes May cause blossom blight by infection of stalks and/or cause lesions on fruit (Bradbury 1986).	Yes NSW, Qld, Tas., Vic. (APPD 2009); WA (Shivas 1989)	Not assessed	Not assessed	No
Pseudomonas viridiflava (Burkholder 1930) Dowson 1939 [Pseudomonadales: Pseudomonoadaceae] Bacterial leaf blight of tomato	Yes (CABI 2009); Hunan on kiwifruit (Hu *et al.* 1998); Yunnan on other plants (Zhang *et al.* 1999) Recorded on grapes in New Zealand (Wilkie *et al.* 1973)	Yes Infects panicles at fruit set, causing them to turn brown and die. Then they dry out, turn black and drop off (Wilkie *et al.* 1973).	Yes Qld, Vic., WA (APPD 2009)	Not assessed	Not assessed	No
Class Mollicutes						
Order Acholeplasmatales						
Candidatus Phytoplasma vitis [Acholeplasmatales: Acholeplasmataceae] Grapevine flavescence doree	Yes (AQSIQ 2006)	Yes Infects phloem of grapevines (CABI-EPPO 1997b). Infection of fruit results in berry shrivelling (CABI 2009). The phytoplasma occurs in stems and fruit (Matus *et al.* 2008).	No records	No Only known insect vector is *Scaphoideus titanus*, a leafhopper that occurs in Europe (Bianco *et al.* 2001). Grafts transmit this phytoplasma. Not seed transmissible (CABI 2009). Only spread internationally by infected propagation material and active or passive spread of the vector (Steffek *et al.* 2007). No records of *S. titanus* in China or Australia.	Not assessed	No
Class Oomycetes						
Order Peronosporales						
Plasmopara viticola (Berk. & M. A. Curtis) Berl. & De Toni [Peronosporales: Peronosporaceae] Grapevine downy mildew	Yes (AQSIQ 2006) Gansu, Shaanxi, (Zhuang 2005)	Yes Infects pedicels, which kills berries. Mature fruit is resistant to infection (Magarey *et al.* 1994).	Yes ACT, NSW, NT, Qld, SA, Tas., Vic., WA, (APPD 2009)	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
DOMAIN EUKARYA						
ANIMALIA (Animal Kingdom)						
Arthropoda						
Class: Arachnida						
Order Trombidiformes						
Acarus telarius (Linnaeus 1758) As *Tetranychus telarius* (Linnaeus) in Zhang (2005b) [Trombidiformes: Tetranychidae] Two-spotted spider mite	Yes (Zhang 2005b)	No *Acarus telarius* feeds only on leaves (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No
Brevipalpus lewisi McGregor, 1949 [Trombidiformes: Tenuipalpidae] Citrus flat mite, grape bunch mite	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	Yes *Brevipalpus lewisi* feeds on leaves and fruits (Zhang 2005b).	Yes NSW, Vic, SA, WA (Poole 2008; APPD 2009)	Not assessed	Not assessed	No
Colomerus vitis (Pagenstecher, 1857) strain a [Trombidiformes: Eriophyidae] Grape erineum mite, grapeleaf blister mite, grape erinose mite	Yes (Li 2004; CEIA-CAES 2005; Zhang 2005b; AQSIQ 2006)	No *Colomerus vitis* strain a forms galls on upper surfaces of leaves (University of California 1992).	Not assessed	Not assessed	Not assessed	No
Colomerus vitis (Pagenstecher, 1857) strain b [Trombidiformes: Eriophyidae] Grape bud mite	Yes (Li 2004; CEIA-CAES 2005; Zhang 2005b; AQSIQ 2006)	No *Colomerus vitis* strain b attacks buds only, it does not form galls (University of California 1992).	Not assessed	Not assessed	Not assessed	No
Oligonychus punicae (Hirst, 1926) [Trombidiformes: Tetranychidae] Ash flower gall mite, avocado brown mite	Yes (Kuang 1983)	No *Oligonychus punicae* feeds on leaves (Vasquez *et al.* 2008).	Not assessed	Not assessed	Not assessed	No
Polyphagotarsonemus latus (Banks, 1904) [Trombidiformes: Tarsonemidae] Broad mite, potato broad mite	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No *Polyphagotarsonemus latus* feeds on leaves (Li 2004; Zhang 2005b; AQSIQ 2006).	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Tetranychus kanzawai Kishida, 1927 Synonym: *Tetranychus hydrangeae* [Trombidiformes: Tetranychidae] Kanzawa spider mite	Yes (Migeon and Dorkeld 2007; Takafuji and Hinomoto 2008)	Yes *Tetranychus kanzawai* mites and webbing are often found on the under surfaces of the leaves, but can occasionally attack and breed on grape berries (Ho and Chen 1994; Ashihara 1996; CABI 2009).	Yes Queensland, NSW (Navajas *et al.* 2001; CSIRO and DAFF 2004c) Absent from WA (Poole 2008)	Yes *Tetranychus kanzawai* has been introduced to, and has established in Queensland. Some areas where it is currently established are likely to have a similar climate to other parts of Australia.	Yes *Tetranychus kanzawai* is a significant polyphagous pest subject to quarantine measures in many parts of the world (Navajas *et al.* 2001).	Yes WA
Class: Insecta						
Order Coleoptera						
Acrothinium gaschkevitschii (Motschulsky, 1860) [Coleoptera: Chrysomelidae] Shining leaf beetle	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No This species feeds on buds, leaves and flowers of grapevines (Zhang 2005b; AQSIQ 2006).	Not assessed	Not assessed	Not assessed	No
Adoretus sinicus Burmeister, 1855 As *Adoretus tenuimaculatus* Waterh [sic] in AQSIQ (2006) [Coleoptera: Scarabaeidae] Chinese rose beetle, flower beetle, brown chestnut chafer	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No Larvae feed on roots of grapevines and adults feed on leaves, buds, young shoots, flowers and fruit of grapevines (Zhang 2005b; AQSIQ 2006). Adults feed only at night and shelter under leaf litter or loose bark away from their hosts during the day. They are not likely to be associated with the host at time of harvest.	Not assessed	Not assessed	Not assessed	No
Anomala corpulenta Motschulsky, 1854 [Coleoptera: Scarabaeidae] Copper green chafer	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No Larvae feed on roots and adults feed on leaves, buds, young shoots, flowers and fruit (Zhang 2005b). This species is likely to be removed from the pathway during harvesting as adults fly off fruit once disturbed. Post-harvest processing of fruit is also likely to see remaining individuals removed from the pathway.	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Anoplophora glabripennis Motschulsky, 1853 [Coleoptera: Cerambycidae] Asian long-horned beetle	Yes (Shang *et al.* 2000)	No *Anoplophora glabripennis* damages grapes and other woody plants as a wood-boring larva (Lingafelter and Hoebeke 2002). Adults also do some maturation feeding on the leaves, stems and bark of many woody plant species. They are large beetles likely to be disturbed during harvest (CABI-EPPO 1999). *Anoplophora glabripennis* is unlikely to enter the pathway at any stage of development.	Not assessed	Not assessed	Not assessed	No
Anoplistes halodendri Kozlovi (Semenov & Znojdo 1934) [Coleoptera: Cerambycidae] Red-lined Asian long-horned beetle	Yes South Guizhou (Luo *et al.* 2005)	No *Anoplistes halodendri* has wood-boring larvae in grapes (Luo *et al.* 2005). This species is unlikely to be on the pathway.	Not assessed	Not assessed	Not assessed	No
Aulacophora femoralis chinensis Weise, 1923 As *Aulacophora femoralia chinensis* in Li (2004) [Coleoptera: Chrysomelidae] Cucurbit leaf beetle, orange brown galerucid	Yes (Li 2004)	No Adults feed on the leaves of grapes, pears, apples and leaf vegetables while the larvae live in the soil and feed on young plant roots (Li 2004).	Not assessed	Not assessed	Not assessed	No
Bromius obscurus (Linnaeus, 1758) [Coleoptera: Chrysomelidae] Western grape rootworm, leaf beetle	Yes (Zhang 2005b; AQSIQ 2006)	No Feeds on leaves, shoots and young fruit of grapevines (Zhang 2005b; AQSIQ 2006). It is unlikely to be feeding on grapes at harvest time.	Not assessed	Not assessed	Not assessed	No
Byctiscus lacunipennis (Jekel, 1860) [Coleoptera: Rhynchitidae] Grape leaf roller weevil	Yes (Zhang 2005b; AQSIQ 2006)	No This species eats leaves of grapevines (Zhang 2005b; AQSIQ 2006).	Not assessed	Not assessed	Not assessed	No
Ceresium sinicum ornaticolle Pic, 1907 [Coleoptera: Cerambycidae] Longhorn beetle	Yes South Guizhou (Luo *et al.* 2005)	No Larvae of this species attack woody parts of grapevines as internal feeders (Luo *et al.* 2005).	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Chlorophorus quatuordecimmaculatus (Chevrolat, 1863) As *Chloriophorus quatuodecimmaculata* (Chevrolat, 1863) in Luo *et al.* (2005) [Coleoptera: Cerambycidae] Fourteen spot tiger long-horned beetle	Yes (Li 2004; Luo *et al.* 2005; Zhang 2005b)	No Larvae bore through larger stems of grapevines while adults eat the flowers (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No
Coccinella transversalis Fabricius, 1781 [Coleoptera: Coccinellidae] Transverse ladybird	Yes (Ades and Kendrick 2004; CABI 2009)	No Adults and larvae eat soft-bodied insects, such as aphids (OzAnimals 2009b).	Yes (ABRS 2009)	Not assessed	Not assessed	No
Dryocoetiops coffeae (Eggers, 1923) [Coleoptera: Curculionidae: Scolytinae] Bark beetle	Yes (Luo *et al.* 2005)	No Scolytine beetles are associated with woody plant products (Luo *et al.* 2005). They are unlikely to be on the pathway.	Not assessed	Not assessed	Not assessed	No
Egiona viticola Luo [Coleoptera: Curculionidae] Big eyed weevil	Yes South Guizhou (Luo *et al.* 2005)	No Wood-boring pest of grapevines (Luo *et al.* 2005).	Not assessed	Not assessed	Not assessed	No
Gametis jucunda (Faldermann, 1835) As *Oxycetonia jucunda* Faldermann, 1835 in Zhang (2005b) [Coleoptera: Scarabaeidae: Cetoniinae] Citrus flower chafer, smaller green flower chafer	Yes (Zhang 2005b)	No Larvae feed on roots while adults feed on grape flowers (Zhang 2005b). It is unlikely to be present at harvest time.	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Harmonia axyridis (Pallas, 1773) [Coleoptera: Coccinellidae] Harlequin ladybird	Yes (Koch 2003; Li *et al.* 2008; CABI 2009)	Yes Adults of *H. axyridis* can attack ripe fruit and can form clusters of thousands of individuals. They can be difficult to remove from grape bunches. Larvae feed on aphids and may range anywhere on the grape plants, including onto fruits (Kovach 2004; Galvan *et al.* 2006).	No records found	Yes *Harmonia axyridis* was accidentally introduced to the USA, Canada, Mexico, UK and many countries in western Europe. In the UK it spread at a rate of 58-114 kilometers per year. Many of these areas have a similar climate to Australia (de Almeida and da Silva 2002; Koch *et al.* 2006; Brown *et al.* 2008a).	Yes *Harmonia axyridis* has caused significant financial losses to vineyards in the USA, as the beetle taints wine produced from contaminated grapes, reducing its value (Koch *et al.* 2006). It has also invaded houses, where it stains furniture and can induce severe allergic reactions in humans, incurring cleanup and medical costs to society (Kovach 2004; Potter *et al.* 2005; Galvan *et al.* 2006; Roy and Roy 2008; Goetz 2009; EPPO 2009).	Yes
Hayashiclytus acutivittis (Kraatz, 1879) Synonym: *Rhaphuma acutivittis* Kraatz, 1879 [Coleoptera: Cerambycidae]	Yes (Zhang 2005b)	No Zhang (2005b) lists this species as a pest of grapevine. It is unlikely that any life history stage will be present on the pathway, as Cerambycid larvae generally feed internally on woody plant material, while adults feed at flowers or on foliages (CSIRO 1991).	Not assessed	Not assessed	Not assessed	No
Holotrichia diomphalia (Bates, 1888) [Coleoptera: Scarabaeidae] Northeastern larger black chafer, Korean black chafer	Yes (Zhang 2005b)	No Larvae eat roots while adults feed on shoots, young leaves and flowers (AQSIQ 2007).	Not assessed	Not assessed	Not assessed	No
Holotrichia oblita (Faldermann, 1835) [Coleoptera: Scarabaeidae] North China larger black chafer	Yes (Zhang 2005b; AQSIQ 2006)	No Recorded eating grapevine leaves (AQSIQ 2006).	Not assessed	Not assessed	Not assessed	No
Hypothenemus javanus (Eggers, 1908) As *Hypithenemus javanus* in Luo *et al.* (2005) [Coleoptera: Curculionidae: Scolytinae] Bark beetle	Yes South Guizhou (Luo *et al.* 2005)	No Scolytine beetles are associated with woody plant products (Luo *et al.* 2005). They are unlikely to be on the pathway.	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Hypothenemus erectus Leconte, 1876 [Coleoptera: Curculionidae: Scolytinae] Bark beetle	Yes South Guizhou (Luo *et al.* 2005)	No Scolytine beetles are associated with woody plant products (Luo *et al.* 2005). They are unlikely to be on the pathway.	Not assessed	Not assessed	Not assessed	No
Hypothenemus eruditus Westwood, 1836 [Coleoptera: Curculionidae: Scolytinae] Bark beetle	Yes South Guizhou (Luo *et al.* 2005).	No Scolytine beetles are associated with woody plant products (Luo *et al.* 2005). They are unlikely to be on the pathway.	Not assessed	Not assessed	Not assessed	No
Maladera orientalis (Motschulsky, 1857) As *Serica orientalis* Motschulsky, 1857 in Zhang (2005b) [Coleoptera: Scarabaeidae] Smaller velvety chafer	Yes (Li 2004; Zhang 2005b)	No Larvae feed on the roots of grapevines while adults feed on the young shoots, leaves, and flowers of grapes (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No
Merhynchites sp. [Coleoptera: Rhynchitidae] Grape berry weevil	Yes (Li 2004; Zhang 2005b; AQSIQ 2006; AQSIQ 2009b)	Yes Adults and larvae damage the fruit and seeds of grape (*Vitis vinifera*) (AQSIQ 2006; AQSIQ 2009b) and Amur grapes (*Vitis amurensis*) (Li 2004; AQSIQ 2009b) . Adults feed on the skin and pulp of grapes and lay their eggs in grape seeds, which are then eaten by the larvae (Li 2004; Zhang 2005b; AQSIQ 2006; AQSIQ 2009b).	No record found (Zimmerman 1994)	Yes The only known hosts of this yet unnamed species are grapes (*Vitis* spp.) (Li 2004; AQSIQ 2006; AQSIQ 2009b). This host is widely but sporadically distributed throughout Australia as a horticultural crop and amenity plantings.	Yes Adults and larvae feed directly on the grape berries, eating both the flesh (adults) and seeds (larvae). The feeding activities of *Merhynchites* sp. render grapes unfit for human consumption and unmarketable (AQSIQ 2009b).	Yes
Oides decempunctata (Bilberg, 1808) [Coleoptera: Chrysomelidae] Grape leaf beetle	Yes (Li 2004; CEIA-CAES 2005; Zhang 2005b; AQSIQ 2006)	No This species is recorded feeding on grapevine leaves in China (Zhang 2005b; AQSIQ 2006).	Not assessed	Not assessed	Not assessed	No
Oides tarsata (Baly, 1881) [Coleoptera: Chrysomelidae] Grape yellow leaf beetle	Yes (AQSIQ 2006)	No This species is recorded feeding on grapevine leaves (AQSIQ 2006).	Not assessed	Not assessed	Not assessed	No
Phymatodes albicinctus Bates, 1873 [Coleoptera: Cerambycidae] Whitebanded longicorn beetle	Yes South Guizhou (Luo *et al.* 2005)	No Larvae of this species feed internally on woody parts of the grapevine (Luo *et al.* 2005).	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Phymatodes mediofasciatus Pic, 1933 [Coleoptera: Cerambycidae] Longicorn beetle	Yes South Guizhou (Luo *et al.* 2005)	No Larvae of *P. mediofasciatus* are internal feeders that attack vine stems 4-8 mm thick. The adults, although closely associated with grapevines do not feed and fly between May-July annually (Cherepanov 1991). No stage of this species' life history is likely to be present on this pathway.	Not assessed	Not assessed	Not assessed	No
Popillia japonica Newman, 1838 [Coleoptera: Scarabaeidae] Japanese beetle	Yes Northern China (EPPO 2006a)	Yes *Popillia japonica* is recorded to feed on the foliage, flowers and fruit of grapes (Pfeiffer and Schultz 1986a).	No verified records found. The APPD records of *P. japonica* from NSW represent quarantine interceptions.	Yes *Popillia japonica* has been accidentally introduced into the USA where it is now widespread. The ability of *P. japonica* larvae to feed on grass roots while the adults feed on foliage, flowers and fruit makes it ideally suited to exploiting Australian urban and agricultural areas, especially home gardens with lawns.	Yes *Popillia japonica* inflicts millions of dollars damage through lost production and control costs to the USA each year. Agricultural crops damaged by *P. japonica* include apples (*Malus* spp.), stonefruits (*Prunus* spp.), berries (*Rubus* spp.) and grapes (*Vitis* spp.). Home gardens and lawns are also badly affected by adults and larvae, respectively.	Yes
Popillia mutans Newman, 1838 Synonym: *Mimadoretus mutans* (Newman, 1838) [Coleoptera: Scarabaeidae] Scarab beetle	Yes (Li 2004)	Yes Adults feed on flowers, leaves and occasionally on fruit, while larvae feed on roots (Tan *et al.* 1998). Not reported to cause damage to grapes (AQSIQ 2006).	No records found	Yes The overall biology of *Popillia* beetles is similar. Adults attack foliage, flowers and fruit, while larvae feed on roots of grasses. This combination of features has allowed the closely allied *P. japonica* to become established and widespread through large areas of North America.	Yes The overall biology of *Popillia* species makes them well suited to cause damage in gardens and agricultural areas. Although of little significance in its native habitat, the closely allied *P. japonica* has become a serious pest in North America, where it causes millions of dollars worth of damage annually.	Yes

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Popillia quadriguttata (Fabricius, 1787) [Coleoptera: Scarabaeidae] Chinese rose beetle	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	Yes Larvae feed on roots of grapevines while adults feed on leaves, flowers and fruit of grapes (Zhang 2005b; AQSIQ 2006).	No records found	Yes The overall biology of *Popillia* beetles is similar. Adults attack foliage, flowers and fruits, while larvae feed on roots of grasses. This combination of features has allowed the closely allied *P. japonica* to become established and widespread through large areas of North America.	Yes The overall biology of *Popillia* species makes them well suited to causing damage in gardens and agricultural areas. Although of little significance in its native habitat, the closely allied *P. japonica* has become a serious pest in North America, where it causes millions of dollars worth of damage annually.	Yes
Protaetia brevitarsis Lewis, 1879 As *Potosia brevitarsis* (Lewis, 1879) in AQSIQ (2006). [Coleoptera: Scarabaeidae] Flower beetle	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No Larvae feed on roots of grapevines while adults feed on leaves (AQSIQ 2006), buds, leaves, flowers and fruit of grapes (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No
Proagopertha lucidula (Faldermann, 1835) [Coleoptera: Scarabaeidae] Lucidula chafer, apple fairy chafer	Yes (Li 2004; Zhang 2005b)	No Larvae feed on the roots of grapevines while adults feed on the buds, leaves, flowers or fruit of grapes (Zhang 2005b; AQSIQ 2007). Adults fly off fruit, once disturbed, so this species is likely to be removed from the pathway during harvesting and processing of fruit.	Not assessed	Not assessed	Not assessed	No
Scelodonta lewisii Baly, 1874 As *Scelod ontaewisii* Baly in AQSIQ (2006) [Coleoptera: Chrysomelidae]	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No This species is recorded eating leaves of grapevines (AQSIQ 2006). Larvae live in the soil where they feed on the young roots of grapevines causing very minor damage (Li 2004).	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Sinoxylon sp. [Coleoptera: Bostrichidae] Auger beetles	Yes (Zhang 2005b; AQSIQ 2006)	No Adults and larvae bore into the roots, stems and branches of grapevines (Zhang 2005b; AQSIQ 2006). Bostrichid beetles are wood-boring specialists unlikely to be associated with grape berries (Lawrence and Britton 1994).	Not assessed	Not assessed	Not assessed	No
Sinoxylon viticonus L. Hang [Coleoptera: Bostrichidae] Grape bostrichid	Yes A serious pest of grapevines in the southern part of Guizhou province, China (Luo *et al.* 2005).	No Bostrichid beetles are wood-boring specialists unlikely to be associated with grape berries (Lawrence and Britton 1994).	Not assessed	Not assessed	Not assessed	No
Stenygrinum quadrinotatum Bates, 1873 As *Srenygrinum quadrinotatum* in Luo *et al.* (2005) [Coleoptera: Cerambycidae] Longhorn beetle	Yes South Guizhou (Luo *et al.* 2005)	No *Stenygrinum quadrinotatum* larvae attack woody parts of grape plants as an internal borer (Luo *et al.* 2005).	Not assessed	Not assessed	Not assessed	No
Xyleborus cristatulus Schedl, 1953 As *Xytleborus criststus* Schedl in Luo *et al.* (2005) [Coleoptera: Curculionidae: Scolytinae] Woodborer	Yes South Guizhou (Luo *et al.* 2005)	No Scolytine beetles are associated with woody plant products (Luo *et al.* 2005). They are unlikely to be on the pathway.	Not assessed	Not assessed	Not assessed	No
Xylotrechus pyrrhoderus Bates, 1873 [Coleoptera: Cerambycidae] Grape borer, grape tiger longicorn	Yes (Zhang 2005b; AQSIQ 2006)	No Larvae bore into the roots, stems (AQSIQ 2006) and branches of grapevines (Zhang 2005b). Eggs are laid in cracks in bark on stem (Public Health 2006).	Not assessed	Not assessed	Not assessed	No
Xylotrechus robusticollis (Pic, 1936) [Coleoptera: Cerambycidae] Longicorn beetle	Yes South Guizhou (Luo *et al.* 2005)	No Larvae of this species attack woody parts of grapevines as internal feeders (Luo *et al.* 2005).	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Order Diptera						
Bactrocera dorsalis (Hendel, 1912) [Diptera: Tephritidae] Oriental fruit fly	Yes Taiwan (Hsu and Feng 2006), southern China (Podleckis 2003)	Yes (Chu and Tung 1996)	No (Drew and Hancock 1994)	Yes *Bactrocera dorsalis* has significant potential to become established and spread through areas of Australia. This is best evidenced by an incursion of the closely allied papaya fruit fly (*B. papayae* Drew and Hancock, 1994) in north Queensland during the mid-1990s.	Yes *Bactrocera dorsalis* can utilise more than 150 fruit species (Waite 2009). It is considered one of the five most important pests of agriculture in South East Asia (Waterhouse 1993). Females oviposit into the fruit of hosts, eggs hatch inside the fruit and the larvae consume the fruit pulp (CABI 2009).	Yes
Cecidomyia sp. [Diptera: Cecidomyiidae] Grape midge	Yes (Li 2004; Zhang 2005b; AQSIQ 2006; AQSIQ 2009b)	Yes Larvae are internal feeders on grape berries (Li 2004; Zhang 2005b; AQSIQ 2007; AQSIQ 2009b).	No record found Species of this genus occur in Australia (Bugledich 1999).	Yes The known host range of *Cecidomyia* sp. is restricted to *Vitis vinifera* (Li 2004). Although *Cecidomyia* sp. has limited dispersal range and one or two generations per year, other Cecidomyiid midges have successfully spread through agricultural systems elsewhere, notably apple leaf curling midge (*Dasineura mali* Kiefer, 1904) (Biosecurity Australia 2006c).	Yes Larvae of *Cecidomyia* sp. are internal feeders of grape berries, filling them with frass and causing them to enlarge. Affected berries are inedible and unmarketable (Li 2004).	Yes
Drosophila suzukii (Matsumura) Kamizawa, 1931 [Diptera: Drosophilidae] Spotted wing drosophila (SWD), cherry drosophila, cherry fruit fly, cherry vinegar fly (CVF)	Biosecurity Australia is currently conducting a pest-initiated pest risk analysis for *Drosophila suzukii*					

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Order Hemiptera						
Aleurolobus taeonabe (Kuwana, 1911) As *Aleyrodes taonaboe* Kuwana, 1911 in Li (2004) [Hemiptera: Aleyrodidae] Whitefly	Yes (Li 2004)	Yes Adults and nymphs suck plant juice from the leaves and grape berries, reducing yield and quality, often damaging mature grapes (Li 2004).	No (Martin and Gillespie 2001)	Yes Several of Australia's major whitefly pests including the glasshouse whitefly (*Trialeurodes vaporianum*) are introduced species native to the palaearctic region.	Yes *Aleurolobus taeonabe* feeds on leaves and fruits, reducing crop yield and quality. When populations are high, honeydew produced by their feeding activities may promote the growth of sooty moulds, which reduce fruit maketability (Pfeiffer and Schultz 1986b; Blodgett 1992).	Yes
Apolygus lucorum (Meyer-Dür, 1843) As *Lygus lucorum* Meyer Dŭr in AQSIQ (2006) [Hemiptera: Miridae] Small green plant bug, green leaf bug	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No Adults and nymphs suck sap from leaves, flowers and young shoots of grapevines (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No
Arboridia apicalis (Nawa, 1913) Synonym: *Zygina apicalis* Nawa, 1913; *Erythroneura apicalis* Nawa, 1913 (also refer to *Erythroneura* sp.) [Hemiptera: Cicadellidae] Grape leafhopper	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No This species attacks grape, peach, apple, pear and cherry. Adults and nymphs suck sap from the underside of leaves (Li 2004).	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Daktulosphaira vitifoliae (Fitch, 1855) As *Viteus vitifolii* (Fitch, 1855) in AQSIQ (2006); As *Phylloxera vitifolli* (Fitch) in Li (2004) [Hemiptera: Phylloxeridae] Grapevine phylloxera	Yes (AQSIQ 2006) Liaoning, Shaanxi and Shandong (Li 2004; Zhang 2005b; AQSIQ 2009b)	Yes *Daktulosphaira vitifoliae* is a serious but localised pest of grapevines in China. It feeds directly on and damages the roots and undersides of grape leaves (Li 2004). It may be present as a contaminant of grape bunches.	Yes Under official control in Victoria (APPD 2009) and NSW (Botha *et al.* 2000). Not present in WA (Poole 2008).	Yes *Daktulosphaira vitifoliae* is already established in small areas of Australia, where it is under official control (NVHSC 2005). In Australia, several generations per year develop in each growing season (NVHSC 2008). Phylloxera can be spread by human activities, notably movement of grapevine nursery stock and related products including soil associated with infested roots (e.g. carried on footwear or vehicle tyres). Harvesting machinery, other equipment and tools are also implicated with their spread (NVHSC 2005).	Yes *Daktulosphaira vitifoliae* only causes direct harm to grapevines (*Vitis* spp.). The only reliable control measure for *D. vitifoliae* is the complete removal of infested vines and their replacement with grapevines grown on resistant rootstock. This measure has a devastating effect on grape production albeit temporary.	Yes
Dolycoris baccarum (Linnaeus, 1758) [Hemiptera: Pentatomidae] Berry bug, sloe shield bug	Yes (Li 2004; Zhang 2005b)	No Nymphs and adults suck sap from young buds, leaves, young shoots and fruit of grapevines (Zhang 2005b). However, they are not likely to be carried by fruit (AQSIQ 2007) because Pentatomid bugs characteristically drop from their hosts when disturbed, or fly off (Alcock 1971). Harvest and existing processing measures will likely remove most pentatomid bugs from the pathway.	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Empoasca fabae (Harris, 1841) Synonym: *Empoasca mali* (Baron, 1853) [Hemiptera: Cicadellidae] Potato leafhopper	Yes Recorded as a pest of grapevines in USA and Canada (Bostanian *et al.* 2003; Integrated Pest Management Center 2007; Lenz *et al.* 2009; Isaacs and van Timmeren 2009).	No *Empoasca fabae* can cause significant injury to vineyards, causing leaf cupping, reduced shoot growth, and leaf yellowing (Isaacs 2007; Integrated Pest Management Center 2007; Isaacs and van Timmeren 2009). This pest is not likely to be carried by fruit (AQSIQ 2007) because Ciciadellid or leafhoppers characteristically drop from their hosts when disturbed, or fly off. Adults are very active, jumping or flying when disturbed. The immature forms, or nymphs run forward, backward or sideways when disturbed (Isaacs 2007).	No record found	Not assessed	Not assessed	No
Erthesina fullo (Thunberg, 1783) As *Erthesina full* in Zhang (2005b) and as *Erythesina full* in AQIS (1998b) and BA (2005d) [Hemiptera: Pentatomidae] Yellow-spotted stink bug, Hong Kong shield bug	Yes (Li 2004; Zhang 2005b)	No Adults suck sap from stem, leaves and fruit of grapevines (Zhang 2005b). However, they are not likely to be carried by fruit (AQSIQ 2007) because Pentatomid bugs characteristically drop from their hosts when disturbed, or fly off (Alcock 1971). Harvest and existing processing measures will likely remove most pentatomid bugs from the pathway.	Not assessed	Not assessed	Not assessed	No
Erythroneura sp. Including *Erythroneura apicalis* (Nawa, 1913) listed by Li (Li 2001) [Hemiptera: Cicadellidae] Leafhopper	Yes (Li 2004)	No Li (2004) reports that an unidentified *Erythroneura* species sucks the plant juice from the underside of grape leaves resulting in leaf drop. Li (Li 2001) also lists *E. apicalis* as a known pest of grapes in China.	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Halyomorpha halys (Stål, 1855) [Hemiptera: Pentatomidae] Brown marmorated stink bug	Yes (Li 2004; Zhang 2005b)	No In grapes, *H. halys* adults suck sap from the fruit of grapes and the nymphs feed on leaves, stems and fruit of grapes (Zhang 2005b; AQSIQ 2007). Pentatomid bugs are not likely to be carried by fruit (AQSIQ 2007) because they characteristically drop from their hosts when disturbed, or fly off (Alcock 1971). Harvest and existing processing measures will likely remove most pentatomid bugs from the pathway.	Not assessed	Not assessed	Not assessed	No
Icerya purchasi (Maskell, 1876) [Hemiptera: Magarodidae] Cottony cushion scale, fluted scale	Yes (CABI 2009) No host information of *I. purchasi* on grapes in China.	Yes In Korea, this species is found on leaves, branches and fruit of grapevines (NPQS 2007).	Yes (ABRS 2009) Present in WA (Poole 2008).	Not assessed	Not assessed	No
Lycorma delicatula (White, 1845) [Hemiptera: Fulgoridae] Planthopper	Yes (Li 2004; CEIA-CAES 2005; Zhang 2005b; AQSIQ 2006)	No *Lycorma delicatula* damages grape, peach, apricot and pear by feeding on the branches and stems (Li 2004).	Not assessed	Not assessed	Not assessed	No
Maconellicoccus hirsutus (Green, 1908) [Hemiptera: Pseudococidae] Pink hibiscus mealybug	Yes (CABI-EPPO 2004; CABI 2009)	Yes Not recorded from fruit of grapevine (Ben-Dov 2009b). Accidental introductions to new countries are believed to occur via infested plant material including bark, flower/inflorescence, leaves, seedlings and stems (CABI 2009).	Yes ACT, Qld, SA, WA (ABRS 2009)	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Nysius ericae (Schilling, 1829) [Hemiptera: Lygaeidae] Dusky bug, grey bug, chinche gris	Yes (Zhang 2005b)	No Although AQSIQ (2007) advised that there were no reports of this pest harming grapes, Zhang (2005b) reported that adults suck sap from flowers, young fruits and leaves of grapevines. Lygaeid bugs are highly mobile and nervous insects, which are likely to drop off or fly off plants when disturbed. This species is likely to be removed from the pathway during harvesting and existing processing activities.	Not assessed	Not assessed	Not assessed	No
Parthenolecanium corni (Bouché, 1844) [Hemiptera: Coccidae] Plum scale, peach scale, European fruit lecanium scale	Yes (Zhang 2005b; AQSIQ 2006)	Yes This species sucks sap from branches, leaves and fruit of grapevines (Zhang 2005b).	Yes Tas. (APPD 2009), NSW and Vic. (Snare 2006). Absent in WA (Poole 2008).	Yes This pest is widely distributed in temperate and subtropical regions (Ben-Dov 2007).	Yes This pest is highly polyphagous, attacking some 350 plant species placed in 40 families (Ben-Dov 2006a).	Yes (WA)
Parthenolecanium orientalis Borchsenius, 1957 Synonym: *Parthenolecanium corni orientalis* (Ben-Dov 2006a) [Hemiptera: Coccidae] Scale insect	Yes (Li 2004)	Yes Adults damage the leaves, stems and fruit of grape (Li 2004).	No (Ben-Dov 2006a)	Yes *Parthenolecanium orientalis* reproduces parthenogenically (female only), allowing it to quickly exploit new resources. Its wide host range ability to tolerate a range of climatic conditions indicates it is likely to establish and spread through new areas.	Yes This species is polyphagous and known to cause economic damage to many agricultural and amenity plants including currants (*Ribes* sp.); Wisteria (*Wisteria chinensis*); stonefruit (*Prunus* sp.) and willow (*Salix* sp.) (Ben-Dov 2006b); and grape (*Vitis vinifera*) (Li 2004).	Yes
Pinnaspis strachani (Cooley, 1899) [Hemiptera: Coccidae] Hibiscus snow scale	Yes (Watson 2006; CABI 2009)	Yes *Pinnaspis strachani* is a sedentary insect found on both upper and lower leaf surfaces, fruits and stems of its host plants (Tenbrink *et al.* 2007; CABI 2009).	Yes (ABRS 2009) Present in WA (Poole 2008).	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Plautia stali Scott 1874 [Hemiptera: Pentatomidae] Brown-winged green bug	Yes (Liu and Zheng 1994; CABI 2009).	No No record found of *P. stali* on grapes in China. In Japan, *P. stali* eggs and nymphs are not associated with grapes but the adults feed on the fruit (Moriya 1995). Pentatomid bugs are not likely to be carried by fruit (AQSIQ 2007) because they characteristically drop from their hosts when disturbed, or fly off (Alcock 1971). Harvest and existing processing measures will likely remove most pentatomid bugs from the pathway.	Not assessed	Not assessed	Not assessed	No
Planococcus kraunhiae (Kuwana, 1902) [Hemiptera: Pseudococcidae] Japanese mealybug	Yes No host information of *P. kraunhiae* on grapes in China (Ben-Dov 2009c)	Yes In Korea, *P. kraunhiae* is found on leaves, branches and fruit of grapevines (NPQS 2007).	No (Ben-Dov 2009c)	Yes *Planococcus kraunhiae* is a polyphagous species known to feed on *Citrus*, *Diospyros kaki* (persimmon), *Magnolia grandiflora* and *Portulaca* (CABI 2009). Climatic conditions in parts of Australia may be suitable for its establishment and spread.	Yes *Planococcus kraunhiae* is a sap sucking insect that reduces productivity and quality and promotes the growth of sooty mould through production of honeydew (CABI 2009). Although the mouth parts of mealybugs rarely penetrate beyond the fruit epidermis, their feeding activities can also cause fruit spotting and distortion (CABI 2009).	Yes
Pseudococcus comstocki (Kuwana, 1902) [Hemiptera: Pseudococcidae] Comstock's mealybug	Yes (Li 2004; Zhang 2005b)	Yes This species is listed by both Li (2004) and Zhang (2005b) as a pest of table grapes in China.	No (Ben-Dov 2007)	Yes *Pseudococcus comstocki* has been recorded from a number of countries throughout the world (Ben-Dov *et al.* 2009) indicating it has potential to become established and spread through new areas.	Yes This species damages over 300 plant species including several agricultural crops (e.g. banana, peach, pears, lemon, apricot, cherry, catalpa and mulberry) in Asia and Europe (Ben-Dov *et al.* 2009). It damages the leaves and fruits of grapevines and produces honeydew on the fruit surface (Zhang 2005b).	Yes

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Pseudococcus maritimus (Ehrhorn, 1900) [Hemiptera: Pseudococcidae] Grapevine mealybug	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	Yes Early stages damage the young roots of grapevines before moving up onto the vine to damage shoots, stems and fruit (Zhang 2005b).	No verified records found. Literature records for *P. maritimus* in Australia are misidentifications of other mealybug species including *P. affinis*, *P. calceolariae* and *P. longispinus* (Williams 1985), although Williams and Granara de Willink (Williams and Granara de Willink 1992) contradicts this by stating *P. martimus* is common in Australia and the USA. However, Gimpel Jr and Miller (Gimpel Jr and Miller 1996) correctly states that there is no correct records of *P. martimus* outside the New World.	Yes The potential for *P. martimus* to become established and spread in new areas is reflected by its wide host range, which includes cultivated and ornamental plants from 44 families (Ben-Dov 2009d). Most of the listed hosts occur throughout Australia. Climatic conditions in Australia may be suitable for its establishment and spread.	Yes Mealybugs feed on sap, stressing their host plants and reducing yield of commercial crops. Production of honeydew also promotes growth of sooty moulds, which reduce the marketability of fruit (CABI 2009).	Yes
Riptortus pedestris (Fabricius, 1775) [Hemiptera: Alydidae] Bean bug, pod bug	Yes (Zhang 2005b)	No Although AQSIQ (2007) advised that there were no reports of this pest harming grapes, Zhang (2005b) reported that adults and nymphs suck the sap from young shoots and fruit of grapevines. Heteroptera are not likely to be carried by fruit (AQSIQ 2007) because they characteristically drop from their hosts when disturbed, or fly off (Alcock 1971).	Not assessed	Not assessed	Not assessed	No
Trialeurodes vaporariorum (Westwood, 1856) [Hemiptera: Aleyrodidae] Grape whitefly, greenhouse whitefly	Yes (Li 2004; Zhang 2005b)	No Recorded to feed only on leaves (Li 2004; Bi *et al.* 2007).	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Order Hymenoptera						
Ceratina dentipes Friese, 1914 As *C. drntipes* Wu in Luo *et al.* (2005) [Hymenoptera: Apidae] Carpenter bee	Yes South Guizhou (Luo *et al.* 2005)	No *Ceratina dentipes* feeds on woody parts of the grapevine as larvae (Luo *et al.* 2005).	Not assessed	Not assessed	Not assessed	No
Ceratina viticola Sinich [Hymenoptera: Apidae] Small carpenter bee	Yes South Guizhou (Luo *et al.* 2005)	No Eggs are laid on young shoots and larvae bore into stem of grapevines (Luo *et al.* 2005).	Not assessed	Not assessed	Not assessed	No
Polistes chinensis antennalis Pérez, 1905 [Hymenoptera: Vespidae] Asian paper wasp, Japanese paper wasp	Yes (Li 2004)	No Adults eat the flesh of grape, apple and pear fruits. They are often found in vineyards, as the adults also prey on insects associated with grapes (Li 2004). *Polistes* species are aggressive and wary insects capable of inflicting a painful sting to humans. They would almost certainly fly off grapes before they were picked and would likely sting if handled. It is very unlikely they would be present on the pathway.	Not assessed	Not assessed	Not assessed	No
Vespa mandarinia Smith, 1852 [Hymenoptera: Vespidae] Asian giant hornet	Yes (AQSIQ 2006)	No Adult *Vespa* species feed on nectar and sugars from fruit (Spradbery 1973). *Vespa* species are aggressive and wary insects capable of inflicting a painful sting to humans. They would almost certainly fly off grapes before they were picked and would likely sting if handled. It is very unlikely they would be present on the pathway.	Not assessed	Not assessed	Not assessed	No
Order Lepidoptera						
Acosmeryx castanea Rothschild and Jordan, 1903 [Lepidoptera: Sphingidae] Hawk moth	Yes Yunnan, Xinjiang, Jiangxi (Pittaway and Kitching 2006).	No Although recorded from *Vitis* sp. (Pittaway and Kitching 2006), Sphingids generally feed only on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Acosmeryx naga (Moore, 1858) As *Acocmeryx naga* in Zhang (2005b) [Lepidoptera: Sphingidae] Hawk moth	Yes (Zhang 2005b)	No Larvae feed on leaves of Vitaceae (*Vitis* and *Ampelopsis* spp.) (Pittaway and Kitching 2006).	Not assessed	Not assessed	Not assessed	No
Acosmeryx sericeus (Walker, 1856) [Lepidoptera: Sphingidae] Hawk moth	Yes Yunnan (Pittaway and Kitching 2006)	No Although recorded from *Vitis vinifera* (Pittaway and Kitching 2006), Sphingids generally feed only on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No
Acosmeryx shervillii Boisduval, 1875 [Lepidoptera: Sphingidae] Hawk moth	Yes (Pittaway and Kitching 2006)	No Although recorded from grapes (Pittaway and Kitching 2006), Sphingids generally feed only on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No
Actias ningpoana Felder, 1862 Synonym: *Actias selene ningpoana* (Felder, 1862) [Lepidoptera: Saturniidae] Moon moth	Yes (Zhang 2005b)	No The larvae of this species feed on leaves of grapevine (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No
Adoxophyes privatana (Walker, 1863) [Lepidoptera: Tortricidae] Leafroller moth, tortrix moth	Yes (Meijerman and Ulenberg 2009b)	No Although recorded from grapes (*Vitis* spp.) (Robinson *et al.* 2008), there are no records of it affecting commercial grapes in China despite causing widespread damage to *Citrus* crops (Meijerman and Ulenberg 2009b).	Not assessed	Not assessed	Not assessed	No
Ampelophaga khasiana Rothschild, 1895 [Lepidoptera: Sphingidae] Hawk moth	Yes (Pittaway and Kitching 2006)	No Although recorded from grapes (Pittaway and Kitching 2006). Sphingids generally feed only on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No
Ampelophaga rubiginosa Bremer & Grey, 1853 [Lepidoptera: Sphingidae] Grape hornworm	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No The larvae of this species feed on leaves of grapevine (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Amphipyra pyramidea (Linnaeus, 1758) [Lepidoptera: Noctuidae] Copper underwing	Yes (Zhang 2005b)	No AQSIQ (2007) advised that there were no reports of this pest harming grapes and USDA (APHIS 2002) and McLeod (2006) listed this pest as a leaf-feeder. Zhang (2005b) reported that larvae fed on leaves and externally on the fruit skin of grapes. This species is likely to be removed from the pathway during harvesting and processing of fruit.	Not assessed	Not assessed	Not assessed	No
Anomis mesogona (Walker, 1858) [Lepidoptera: Noctuidae] Fruit piercing moth	Yes (Hong Kong Lepidopterists' Society Limited 2004)	No *Anomis mesogona* is a fruit piercing moth, whose adults pierce and suck juice from fleshy fruits at night. They are large, wary moths who shelter in foliage away from fruit during daylight hours. They are unlikely to enter the pathway for this reason (USDA 2002).	Not assessed	Not assessed	Not assessed	No
Aporia crataegi (Linneaus, 1758) [Lepidoptera: Pieridae] Black-veined white moth	Yes (Grichanov and Ovsyannikova 2009a)	No Larvae of *A. crataegi* are recorded to feed on foliage of many fruiting plants including grapes (*Vitis* spp.) (Robinson *et al.* 2008; Grichanov and Ovsyannikova 2009a).	Not assessed	Not assessed	Not assessed	No
Artena dotata (Fabricius, 1794) [Lepidoptera: Noctuidae] Fruit-piercing moth	Yes (Li 2004)	No Adults feed on ripe grapes at night by piercing them and sucking their juices. They are not associated with grapes during daylight hours (Li 2004) and would not enter the pathway for this reason.	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Calyptra lata (Butler, 1881) As *Oraesia lata* (Butler, 1881) in AQSIQ (2006) [Lepidoptera: Noctuidae] Fruit-piercing moth, larger oraesia	Yes (AQSIQ 2006)	No *Calyptrata lata* sucks juice from ripe fruits of many plants at night including grapes. They are medium-sized moths that shelter away from fruit during the day and are easily disturbed by humans (Zaspel *et al.* 2007). It is likely they would be disturbed and fly off during harvest and would not enter the pathway.	Not assessed	Not assessed	Not assessed	No
Calyptra thalictri (Borkhusen, 1790) [Lepidoptera: Noctuidae] Fruit-piercing moth	Yes (Savela 2009) No record found of *C. thalictri* on grapes in China.	No *Calyptra thalictri* is a fruit piercing that feeds on fleshy fruit at night and shelter in foliage during the day. In Korea, ripe fruits of all types are attacked by the moths during the summer and autumn (Lee *et al.* 1970; NPQS 2007). They are medium sized and wary moths that would likely fly away during harvest.	Not assessed	Not assessed	Not assessed	No
Catocala actaea Felde,1874 [Lepidoptera: Noctuidae] White-mark hind winged noctuid	Yes (KISTI 2005) No host information of *C. actaea* on grapes in China.	No In Korea, this species is recorded to feed on grapes and leaves (NPQS 2007). No host information was found on host usage of *C. actaea* in China and it was not recorded as a pest of grapes by AQSIQ (AQSIQ 2006).	Not assessed	Not assessed	Not assessed	No
Cechenena lineosa (Walker, 1856) [Lepidoptera: Sphingidae] Hawk moth	Yes Yunnan and southern Xinjiang Uygur Autonomous Region (Pittaway and Kitching 2006)	No Sphingid moths are foliage feeders (Common 1990). It is unlikely they will be associated with fruits or enter this pathway.	Not assessed	Not assessed	Not assessed	No
Cechenena minor (Butler, 1875) [Lepidoptera: Sphingidae] Hawk moth	Yes Shaanxi, Yunnan (Pittaway and Kitching 2006)	No Sphingid moths are foliage feeders (Common 1990). It is unlikely they will be associated with fruits or enter this pathway.	Not assessed	Not assessed	Not assessed	No

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Clania variegata (Snellen, 1879) As *Cryptothelea variegata* Snellen, 1879; *Eumeta variegata* (Snellen, 1879); *Clania layardi* (Moore); *Clania sikkima* (Moore) in Zhang (2005b). [Lepidoptera: Psychidae] Paulownia bagworm, giant bagworm, large bagworm	Yes (Zhang 2005b)	No AQSIQ (2007) advised that the larvae fed on grape leaves but not on fruit, but there are records of larvae chewing on the skin of grapes Zhang (2005b). This species is likely to be removed from the pathway during harvesting and processing of fruit, as damaged fruit will be trimmed from bunches.	Not assessed	Not assessed	Not assessed	No
Cossus cossus Linneaus, 1758 [Lepidoptera: Cossidae] Goat moth	Yes (Grichanov 2009)	No Cossid moth larvae feed internally on woody parts of plants (Grichanov 2009) and are not associated with fruits. They are unlikely to enter the pathway.	Not assessed	Not assessed	Not assessed	No
Conogethes punctiferalis (Guenée, 1854) As *Dichocrocis punctiferalis* in AQSIQ (2006) [Lepidoptera: Pyralidae] Yellow peach moth	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	Yes Larvae bore into fruit and web the grapes together (Gour and Sriramulu 1992).	Yes (Nielsen *et al.* 1996; APPD 2009).	Not assessed	Not assessed	No
Dasychira feminula [Lepidoptera: Lymantriidae] Tussock moth	Yes Yunnan (Hong Kong Lepidopterists' Society Limited 2004)	No Although *D. feminula* is recorded using *Vitis* as a host (Robinson *et al.* 2008), Lymantriid moths are foliage feeders as larvae with non-feeding adults (Common 1990).	Not assessed	Not assessed	Not assessed	No
Dasychira tenebrosa Walker [Lepidoptera: Lymantriidae] Tussock moth	Yes (Matsumura 1933)	No Although *D. tenebrosa* is recorded using *Vitis* as a host (Robinson *et al.* 2008), Lymantriid moths are foliage feeders as larvae with non-feeding adults (Common 1990).	Not assessed	Not assessed	Not assessed	No
Deilephila elpenor (Linneaus, 1758) [Lepidoptera: Sphingidae] Elephant hawk moth	Yes (Pittaway and Kitching 2006).	No Although recorded from grapes (Pittaway and Kitching 2006), Sphingids generally feed only on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Diaphania indica (Saunders, 1851) Synonym: *Palipta indica* [Lepidoptera: Pyralidae] Cotton caterpillar	Yes (CABI 2009) No record found of *D. indica* on grapes in China.	Yes In Korea, this species is found on leaves and fruit of grapevines (NPQS 2007).	Yes (Nielsen *et al.* 1996)	Not assessed	Not assessed	No
Elibia dolichus (Westwood, 1847) [Lepidoptera: Sphingidae] Hawk moth	Yes Southern China (Pittaway and Kitching 2006). Although listed as occurring on Henan and Guangdong by (Pittaway and Kitching 2006), its contiguous distribution across Nepal and India indicates it is likely to occur in neighbouring Yunnan and the Xinjiang Uygur Autonomous Region.	No Although recorded from grapes (Robinson *et al.* 2008), Sphingids generally feed only on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No
Endoclyta excrescens (Butler, 1877) As *Phassus exeresens* Butler in Li (2004). [Lepidoptera: Hepialidae] Japanese swift moth	Yes (Li 2004; Zhang 2005b)	No The larvae of this species bores into the stems and branches of grapevines (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No
Eudocima fullonia (Linnaeus, 1767) As *Ophideres fullonica*; *Othreis fullonia* (Linnaeus) in AQSIQ (2006) [Lepidoptera: Noctuidae] Fruit-piercing moth, fruit sucking moth, orange piercing moth	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No Adult *Eudocima* species feed on overripe or fermenting fruit at night, but shelter elsewhere during the day (Common 1990; Reddy *et al.* 2007). They will not be associated with grapes during harvest and will not enter the pathway. Larvae of this species feed on *Erythryna* trees (Holloway *et al.* 2001).	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Eudocima tyrannus (Guenée, 1852) As *Adris tyrannus* (Guenée, 1852) in AQSIQ (2006) [Lepidoptera: Noctuidae] Noctuid moth, akebia leaf-like moth	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No Adult *Eudocima* species feed on overripe or fermenting fruit at night, but shelter elsewhere during the day (Common 1990; Reddy *et al.* 2007). They will not be associated with grapes during harvest and will not enter the pathway. Larvae of this species feed on *Erythryna* trees (Holloway *et al.* 2001).	Not assessed	Not assessed	Not assessed	No
Eupoecilia ambiguella (Hübner, 1796) [Lepidoptera: Tortricidae] Grape berry moth	Yes (CABI-EPPO 1986; CABI 2009; Frolov 2009)	Yes *Eupoecilia ambiguella* larvae bore into the grapes (Marcelin 1985). Larvae from the second generation have the greatest potential to affect crop yield (Frolov 2009).	No (Nielsen *et al.* 1996)	Yes *Eupoecillia ambiguella* larvae feed on a wide range of plants including genera present in Australia (e.g. *Cissus*). This species has a wide distribution (Frolov 2009), suggesting it is tolerant of a range of climatic conditions likely to occur in Australia.	Yes *Eupoecilia ambiguella* larvae are polyphagous. First generation larvae eat floral structures, densely covering them with a web, while second generation larvae attack the grapes themselves. These larvae gnaw round holes to enter and feed internally on berries, eating away pulp and unripe seeds before they harden. One larva is able to damage 9-12 berries (Frolov 2009).	Yes
Geina periscelidactylus Fitch, 1854 [Lepidoptera: Pterophoridae] Grape plume moth	Yes (Wu and Li 1998)	No The larva of this moth webs together newly developing leaves. It does not injure the shoot, feeding only on the leaves (Douglas and Cowles 2006).	Not assessed	Not assessed	Not assessed	No
Helicoverpa armigera (Hübner, 1805) As *Heliothis armigera* in Zhang (2005b) [Lepidoptera: Noctuidae] Corn earworm, cotton bollworm, tobacco budworm	Yes (Zhang 2005b)	Yes Larvae attack grape berries, causing cork-like deformities (de Villiers 2006).	Yes (Mathew 1987; Nielsen *et al.* 1996)	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Herpetogramma luctuosalis (Guenée, 1854). As *Sylepta luctuosalis* Guenée, 1854 in Li (2004) [Lepidoptera: Pyralidae]	Yes (Li 2004)	No The larvae feed on grape leaves by rolling the leaves into a cylinder and feeding on them from the inside. Wild and cultivated grapes are the only known hosts (Li 2004).	Not assessed	Not assessed	Not assessed	No
Hippotion celerio (Linneaus, 1758) [Lepidoptera: Sphingidae] Grapevine hawk moth	Yes (Pittaway and Kitching 2006)	Unlikely Larvae of *H. celerio* generally feed on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No
Hyphantria cunea (Drury 1770) [Lepidoptera: Arctiidae] Mulberry moth, fall webworm	Yes (Warren and Tadic 1970; CABI 2009)	No *Hyphantria cunea* larvae feed on foliage only (ISSG 2007; Grichanov and Ovsyannikova 2009b).	Not assessed	Not assessed	Not assessed	No
Ischyja manlia (Cramer, 1776) [Lepidoptera: Noctuidae] Fruit-piercing moth	Yes (Holloway 2009)	No This species is a nocturnal fruit-piercing moth for this species (PaDIL 2007), whose adults shelter in foliage during the day (Li 2004) and will not be associated with grapes at harvest.	Not assessed	Not assessed	Not assessed	No
Illiberis tenuis (Butler, 1877) As *Iuiberis tenuis* in Li (2004). [Lepidoptera: Zygaenidae] Grape leaf worm	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No Larvae feed on young shoots, flowers, leaves and occasionally on young fruit of grapevines (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No
Loepa katinka (Westwood, 1847) [Lepidoptera: Saturniidae] Golden emperor moth	Yes Hebei, Yunnan, Xinjiang (Ades and Kendrick 2001)	No Saturniid moths feed only as larvae, which are foliage specialists (Common 1990).	Not assessed	Not assessed	Not assessed	No
Mamestra brassicae (Linnaeus, 1758) [Lepidoptera: Noctuidae] Cabbage moth	Yes (CABI-EPPO 2001; CABI 2009)	No Larvae feed only on foliage of grapevines (Ovsyannikova and Grichanov 2009).	Not assessed	Not assessed	Not assessed	No
Marumba gaschkewitschii (Bremer & Grey, 1852) [Lepidoptera: Sphingidae] Peach horn worm	Yes (Zhang 2005b)	No Larvae feed only on foliage (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Mocis undata (Fabricius, 1775) [Lepidoptera: Noctuidae] Fruit-piercing moth	Yes (Li 2004)	No Adults are nocturnal fruit piercers, feeding on grapes and other fruiting plants. They will not be on the pathway at harvest (Li 2004). The larvae of this species attack the foliage of a range of plants, but do not feed on grapes (Robinson *et al.* 2008).	Not assessed	Not assessed	Not assessed	No
Nippoptilia vitis (Sasaki, 1913) As *Stenoptilia vitis* Sasaki in Li (2004) [Lepidoptera: Pterophoridae] [Grape plume moth, small grape plume moth	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	Yes Larvae of this moth feed internally on the fruit and seeds of grape, usually causing the young fruit to drop (Li 2004; Zhang 2005b; AQSIQ 2006). They may also feed on the leaves and stems of grapevines (APHIS 2004b).	No (Nielsen *et al.* 1996)	Yes Adults are winged and mobile and feed only on grapes, which are widely but sporadically distributed in Australia (BAIRC 2007).	Yes *Nippoptilia vitis* causes a significant decline in grape yield and fruit quality (BAIRC 2007).	Yes
Nokona regalis (Butler, 1878) As *Paranthrene regalis* (Butler 1878) in AQSIQ (2006) [Lepidoptera: Sesiidae] Grape clearwing moth, gunworm, vine tree borer	Yes (Li 2004; CEIA-CAES 2005; Luo *et al.* 2005; Zhang 2005b; AQSIQ 2006)	No The larvae bore into the tender shoots of grapevines after hatching. They develop, overwinter and pupate within the stem of grapevines (Wu and Huang 1986; Zhou 1991) and are not associated with fruit.	Not assessed	Not assessed	Not assessed	No
Ochyrotica concursa (Walsingham, 1891) [Lepidoptera: Pterophoridae] Plume moth	Yes (Yano 1963)	No This species feeds only as larvae, which are foliage specialists, often sheltering in folded leaves (Yano 1963; Ames *et al.* 1997).	Not assessed	Not assessed	Not assessed	No
Odites ricinella (Stainton, 1859) [Lepidoptera: Oecophoridae] Oecophorid moth	Yes (Hong Kong Lepidopterists' Society Limited 2004)	No Larvae feed on leaves of their hosts (Robinson *et al.* 2001).	Not assessed	Not assessed	Not assessed	No
Oraesia emarginata (Fabricius, 1794) [Lepidoptera: Noctuidae] Fruit-piercing moth, small oraesia	Yes (Li 2004; CEIA-CAES 2005; Luo *et al.* 2005; Zhang 2005b; AQSIQ 2006)	No This species is a nocturnal fruit-piercing moth. As with other fruit-piercing Noctuid moths, adults shelter in foliage during the day (Li 2004) and will not be associated with grapes at harvest.	Not assessed	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Oraesia excavata (Butler, 1878) [Lepidoptera: Noctuidae] Fruit-piercing moth, reddish oraesia	Yes (Li 2004; CEIA-CAES 2005; Luo *et al.* 2005; Zhang 2005b; AQSIQ 2006)	No This species is a nocturnal fruit-piercing moth. As with other fruit-piercing Noctuid moths, adults shelter in foliage during the day (Li 2004) and will not be associated with grapes at harvest.	Not assessed	Not assessed	Not assessed	No
Orgyia postica [Lepidoptera: Lymantriidae] Cocoa tussock moth	Yes Yunnan (CABI 2009)	No Larvae preferentially feed on fruits, including grapes. At harvest, this species will occur as eggs associated with the spent cocoons of the wingless female moths. They are unlikely to enter the pathway because they occur only on leaves and stems, and would not be harvested (Sanchez and Laigo 1968; Gupta and Singh 1986).	Not assessed	Not assessed	Not assessed	No
Pergesa acteus (Cramer, 1779) [Lepidoptera: Sphingidae] Hawk moth	Yes Shaanxi, Yunnan, Xinjiang (Pittaway and Kitching 2006)	No. Although recorded from grapevines (Pittaway and Kitching 2006), Sphingids generally feed only on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No
Peridroma saucia (Hübner, 1808) [Lepidoptera: Arctiidae] Variegated cutworm, pearly underwing moth	Yes (Kuang 1985; CABI 2009)	No *Peridroma saucia* larvae feed on buds on grapevines (UCANR 2008a; MAF Biosecurity New Zealand 2009).	Not assessed	Not assessed	Not assessed	No
Rhagastis castor aurifera (Butler, 1875) [Lepidoptera: Sphingidae] Hawk moth	Yes Yunnan and Xinjiang Uygur Autonomous Region (Pittaway and Kitching 2006)	No Although recorded from grapevines (Pittaway and Kitching 2006), Sphingids generally feed only on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No
Rhagastis confusa Rothschild and Jordan, 1903 [Lepidoptera: Sphingidae] Hawk moth	Yes Yunnan (Pittaway and Kitching 2006)	No Although recorded from grapevines (Pittaway and Kitching 2006), Sphingids generally feed only on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No

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Rhagastis mongoliana (Butler, 1876) [Lepidoptera: Sphingidae]	Yes (Zhang 2005b)	No Larvae feed on leaves of grapevines (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No
Sarbanissa subflava (Moore, 1877) As *Seudyra subflava* Moore, 1877 in AQSIQ (2006) [Lepidoptera: Noctuidae] Boston ivy tiger-moth	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No The larvae feed on young shoots and leaves of grapevines (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No
Sarbanissa transiens (Walker, 1855) Synonym: *Creatonotatus transiens* (Walker) [Lepidoptera: Noctuidae]	Yes Shandong, Shaanxi, Yunnan, Xinjiang (Ades and Kendrick 2001)	No Larvae of the similar *S. subflava* feed on young shoots and leaves of grapevines (Zhang 2005b). Although the biology of *S. transiens* is not recorded, it is expected to be similar.	Not assessed	Not assessed	Not assessed	No
Serrodes campana Guenée 1852 [Lepidoptera: Noctuidae] Fruit-piercing moth	Yes (KISTI 2005) No record found of *S. campana* affecting grapes in China.	Yes This species is a nocturnal fruit piercing moth (NPQS 2007). As with other fruit-piercing Noctuid moths, adults shelter in foliage during the day and will not be associated with grapes at harvest.	Not assessed	Not assessed	Not assessed	No
Sparganothis pilleriana (Denis & Schiffermüller, 1775) [Lepidoptera: Tortricidae] Leaf-rolling tortrix	Yes (Li 2004)	No The larvae roll vine leaves, feeding on them from the inside (Li 2004).	Not assessed	Not assessed	Not assessed	No
Sphecodina caudata (Bremer & Grey, 1853) [Lepidoptera: Sphingidae]	Yes (Zhang 2005b)	No The larvae feed only on leaves of grapevines (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No
Spirama retorta (Clerck, 1764) [Lepidoptera: Noctuidae] Owlet moth	Yes (Li 2004)	No Adults are nocturnal fruit piercers, sucking the juices of grape, apple, pear and citrus, causing fruit rot (Li 2004). As with other fruit-piercing Noctuid moths, adults shelter in foliage during the day and will not be associated with grapes at harvest.	Not assessed	Not assessed	Not assessed	No

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Spodoptera exigua (Hübner, 1808) [Lepidoptera: Noctuidae] Cluster caterpillar, oriental leafworm moth.	Yes (CABI 2009)	Yes Larvae attack *Vitis vinifera* and may graze on fruit as external feeders (CABI 2009).	Yes (Nielsen *et al.* 1996)	Not assessed	Not assessed	No
Spodoptera litura Fabricius, 1775 [Lepidoptera: Noctuidae] Cluster caterpillar, oriental leafworm moth	Yes (CABI 2009)	Yes Larvae attack *Vitis vinifera* and may graze on fruit as external feeders (CABI 2009).	Yes (Nielsen *et al.* 1996)	Not assessed	Not assessed	No
Stathmopoda auriferella (Walker, 1864) [Lepidoptera: Oecophoridae] Apple heliodinid	Yes (Hiramatsu *et al.* 2001). No record found of *S. auriferella* affecting grapes in China. In Korea, this pest is found on grapes (NPQS 2007).	Yes Found on grape fruit (APHIS 2002; NPQS 2007). USDA report that in Korea, *S. auriferella* larvae web together flower buds and newly set fruit, often causing affected plant parts to drop from the vine. Larvae also burrow into the green berries, which may split, shrivel, or fall off when damaged (APHIS 2004a).	No (Nielsen *et al.* 1996)	Yes *Stathmopoda auriferella* has a wide range of hosts including table grapes, *Acacia*, kiwifruit, mandarin, navel orange, coffee, sunflower, lac scale, fuji apple, mango, avocado, chir pine, peach, nectarine, pomegranate and sorghum (Yamazaki and Sugiura 2003; Robinson *et al.* 2007a; CABI 2009). It has been reported from Japan, Korea as well as China (Park *et al.* 1994; Yamazaki and Sugiura 2003; Shanghai Insect Science Network 2009). This wide geographic range suggests that climatic conditions in parts of Australia would be suitable for its establishment and spread.	Yes *Stathmopoda auriferella* larvae damage the leaves, buds and fruit of a range of agricultural crops *Citrus*, *Mangifera*, *Vitis* and *Prunus* spp. (Yamazaki and Sugiura 2003; CABI 2009). They also feed on important ecological species such as *Acacia* (Robinson *et al.* 2007a).	Yes
Theretra alecto (Linneaus, 1758) [Lepidoptera: Sphingidae] Hawk moth	Yes Yunnan, Xinjiang (Pittaway and Kitching 2006)	No Although recorded from grapevines (Pittaway and Kitching 2006), Sphingids generally feed only on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No
Theretra boisduvalii (Bugnion, 1839) [Lepidoptera: Sphingidae] Hawk moth	Yes Yunnan (Pittaway and Kitching 2006)	No Although recorded from grapevines (Pittaway and Kitching 2006), Sphingids generally feed only on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No

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Theretra clotho (Drury, 1773) [Lepidoptera: Sphingidae] Hawk moth	Yes Shandong, Shaanxi, Yunnan, Xinjiang (Pittaway and Kitching 2006)	No Although recorded from grapevines (Pittaway and Kitching 2006), Sphingids generally feed only on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No
Theretra japonica (Boisduval, 1869) [Lepidoptera: Sphingidae] Hawk moth	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No The larvae feed on grapevine leaves (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No
Theretra oldenlandiae (Fabricius, 1775) [Lepidoptera: Sphingidae] Hawk moth	Yes Hebei, Shanxi, Shaanxi, Henan, Yunnan, Xinjiang (Pittaway and Kitching 2006)	No Although recorded from grapevines (Pittaway and Kitching 2006), Sphingids generally feed only on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No
Theretra pallicosta (Walker, 1856) [Lepidoptera: Sphingidae] Hawk moth	Yes Shaanxi, Yunnan (Pittaway and Kitching 2006)	No Although recorded from grapevines (Pittaway and Kitching 2006), Sphingids generally feed only on foliage (Common 1990).	Not assessed	Not assessed	Not assessed	No
Thinopteryx crocoptera Kollar, [Lepidoptera: Geometridae] Colourful looper moth	Yes (Barlow 1982)	No Geometrid larvae are foliage feeders. This species pupates in folded leaves of the host.	Not assessed	Not assessed	Not assessed	No
Thyas juno (Dalman, 1823) [Lepidoptera: Noctuidae] Rose of Sharon leaflike moth, fruit-piercing moth	Yes (Li 2004)	No A nocturnal fruit-piercing moth, whose adults suck the juice of fruit and shelter in foliage during the day. Larvae feed on the leaves of grape, apple, pear and walnut and are not found on fruit (Li 2004).	Not assessed	Not assessed	Not assessed	No
Trichosea champa [Lepidoptera: Pantharidae]	Yes (An Identification Guide of Japanese Moths 2009)	No Larvae feed on foliage of their host plants (An Identification Guide of Japanese Moths 2009).	Not assessed	Not assessed	Not assessed	No

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Xestia c-nigrum (Linnaeus, 1758) [Lepidoptera: Arctiidae] Spotted cutworm	Yes (CABI-EPPO 1979; CABI 2009)	No Larvae feed on foliage close to ground level at night and shelter in litter on the ground during the day (TFREC 2008; Pfeiffer 2009). They are unlikely to be associated with the fruit at harvest (day-time) (TFREC 2008; MAF Biosecurity New Zealand 2009).	Not assessed	Not assessed	Not assessed	No
Zeuzera pyrina (Linnaeus, 1761) [Lepidoptera: Cossidae] Leopard moth, wood leopard moth, apple stem borer	Yes (Li 2004)	No The larvae tunnel inside the stems and branches of grapevines where they feed on the phloem and xylem. They are not associated with grape berries (Li 2004).	Not assessed	Not assessed	Not assessed	No
Order Thysanoptera						
Frankliniella occidentalis Pergande, 1895 [Thysanoptera: Thripidae] Western flower thrips	Yes Found on grapes (MAF Biosecurity New Zealand 2009)	Yes *Frankliniella occidentalis* are commonly found feeding on leaves, stems, flowers and fruit of grape plants. Female thrips can lay up to 100 eggs which hatch into larvae or nymphs. Nymphs are similar to adults but without wings; after feeding they pupate in the soil. Thrips are present throughout the year (Kulkarni *et al.* 2007).	Yes (Mound 2001) Not recorded in either the NT or Tasmania (NTRDPIGR 2009; DPIW Tasmania 2009).	Yes *Frankliniella occidentalis* is a highly polyphagous species with a wide host range. It has already established and spread in most areas of Australia.	Yes Adult thrips attack most parts of their host plants as adults and larvae and lay their eggs directly into plant tissues. Their feeding activities can stress plants and reduce crop yields, as well as scarring fruit and flowers to render them unmarketable. They also vector tospoviruses, which also contribute to reduction of crop yield and production of unmarketable produce and can also cause entire crop losses (CABI 2009).	Yes (NT, Tas.)
Rhipiphorothrips cruentatus Hood, 1919 [Thysanoptera: Thripidae] Grapevine thrips, rose thrips	Yes (Zhang 2007; CABI 2009)	Yes *Rhipiphorothrips cruentatus* usually feed on the lower surface of leaves, often in groups. They can also attack blossoms and developing berries, which develop a corky layer and become brown (Kulkarni *et al.* 2007).	No (Mound 2001)	Yes *Rhipiphorothrips cruentatus* is a polyphagous species attacking a number of commercial host plants including cashew nut, sugarapple, mango and guava (CABI 2009).	Yes *Rhipiphorothrips cruentatus* is a polyphagous species feeding on the fruit, stems, leaves of ornamentals, shrubs and tree crops (Mound 2001).	Yes

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Scirtothrips dorsalis Hood, 1919 [Thysanoptera: Thripidae] Castor thrips, chilli thrips, strawberry thrips	Yes (Zhang 2005b)	No Like *R. cruentatus*, *S. dorsalis* usually feed on the lower surface of leaves, often in groups. They can also attack blossoms and developing berries, which develop a corky layer and become brown (Kulkarni *et al.* 2007).	Yes QLD, NT, NSW (CSIRO and DAFF 2004a), including WA (Poole 2008).	Not assessed	Not assessed	No
Thrips tabaci Lindemann, 1889 [Thysanoptera: Thripidae] Onion thrips	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	Yes Adults and larvae feed on young berries (Lewis 1997). They also feed on mature fruit, causing damaged fruit to develop a visible red ring (Roditakis and Roditakis 2007).	Yes NSW, NT, Qld, SA, Tas., Vic., WA (APPD 2009)	Not assessed	Not assessed	No
Order Orthoptera						
Oecanthus indicus Saussure, 1878 [Orthoptera: Gryllidae] Singing tree cricket	Yes (Li 2004; Zhang 2005b; AQSIQ 2006)	No This species lays its eggs into mature branches of grapevines, sometimes causing stem breakage (Zhang 2005b).	Not assessed	Not assessed	Not assessed	No
DOMAIN FUNGI						
Class Agaricomycetes						
Order Acaricales						
Armillaria tabescens (Scop. ex Fr.) Emel [Acaricales: Marasmiaceae] Armillaria root rot	Yes (CIQSA 2001a)	No Infects roots (Drake 1990; Li 2004).	Not assessed	Not assessed	Not assessed	No
Order Ceratobasidiales						
Rhizoctonia solani Kühn Teleomorph: *Thanatephorus cucumeris* (Frank) Donk [Ceratobasidiales: Ceratobasidiaceae]	Yes (CABI 2009; Farr and Rossman 2009)	No *Rhizoctonia solani* is soil-borne. Although *T. cucumeris* is capable of growing on aerial parts of the plant including fruit (Olsen 1999), there are no reports of this occurring in grapes.	Not assessed	Not assessed	Not assessed	No

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Order Poriales						
Sclerotium rolfsii Sacc. Teleomorph: *Athelia rolfsii* (Curzi) C.C. Tu & Kimbr. As *Pellicularia rolfsii* West in AQSIQ (2006) [Poriales: Atheliaceae] Sclerotium stem rot	Yes (AQSIQ 2006)	No Infects stems near the ground (Li 2004).	Not assessed	Not assessed	Not assessed	No
Class Ascomycetes						
Order Amphisphaeriales						
Physalospora baccae sensu Nishikado non Cavara As *Guignardia baccae* (Cav.) Trcz. in AQSIQ (2006). [Amphisphaeriales: Hyponectriaceae] Grapevine black rot	Yes Across major grape production regions (AQSIQ 2006; Qi *et al.* 2007; NYZSW 2009)	Yes *Physalospora baccae* mainly infects peduncles, pedicels and fruits of grapes (BAIKE 2009; NYZSW 2009). During May and June, conidia and ascospores spread to grape clusters by wind and rain and insects (NYZSW 2009). Symptoms start to appear in July. The peak infection period is from July to September when the weather is warm and humid. Infections are most likely to occur from the onset of ripening to harvest (BAIKE 2009; NYZSW 2009). *Physalospora baccae* was assessed as on the pathway by USDA for the import of table grapes from South Korea (APHIS 2002).	No records	Yes *Physalospora baccae* is present across the major grape growing regions of China (Liu *et al.* 2006a; BAIKE 2009; NYZSW 2009). It is also present in east Europe, Japan, Portugal, South Korea and Spain (Nishikado 1921; Bensaude 1926; Berro Aguilera 1926; Vekesciaghin 1933; Shin *et al.* 1984). This suggests that this fungus can establish and spread under a wide range of climatic environments. Many other *Physalospora* species are already present and established in Australia (APPD 2009).	Yes *Physalospora baccae* mainly infects peduncles, pedicels and fruit of grapes (BAIKE 2009; NYZSW 2009). The disease incidence is high in some years with hot and humid weather from July to September and in vineyards which are not well managed. For example, up to 75% of fruit was infected in a vineyard in Jiangxi province (Li 1984). High disease incidences (about 30% fruit infection rates) were also reported in vineyards in the provinces of Hunan, Fujian and Shanxi (Hu and Lin 1993; Gao *et al.* 1999).	Yes

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Order Diaporthales						
Greeneria uvicola (Berkley & M.A. Curtis) Punithalingam [Diaporthales: Not assigned] Bitter rot	Yes Reported in the southern part of Jiangsu (Yan *et al.* 1998).	Yes Bitter rot can affect young shoots, stems of fruit bunches, pedicels and berries. *Greeneria uvicola* usually attacks berries via the pedicel. Within a few days of infection, berries soften and are bitter to taste, some are easily detached while others shrivel and mummify (McGrew 1988; Momol *et al.* 2007).	Yes NSW, Qld (APPD 2009) Not in WA (DAWA 2006)	Yes *Greeneria uvicola* is present in Australia, Brazil, China, Costa Rica, India, South Africa and USA (Sutton and Gibson 1977; Ullasa and Rawal 1986; Kummuang *et al.* 1996b; Yan *et al.* 1998; Steel 2007). In Australia, *G. uvicola* has been reported from north-eastern New South Wales on wine grapes, and table grapes at Mundubbera in Queensland (Castillo-Pando *et al.* 1999; Sergeeva *et al.* 2001). Environments with climates similar to these regions exist in various parts of Western Australia suggesting that *G. uvicola* has the potential to establish and spread in Western Australia.	Yes *Greeneria uvicola* attacks many species of grape, including *Vitis vinifera* (European grape), *V. labrusca* (fox grape) and *V. rotundifolia* (muscadine grape) (Sutton and Gibson 1977; Farr *et al.* 2001). Affected berries shrivel and rot or become soft, bitter-tasting and are easily detached (Pearson and Goheen 1988). At worst, *G. uvicola* can kill the grapevine through girdling. *Greeneria uvicola* has also been reported on mature fruit of cherry, strawberry, peach and banana under experimental conditions (Ridings and Clayton 1970).	Yes (WA)
Order Dothideales						
Asperisporium vitiphyllum (Speschnew) Deighton [Dothideales: Not Assigned]	Yes Aksu, Xinjiang (Zhuang 2005; AQSIQ 2009b)	Yes Infects fruit (USDA 2005).	No records	Yes Spores are airborne (Waisel *et al.* 1997).	No No evidence for economic significance (USDA 2005).	No
Order Hypocreales						
Fusarium anthophilum (A. Braun) Wollenw. [Hypocreales: Hypocreaceae]	Yes (Farr *et al.* 2008)	Yes Infects fruit (Muniz *et al.* 2003).	Yes NT, Qld., Vic., WA (APPD 2009)	Not assessed	Not assessed	No
Order Phyllachorales						
Colletotrichum acutatum Simmonds ex Simmonds [Phyllachorales: Phyllachoraceae]	Yes (Zhang *et al.* 2008)	Yes Infects fruit (Whitelaw-Weckert *et al.* 2007).	Yes NSW, Qld, SA, Vic., WA (DAWA 2006; APPD 2009)	Not assessed	Not assessed	No

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Order unassigned						
Phragmocephala stemphylioides (Corda) S.J. Hughes var. *baccata* Taxus [Not Assigned: Not Assigned]	Yes Liupan Mountain, Ningxia (Zhuang 2005; AQSIQ 2009b)	No AQSIQ (2009c) advises that the pathogen only infects leaves.	Not assessed	Not assessed	Not assessed	No
Class Dothideomycetes						
Order Acrospermales						
Acrospermum viticola Ikata [Acrospermales: Acrospermaceae] Leaf spot	Yes (AQSIQ 2006; Farr and Rossman 2009)	No Infects leaves (Li 2004; AQSIQ 2006).	Not assessed	Not assessed	Not assessed	No
Order Botryosphaeriales						
Botryosphaeria dothidea (Moug.: Fr.) Ces. & De Not. Anamorph*: Fusicoccum aesculi* Corda [Botryosphaeriales: Botryosphaeriaceae]	Yes (Farr and Rossman 2009)	Yes Causes spots and cankers on shoots and round, sunken lesions on berries as they mature (Van Niekerk *et al.* 2000).	Yes NSW, Qld, Vic., WA (APPD 2009)	Not assessed	Not assessed	No
Botryosphaeria stevensii Shoemaker Anamorph: *Diplodia mutila* (Fr.: Fr.) Mont. [Botryosphaeriales: Botryosphaeriaceae]	Yes (Farr and Rossman 2009)	Yes Causes spots and cankers on shoots and can infect fruit (Van Niekerk *et al.* 2000)	Yes ACT, NSW, Vic., WA (APPD 2009)	Not assessed	Not assessed	No

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Guignardia bidwellii (Ellis) Viala & Ravaz Anamorph: *Phyllosticta ampelicida* (Engelm.) Van der Aa [Botryosphaeriales: Botryosphaeriaceae] Black spot	Yes Henan, Jiangsu, Liaoning, Shandong, Sichuan and Xinjiang (AQSIQ 2006; AQSIQ 2007)	Yes Infects fruit (AQSIQ 2006; AQSIQ 2007; CABI 2009; Farr and Rossman 2009), as well as leaves, stalks and new branches (AQSIQ 2007; Farr and Rossman 2009). Affected fruit show puce stains and grow soft, then shrink to dark fruits with many black dots (AQSIQ 2007).	No records	Yes *Guignardia bidwellii* overwinters in mummies, either in the vine or on the ground. Ascospores are airborne and disperse moderate distances and conidia are splash dispersed only short distances (Wilcox 2003).	Yes All young green tissues of the vine are susceptible to infection by *G. bidwellii*. Infection of the fruit is by far the most serious phase of the disease and may result in substantial economic loss. Flowers do not become infected while the bud caps remain attached, but are extremely susceptible for the first two to three weeks after the bud cap falls off. *Vitis vinifera* cultivars maintain a reduced level of susceptibility until 6 or 7 weeks after the flowers open.	Yes
Lasiodiplodia theobromae (Pat.) Griffon & Maubl. Teleomorph*: Botryosphaeria rhodina* (Berk. & Curtis) Arx [Botryosphaeriales: Botryosphaeriaceae] Lasiodiplodia cane dieback	Yes (Li 2004)	Yes Grapes can be infected at bloom and maturity. When infected at bloom, there is a latency period before symptoms manifest (Hewitt 1974).	Yes NT, Qld, WA (APPD 2009)	Not assessed	Not assessed	No
Order Capnodiales						
Cercospora truncata Ellis & Everh. [Capnodiales: Mycosphaerellaceae]	Yes Shaanxi (Zhuang 2005)	Yes Affects leaves (Farr and Rossman 2009; AQSIQ 2009b).	Not assessed	Not assessed	Not assessed	No
Cladosporium cladosporoides (Fresen.) GA de Vries [Capnodiales: Davidiellaceae]	Yes (Liang and Zeng 1980)	Yes Infects fruit (Briceño and Latorre 2007)	Yes ACT, NSW, NT, Qld, SA, Tas., Vic., WA (APPD 2009); WA (DAWA 2006)	Not assessed	Not assessed	No
Cladosporium herbarum (Pers.: Fr.) Link [Capnodiales: Mycosphaerellaceae] Cladosporium rot	Yes (Li 2004)	Yes Infects fruit after injury causing rot (University of California 1992).	Yes NSW, Qld, SA, Tas. Vic., WA (APPD 2009)	Not assessed	Not assessed	No

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Cladosporium uvarum McAlpine [Capnodiales: Mycosphaerellaceae] Cladosporium bunch rot	Yes Shaanxi (Zhuang 2005)	Yes Causes bunch rot (Nicholas *et al.* 1994; Robert *et al.* 2009).	Yes (Dugan *et al.* 2004) Not present in WA (DAWA 2006).	Yes Spores are airborne (Erkara *et al.* 2008). The fungus has established and spread in other parts of Australia.	No No evidence of economic significance (Nicholas *et al.* 1994).	No
Passalora dissiliens (Duby) U. Braun & Crous [Capnodiales: Mycosphaerellaceae]	Yes Shaanxi, Xinjiang (Zhuang 2005)	No Causes variable leaf spot symptoms (Deighton 1976).	Not assessed	Not assessed	Not assessed	No
Pseudocercospora brachypus (Ellis & Everh.) X.J. Liu & Y.L. Guo Teleomorph: *Mycosphaerella angulata* W.A. Jenkins [Capnodiales: Mycosphaerellaceae]	Yes Guangdong, Guangzhou (Zhuang 2001; AQSIQ 2009b)	No Affects leaves (Jenkins 1941).	Not assessed	Not assessed	Not assessed	No
Pseudocercospora vitis (Lév.) Speg. Teleomorph: *Mycosphaerella personata* B.B. Higgins As *Phaeoisariopsis vitis* (Lév.) Sawada in AQSIQ (2006) [Capnodiales: Mycosphaerellaceae] Grapevine leaf spot	Yes (AQSIQ 2006; Farr and Rossman 2009); Guangdong, Yunnan (Zhuang 2001); Gansu (Zhuang 2005)	No Infects leaves (Li 2004; AQSIQ 2006; APPD 2009).	Not assessed	Not assessed	Not assessed	No
Septoria ampelina Berk. & M. A. Curtis [Capnodiales: Mycosphaerellaceae] Septoria leaf spot	Yes (Li 2004)	No Infects leaves (Li 2004)	Not assessed	Not assessed	Not assessed	No
Order Myriangiales						
Elsinoë ampelina Shear Anamorph: *Sphaceloma ampelinum* de Bary [Myriangiales: Elsinoaceae] Grape anthracnose	Yes (CABI 2009; Farr and Rossman 2009); Guangdong, Hong Kong (Zhuang 2001)	Yes Infected berries have round, sunken and initially brown spots that enlarge to form 'bird's eye spots' of 2-7 mm (Emmett *et al.* 1994a). These are dark purple-black and have thin, red edging and sometimes grey centres.	Yes NSW, NT, Qld, Tas., Vic., WA (APPD 2009)	Not assessed	Not assessed	No
Order Pleosporales						
Alternaria alternata (Fr. Fr.) Keissl [Pleosporales: Pleosporaceae] Alternaria leaf blight, brown spot	Yes (Li 2004)	Yes Infects young and mature berries. It is commonly a post harvest rot (Swart *et al.* 1995).	Yes ACT, NSW, NT, Qld, SA, Tas., Vic., WA (APPD 2009)	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Alternaria viticola Brunaud [Pleosporales: Pleosporaceae] Spike stalk brown spot	Yes Anhui, Beijing, Hebei, Henan, Hunan, Liaoning (Zhang 2005b); Hebei, Henan, Hunan, Liaoning, Shandong and Shanghai (Grapevinewine 2003); Liaoning, Shandong, Hunan (AQSIQ 2007); Hebei, Henan, Liaoning, Shandong (Li 2004) and Xinjiang (Ma *et al.* 2004).	Yes Infects young fruit (Li 2004; AQSIQ 2006). Mainly attacks young, tender rachises, peduncles and pedicels of grape fruit with no symptoms seen in old inflorescences (AQSIQ 2007). No major symptoms on fruits (AQSIQ 2007). AQSIQ (2007) claimed that this pathogen is not on the pathway.	No records	Yes *Alternaria viticola* is present in Anhui, Beijing (Zhang 2005b), Hebei, Henan, Hunan, Liaoning (Grapevinewine 2003; Zhang 2005b), Shandong, Shanghai (Grapevinewine 2003) and Xinjiang (Ma et al 2004). This suggests that this fungus can establish under a wide range of climatic environments. Environments with climates similar to these regions exist in various parts of Australia suggesting that *A. viticola* has the potential to establish in Australia. Many other *Alternaria* species are already present and established in Australia (APPD 2009).	Yes *Alternaria viticola* can cause serious drop off of flowers and young fruit, leading to a yield reduction of 30–40% (Ma *et al.* 2004). *Alternaria viticola* causes disease on *Vitis* species (Ma *et al.* 2004; Zhang 2005b), which may affect table grape and wine industries.	Yes
Alternaria vitis Cavara [Pleosporales: Pleosporaceae] Grapevine alternariosis	Yes (Farr and Rossman 2009)	No Infects leaves (Suhag and Kaushik 1982).	Not assessed	Not assessed	Not assessed	No
Stemphylium botryosum Wallr. Teleomorph: *Pleospora tarda* E. G. Simmons [Pleosporales: Pleosporaceae] Stemphylium rot	Yes (Farr and Rossman 2009)	Yes Listed as a berry rot or raisin mould (Pearson 1993).	Yes NSW, SA, Tas., Vic., WA (APPD 2009)	Not assessed	Not assessed	No
Class Eurotiomycetes						
Order Eurotiales						
Aspergillus niger Tiegh. [Eurotiales: Trichocomaceae]	Yes (Farr and Rossman 2009)	Yes Infects berries as a post harvest rot (Perrone *et al.* 2006).	Yes ACT, NSW, NT, Qld, SA, Vic., WA (APPD 2009)	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Class Leotimycetes						
Order Erysiphales						
Erysiphe necator Schwein. Anamorph: *Oidium tuckeri* Berk. As *Uncinula necator* (Schw) Burr in AQSIQ (2006) [Erysiphales: Erysiphaceae] Grapevine powdery mildew	Yes (AQSIQ 2006; Farr and Rossman 2009)	Yes Infects fruit with visible symptoms. These include an ash-grey growth, web-like patterns and splitting (Emmett *et al.* 1994b).	Yes NSW, NT, Qld, SA, Tas. Vic., WA (APPD 2009)	Not assessed	Not assessed	No
Order Helotiales						
Botrytis cinerea Pers.: Fr. Teleomorph: *Botryotinia fuckeliana* (de Bary) Whetzel [Helotiales: Sclerotiniaceae] Grey mould rot	Yes (AQSIQ 2006; Farr and Rossman 2009) Gansu, Ningxia (Zhuang 2005)	Yes Symptoms are berries with 'slippery skin' and bunches of grapes with grey mouldy growth (Nicholas *et al.* 1994).	Yes ACT, NSW, Qld, SA, Tas., Vic., WA (APPD 2009)	Not assessed	Not assessed	No
Hinomyces moricola (I. Hino) Narumi & Y. Harada Teleomorph: *Grovesinia pyramidalis* M.H. Cline, J.L. Crane & S.P. Cline [Helotiales: Sclerotiniaceae] Zonate leaf spot	Yes Taiwan (Li 2004)	No Infects leaves (Li 2004).	Not assessed	Not assessed	Not assessed	No
Monilinia fructicola (G. Winter) Honey Anamorph: *Monilia fructicola* L. R. Batra [Helotiales: Sclerotiniaceae] Brown rot	Yes (CABI 2009)	Yes Attacks young flowers and they drop off (Ma and Sheng 1995). Also infects fruit (Visarathanonth *et al.* 1988)	Yes ACT, NSW, Qld, SA, Tas., Vic., WA (APPD 2009)	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Monilinia fructigena Honey Anamorph: *Monilia fructigena* Schumach. [Helotiales: Sclerotiniaceae] Brown rot	Yes Anhui, Henan, Hubei, Hunan, Jiangsu, Liaoning, Shaanxi, Shandong, Shanxi, Sichuan, Yunnan, Taiwan and Zhejiang (AQSIQ 2007; Farr and Rossman 2009)	Yes Causes raised light brown pustules on the fruit that often expand enclosing the fruit to form a dark, wrinkled, hard mummified fruit (States Environmental Protection Agency 2004). Grape is not a main host. No report of harm to grapes in China (AQSIQ 2007). AQSIQ (2007) suggested that it is not on pathway.	No records	Yes Brown rot disease caused by *M. fructigena* is common in pome and stone fruit. Grapevine is a minor host of this pathogen (CABI 2009). The spores of this fungus can be spread from one orchard to another through air (Jones 1990; Ma 2006).	Yes *Monilinia fructigena* produces visible symptoms on grapes and causes raised light brown pustules that often expand enclosing the fruit to form a dark, wrinkled and hard mummified fruit (United States Environmental Protection Agency 2004). *Monilinia fructigena* could also spread to more susceptible hosts e.g. stone and pome fruit, where significant pre and post harvest fruit losses are reported (Jones 1990).	Yes
Class Puccinimycetes						
Order Helicobasidiales						
Helicobasidium mompa Tanaka [Helicobasidiales: Helicobasidiaceae] Violet root rot of apple	Yes (AQSIQ 2006)	No Infects roots (AQSIQ 2006; CABI 2009).	Not assessed	Not assessed	Not assessed	No
Order Pucciniales						
Phakopsora ampelopsidis Diet. & P. Syd. [Pucciniales: Phakopsoraceae] Ampelopsis rust fungus	Yes Fujian, Guangdong, Guangxi, Jiansu, Sichuan, Yunnan (Li 2001; AQSIQ 2006)	No This species does not infect *Vitis* spp. (Ono 2000).	Not assessed	Not assessed	Not assessed	No
Phakopsora euvitis Y. Ono [Pucciniales: Phakopsoraceae] Grape rust fungus	Yes (Farr and Rossman 2009)	Yes Infects leaves (AQSIQ 2006; CABI 2009) and young shoots (Li 2004). Uredospores may contaminate bunches during harvest (Zhang 2005b). Occasionally infects rachises (Pearson and Goheen 1988).	No Recorded in NT (Weinert *et al.* 2003; APPD 2009) but has since been eradicated (Liberato *et al.* 2007).	Yes *Phakopsora euvitis* established in Northern Territory before eradication (Weinert *et al.* 2003). Rust fungi spores are wind dispersed (Deacon 2005).	Yes Can cause a serious grapevine disease (CABI-EPPO 2006).	Yes

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Class Sordariomycetes						
Order Diaporthales						
Phomopsis viticola (Sacc.) Sacc. Teleomorph: *Diaporthe viticola* Nitschke Synonym: *Fusicoccum viticolum* Redd. As *Cryptosporella viticola* Red in AQSIQ (2006) [Diaporthales: Valsaceae] Phomopsis cane and leaf spot	Yes Hebei, Liaoning, Shandong (Zhang 2005b; AQSIQ 2007; CABI 2009) As *Fusicoccum viticolum*: Gansu (Zhang 2005b)	Yes Infects all parts of grape bunches (berries, pedicels and peduncles) throughout the growing season but most infections appear to occur early in the growing season (Ellis and Erincik 2005). Berry infection is favoured by long (20-30 hr) wet periods at flowering (Emmett *et al.* 1994c). Symptoms appear at cut sites, grafting places and branches. Mainly affects grapes vines which are more than two years old with newly-grown vines not affected (AQSIQ 2007). AQSIQ (2007) could find no reports of harm to grape berries and suggested that it is not on pathway.	Yes (Merrin *et al.* 1995); NSW, Qld, SA, Vic., WA (APPD 2009) (except Type 2 in WA); Tas. (Mostert *et al.* 2001)	Yes *Phomopsis viticola* is established in temperate climatic regions throughout the viticultural world and has been reported in Africa, Asia, Australia (except Western Australia), Europe and North America (Hewitt and Pearson 1988). Some areas of Western Australia have a suitable temperate climate.	Yes *Phomopsis viticola* is a serious pathogen of grapes in several viticultural regions of the world (Hewitt and Pearson 1988). Berry infection, either direct or via infected rachis tissues (Erincik *et al.* 2001) can occur throughout the growing season but most fruit infections probably occur early in the season (Erincik *et al.* 2001). Once inside green tissues of the berry, the fungus becomes latent (Erincik *et al.* 2002) and infected berries remain without symptoms until late in the season when the fruit matures (Ellis and Erincik 2005).	Yes (WA)
Pilidiella diplodiella (Speg.) Crous & Van Niekerk As *Coniothyrium diplodiella* (Sperg.) Sacc in AQSIQ (2006) [Diaporthales: Melanconidaceae] Grapevine white rot	Yes (AQSIQ 2006); Guangdong (Zhuang 2001)	Yes Infects young and mature fruit, causing purple-brown spots, yellowing and then browning and drying out of the fruit (Lauber and Schuepp 1968).	Yes As *Coniella diplodiella*: NSW, WA (APPD 2009); WA (Shivas 1989)	Not assessed	Not assessed	No
Order Hypocreales						
Fusarium solani (Mart.) Sacc. Teleomorph: *Haematonectria haematococca* (Berk. & Broome) Samuels & Rossman [Hypocreales: Nectriaceae] Dry rot	Yes (AQSIQ 2006)	Yes Infects roots (Lele *et al.* 1978) and shoots, attacking the xylem vessels (Atia *et al.* 2003). Therefore, it may be present in stems.	Yes NSW, NT, Qld, SA, Tas., Vic., WA (APPD 2009); WA (Shivas 1989)	Not assessed	Not assessed	No
Trichothecium roseum (Pers.) Link [Hypocreales: Not Assigned] Pink mould rot	Yes (Farr and Rossman 2009)	Yes Infects mature fruit (Blancard *et al.* 2006).	Yes ACT, NSW, Qld, SA, Vic., WA (APPD 2009)	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Order Phyllachorales						
Glomerella cingulata (Stoneman.) Spauld. & H. Schrenk Anamorph: *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc. [Phyllachorales: Glomerellaceae] Anthracnose	Yes (AQSIQ 2006)	Yes Symptoms, circular brown spots, appear as berries ripen (Kummuang *et al.* 1996b).	Yes ACT, NSW, NT, Qld, SA, Tas., Vic., WA (APPD 2009)	Not assessed	Not assessed	No
Verticillium dahliae Kleb. [Phyllachorales: Plectosphaerellacea] Verticillium wilt	Yes (CABI 2009)	No Infects roots (Walker and Wicks 1994) causing vascular wilt.	Not assessed	Not assessed	Not assessed	No
Order Xylariales						
Pestalotiopsis uvicola (Speg.) Bissett [Xylariales: Amphisphaeriaceae]	Yes Henan, Jiangsu, Liaoning, Shandong and Shanxi (Zhang 2005b).	Yes Infects canes, berries, flowers and leaves. Berries are infected more readily at later stages of development than at earlier stages (Sergeeva *et al.* 2005).	Yes NSW, Qld, WA (APPD 2009); NSW (Sergeeva *et al.* 2005)	Not assessed	Not assessed	No
Rosellinia necatrix Prill. Anamorph: *Dematophora necatrix* R. Hartig As *Rosellinia nacatrix* Berlese in AQSIQ (2006) [Xylariales: Xylariaceae] White root rot of trees	Yes (AQSIQ 2006)	No Infects roots (Walker and Wicks 1994).	Not assessed	Not assessed	Not assessed	No
Class Zygomycetes						
Order Mucorales						
Rhizopus arrhizus A. Fischer [Mucorales: Mucoraceae] Fruit rot	Yes (Li 2004; Farr and Rossman 2009)	Yes Can infect berries after injury (University of California 1992). Storage rot (Li 2004). Can infect intact berries at low rates (Hewitt 1974).	Yes NSW, Vic. (APPD 2009) Not present in WA (DAWA 2006).	Yes Spores are airborne (Nicholas *et al.* 1994).	No There are no reports of *R. arrhizus* being of economic significance on grapes in the states of Australia where it is present.	No
Rhizopus stolonifer (Ehrenb.: Fr.) Vuill. [Mucorales: Mucoraceae] Fruit rot	Yes (Li 2004; Farr and Rossman 2009)	Yes Found on berries at harvest (McLaughlin *et al.* 1992). Storage rot (Li 2004).	Yes NSW, NT, Qld, Vic., WA (APPD 2009)	Not assessed	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
VIROIDS						
Australian grapevine viroid [Pospiviroidae: Aspcaviroid]	Yes (Jiang *et al.* 2009b)	Yes Infects systemically; present in fruit and seed (Little and Rezaian 2003; Singh *et al.* 2003; Albrechtsen 2006)	Yes (Habili 2009)	Not assessed	Not assessed	No
Grapevine yellow speckle viroid 1 [Pospiviroidae: Aspcaviroid]	Yes Xinjiang (Li *et al.* 2007)	Yes Infects systemically; present in fruit and seed (Little and Rezaian 2003; Singh *et al.* 2003; Li *et al.* 2006; Albrechtsen 2006)	Yes (Koltunow *et al.* 1989) Not recorded in WA (DAWA 2006) The movement of fruit into WA from eastern states, where *grapevine yellow speckle viroid 1* occurs, is regulated.	No Transmitted by grafting, abrasion and through seed (Singh *et al.* 2003; Li *et al.* 2006; Albrechtsen 2006). Infected grapevine seedlings are unlikely to establish (see Chapter 4). The absence of reports of naturalised and weedy grapevines in Australia suggests that most seeds will not germinate and the small number of seedlings that may grow do not survive.	Not assessed	No
Grapevine yellow speckle viroid 2 [Pospivirodae: Aspcaviroid]	Yes (Li *et al.* 2007)	Yes Infects systemically; present in fruit and seed (Little and Rezaian 2003; Singh *et al.* 2003; Li *et al.* 2006; Albrechtsen 2006)	Yes (Koltunow *et al.* 1989) Not recorded in WA (DAWA 2006). The movement of fruit into WA from eastern states, where *grapevine yellow speckle viroid 2* occurs, is regulated.	No Transmitted by grafting, abrasion and through seed (Little and Rezaian 2003; Albrechtsen 2006). Infected grapevine seedlings are unlikely to establish (see Chapter 4). The absence of reports of naturalised and weedy grapevines in Australia suggests that most seeds will not germinate and the small number of seedlings that may grow do not survive.	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Grapevine yellow speckle viroid 3 *(Chinese grapevine viroid)* [Pospiviroidae: Aspcaviroid]	Yes Xinjiang, Shenyang, Beijing (Jiang *et al.* 2009a).	Yes Infects systemically, so probably present in grape berries (Jiang *et al.* 2009a).	No record found	No Seed transmission not reported (Jiang *et al.* 2009a), but considered possible. Also transmitted by grafting and abrasion. Infected grapevine seedlings are unlikely to establish (see Chapter 4). The absence of reports of naturalised and weedy grapevines in Australia suggests that most seeds will not germinate and the small number of seedlings that may grow do not survive.	Not assessed	No
Hop stunt viroid [Pospiviroidae: Hostuviroid]	Yes Xinjiang (Li *et al.* 2006)	Yes Infects systemically; present in fruit and seed (Little and Rezaian 2003; Singh *et al.* 2003; Li *et al.* 2006; Albrechtsen 2006)	Yes SA, Vic. (Koltunow *et al.* 1988) Not recorded in WA (DAWA 2006). The movement of fruit into WA from eastern states where hop stunt viroid occurs is regulated.	No Transmitted by grafting, abrasion and through seed (Little and Rezaian 2003; Singh *et al.* 2003; Albrechtsen 2006). Infected grapevine seedlings are unlikely to establish (see Chapter 4). The absence of reports of naturalised and weedy grapevines in Australia suggests that most seeds will not germinate and the small number of seedlings that may grow do not survive.	Not assessed	No
Citrus exocortis viroid [Pospiviroidae: Pospiviroid]	Yes (CABI 2009)	Yes Infects systemically; present in fruit and seed (Little and Rezaian 2003; Singh *et al.* 2003; Albrechtsen 2006).	Yes NSW, Qld, SA (Buchen-Osmond 2002) Not recorded in WA (DAWA 2006). The movement of fruit into WA from eastern states where citrus exocortis viroid occurs is regulated.	No Transmitted by grafting, abrasion and through seed (Little and Rezaian 2003; Singh *et al.* 2003; Albrechtsen 2006). Infected grapevine seedlings are unlikely to establish (see Chapter 4). The absence of reports of naturalised and weedy grapevines in Australia suggests that most seeds will not germinate and the small number of seedlings that may grow do not survive.	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
DOMAIN VIRUSES						
POSITIVE SENSE SINGLE-STRANDED DNA						
Alfalfa mosaic virus [Bromoviridae: Alfamovirus]	Yes Neimenggu, Shaanxi, Zhejiang (CABI 2009)	Yes Infects systemically; probably present in fruit (Van Vloten-Doting and Gibbs 1996)	Yes NSW, Qld (APPD 2009); NSW, Qld, SA, Tas., Vic., WA (Buchen-Osmond 2002)	Not assessed	Not assessed	No
Cucumber mosaic virus [Bromoviridae: Cucumovirus]	Yes (CABI 2009)	Yes Infects all parts of the plant (University of California 1992).	Yes NSW, Qld, SA, Tas., Vic., WA (APPD 2009; CABI 2009)	Not assessed	Not assessed	No
Broad bean wilt virus 2 [Comoviridae: Fabavirus]	Yes (Zhou 2002; CABI 2009)	Yes Recorded in grapevine (CIHEAM 2006). Probably infects systemically.	Yes NSW (Schwinghamer *et al.* 2007). May be present in Qld (APPD 2009) but the records could be of broad bean wilt virus 1.	No At least one strain is transmitted in seed of *Vicia faba* (Zhou 2002) but no record of seed transmission in *Vitis* spp. was found. Transmitted in a non-persistent manner by aphids, including *Myzus persicae, Aphis craccivora* and *Acyrthosiphon pisum*. No records of acquisition from infected berries.	Not assessed	No
Grapevine fanleaf virus Synonym: Grapevine yellow mosaic virus [Comoviridae: Nepovirus]	Yes (AQSIQ 2006); Fujian, Hebei, Shandong (CABI 2009)	Yes Infects systemically; present in fruit and seed. Associated with the endosperm of grape seeds (Habili *et al.* 2001).	Yes NSW (APPD 2009); SA (Stansbury *et al.* 2000; Habili *et al.* 2001); Vic. (Habili *et al.* 2001). Under quarantine in Australia (Habili *et al.* 2001). Not recorded in WA (DAWA 2006).	No Transmitted through seed (Martelli *et al.* 2001b). Also transmitted by a nematode vector (*Xiphinema index*) and by grafting (Habili *et al.* 2001; CABI 2009). Infected grapevine seedlings are unlikely to establish (see Chapter 4). The absence of reports of naturalised and weedy grapevines in Australia suggests that most seeds will not germinate and the small number of seedlings that may grow do not survive.	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Tobacco ringspot virus [Comoviridae: Nepovirus]	Yes (CABI 2009)	Yes Infects systemically; present in fruit and seed. (Kearns and Mossop 1984; Emmett and Hamilton 1994).	Yes Qld, SA, WA (CABI-EPPO 1997d)	Not assessed	Not assessed	No
Tomato ringspot virus [Comoviridae: Nepovirus] Ringspot of tomato	Yes Zhejiang (CABI 2009)	Yes Infects systemically; present in fruit and seed (Uyemoto 1975; Pearson and Goheen 1988).	No Recorded in SA (Chu *et al.* 1983; Cook and Dubé 1989), but there are no further records, the infected plants no longer exist, and the virus is believed to be absent.	No Seed transmitted (Uyemoto 1975). Also transmitted by nematodes (*Xiphinema* spp.) and by grafting (Stace-Smith 1984). Infected grapevine seedlings are unlikely to establish (see Chapter 4). The absence of reports of naturalised and weedy grapevines in Australia suggests that most seeds will not germinate and the small number of seedlings that may grow do not survive.	Not assessed	No
Grapevine leafroll associated virus 2 [Closteroviridae: Closterovirus]	Yes (AQSIQ 2006; Liu *et al.* 2006b)	Yes Infects systemically; probably present in fruit (CABI 2009).	Yes SA, NSW, Vic. (CABI 2009); WA (DAWA 2006)	Not assessed	Not assessed	No
Grapevine leafroll associated virus 3 [Closteroviridae: Ampelovirus]	Yes (AQSIQ 2006; Liu *et al.* 2006b)	Yes Infects systemically; probably present in fruit (CABI 2009).	Yes SA, NSW, Vic. (Habili and Symons 2000); WA (DAWA 2006)	Not assessed	Not assessed	No
Grapevine leafroll associated virus 7 [Closteroviridae]	Yes (Benson *et al.* 2008)	Yes Infects systemically; probably present in fruit (CIHEAM 2006).	No records	Yes The virus is graft transmissible (CIHEAM 2006). The mechanism of natural transmission is not known. Other viruses from the Closteroviridae are transmitted by mealybugs, scales, whiteflies and aphids (CIHEAM 2006). Grapevine leafroll-associated virus 7 may also be transmitted by one or more of these insect vectors. Unlikely to be transported from infected fruit to a suitable host.	No The virus has been detected in vines with symptoms and in asymptomatic vines (Morales and Monis 2007). It causes mild leafroll symptoms (Choueiri *et al.* 1996). No report has been found indicating yield losses associated with infection.	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Grapevine rupestris stem pitting-associated virus [Flexiviridae: Foveavirus]	Yes (Ribeiro *et al.* 2004)	Yes Infects systemically; probably present in fruit (Petrovic *et al.* 2003; CIHEAM 2006).	Yes (Habili and Symons 2000)	Not assessed	Not assessed	No
Grapevine virus A As Grapevine stempitting virus and Grapevine corky bark virus in AQSIQ (2006) [Flexiviridae: Vitivirus]	Yes (AQSIQ 2006)	Yes Infects systemically; probably present in fruit (CIHEAM 2006).	Yes Vic. (APPD 2009); SA (Habili and Symons 2000) Not recorded in WA (DAWA 2006). The movement of fruit into WA from eastern states where *Grapevine virus A* occurs is regulated.	No Not seed transmitted; transmitted by grafting; transmitted by the scale insect *Neopulvinaria innumerabilis* and by the mealy bugs *Planococcus citri*, *Pl. ficus*, *Pseudococcus longispinus*, *Ps. affinis* and *Heliococcus bohemicus* (Martelli *et al.* 2001a). Unlikely to be co-transported with a vector insect or to be transmitted from imported fruit to a suitable host plant.	Not assessed	No
Grapevine virus B [Flexiviridae: Vitivirus]	Yes Sichuan (Liu *et al.* 2004)	Yes Infects systemically (Martelli 1997); probably present in fruit.	Yes Vic. (Habili 2009) Not recorded in WA (DAWA 2006). The movement of fruit into WA from eastern states, where *Grapevine virus B* occurs, is regulated.	No Not seed transmitted; transmitted by grafting; transmitted by the mealy bugs *Planococcus ficus*, *Pseudococcus longispinus* and *Ps. affinis* (CIHEAM 2006). Unlikely to be co-transported with a vector insect or to be transmitted from imported fruit to a suitable host plant.	Not assessed	No

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Tobacco necrosis viruses [Tombusviridae: Necrovirus]	Yes Xinjiang and Jiangsu in several crop species (Huang *et al.* 1984; Xi *et al.* 2008)	Yes Causes necrosis of leaves and stems (Brunt and Teakle 1996). Virus particles released from plant debris and acquired in soil by zoospores of chytrid fungi (*Olpidium* spp.) may be transmitted to suitable hosts (Uyemoto 1981; Spence 2001; CABI 2009). Necroviruses may also be transmitted in soil water without a vector (Lommel *et al.* 2005).	Yes Viruses likely to be strains of TNVs A and D have been recorded in Vic. and Qld (Finlay and Teakle 1969; Teakle 1988). TNV Nebraska isolate has not been recorded in Australia, nor have other TNVs that have since been renamed or have not yet been formally classified (Tomlinson *et al.* 1983; Zhang *et al.* 1993; Cardoso *et al.* 2005; NCBI 2009).	Yes TNV strains are established in Australia (Teakle 1988). TNVs infect vegetable crop plants, ornamental plants and tree species (Brunt and Teakle 1996; CABI 2009; Zitikaite and Staniulis 2009) and many of these hosts occur in Australia. TNVs are transmitted by *Olpidium* spp. (Rochon *et al.* 2004; Sasaya and Koganezawa 2006) and these vectors occur in Australia (McDougall 2006; Maccarone *et al.* 2008).	Yes TNVs cause rusty root disease of carrot, Augusta disease of tulip, stipple streak disease of common bean, necrosis diseases of cabbage, cucumber, soybean and zucchini and ABC disease of potato (Uyemoto 1981; Smith *et al.* 1988; Xi *et al.* 2008; Zitikaite and Staniulis 2009).	Yes
Grapevine fleck virus [Tymoviridae: Maculavirus]	Yes (AQSIQ 2006)	Yes Infects systemically. Present in fruit (Emmett and Hamilton 1994).	Yes Vic. (APPD 2009) Not recorded in WA (DAWA 2006). The movement of fruit into WA from eastern states, where *Grapevine virus B* occurs, is regulated.	No Not seed transmitted (CIHEAM 2006). Transmitted by grafting; no known arthropod vector (CIHEAM 2006).	Not assessed	No
NEGATIVE SENSE SINGLE-STRANDED RNA						
Tomato spotted wilt virus [Bunyaviridae: Tospovirus]	Yes (CABI 2009)	Yes Infects all parts of the plant (University of California 1992).	Yes NSW, NT, Qld, SA, Tas., Vic. (Persley *et al.* 2006); Qld, Vic. (APPD 2009); WA (Buchen-Osmond 2002).	Not assessed	Not assessed	No

Appendix A2 Sanitary pests

Pest	Present in China	Potential to be on pathway	Present within Australia	Potential sanitary risk
DOMAIN EUKARYA				
ANIMALIA (Animal Kingdom)				
Arthropoda				
Class: Arachnida				
Order Araneae				
Latrodectus mactans Urquhart, 1890 [Araneae: Theridiidae] Black widow spider	Yes Henan, Sichuan (Li 2008) No information found on this species being found in natural and agricultural environments in China. Provinces above are not listed as producing grapes for export.	Yes A spider was discovered in a box of Californian grapes by a greengrocer in Northern Ireland, was subsequently identified as an adult female of *L. mactans* (Ross 1988). In NZ *L. mactans* has been found in table grapes imported from California on multiple occasions (NZ Ministry of Health 2002).	No records found	Yes *Latrodectus mactans* is a well known poisonous spider (NZ Ministry of Health 2002).
Latrodectus tredecimguttatus Rossi 1790 [Araneae: Theridiidae] European black widow spider, karakurt	Yes Xinjiang Uyghur Autonomous Region, Yunnan, Inner Mongolia, Gansu (Chief Medical Network 2006; Yang *et al.* 2007). Widespread In Xinjiang in more than 20 cities and counties (Chief Medical Network 2006). AQSIQ (2009c) has advised that this spider has been reported from fields in Xinjiang but not associated with vineyards.	Yes A spider of this species recently found in a pack of seedless grapes (country of origin not specified) bought in a supermarket in the UK (Fresh Plaza 2008). Recorded as a significant hazard for farmers and field workers in vineyards (Mullen *et al.* 2009). In Xinjiang known from natural hillsides, farmland and orchards (Chief Medical Network 2006).	No records found	Yes *Latrodectus tredecimguttatus* is a poisonous spider, bites from which can place affected individuals in hospital (Díez García *et al.* 1996; Clinical Toxinology Resources 2007). Found from southern Europe south-west and central Asia to western and northern China (Duma 2006). In Central Asia it is a pest of pasture land and high densities can occur. Bites from this spider are reported to kill livestock such as cattle and camels (Tarabaev 1991; BBC 2004). In Xinjiang it is known to bite animals and people, especially farm workers (Chief Medical Network 2006; Yan *et al.* 2007).

Appendix B Additional quarantine pest data

Quarantine pest	***Tetranychus kanzawai* Kishida, 1927**[WA]
Synonyms	*Tetranychus hydrangeae* Pritchard & Baker, 1955
Common name(s)	Kanzawa spider mite, tea red spider mite, hydrangea spider mite (CSIRO and DAFF 2004c; CABI 2009)
Main hosts	*Arachis hypogaea* (groundnut), *Camellia sinensis* (tea), *Carica papaya* (papaw), *Citrus*, *Fragaria ananassa* (strawberry), *Glycine max* (soybean), *Hydrangea* (hydrangea), *Humulus lupulus* (hop), *Malus domestica* (apple), *Morus alba* (mora), *Prunus avium* (sweet cherry), *Prunus persica* (peach), *Pyrus communis* (European pear), *Solanum melongena* (aubergine), *Vitis vinifera* (grapevine) (CABI 2009).
Distribution	Presence in Australia: Yes (Queensland, NSW) (CSIRO and DAFF 2004c). Presence in China: Yes (Anhui, Fujian, Jiansu, Jiangxi, Jilian, Liaoning, Shaanxi, Shandong, Shanghai and Zhejiang) (Yang *et al.* 1991; Zhang *et al.* 1996a; Cao *et al.* 1998; EPPO 2006b; Takafuji and Hinomoto 2008; CABI 2009) . Presence elsewhere: *Tetranychus kanzawai* has been reported from a variety of environments including North America (Mexico), Africa (South Africa), Asia (China, India, Japan, Korea, Thailand, Indonesia) and Oceania (Australia, Papua New Guinea) (Migeon and Dorkeld 2006; CABI 2009).
Quarantine pest	***Harmonia axyridis* (Pallas, 1773)**
Synonyms	None
Common name(s)	Harlequin ladybird, Multicoloured Asian lady beetle
Main hosts	Predator of soft bodied insects (e.g. aphids, scales) (Koch 2003; Brown *et al.* 2008a) in a wide range of arboreal (broadleaf and conifer) and herbaceous habitats (Ker and Carter 2004; Koch *et al.* 2006). *Cucurbita moschata* (pumpkin), *Malus domestica* (apple), *Pyrus communis* (pear), *Prunus domestica* (plum), *Prunus persica* (peach), *Rubus* (raspberry) and *Vitis vinifera* (grape), (Koch and Galvan 2008; EPPO 2009)
Distribution	Presence in Australia: No record found Presence in China: Yes, from the northeast to the Himalayas (Komai and Chino 1969; Koch 2003; Su *et al.* 2009) Presence elsewhere: Argentina, Austria, Belarus, Belgium, Brazil, Canada, Czech Republic, Denmark, France, Germany, Greece, Hungary, Italy, Japan, Jersey, Korea, Luxemburg, Mexico, Netherlands, Norway, Poland, Portugal, Romania, and eastern Russia (Siberia), Serbia, Slovakia, Spain, Sweden, Switzerland, Ukraine, United Kingdom and USA (Komai and Chino 1969; de Almeida and da Silva 2002; Koch 2003; Koch *et al.* 2006; Roy and Roy 2008; Brown *et al.* 2008a; EPPO 2009; Su *et al.* 2009).
Quarantine pest	***Merhynchites* sp.**
Synonyms	None
Common name(s)	Grape berry weevil
Main hosts	*Vitis vinifera* (grape) (AQSIQ 2006; AQSIQ 2009b) and Amur grapes (*Vitis amurensis*) (Li 2004; AQSIQ 2009b).
Distribution	Presence in Australia: No record found (Zimmerman 1994). Presence in China: Yes (Li 2004; AQSIQ 2006). This species is restricted to north Shanxi in northern China (Li 2004; AQSIQ 2007; AQSIQ 2009b). Presence elsewhere: Various *Merhynchites* species also in USA (Harpootlian 2005; ITIS 2007).
Quarantine pest	***Popillia japonica* (Newman, 1838)**
Synonyms	*Popillia plicatipennis* Burmeister, 1844 Confused with *P. quadriguttata* in Korea (Lee *et al.* 2007).
Common name(s)	Japanese beetle, velvety chafer beetle
Main hosts	*Acer* spp. (maple), *Asparagus officinalis* (asparagus), *Betula populifera* (paper birch), *Glycine max* (soybean), *Hibiscus spp.* (hibiscus), *Juglans nigra* (black walnut), *Malus* spp. (apple), *Plananus acerifolia* (plane tree), *Populus nigra* (black poplar), *Prunus* spp. (stinkwood), *Rheum hybridum* (rhubarb), *Rosa* spp. (roses), *Ulmus* spp. (elm), *Vitis vinifera* (grapevine), *Zea mays* (maize) (Fleming 1972; CABI 2009). Total host range includes over 300 species (Potter and Held 2002).
Distribution	Presence in Australia: No record found. Presence in China: Yes; northern provinces of Heliojiang, Jilin, Zhejing, Gansu and Qinghai (CABI-EPPO 1997c; Gansu Academy of Agricultural Sciences 2010). Presence elsewhere: Japanese archipelago, Russian Federation (Kuril Islands, Amurland) (Löbl and Smetana 2006) and the USA (Fleming 1972).

Quarantine pest	***Popillia mutans* (Newman, 1838)[EP]**
Synonyms	*Popillia indigonacea* Motschulsky, 1854
Common name(s)	Tumble-bug
Main hosts	*Dimocarpus longan* (longan) (Tan *et al.* 1998; AQSIQ 2003a; AQSIQ 2003b), *Diospyros kaki* (sweet persimmon) (Lee *et al.* 2002), *Litchi chinensis* (lychee) and *Vitis vinifera* (Tan *et al.* 1998; AQSIQ 2003a; AQSIQ 2003b).
Distribution	Presence in Australia: No record found Presence in China: Yes (Li 2004) , all provinces, including Taiwan (Löbl and Smetana 2006). Presence elsewhere: French Indochina, Korea, northern India and Russia (Kim 1995; Anonymous 2003; Löbl and Smetana 2006; Lee *et al.* 2007).
Quarantine pest	***Popillia quadriguttata* (Fabricius, 1787) [EP]**
Synonyms	*Trichus biguttatus* Fabricius, 1794 *Popillia chinensis* Frivaldszky, 1890 *P. ruficollis* Kraatz, 1892 *P. uchidai* Niijima & Kinoshita, 1923 *P. bogdsanowi* Ballion, 1871 *P. castanoptera* Hope, 1843 *P. chinensis* Frivaldszky, 1890 *P. dichroa* Blanchard, 1851 *P. frivaldszkyi* Kraatz, 1892 *P. purpurascens* Kraatz, 1892 *P. sordida* Kraatz, 1892 *P. straminipennis* Kraatz, 1892 Previously confused with *P. japonica*; Korean specimens of *P. japonica* are apparently misidentified *P. quadriguttata* (Lee *et al.* 2007).
Common name(s)	Chinese rose beetle, white grub
Main hosts	*Acalypha australis* (Asian acalypha); *Arachis hypogaea* (peanut); *Artemisia princeps* var. *orientalis*; *Camellia sinensis* var. *sinensis* (Chinese tea); *Corylus heterophylla* (Siberian hazelnut); *Crataegus pinnatifida* (Chinese hawthorn); *Dimocarpus longan* (longan); *Dioscorea nipponica*; *Dioscorea septemloba*; *Diospyros kaki* (Japanese persimmon); *Glycine max* (soybean); *Hibiscus syriacus* (rose of Sharon); *Ilex crenata* (box-leaf holly, Japanese holly); *Ipomoea batatas* (sweet potato); *Ligustrum obtusifolium* (border privet); *Liriodendron tulipifera* (tulip tree); *Litchi chinensis* (lychee); *Malus* spp.; *Oenothera odorata* (fragrant evening primrose); *Platanus orientalis* (Oriental plane); *Populus simonii* (Chinese poplar); *Prunus* spp.; *Pteridium aquilinum* (bracken fern); *Punica granatum* (pomegranate); *Pyrus* spp.; *Quercus sp*; *Rubus* spp.; *Salix koreensis*; *Solanum* spp., including *S. tuberosum*; *Sorghum vulgare* (sorghum); *Tilia mandshurica* (Manchurian linden); *Wisteria floribunda* (Japanese wisteria); *Ulmus* spp.; *Vitis coignetiae* (crimson gloryvine); *Zanthoxylum* spp. and *Zea mays* (maize) (Sang 1979; Chung 1983; Yang *et al.* 1991; Tan *et al.* 1998; Lee *et al.* 2002; AQSIQ 2003a; AQSIQ 2003b).
Distribution	Presence in Australia: No record found Presence in China: Yes (Li 2004; Zhang 2005b; AQSIQ 2006) Presence elsewhere: Korea (Ku *et al.* 1999; Kim 2001), Taiwan and Vietnam (Kim 2001) and Russian Federation (Amurland) (Löbl and Smetana 2006).
Quarantine pest	***Bactrocera dorsalis* (Hendel, 1912)[EP]**
Synonyms	*Dacus dorsalis* Hendel, 1912 *Bactrocera conformis* Doleschall, 1858 (preocc.) *Chaetodacus dorsalis* (Hendel, 1912) *Chaetodacus ferrugineus dorsalis* (Hendel, 1912) *Chaetodacus ferrugineus okinawanus* (Shiraki, 1933) *Musca ferruginea* (Fabricius, 1794) *Musca ferruginea* Fabricius, 1794 (preocc.) *Strumeta dorsalis* (Hendel, 1912)
Common name(s)	Oriental fruit fly
Main hosts	*Aegle marmelos* (bael fruit), *Anacardium occidentale* (cashew), *Annona reticulata* (bullock's heart), *A. squamosa* (sugar apple), *Areca catechu* (betelnut palm), *Artocarpus altilis* (breadfruit), *A. heterophyllus* (jackfruit), *Capsicum annuum* (bell pepper), *Chrysophyllum cainito* (caimito), *Citrus maxima* (pummelo), *C. reticulata* (mandarin orange), *Coffea arabica* (arabica coffee), *Cucumis melo* (melon), *C. sativus* (cucumber), *Dimocarpus longan* (longan), *Ficus racemosa* (cluster fig), *Litchi chinensis* (lychee), *Malus pumila* (apple), *Mangifera foetida* (bachang mango), *M. indica* (mango), *Manilkara zapota* (sapodilla),

	Mimusops elengi (Asian bulletwood), *Momordica charantia* (bitter gourd), *Muntingia calabura* (Jamaican cherry), *Musa* sp. (banana), *Nephelium lappaceum* (rambutan), *Persea americana* (avocado), *Prunus armeniaca* (apricot), *P. avium* (gean), *P. cerasus* (sour cherry), *P. domestica* (plum, prune), *P. mume* (Japanese apricot), *P. persica* (peach), *Psidium guajava* (guava), *Punica granatum* (pomegranate), *Pyrus communis* (pear), *Syzygium aqueum* (water apple), *S. aromaticum* (clove), *S. cumini* (jambolan), *S. jambos* (rose apple), *S. malaccense* (Malay apple), *S. samarangense* (wax apple), *Terminalia catappa* (Indian almond), *Ziziphus jujuba* (jujube), *Ziziphus mauritiana* (Chinese date) (Tsuruta *et al.* 1997; Allwood *et al.* 1999), *Vitis vinifera* (grapevine) (Chu and Tung 1996).
Distribution	Presence in Australia: No record found Presence in China: The northernmost border of *B. dorsalis* distribution is 30 °N (± 2) degrees north latitude in China (Drew and Hancock 1994; Wu 2005). Presence elsewhere: Bangladesh, Bhutan, Brunei Darussalam, Cambodia, Christmas Island, French Guiana, Guam, Guyana, India, Indonesia, Japan, Laos, Malaysia, Myanmar, Nauru, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Suriname, Taiwan, Thailand, USA, Vietnam (Waterhouse 1993; Drew and Hancock 1994; CABI 2009).
Quarantine pest	***Cecidomyia* sp.**
Synonyms	*Retinodiplosis* sp. (CABI 2009)
Common name(s)	Grape midge
Main hosts	*Vitis vinifera* (grape) (Li *et al.* 2004).
Distribution	Presence in Australia: Uncertain, species of this genus occur in Australia (Bugledich 1999; APPD 2009). Presence in China: Jilin, Liaoning, Shaanxi, Shanxi (Li 2004; Zhang 2005b; AQSIQ 2007; AQSIQ 2009b). Presence elsewhere: North America, *Cecidomyia* sp., which causes grape blister galls and *Cecidomyia viticola*, the grape tube gallmaker, both occur in America (Williams *et al.* 2006). The damage caused suggests the American (Williams *et al.* 2006) *Cecidomyia* sp. may be a different species from the Chinese *Cecidomyia* sp.
Quarantine pest	***Aleurolobus taeonabe* (Kuwana, 1911)**
Synonyms	*Aleyrodes taeonabe* (Kuwana) *Aleyrodes taonaboe* (Kuwana) (Li 2004) *Aleurolobus taonabae* (Martin and Mound 2007) *Aleurolobus chinensis* Takahashi 1936 (Martin and Mound 2007; Lucid 2007)
Common name(s)	Grape whitefly
Main hosts	*Vitis vinifera* (grape), *Crataegus* spp., hawthorn (Li 2004), *Mallotus japonicus*, *Ternstroemia japonica* (Takahashi 1954). There are no reports of other host plants.
Distribution	Presence in Australia: No record found (Martin and Gillespie 2001). Presence in China: Hebei, Shanxi and Shandong (Li 2004) and Taiwan (Dubey and Ko 2009). Note: AQSIQ (2007) states that *Aleyrodes taeonabe* Kuwana is not recorded in China due to nomenclature difference. Presence elsewhere: Japan and India (Dubey and Ko 2009).
Quarantine pest	***Daktulosphaira vitifoliae* (Fitch, 1855)**
Synonyms	*Daktulosphaira vitifoliae* (Fitch) *Phylloxera vastatrix* Planchon *Phylloxera vitifoliae* (Fitch)
Common name(s)	Grapevine phylloxera, vine louse
Main hosts	The principal economic hosts are *Vitis* spp.
Distribution	Presence in Australia: New South Wales, Queensland, South Australia, Victoria (CABI 2009) Presence in China: Liaoning, Shaanxi, Shandong and Taiwan (CABI 2009; AQSIQ 2009b) . Presence elsewhere: Algeria, Argentina, Armenia, Austria, Azerbaijan, Bermuda, Bolivia, Bosnia and Herzegovina, Brazil, Bulgaria, Canada, Colombia, Croatia, Czech Republic, EU, France, Georgia, Germany, Greece (but not Crete), Hungary, India, Israel, Italy, Japan, Jordan, Korea Democratic People's Republic, Korea Republic, Lebanon, Luxembourg, Macedonia, Malta, Mexico, Moldova, Morocco, New Zealand, Panama, Peru, Portugal, Romania, Russia (southern), Slovakia, Slovenia, South Africa, Spain, Switzerland, Syria, Turkey, Tunisia, UK, Ukraine, Uruguay, USA, Venezuela, Yugoslavia, Zimbabwe (CABI 2009).
Quarantine pest	***Parthenolecanium* corni (Bouché, 1844)[EP, WA]**
Synonyms	*Coccus rosarum* Snellen van Volenhoven, 1862, *C. tiliae* Fitch, 1851, *Eulecanium corni corni* (Bouché); *E. fraxini* King, 1902, *E. guignardi* King, 1901, *E. kansasense* (Hunter) King, 1901, *E. rosae* King, 1901, *E. vini* (Bouché) Cockerell, 1901, *Lecanium* (*Eulecanium*) *armeniacum* Craw; Cockerell & Parrott, 1899, *L.*

	(E.) assimile Newstead; Reh, 1903, *L. (E.) aurantiacum* Hunter, 1900, *L. (E.) canadense* Cockerell; Cockerell & Parrott, 1899, *L. (E.) caryarum* Cockerell, 1898, *L. (E.) corylifex* Fitch; Cockerell, 1896, *L. (E.) crawii* Ehrhorn Cockerell & Parrott, 1899, *L. (E.) cynosbati* Fitch, Cockerell & Parrott, 1899, *L. (E.) fitchii* Cockerell & Parrott, 1899, *L. (E.) kingii* Cockerell, 1898, *L. (E.) lintneri* Cockerell & Bennett; Cockerell, 1895, *L. (E.) maclurarum* Cockerell, 1898, *L. (E.) ribis* Fitch, Cockerell & Parrott, 1899, *L. (E.) rugosum* Signoret; Cockerell, 1896, *L. (E.) rugosum* Signoret; Cockerell, 1896, *L. (E.) vini* Bouché, King & Reh, 1901, *L. adenostomae* Kuwana, 1901, *L. armeniacum* Craw, 1891, *L. assimile* Newstead, 1892, *L. canadense* Cockerell; Cockerell, 1899, *L. caryae canadense* Cockerell, 1895, *L. corni* Bouché, 1844, *L. corni robiniarum* Marchal, 1908, *L. coryli* (Linnaeus), Sulc, 1908 (misidentification), *L. corylifex* Fitch, 1857, *L. crawii* Ehrhorn, 1898, *L. cynosbati* Fitch, 1857, *L. fitchii* Signoret, 1872, *L. folsomi* King, 1903, *L. juglandifex* Fitch, 1857, *L. kansasense* Hunter, 1899, *L. lintneri* Cockerell & Bennett in Cockerell, 1895, *L. maclurae* Hunter, 1899, *L. obtusum* Thro, 1903, *L. persicae crudum* Green, 1917, *L. pruinosum armeniacum* Craw, Tyrell, 1896, *L. rehi* King in King & Reh, 1901, *L. ribis* Fitch, 1857, *L. robiniarum* Douglas, 1890, *L. rugosum* Signoret,1873, *L. tarsalis* Signoret, 1873, *L. vini* Bouché, 1851, *L. websteri* King, 1902, *L. wistariae* Signoret, 1873, *Parthenolecanium corni* (Bouché); Borchsenius, 1957, *P. coryli* (Linnaeus); Sulc, 1908 (misidentification) (CABI 2009).
Common name(s)	European fruit lecanium, brown scale, peach scale
Main hosts	*Parthenolecanium corni* is highly polyphagous, attacking some 350 plant species placed in 40 families. It attacks a wide range of crops, mostly woody fruit trees and ornamentals. Primary hosts are: *Crataegus* (hawthorns), *Malus* (ornamental species apple), *Prunus domestica* (damson), *Prunus persica* (peach), *Ribes nigrum* (blackcurrant), *Ribes rubrum* (red currant), *Rosa* (roses), *Vitis vinifera* (grapevine) (CABI 2009).
Distribution	Presence in Australia: Yes (except Western Australia) (CSIRO and DAFF 2004b). Presence in China: Yes (Zhang 2005b; AQSIQ 2006). Presence elsewhere: Afghanistan, Albania, Algeria, Argentina, Armenia, Austria, Azerbaijan, Belgium, Brazil, Bulgaria, Canada, Chile, Czech Republic, Denmark, Egypt, Finland, France, Georgia (Republic), Germany, Greece, Hungary, India, Iran, Italy, Japan, Kazakhstan, Korea (North), Korea (South), Kyrgyzstan, Latvia, Lebanon, Libya, Lithuania, Luxembourg, Malta, Mexico, Moldova, Mongolia, Netherlands, New Zealand, Norway, Pakistan, Peru, Poland, Portugal, Romania, Russian Federation, Serbia/Montenegro, Slovakia, Spain, Sweden, Switzerland, Syria, Tajikistan, Turkey, Turkmenistan, Ukraine, United Kingdom, USA, Uzbekistan, Yugoslavia (CABI 2009).
Quarantine pest	***Parthenolecanium orientalis* (Borchsenius, 1957)**
Synonyms	*Parthenolecanium corni orientalis* (Bouché, 1844)
Common name(s)	Scale
Main hosts	*Prunus* spp. (almonds, apricots, cherries, peaches and plums), *Ribes* (currants), *Salix* spp. (willow), *Wisteria chinensis* (Chinese wisteria) (Ben-Dov 2007), *Vitis vinifera* (grapevine) (Li 2004).
Distribution	Presence in Australia: No record found (Ben-Dov 2009a). Presence in China: Northeast China, north China, northwest China, east China, south China (Li 2004; AQSIQ 2007). Presence elsewhere: Korea (Ben-Dov 2007).
Quarantine pest	***Planococcus kraunhiae* (Kuwana, 1902)[EP]**
Synonyms	*Dactylopius kraunhiae* Kuwana, 1902 *Planococcus siakwanensis* Borchsenius, 1962 *Dactylopius krounhiae* Kuwana, 1917 *Planococcus kraunhiae* Ferris, 1950 *Pseudococcus kraunhiae* Fernald, 1903
Common name(s)	Japanese mealybug
Main hosts	*Actinidia* (kiwifruit), *Agave americana* (Century plant), *Artocarpus lanceolata*, *Broussonetia kazinoki* (Japanese paper mulberry), *Casuarina stricta* (she oak), *Citrus junos* (yuzu), *Citrus nobilis* (tangor), *Citrus paradisi* (grapefruit), *Codiaeum variegatum pictum* (variegated laurel), *Coffea arabica* (coffee), *Crinum asiaticum* (poison bulb), *Cucurbita moschata* (pumpkin), *Cydonia sinensis* (quince), *Digitaria sanguinalis* (crab-grass), *Diospyros* kaki (Japanese kaki), *Ficus carica* (fig), *Gardenia jasminoides* (common gardenia), *Ilex* (holly), *Magnolia grandiflora* (magnolia), *Mallotus japonicus* (green tiger lotus), *Morus alba* (white mulberry), *Musa basjoo* (Japanese banana), *Nandina domestica* (heavenly bamboo), *Nerium indicum* (Indian oleander), *Olea chrysophylla* (African olive), *Platanus orientalis* (oriental planetree), *Portulaca oleracea* (pigweeds), *Pyrus ussuriensis* (ornamental pear), *Rhododandron indicum* (azalea), *Trachycarpus exelsus fortunei* (wind-mill palm), *Wisteria floribunda* (Japanese wisteria) (Ben-Dov 1994).
Distribution	Presence in Australia: No record found (APPD 2009; ABRS 2009). Presence in China: Yes, Yunnan, Taiwan (Kawai 1980; Fang *et al.* 2001; Ben-Dov 2004). Presence elsewhere: Japan, Philippines, South Korea, USA (Ben-Dov 2004).

Quarantine pest	***Pseudococcus comstocki* (Kuwana, 1902)[EP]**
Synonyms	*Dactylopius comstocki* Kuwana, 1902
Common name(s)	Comstock's mealybug
Main hosts	*Aesculus* spp. (horse chestnut), *Aglaia odorata* (Chinese perfume tree), *Alnus japonica* (Japanese alder), *Amaryllis vittata*, *Artemisia*, *Buxus microphylla* (littleleaf boxwood), *Camellia japonica* (camellia), *Castanea* (chestnut), *Catalpa* (northern catalpa), *Celtis willdenowiana* (enoki), *Cinnamomum camphorae* (camphor tree), *Citrus* (citrus), *Crassula tetragona* (miniature pine tree), *Cydonia oblonga* (quince), *Cydonia sinensis* (Chinese quince), *Deutzia parviflora typical* (gaura), *Dieffenbachia picta* (dumb cane), *Erythrina indica* (rainbow eucalyptus), *Euonymus alatus* (winged euonymus), *Fatsia japonica* (Japanese aralia), *Ficus carica* (fig), *Fiwa japonica*, *Forsythia koreana* (forsythia), *Gardenia jasminoides* (gardenia), *Ginkgo biloba* (ginkgo), *Hydrangea* (hydrangea), *Ilex cornuta* (Chinese holly), *Ilex crenata microphylla* (Korean gem), *Kraunhia*, *Lagerstroemia indica* (crepe myrtle), *Ligustrum ibota angustifolium*, *Lonicera* (honeysuckle), *Loranthus* (mistletoe), *Malus pumila* (paradise apple), *Malus sylvestris* (crab apple), *Masakia japonica* (Japanese euonymus), *Monstera deliciosa* (monstera), *Morus alba* (white mulberry), *Musa* (bananas), *Nephelium lappaceum* (rambutan), *Opuntia dillenii* (prickly pear), *Orixa japonica* (Japanese orixa), *Pandanus* (screwpines), *Persica vulgaris* (peach), *Pinus thunbergiana* (Japanese black pine), *Populus* (poplar), *Prunus mume* (Japanese apricot), *Punica granatum* (pomegranate), *Pyrus communis* (European pear), *Pyrus serotina culta* (black cherry), *Rhamnus* (buckthorn), *Rhododendron mucronulatum* (Korean Rhododendron), *Sasamorpha* (bamboo), *Taxus* (yew), *Torreya nucifera* (Japanese torreya), *Trema orientalis* (nalita), *Viburnum awabucki* (acacia confuse), *Zinnia elegans* (zinnia) (Ben-Dov 2005a).
Distribution	Presence in Australia: No record found (APPD 2009; ABRS 2009). Presence in China: Beijing, Fujian, Guangdong, Hong Kong, Hunan, Inner Mongolia, Xizhang, Zhejiang (CABI 2009). Presence elsewhere: Afghanistan, Argentina, Armenia, Azerbaijan, Brazil, Canada, Canary Islands, Federated States of Micronesia, Indonesia, Iran, Italy, Japan, Kampuchea, Kazakhstan, Madeira Islands, Malaysia, Mexico, Northern Mariana Islands, Russia, Saint Helena, South Korea, Sri Lanka, Tajikistan, Turkmenistan, USA, Uzbekistan, Vietnam (Ben-Dov 2005a; Ben-Dov 2005b).
Quarantine pest	***Pseudococcus maritimus (*Ehrhorn, 1900)[EP]**
Synonyms	*Dactylopius maritimus* Ehrhorn, 1900 *Pseudococcus bakeri* Essig, 1910 *Pseudococcus omniverae* Hollinger, 1917
Common name(s)	Grape mealybug, Baker's mealybug, ocean mealybug
Main hosts	More than 80 hosts in more than 40 families, including *Citrus*, *Malus*, *Prunus*, *Pyrus*, *Vitis* spp. For a comprehensive list see (Ben-Dov 2009d).
Distribution	Presence in Australia: No record found (APPD 2009; ABRS 2009). Presence in the China: (Zhang 2005b; AQSIQ 2006). Presence elsewhere: Argentina, Armenia, Bermuda, Brazil, Canada, Chile, Colombia, French Guiana, Guatemala, Hungary, Indonesia, Mexico, Netherlands, Poland, Puerto Rico, Russia (CABI 2009; Ben-Dov 2009d).
Quarantine pest	***Eupoecilia ambiguella* (Hübner, 1796)**
Synonyms	*Clysia ambiguella* Hübner, 1796 *Cochylis ambiguella* Hübner, 1879 *Clysiana ambiguella* Hübner *Tinea ambiguella* Hübner, 1796 *Conchylis ambiguella* Hübner, 1796
Common name(s)	Grape moth, grape berry moth, grapevine moth, grape bud moth, vine moth
Main hosts	*Ampelopsis* (Virginia creeper), *Fraxinus* (ash), *Galium* (yellow bedstraw), *Prunus domestica* (plum), *Prunus salicina* (Japanese plum), *Prunus spinosa* (blackthorn), *Ribes nigrum* (blackcurrant), *Viburnum lantana*, *Vitis vinifera* (grapevine) (CABI 2009; INRA 2009).
Distribution	Present in Australia: No record found (Nielsen *et al.* 1996). Present in China: Guangdong, Jiangsu, Sichuan and Zhejiang (CABI 2009; Frolov 2009). Presence elsewhere: Armenia, Austria, Azerhaijan, Belgium, Brazil, Bulgaria, Czechoslovakia, Denmark, England, Finland, France, Georgia, Germany, Hungary, India, Italy, Japan, Kazakhstan, Kyrgyzstan, Latvia, Luxembourg, Moldova, Montenegro, Norway, Pakistan, Poland, Portugal, Romania, Russia, Serbia, Spain, Switzerland, Ukraine and Uzbekistan (CABI 2009; Frolov 2009).
Quarantine pest	***Nippoptilia vitis* (Sasaki, 1913)**
Synonyms	*Stenoptilia vitis* Sasaki (Anonymous 1935)

Common name(s)	Grape plume moth, Small grape plume moth
Main hosts	*Vitis vinifera* (Zhang 2005b).
Distribution	Presence in Australia: No record found (Nielsen *et al.* 1996). Presence in China: Yes, in Guangxi, Guizhou, Hebei, Henan, Jilin and Taiwan (Zheng *et al.* 1993; Wu and Li 1998; Li 2004; Zhang 2005b; AQSIQ 2006; AQSIQ 2007). Presence elsewhere: Japan (Hori 1933), Korea (APHIS 2004b).
Quarantine pest	***Stathmopoda auriferella* (Walker, 1864)[EP]**
Synonyms	*Gelechia auriferella* Walker, 1864 *Stathmopoda adulatrix* Meyrick, 1917 *Stathmopoda theoris* Meyrick, 1906
Common name(s)	Apple heliodinid
Main hosts	The larvae feed on the fruit, flowers and leaves of *Citrus unshiu* Marcow (unshu mandarin) in Japan (MAFF 2008). Other hosts include: *Acacia nilotica* (babul) (Robinson *et al.* 2007a), *Actinidia deliciosa* (kiwifruit) (Yamazaki and Sugiura 2003), *Albizia altissima* (Sonoran desert) (Robinson *et al.* 2007a), *Citrus reticulata* (mandarin) (Yamazaki and Sugiura 2003), *Citrus sinensis* (navel orange) (CABI 2009), *Cocos nucifera* (coconut palm), *Coffea canephora* (coffee), *Coffea liberica* (liberica coffee), *Helianthus annuus* (sunflower) (Yamazaki and Sugiura 2003), *Kerria communis* (lac scale) (Robinson *et al.* 2007a), *Malus pumila* var. domestica (fuji apple) (MAFF 2008), *Mangifera indica* (mango) (CABI 2009); *Persea* spp. (avocado) (Yamazaki and Sugiura 2003), *Nephelium ophiodes*, *Pinus roxburghii* (chir pine), *Prunus salicina*, *Prunus persica* (peach), *Prunus persica* var. nucipersica (nectarine), *Punica granatum* (pomegranate) (Yamazaki and Sugiura 2003), *Sorghum bicolor bicolor* (sorghum), *Tistania* sp. (Robinson *et al.* 2007a), *Vitis vinifera* (table grape) (Yamazaki and Sugiura 2003).
Distribution	Presence in Australia: No record found (Nielsen *et al.* 1996) Presence in China: Shanghai and Zhejiang (Hiramatsu *et al.* 2001; Shanghai Insect Science Network 2009). Presence elsewhere: Egypt (Badr *et al.* 1986) ; Greece (Nel and Nel 2003); India (Robinson *et al.* 2007a); Indonesia, Japan (Osaka City, Honshu) (Yamazaki and Sugiura 2003); Korea (Republic of) (Park *et al.* 1994); Malaysia, Pakistan, Philippines, Seychelles, Sri Lanka, Thailand (Robinson *et al.* 2007a).
Quarantine pest	***Frankliniella occidentalis* (Pergande, 1895)[EP, Tas, NT]**
Synonyms	*Euthrips helianthi* Moulton, 1911 *Euthrips tritici californicus* Moulton, 1911 *Frankliniella chrysanthemi* Kurosawa, 1941 *Frankliniella canadensis* Morgan, 1925 *Frankliniella claripennis* Morgan, 1925 *Frankliniella conspicua* Moulton, 1936 *Frankliniella dahliae* Moulton, 1948 *Frankliniella dianthi* Moulton, 1948 *Frankliniella nubila* Treherne, 1924 *Frankliniella occidentalis brunnescens* Priesner, 1932 *Frankliniella occidentalis dubia* Priesner, 1932 *Frankliniella syringae* Moulton, 1948 *Frankliniella trehernei* Morgan, 1925 *Frankliniella tritici maculata* Priesner, 1925 *Frankliniella tritici moultoni* Hood, 1914 *Frankliniella umbrosa* Moulton, 1948 *Frankliniella venusta* Moulton, 1936
Common name(s)	Western flower thrips
Main hosts	*Allium cepa* (onion), *Amaranthus palmeri* (Palmer amaranth), *Arachis hypogaea* (groundnut), *Begonia*, *Beta vulgaris* (beetroot), *Beta vulgaris* var. *saccharifera* (sugarbeet), *Brassica oleracea* var. capitata (cabbage), *Capsicum annuum* (capsicum), *Carthamus tinctorius* (safflower), *Chrysanthemum morifolium* (chrysanthemum), *Citrus x paradisi* (grapefruit), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita maxima* (giant pumpkin), *Cucurbita pepo* (ornamental gourd), *Cyclamen*, *Dahlia*, *Daucus carota* (carrot), *Dianthus caryophyllus* (carnation), *Euphorbia pulcherrima* (poinsettia), *Ficus carica* (fig), *Fragaria ananassa* (strawberry), *Fuchsia*, *Geranium* (cranesbill), *Gerbera jamesonii* (African daisy), *Gladiolus hybrids* (sword lily), *Gossypium* (cotton), *Gypsophila* (baby's breath), *Hibiscus* (rosemallows), *Impatiens* (balsam), *Kalanchoe*, *Lactuca sativa* (lettuce), *Lathyrus odoratus* (sweet pea), *Leucaena leucocephala* (leucaena), *Limonium sinuatum* (sea pink), *Lisianthus*, *Lycopersicon esculentum* (tomato), *Malus domestica* (apple), *Medicago sativa* (lucerne), *Orchidaceae* (orchids), *Petroselinum crispum* (parsley),

	Phaseolus vulgaris (common bean), *Pisum sativum* (pea), *Prunus armeniaca* (apricot), *Prunus domestica* (plum), *Prunus persica* (peach), *Prunus persica* var. nucipersica (nectarine), *Purshia tridentata* (bitterbrush), *Raphanus raphanistrum* (wild radish), *Rhododendron* (Azalea), *Rosa* (roses), *Saintpaulia ionantha* (African violet), Salvia (sage), *Secale cereale* (rye), *Sinapis arvensis* (wild mustard), *Sinningia speciosa* (gloxinia), *Solanum melongena* (aubergine), *Sonchus* (Sowthistle), *Syzygium jambos* (rose apple), *Trifolium* (clovers), *Triticum aestivum* (wheat), *Vitis vinifera* (grapevine) (CABI 2009).
Distribution	Presence in Australia: New South Wales, Queensland, South Australia, Western Australia, Tasmania, Victoria (CABI 2009; ABRS 2009) Presence in China: Beijing, Yunnan (Ren 2006; Wu *et al.* 2009) Presence elsewhere: Albania, Algeria, Argentina, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Estonia, Finland, France, Germany, Greece, Guana, Guatemala, Hungary, Ireland, Israel, Japan, Kenya, Korea (Republic), Kuwait, Lithuania, Macedonia, Malaysia, Malta, Martinique, Mexico, Morocco, Netherlands, New Zealand, Norway, Peru, Poland, Portugal, Puerto Rico, Romania, Russia, Serbia/Montenegro, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Swaziland, Sweden, Switzerland, United Kingdom, USA, Turkey, Uruguay, Venezuela, Zimbabwe (CABI 2009).
Quarantine pest	***Rhipiphorothrips cruentatus* Heed, 1919[EP]**
Synonyms	*Rhipiphorothrips karna* Ramakrishna 1928
Common name(s)	Grapevine thrips, rose thrips
Main hosts	*Anacardium occidentale* (cashew nut), *Annona squamosa* (sugarapple), *Mangifera indica* (mango), *Psidium guajava* (guava), *Punica granatum* (pomegranate), *Rosa rugosa* (Rugosa rose), *Syzygium cumini* (black plum), *Syzygium samarangense* (water apple), *Terminalia catappa* (Singapore almond), *Vitis vinifera* (grapevine) (CABI 2009).
Distribution	Presence in Australia: No record found (ABRS 2009). Presence in China: Guangdong, Hainan (CABI 2009). Presence elsewhere: Afghanistan, Bangladesh, India, Oman, Myanmar, Pakistan, Sri Lanka and Thailand (CABI 2009).
Quarantine pest	***Physalospora baccae* sensu Nishikado non Cavara**
Synonyms	There has been some debate about the taxonomy of *Physalospora baccae*. The name *Physalospora baccae* Cavara is a nomen dubium of unknown application. There is therefore no way of establishing that the grape pathogen to which this name is applied in Japan and Korea is the same as the original European pathogen. The grape pathogen should be designated as '*Physalospora baccae* sensu Asian authors' (Pennycook 2009). Japanese usage appears to be based on studies such as Nishikado (1921), which applied old and outdated taxonomic concepts. However, '*Physalospora baccae* sensu Nishikado non Cavara' has been listed in NIAS Genebank as the current name for *Physalospora baccae* recorded in Japan. In China, *Physalospora baccae* Cavara has been known as a synonym of *Guignardia baccae* (Cav.) Trcz. (Qi *et al.* 2007), which itself is not a valid name. *Guignardia baccae* (Cav.) Trcz was included in the pest list provided by AQSIQ (2006).
Common name(s)	Grape cluster black rot
Main hosts	Host range is *Vitis* spp. (Zhang 2005b; NYZSW 2009).
Distribution	Presence in Australia: No record found (APPD 2009). Presence in China: *Physalospora baccae* is present across the major grape growing regions of China (Zhang 2005b; NYZSW 2009). Presence elsewhere: Besarabia, Japan, Portugal, South Korea, Spain (Nishikado 1921; Bensaude 1926; Berro Aguilera 1926; Vekesciaghin 1933; Shin *et al.* 1984).
Quarantine pest	***Greeneria uvicola* (Berk. & M.A. Curtis) Punith.[WA]**
Synonyms	Some taxonomic confusion exists; in some cases *Guignardia bidwellii* is stated to be the teleomorph of *G. uvicola* but these are separate fungi regions (Steel 2007) and in older literature, *G. uvicola* is referred to as *Melanconium fuligineum*. *Greeneria uvicola* has not been assigned to a family (Mycobank 2009).
Common name(s)	Bitter rot, ripe rot of grape
Main hosts	The primary host of *G. uvicola* is the muscadine grape, *Vitis rotundifolia*, but other *Vitis* spp. are also susceptible, including *V. vinifera*, *V. bourquiniana*, *V. labrusca*, *V. munsoniana*, as is apple (*Malus pumila*). No other natural hosts are known but *G. uvicola* can infect a number of other fruit including cherry, strawberry, peach and banana under experimental conditions (Ridings and Clayton 1970).
Distribution	Presence in Australia: Reported from north-eastern New South Wales on wine grapes, and table grapes at Mundubbera in Queensland (Castillo-Pando *et al.* 1999; Sergeeva *et al.* 2001). Presence in China: Reported in southern part of Jiangsu province (Yan *et al.* 1998). Presence elsewhere: Brazil, Costa Rica, Cuba, India, South Africa, USA (Sutton and Gibson 1977; Ullasa and Rawal 1986; Kummuang *et al.* 1996b; Yan *et al.* 1998; Steel 2007).
Quarantine pest	***Guignardia bidwellii* (Ellis) Viala & Ravaz**

Synonyms	*Phyllosticta ampelicida* (Engelm.) Aa, *Phoma uvicola* Berk. & M.A. Curtis, *Naemospora ampelicida* Englem., *Phoma ustulata* Berk. & M.A. Curtis, *Depazea labruscae* Englem., *Phoma uvicola* var. labruscae Thüm, *Phyllosticta viticola* Thüm, *Septoria viticola* Berk. & M.A. Curtis, *Sacidium viticolum* Cooke, *Phyllosticta ampelopsidis* Ellis & Martin, *Phyllosticta vulpinae* Allesch., *Phyllostictina uvicola* (Berk. & M.A. Curtis) Hohn., *Phyllostictina clemensae* Petr., *Phyllostictina viticola* (Berk. & M.A. Curtis) Petr., *Sphaeria bidwellii* Ellis, *Laestadia bidwellii* (Ellis) Viala & Ravaz, *Physalospora bidwellii* (Ellis) Sacc., *Carlia bidwellii* (Ellis) Prunet, *Botryosphaeria bidwellii* (Ellis) Petr. (CABI 2009).
Common name(s)	Black rot
Main hosts	*Ampelopsis* (wild grape), *Asplenium nidus* (bird's nest fern), *Cissus* (ornamental vine), *Citrus*, *Parthenocissus quinquefolia* (Virginia creeper), *Vitis arizonica* (canyon grape), *Vitis labrusca* (fox grape), *Vitis vinifera* (grapevine) (CABI 2009).
Distribution	Presence in Australia: No. One record in 1897 from an unknown location (APPD 2009). Presence in China: Yes, Henan, Jiangsu, Liaoning, Shandong, Sichuan, Xinjiang (AQSIQ 2006; AQSIQ 2007; CABI 2009) and Taiwan (CABI 2009). Presence elsewhere: Argentina, Austria, Barbados, Brazil, Bulgaria, Canada, Chile, Cuba, Cyprus, El Salvador, Former Yugoslavia, France, Germany, Guyana, Haiti, India, Iran, Italy, Jamaica, Japan, Korea, Martinique, Mexico, Morocco, Mozambique, Pakistan, Panama, Philippines, Romania, Russian Federation, Slovakia, Sudan, Switzerland, Turkey, Ukraine, Virgin Islands (US), Uruguay, USA and Venezuela (CABI 2009).
Quarantine pest	***Alternaria viticola* Brunaud**
Synonyms	None known
Common name(s)	Spike-stalk brown spot
Main hosts	*Vitis* spp. including some multispecies hybrid grapes (Ma *et al.* 2004; Zhang 2005b).
Distribution	Presence in Australia: No record found (APPD 2009). Presence in China: Anhui, Beijing (Zhang 2005b), Hebei, Henan, Hunan, Liaoning, Shandong and Shanghai (Grapevinewine 2003), Liaoning, Shandong, Hunan (AQSIQ 2007) and Xinjiang (Ma *et al.* 2004). Presence elsewhere: No records.
Quarantine pest	***Monilinia fructigena* (Aderh. & Ruhland) Honey** [EP]
Synonyms	*Monilia fructigena* Schumach, *Sclerotinia fructigena* (J. Schröt.) Norton, *Sclerotinia fructigena* Aderh, *Stromatinia fructigena* (J. Schröt.) Boud (Ma 2006; CABI 2009).
Common name(s)	Apple brown rot
Main hosts	*Amelanchier canadensis* (thicket serviceberry), *Berberis* (barberries), *Capsicum* (peppers), *Cornus mas* (cornelian cherry), *Corylus avellana* (hazel), *Cotoneaster*, *Crataegus laevigata*, *Cydonia oblonga* (quince), *Diospyros kaki* (persimmon), *Eriobotrya japonica* (loquat), *Ficus carica* (fig), *Fragaria* spp., *Lycopersicon esculentum* (tomato), *Malus domestica* (apple), *Mespilus germanica* (medlar), *Prunus* spp. (stone fruit), *Psidium guajava* (guava), *Pyrus* spp. (pears), *Rhododendron* (Azalea), *Rosa* (roses), *Rubus* spp. (blackberry, raspberry), *Sorbus*, *Vaccinium* (blueberries), *Vitis vinifera* (grapevine) (Ma 2006; CABI 2009).
Distribution	Presence in Australia: No record found (APPD 2009). Presence in China: Anhui, Henan, Hubei, Hunan, Jiangsu, Liaoning, Shaanxi, Shandong, Shanxi, Sichuan, Yunnan and Zhejiang provinces and Taiwan (CIQSA 2001a; CIQSA 2001b; AQSIQ 2005; Ma 2006; AQSIQ 2007). Presence elsewhere: Afghanistan, Armenia, Austria, Azerbaijan, Belarus, Belgium, Brazil, Bulgaria, Chile, Croatia, Cyprus, Czech Republic, Denmark, Egypt, Finland, France, Georgia, Germany, Greece, Hungary, India, Iran, Ireland, Israel, Italy, Japan, Latvia, Lebanon, Lithuania, Luxembourg, Moldova, Montenegro, Morocco, Nepal, North Korea, Norway, Netherlands, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, Uruguay, Uzbekistan, Yugoslavia (CABI 2009).
Quarantine pest	***Phakopsora euvitis* Y. Ono**
Synonyms	*Aecidium meliosmae-myrianthae* Henn. & Shirae *Phakopsora ampelopsidis* pro parte *Physopella ampelopsidis* pro parte *Physopella vialae* (Lagerh.) Buriticá & J.F. Hennen *Physopella vitis* (Thüm.) Arthur *Uredo vialae* Largerh *Uredo vitis* Thüm
Common name(s)	Grapevine rust
Main hosts	*Vitis* spp. (mainly *V. labrusca*, *V. vinifera*, but also *V. amurensis*, *V. coignetiae*, *V. ficifolia*, *V. flexuosa*).

	Phakopsora euvitis is a heteroecious rust. Pycnidia and aecia have only been observed in Japan on *Meliosma myriantha*. In most other areas, only uredia and telia are produced.
Distribution	Presence in Australia: In 2001, *P. euvitis* was reported in Australia in the Northern Territory but has been eradicated (DAFF 2009). Presence in China: Anhui, Gansu, Guangdong, Guangxi, Guizhou, Hong Kong, Hunan, Jiangsu, Jiangxi, Shaanxi, Shandong, Sichuan and Taiwan (AQSIQ 2009b). Presence elsewhere: Bangladesh, Barbados, Brazil, Colombia, Costa Rica, Cuba, Democratic People's Republic of Korea, Guatemala, India, Indonesia, Jamaica, Japan, Korea, Malaysia, Myanmar, Nepal, Philippines, Puerto Rico, Russian Far East, Sri Lanka, Thailand, Trinidad and Tobago, USA, Venezuela, Vietnam, Virgin Islands (CABI 2009).
Quarantine pest	***Phomopsis viticola* (Sacc.)**[EP, WA]
Synonyms	*Phoma viticola* Sacc., *Phoma flaccida* Viala & Ravaz, *Cryptosporella viticola* Shear, *Diaporthe viticola* Nitschke, *Fusicoccum viticolum* Reddick, *Diplodia viticola* Desm. (CABI 2009).
Common name(s)	Phomopsis cane and leaf spot, Phomopsis cane and leaf blight, grapevine black knot, grapevine necrosis, grapevine dead arm (CABI 2009).
Main hosts	*Ampelopsis quiquefolia*, *Parthenocissus quinquefolia* (Virginia creeper), *Vitis aestivalis* (summer grape), *Vitis labrusca* (fox grape), *Vitis rotundifolia* (Muscadine grape), *Vitis rupestris* (North American grapevine) and *Vitis vinifera* (Eurasian grapevine) (CABI 2009).
Distribution	Presence in Australia: New South Wales, Victoria and South Australia but not in Western Australia (Merrin *et al.* 1995); Queensland (APPD 2009); Tasmania (Mostert *et al.* 2001). Presence in China: Liaoning, Shandong and Hunan provinces (AQSIQ 2007); present in all grape production areas (Zhang 2005b). Presence elsewhere: Austria, Belgium, Bosnia/Herzegovina, Brazil, Brunei Darussalam, Bulgaria, Canada, Chile, Croatia, Egypt, France, Georgia, Germany, Greece, Hungary, India, Italy, Japan, Kenya, Macedonia, Mexico, Moldova, Netherlands, New Zealand, Poland, Portugal, Romania, Russian Federation, Serbia/Montenegro, Slovenia, South Africa, Spain, Switzerland, Turkey, Ukraine, United Kingdom, USA, Venezuela, Yugoslavia, Zimbabwe (Hewitt and Pearson 1988; CABI 2009).
Quarantine pest	**Tobacco necrosis viruses**
Synonyms	(The names below are used for distinct necrovirus species that have been called 'tobacco necrosis virus') *Chenopodium necrosis virus*, *Olive mild mosaic virus*, *Tobacco necrosis virus A*, *Tobacco necrosis virus D*, *Tobacco necrosis virus Nebraska isolate*
Common name(s)	Tobacco necrosis virus
Main hosts	*Brassica oleracea* (cabbage), *Chenopodium quinoa* (quinoa), *Cucumis sativus* (cucumber), *Cucurbita pepo* (zucchini), *Daucus carota* (carrot), *Fragaria* × *ananassa* (strawberry), *Glycine max* (soybean), *Malus pumila* (apple), *Nicotiana tabacum* (tobacco), *Lactuca sativa* (lettuce), *Olea europaea* (olive), *Phaseolus vulgaris* (common bean), *Solanum tuberosum* (potato), *Tulipa* sp. (tulip) (other hosts are infected but remain symptomless) (Kassanis 1970; Brunt and Teakle 1996; CABI 2009; Zitikaite and Staniulis 2009).
Distribution	Presence in Australia: Queensland and Victoria (Finlay and Teakle 1969; Teakle 1988). Presence in China: Probably widespread but species and strain distributions are unknown; recorded in Jiangsu and Xinjiang (Huang *et al.* 1984; Xi *et al.* 2008). Presence elsewhere: (probably worldwide but species and strain distributions are largely unknown) Belgium, Brazil, Canada, China, Czechoslovakia (former), Denmark, Finland, France, Germany, Hungary, India, Italy, Japan, Latvia, Netherlands, New Zealand, Norway, Romania, Russia, South Africa, Spain, Sweden, Switzerland, Turkey, United Kingdom (CABI 2009).
Sanitary pest	***Latrodectus mactans* (Fabricius, 1775)**[EP]
Synonyms	*Aranea mactans* Fabricius, 1775 *Meta schuchii* C. L. Koch, 1836 *Latrodectus insularis* Dahl, 1902 *Latrodectus insularis lunulifer* Dahl, 1902 *Latrodectus sagittifer* Dahl, 1902 *Latrodectus hahli* Dahl, 1902 *Latrodectus luzonicus* Dahl, 1902 *Latrodectus albomaculatus* Franganillo, 1930 *Latrodectus agoyangyang* Plantilla & Mabalay, 1935 *Latrodectus mactans mexicanus* Gonzalez, 1954
Common name(s)	Black widow spider, Southern black widow

Main hosts	Insectivore; Insects (flies, mosquitoes, locusts, grasshoppers, beetles and caterpillars) and also wood lice, diplopods, chilopods and other arachnids (McCorkle 2002). *Latrodectus mactans* is not a phytosanitary pest associated with table grapes. It may be a sanitary issue for imported table grapes as spiders may be found in and around vineyards as they prey on insect pests that are found associated with grapes (Furness 1994). This might have implications on humans and animals as although *L. mactans* is not aggressive to humans, the female's venom can have serious consequences for the very young or elderly (McCorkle 2002).
Distribution	Presence in Australia: No record found (APPD 2009). Presence in China: Henan and Sichuan (Li 2008) Hainan, Taiwan (Catalogue of Life China 2010) Presence elsewhere: Canada, Chile, Mexico, the West Indies and USA (Schenone and Correa 1985; McCorkle 2002; Clinical Toxinology Resources 2010).
Sanitary pest	***Latrodectus tredecimguttatus* (Rossi, 1790)**
Synonyms	*Latrodectus 13decimguttatus* Walckenaer 1805 *Latrodectus argus* Audouin 1826 *Latrodectus erebus* Audouin 1826 *Latrodectus hispidus* C. L. Koch 1837 *Latrodectus 5-guttatus* Krynicki 1837 *Latrodectus quinguttatus* *Latrodectus malmignatus* Walckenaer 1837 *Latrodectus martius* Walckenaer 1837 *Latrodectus oculatus* Walckenaer 1837 *Latrodectus venator* Walckenaer 1837 *Latrodectus 13-guttatus* C. L. Koch 1837 *Latrodectus conglobatus* C. L. Koch 1837 *Latrodectus lugubris* Motschulsky 1849 *Latrodectus tredecimguttatus lugubris* Thorell 1875 *Latrodectus mactans* (Fabricius, 1775) *Latrodectus mactans tredecimguttatus* Fuhn 1966
Common name(s)	European black widow spider, Mediterranean black widow or steppe spider
Main hosts	*Latrodectus tredecimguttatus* is not a phytosanitary pest associated with table grapes. However, it may be a sanitary issue for imported table grapes, which might have implications on human and animals. This species primarily lives in steppes and other grasslands, and can be a significant problem in areas where grain is harvested by hand.
Distribution	Presence in Australia: No record found (APPD 2009). Presence in China: Indigenous to some areas of the Xinjiang (Yang *et al.* 2007). Presence elsewhere: It is commonly found throughout the Mediterranean region, ranging from Spain to southwest and central Asia, hence the name (Duma 2006).

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[8], 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.

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

[8] The Australian Government Department of Health and Ageing is responsible for human health aspects of quarantine.

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, Fisheries and Forestry 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 Biosecurity Services Group (BSG) within the Department takes the lead in biosecurity and quarantine policy development and implementation of risk management measures across the biosecurity continuum, and:

- through Biosecurity Australia, conducts risk analyses, including IRAs, and develops recommendations for biosecurity policy as well as providing quarantine advice to the Director of Animal and Plant Quarantine
- through the Australian Quarantine and Inspection Service (AQIS), 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 and
- 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 BSG 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 good being imported or proposed for importation, Biosecurity Australia 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 and Ageing 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. Biosecurity Australia 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, Water, Heritage and the Arts (DEWHA) 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 DEWHA directly for further information.

When undertaking risk analyses, Biosecurity Australia consults with DEWHA about environmental issues and may use or refer to DEWHA'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 at www.comlaw.gov.au.

International agreements and standards

The process set out in the *Import Risk Analysis Handbook 2007 (update 2009)* 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, Biosecurity Australia:

- identifies the pests and diseases of quarantine concern that may be carried by the good
- assesses the likelihood that an identified pest or disease or pest 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, Biosecurity Australia 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 Biosecurity Australia'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. Biosecurity Australia's assessment of risk may also take the form of a non-regulated analysis of existing policy or technical advice to AQIS. Further information on the types of risk analysis is provided in the *Import Risk Analysis Handbook 2007 (update 2009)*.

Glossary

Term or abbreviation	Definition
Additional declaration	A statement that is required by an importing country to be entered on a phytosanitary certificate and which provides specific additional information on a consignment in relation to regulated pests (FAO 2009).
Appropriate level of protection (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 2009).
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 2009).
Biosecurity Australia	The unit, within the Biosecurity Services Group, responsible for recommendations for the development of Australia's biosecurity policy.
Biosecurity Services Group (BSG)	The group responsible for the delivery of biosecurity policy and quarantine services within the Department of Agriculture, Fisheries and Forestry.
Certificate	An official document which attests to the phytosanitary status of any consignment affected by phytosanitary regulations (FAO 2009).
Consignment	A quantity of plants, plant products and/or other articles being moved from one country to another and covered, when required, by a single phytosanitary certificate (a consignment may be composed of one or more commodities or lots) (FAO 2009).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO 2009).
Endangered area	An area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss (FAO 2009).
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO 2009).
Establishment	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2009).
Fresh	Living; not dried, deep-frozen or otherwise conserved (FAO 2009).
Host range	Species capable, under natural conditions, of sustaining a specific pest or other organism (FAO 2009).
Import permit	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2009).
Import risk analysis	An administrative process through which quarantine policy is developed or reviewed, incorporating risk assessment, risk management and risk communication.
Infestation (of a commodity)	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2009).
Inspection	Official visual examination of plants, plant products or other regulated articles to determine if pests are present and/or to determine compliance with phytosanitary regulations (FAO 2009).
Intended use	Declared purpose for which plants, plant products, or other regulated articles are imported, produced, or used (FAO 2009).
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment (FAO 2009).
International Standard for Phytosanitary Measures (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 2009).
Introduction	The entry of a pest resulting in its establishment (FAO 2009)
Lot	A number of units of a single commodity, identifiable by its homogeneity of composition, origin etc., forming part of a consignment (FAO 2009).
National Plant Protection Organization (NPPO)	Official service established by a government to discharge the functions specified by the IPPC (FAO 2009).
Official control	The active enforcement of mandatory phytosanitary regulations and the application of mandatory phytosanitary procedures with the objective of eradication or containment of quarantine pests or for the management of regulated non-quarantine pests (FAO 2009).

Term or abbreviation	Definition
Pathway	Any means that allows the entry or spread of a pest (FAO 2009).
Pest	Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2009).
Pest categorisation	The process for determining whether a pest has or has not the characteristics of a quarantine pest or those of a regulated non-quarantine pest (FAO 2009).
Pest free area (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 2009).
Pest free place of production	Place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period (FAO 2009).
Pest free production site	A defined portion of a place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this conditions is 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 2009).
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 2009).
Pest risk assessment (for quarantine pests)	Evaluation of the probability of the introduction and spread of a pest and of the associated potential economic consequences (FAO 2009).
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2009).
Phytosanitary certificate	Certificate patterned after the model certificates of the IPPC (FAO 2009).
Phytosanitary measure	Any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO 2009).
Phytosanitary regulation	Official rule to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests, including establishment of procedures for phytosanitary certification (FAO 2009).
Polyphagous	Feeding on a relatively large number of hosts from different genera.
PRA area	Area in relation to which a pest risk analysis is conducted (FAO 2009).
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO 2009).
Regulated article	Any plant, plant product, storage place, packing, conveyance, container, soil and any other organism, object or material capable of harbouring or spreading pests, deemed to require phytosanitary measures, particularly where international transportation is involved (FAO 2009).
Restricted risk	Risk estimate with phytosanitary measure(s) applied.
Spread	Expansion of the geographical distribution of a pest within an area (FAO 2009).
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures (WTO 1995).
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.
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 (FAO 2009).
Unrestricted risk	Unrestricted risk estimates apply in the absence of risk mitigation measures.

References

ABARE (2006) *Agriculture in China: developments and significance for Australia*. 06.2, Australian Bureau of Agricultural and Resource Economics, Canberra.

ABRS (2009) Australian faunal directory. Australian Biological Resources Study: Australian Faunal Directory. http://www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/index.html (Accessed 10 December 2009).

ABS (2009a) *Agricultural commodities*. 7121.0, Australian Bureau of Statistics, Canberra.

ABS (2009b) *Australia: exports 080610 grapes, fresh*. Australian Bureau of Statistics, Canberra.

ABS (2009c) Australian Wine and Grape Industry 2008: re-issue. Australian Bureau of Statistics. www.abs.gov.au (Accessed 5 January 2010).

Ades GWJ, Kendrick RC (2004) *Hong Kong fauna: a checklist of selected taxa*. Fauna Conservation Department, Kadoorie Farm and Botanic Garden, Hong Kong.

Ades GWJ, Kendrick RC (2001) *Hong Kong fauna: a checklist of selected taxa*. Geocarto International Centre, Hong Kong.

Afshari R, Khadem-Rezaiyan M, Balali-Mood M (2009) Spider bite (latrodectism) in Mashhard, Iran. *Human and Experimental Toxicology* 28: 697-702.

Agrios GN (1997) *Plant pathology*. Academic Press, San Diego.

Albrechtsen SE (2006) Appendix 1: list of seed-transmitted viruses and viroids. In *Testing methods for seed-transmitted viruses: principles and protocols* pp. 241-246. CAB International, Wallingford.

Alcock J (1971) The behavior of a stinkbug, *Euschistus conspersus* Uhler (Hemiptera: Pentatomidae). *Psyche* 78: 215-228.

Allwood AJ, Chinajariyawong A, Kritsaneepaiboon S, Drew RAI, Hamacek EL, Hancock DL, Hengsawad C, Jipanin JC, Jirasurat M, Krong CK, Leong CTS, Vijaysegaran S (1999) Host plant records for fruit flies (Diptera: Tephritidae) in Southeast Asia. *Raffles Bulletin of Zoology* 47: 12-16.

Ames T, Smit NEJM, Braun AR, O'Sullivan JN, Skoglund LG (1997) *Sweet potato: major pests, diseases, and nutritional disorders*. International Potato Center, Lima.

An Identification Guide of Japanese Moths (2009) *Trichosea champa* (Moore). http://www.jpmoth.org/~dmoth/79_Panteidae/3403%20Trichosea%20champa/Trichosea%20champa.htm (Accessed 13 January 2010).

ANBG (2009) Australia's virtual herbarium. Australian National Botanic Gardens. http://www.anbg.gov.au/avh/ (Accessed 20 November 2009).

Anonymous (2003) Check list of the Oriental Popillia. http://www3.famille.ne.jp/~kazuo/popi.html (Accessed 15 January 2010).

ANPSA (2010) *Pittosporum undulatum*. Australian Native Plants Society. http://asgap.org.au/p-und.html (Accessed 19 January 2010).

APHIS (2002) *Importation of grapes (Vitis spp.) from Korea into the United States: a qualitative, pathway-initiated pest risk assessment*. United States Department of Agriculture, Riverdale.

APHIS (2003) Plant protection and quarantine: Asian gypsy moth. http://www.aphis.usda.gov/publications/plant_health/content/printable_version/fs_phasiangm.pdf (Accessed 2009).

APHIS (2004a) '7 CFR part 319 importation of fruits and vegetables: grapes from South Korea. *Federal Register* 69: 65053-65067.

APHIS (2004b) Importation of fruits and vegetables: rules and regulations. United States Department of Agriculture. http://a257.g.akamaitech.net/7/257/2422/06jun20041800/edocket.access.gpo.gov/2004/pdf/04-55525.pdf (Accessed 31 March 2009).

APHIS (2008) Japanese beetle (*Popillia japonica* Newman). United States Department of Agriculture. http://www.aphis.usda.gov/plant_health (Accessed 28 July 2008).

APPD (2009) Australian Plant Pest Database. Australian Plant Pest Database, Plant Health Australia. http://www.planthealthaustralia.com.au/site/project_details.asp?ID=1&Category=4 (Accessed 2009).

Apple and Pear Australia Limited (2010) Apal. http://www.apal.org.au/index.cfm (Accessed 21 January 2010).

APVMA (2009) *Permit to allow minor use of a registered AGVET chemical product: for the control of Phylloxera in table grapes*. Australian Pesticides and Veterinary Medicines Authority, Symonston.

AQIS (1998a) *Final import risk analysis of the importation of fruit of Fuji apple (Malus pumila Miller var. domestica Schneider) from Aomori prefecture in Japan*. Australian Quarantine and Inspection Service, Canberra.

AQIS (1998b) *Final import risk analysis of the importation of fruit of Ya pear (Pyrus bretschneideri Redh.) from the People's Republic of China (Hebei and Shandong Provinces)*. Australian Quarantine and Inspection Service, Canberra.

AQIS (1999) *Final import risk analysis on the importation of fresh fruit of Korean pear (Pyrus ussuriensis var. viridis T. Lee) from The Republic of Korea*. Australian Quarantine and Inspection Service, Canberra.

AQIS (2000) *Final import risk analysis for the importation of fresh table grapes (Vitis vinifera L.) from the state of California in the United States of America*. Australian Quarantine and Inspection Service, Canberra.

AQIS (2009a) ICON. http://netprod.aqis.gov.au/icon32/asp/homecontent.asp (Accessed 20 November 2009).

AQIS (2009b) Live arthropods (other than bees). Australian Quarantine and Inspection Service. http://www.daffa.gov.au/aqis (Accessed 27 October 2009).

AQSIQ (2003a) Comments provided on the technical issues paper on the IRA on longan and lychee fruit from China. State General Administration for Quality Supervision and Inspection and Quarantine of the People's Republic of China (AQSIQ), 18 June 2003.

AQSIQ (2003b) Response to Biosecurity Australia questions. State General Administration for Quality Supervision and Inspection and Quarantine of the People's Republic of China (AQSIQ), March 2003.

AQSIQ (2005) *Export technical reference information for Chinese apple*. The General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, Beijing.

AQSIQ (2006) *Export technical reference information for Chinese grape received on 20 July 2006*. The General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, Beijing.

AQSIQ (2007) *Reply on supplementary information on pests in table grapes exported from China to Australia received on 19 March 2007*. General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, Beijing.

AQSIQ (2008) *Information for the vineyard management, harvest, package and storage of Chinese table grape*. General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, Beijing.

AQSIQ (2009a) *Analysis report on risks of pests contained in table grapes imported from Australia (draft)*. The General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, Beijing.

AQSIQ (2009b) *Annex 1: supplementary information for export of Chinese fruit to Australia received on 30 April 2009*. General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, Beijing.

AQSIQ (2009c) Various information and advice provided by China's General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ), the regional and local China Entry-Exit Inspection and Quarantine Bureaux (CIQs) and the CIQ Association during and in association with Biosecurity Australia's table grape verification visit to Hebei Province and Xingjiang Uygur Autonomous Region, 14-21 September 2009. The General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ), Beijing.

Arnold C, Rossetto M (2002) Comparative population studies in two *Cissus* species (Vitaceae) across fragmented and undisturbed rainforest habitats. *Cunninghamia* 7: 683-693.

Arrigo N, Arnold C (2007) Naturalised *Vitis* rootstocks in Europe and consequences to native wild grapevine. *PloS ONE* 6: 1-8.

Ashihara W (1995) Studies on the occurrence of the Kanzawa spider mite, *Tetranychus kanzawai* Kishida (Acarina: Tetranychidae) and its biological control by *Phytoseiulus*

persimilis Athias-Henriot (Acarina: Phytoseiidae) on grapevine in greenhouses. *Bulletin of the Fruit Tree Research Station* 6: 75-151.

Ashihara W (1996) Effect of grape cultivars and insecticide application on reproduction and occurrence of *Tetranychus kanzawai* Kishida (Acarina: Tetranychidae). *Japanese Journal of Applied Entomology and Zoology* 40: 55-59.

Asjes CJ, Blom-Barnhoorn GJ (2002) Control of spread of Augusta disease caused by tobacco necrosis virus in tulip by composting residual waste of small bulbs, tunics, roots and soil debris. *ISHS Acta Horticulturae* 570: 283-286. (Abstract only)

Atia MMM, Aly AZ, Tohamy MRA, El-Shimy H, Kamhawy MA (2003) Histopathological studies on grapevine die-back. *Journal of Plant Diseases and Protection* 110: 131-142.

Australian Biological Control (2009) Entomopathogenic nematodes. The good bug guide. http://www.goodbugs.org.au/Good%20bugs%20available/Resources/Nematodes.pdf (Accessed 18 January 2010).

Australian National Botanic Gardens, Australian National Herbarium (2008) Australian Plant Name Index: APNI. Integrated Botanical Information System (IBIS). http://www.anbg.gov.au/apni/index.html (Accessed 2008).

Australian Nurseries Online (2009) Fruit trees and grape vines. www.nurseriesonline.com.au (Accessed 21 November 2009).

Australian Table Grape Association (2008) Australian industry. Australian Table Grape Association. http://www.atga.com.au/industry.php (Accessed 3 February 2009).

Azam MGN (2002) *Management of spider mites (Tetranychidae) in vegetable crops in Carnarvon*. Farmnote No. 25/2002, Department of Agriculture, Western Australia.

Badr MA, Oshaibah AA, Al-Gamai MM, Salem MM (1986) Taxonomy of five species of superfamily Yponomeutoidea. *Agricultural Research Review* 61: 257-272.

BAIKE (2009) *Physalospora baccae*. http://baike.baidu.com/view/1531691.htm (Accessed 15 October 2009).

Bailey PT, Furness GO (1994) Pests of newly-planted vineyards. In *Diseases and pests* (eds. Nicholas P, Margery P, Wachtel M) pp. 65-67. Winetitles, Adelaide.

Bailey PT, Furness GO, Charles JG (1994) Overview. In *Diseases and pests* (eds. Nicholas P, Margery P, Wachtel M) pp. 45-46. Winetitles, Adelaide.

BAIRC (2007) Grape plume moth: *Stenoptilla vitis* Sasaki. http://www.agridata.gov.cn (Accessed 13 April 2007).

Baker GJ, Bailey PT, Charles JG (1994) Lightbrown apple moth. In *Diseases and pests* (eds. Nicholas P, Margery P, Wachtel M) pp. 47-50. Winetitles, Adelaide.

Barlow HS (1982) *An introduction to the moths of South East Asia*. The Malayan Nature Society, Kuala Lumpur.

Batra LR (1979) First authenticated North American record of *Monilinia fructigena*, with notes on related species. *Mycotaxon* 8: 476-484.

Batra LR (1991) *World species of Monilinia (fungi): their ecology, biosystematics and control*. J. Cramer, Berlin.

Batra LR, Harada Y (1986) A field record of apothecia of *Monilinia fructigena* in Japan and its significance. *Mycologia* 78: 913-917.

Bawden FC (1956a) External symptoms of infected plants. In *Plant viruses and virus diseases* pp. 18-36. Chronica Botanica Company, Waltham.

Bawden FC (1956b) Methods of transmission. In *Plant viruses and virus diseases* pp. 58-79. Chronica Botanica Company, Waltham.

BBC (2004) Spiders plague Kazakh camels. www.bbc.co.uk/2/hi/europe/3857927.stm (Accessed 22 December 2009).

Ben-Dov Y (1994) *A systematic catalogue of the mealy bugs of the world (Insecta, Homoptera, Coccoidea: Pseudococcidae and Putoidae) with data on geographical distribution, host plants, biology and economic importance*. Intercept Limited, Andover.

Ben-Dov Y (2004) *Planococcus kraunhiae* (Kuwana, 1902). ScaleNet, Catalogue Query Results. http://csvh.org/col08/show_database_details.php?database_name=ScaleNet (Accessed 29 October 2009).

Ben-Dov Y (2005a) Pseudococcidae. ScaleNet, Catalogue Query Results. http://www.sel.barc.usda.gov/scalecgi/chklist.exe?Family=Pseudococcidae&genus (Accessed 8 April 2009).

Ben-Dov Y (2005b) The malvastrum mealybug *Ferrisis malvastra* (Hemiptera, Coccoidae, Pseudococcidae): distribution, host plants and pest status in Israel. *Phytoparasitica* 33: 154-156.

Ben-Dov Y (2006a) *Parthenolecanium corni apuliae* (Nuzzaci). ScaleNet, Catalogue Query Results. http://www.sel.barc.usda.gov/ (Accessed 16 February 2007).

Ben-Dov Y (2006b) *Parthenolecanium orientalis*. ScaleNet, Catalogue Query Results. http://www.sel.barc.usda.gov/catalogs/coccidae/Parthenolecaniumorientalis.htm (Accessed 5 April 2007).

Ben-Dov Y (2006c) *Planococcus kraunhiae* (Kuwana). Catalogue Query Results, United States Department of Agriculture. http://www.sel.barc.usda.gov/catalogs/pseudoco/Planococcuskraunhiae.htm (Accessed 27 October 2009).

Ben-Dov Y (2006d) *Pseudococcus maritimus* (Ehrhorn). ScaleNet, Catalogue Query Results. http://www.sel.barc.usda.gov (Accessed 29 July 2008).

Ben-Dov Y (2007) *Pseudococcus comstocki* (Kuwana). ScaleNet, Catalogue Query Results. http://www.sel.barc.usda.gov/catalogs/pseudoco/Pseudococcuscomstocki.htm (Accessed 1 June 2007).

Ben-Dov Y (2009a) Coccidae: ScaleNet. http://www.sel.barc.usda.gov/SCALENET/cite.htm (Accessed 2 December 2009).

Ben-Dov Y (2009b) *Maconellicoccus hirsutus* (Green). http://www.sel.barc.usda.gov/catalogs/pseudoco/Maconellicoccushirsutus.htm (Accessed 12 January 2010).

Ben-Dov Y (2009c) *Planococcus kraunhiae* (Kuwana). Catalogue Query Results, United States Department of Agriculture. http://www.sel.barc.usda.gov/scalenet/query.htm (Accessed 27 October 2009).

Ben-Dov Y (2009d) *Pseudococcus maritimus* (Ehrhorn). ScaleNet, Catalogue Query Results. http://www.sel.barc.usda.gov/catalogs/pseudoco/Pseudococcusmaritimus.htm (Accessed 20 March 2009).

Ben-Dov Y, Miller DR, Gibson GAP (2009) ScaleNet. ScaleNet, Catalogue Query Results. http://www.sel.barc.usda.gov/scalenet/scalenet.htm (Accessed 23 March 2009).

Bensaude M (1926) Diseases of economic plants in the Azores. *Kew Bulletin of Miscellaneous Information* 9: 381-389.

Benson DA, Karsch-Mizrachi I, Lipman DJ, Ostell J, Wheeler DL (2008) GenBank. *Nucleic Acids Research* 36: D25-D35.

Berro Aguilera JM (1926) *Report of the experiments and investigations carried out at the Plant Pathology Station, Almeria, during the year 1925, on Ceratitis capitata and other diseases of the Ohanes grape*. Plant Pathology Station, Almeria.

Bi J, Tuan S, Toscano NC (2007) Impact of greenhouse whitefly management on strawberry fruit quality. *Insect Science* 14: 151-156.

Bianco P, Alma A, Scattini G, Arzone A (2001) Transmission of 16Srv phytoplasmas by *Scaphoideus titanus* Ball in northern Italy. *Plant Protection Science* 37: 49-56.

Biosecurity Australia (2002) *Citrus imports from the Arab Republic of Egypt: a review under existing import conditions for citrus from Israel*. Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2003) *Netherlands truss tomatoes: import policy*. Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2005a) *Draft extension of existing policy for pears from The People's Republic of China*. Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2005b) *Final extension of policy for the importation of pears from the People's Republic of China*. Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2005c) *Final report: extension of existing policy for sweet oranges from Italy*. Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2005d) *Final report: import risk analysis for table grapes from Chile*. Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2006a) *Biosecurity Australia policy memorandum 2006/32: revised conditions for the importation of Californian table grapes*. Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2006b) *Final Import risk analysis for stone fruit from New Zealand into Western Australia*. Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2006c) *Final import risk analysis report for apples from New Zealand: part a, b and c*. Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2006d) *Policy for the importation of fresh mangoes (Mangifera indica L.) from Taiwan*. Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2008) *Final import risk analysis report for fresh mango fruit from India*. Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2009a) *Final import risk analysis for fresh greenhouse-grown capsicum (Paprika) fruit from the Republic of Korea*. Department of Agriculture, Fisheries and Forestry, Canberra.

Biosecurity Australia (2009b) *Final import risk analysis report for fresh Unshu mandarin fruit from Shizuoka prefecture in Japan*. Department of Agriculture, Fisheries and Forestry, Canberra.

Blancard D, La Guerche S, Chamont S, Sauris P, Dauphin B, Darrier P (2006) Grape berry rot and aromatic defects: initial observations in vineyards. *Phytoma* 592: 1-6.

Blodgett EC (1992) Grape whitefly. In *Grape pest management* (eds. Flaherty DL, Christensen LP, Lanini WT, Marois JJ, Phillips PA, Wilson LT) pp. 245-246. Division of Agriculture and Natural Resources, University of California, Oakland.

Bolland HR, Gutierrez J, Flechtmann CHW (1998) *World catalogue of the spider mite family (Acari: Tetranychidae)*. Brill, Boston.

Bos L (1999a) Symptoms of virus diseases. In *Plant viruses, unique and intriguing pathogens: a textbook of plant virology* pp. 27-29. Backhuys Publishers, Leiden.

Bos L (1999b) Vector specificity and helper dependent transmission. In *Plant viruses, unique and intriguing pathogens: a textbook of plant pathology* pp. 64-72. Backhuys Publishers, Leiden.

Bostanian NJ, Vincent C, Goulet H, Lesage L, Lasnier J, Bellemare J, Mauffette Y (2003) The arthropod fauna of Quebec vineyards with particular reference to phytophagous arthropods. *Journal of Economic Entomology* 96: 1221-1229.

Botha J, Hardie D, Power G (2000) *Grape phylloxera-Daktulosphaira vitifoliae:* exotic threat to Western Australia. *Factsheet* 2: 1-2.

Botha JH, Stephenson BE, Tille PJ (2007) Phylloxera and its threat to Western Australia. *ISHS Acta Horticulturae* 733: 101-106.

Botton M, Walker MA (2009) Grape phylloxera in Brazil. *Acta Horticulturae (ISHS)* 816: 39-40.

Bradbury JF (1986) *Guide to plant pathogenic bacteria*. CAB International, Slough.

Brake V (2003) *Fresh produce imports: a quarantine perspective*. Brisbane, Australian Quarantine and Inspection Service, Canberra.

Briceño EX, Latorre BA (2007) Outbreaks of Cladosporium rot associated with delayed harvest wine grapes in Chile. *Plant Disease* 91: 1060. (Abstract only)

Brown PMJ, Adriaens T, Bathon H, Cuppen J, Goldarazena A, Hägg T, Kenis M, Klausnitzer BEM, Kovár I, Loomans AJM, Majerus MEN, Nedved O, Pedersen J, Rabitsch W, Roy HE, Ternois V, Zakharov IA, Roy DB (2008a) *Harmonia axyridis* in Europe: spread and distribution of a non-native Coccinellid. *BioControl* 53: 5-21.

Brown PMJ, Roy HE, Rothery P, Roy DB, Ware RL, Majerus MEN (2008b) *Harmonia axyridis* in Great Britain: analysis of the spread and distribution of a non-native coccinellid. *BioControl* 53: 55-68.

Brunt AA, Teakle DS (1996) Tobacco necrosis necrovirus. In *Viruses of plants: descriptions and lists from the VIDE database* (eds. Brunt AA, Crabtree K, Dallwitz MJ, Gibbs A, Watson L) pp. 1256-1259. CAB International, Wallingford.

Buchanan GA (1987) The distribution of grape phylloxera, *Daktulosphaira vitifolii* (Fitch), in central and north-eastern Victoria. *Australian Journal of Experimental Agriculture* 27: 591-595.

Buchen-Osmond C (2002) Virus of plants in Australia. ICTVdB: The Universal Virus Database, version 4. http://www.ncbi.nlm.nih.gov/ICTVdb/Aussi/ausidesc.htm (Accessed 30 January 2009).

Buckstrup MJ, Bassuk NL (2000) Native for native's sake. http://www.treelink.org/woodnotes/vol3/no2/article2.html (Accessed 30 November 2009).

Bugledich EMA (1999) *Diptera: Nematocera*. Commonwealth Scientific and Industrial Research Organisation, Canberra.

Bureau of Meteorology (2009) Climate data online. http://www.bom.gov.au/climate/averages/ (Accessed 27 February 2009).

Bureau of Meteorology (2010) Average annual & monthly maximum, minimum, & mean temperature. http://www.bom.gov.au/ (Accessed 19 January 2010).

Byrde RJW, Willets HJ (1977) *The brown rot fungi of fruit: their biology and control*. A. Wheaton & Co., Exeter.

CABI (2005) Forestry compendium: *Parthenolecanium corni*. CABI Compendium. http://www.cabicompendium.org/fc/datasheet.asp?CCODE=PTLCCO&COUNTRY=0 (Accessed 11 January 2009).

CABI (2009) Crop protection compendium. CABI Compendium. http://www.cabi.org.compendia (Accessed 2009).

CABI-EPPO (1979) Commonwealth Institute of Entomology, distribution maps of plant pests, map no. 400: *Xestia c-nigrum*. CAB Abstracts plus. http://www.cababstractsplus.org/DMPP/Index.asp (Accessed 31 August 2009).

CABI-EPPO (1986) Commonwealth Institute of Entomology, distribution maps of plant pests, map no. 76: *Eupoecilia ambiguella*. http://cababstractsplus.org/DMPP/Index.asp (Accessed 31 August 2009).

CABI-EPPO (1997a) Datasheets on quarantine pests: *Bactrocera dorsalis* . European and Mediterranean Plant Protection Organisation. http://www.eppo.org/ (Accessed 18 September 2009).

CABI-EPPO (1997b) Datasheets on quarantine pests: Grapevine flavescence dorée phytoplasma. In *Quarantine pests for Europe* (eds. Smith IM, McNamara DG, Scott PR, Holderness M) pp. 1-9. CAB International, Wallingford.

CABI-EPPO (1997c) Datasheets on quarantine pests: *Popillia japonica*. European and Mediterranean Plant Protection Organisation. http://www.eppo.org/ (Accessed 13 January 2010).

CABI-EPPO (1997d) Datasheets on quarantine pests: Tobacco ringspot *'nepovirus*'. In *Quarantine pests for Europe* (eds. Smith IM, McNamara DG, Scott PR, Holderness M) pp. 1-5. CAB International, Wallingford.

CABI-EPPO (1997e) Datasheets on quarantine pests: *Viteus vitifoliae*. European and Mediterranean Plant Protection Organisation. http://www.eppo.org/ (Accessed 27 November 2009).

CABI-EPPO (1999) Datasheets on quarantine pests: *Anoplophora glabripennis* . European and Mediterranean Plant Protection Organisation. http://www.eppo.org/ (Accessed 12 January 2010).

CABI-EPPO (2001) Commonwealth Institute of Entomology, distribution maps of plant pests, map no. 256: *Aphis spiraecola*. CAB Abstracts plus. http://www.cababstractsplus.org/DMPP/Index.asp (Accessed 31 August 2009).

CABI-EPPO (2004) Commonwealth Institute of Entomology, distribution maps of plant pests, map no. 100: *Maconellicoccus hirsutus* (Green). CAB Abstracts plus. http://cababstractsplus.org/DMPP/Index.asp (Accessed 27 March 2009).

CABI-EPPO (2006) *Phakopsora euvitis*: Grapevine rust. European and Mediterranean Plant Protection Organisation. http://www.eppo.org/QUARANTINE/Alert_List/fungi/PHLLAM.htm (Accessed 2 March 2009).

Caciagli P (2007) Survival of whiteflies during long-distance transportation of agricultural products. *Journal of Insect Science* 8: 1.

Campbell JF, Ozra G, Yoder F, Lewis E, Gaugler R (1998) Spatial and temporal ,distribution of endemic and released entomopathogenic nematode populations in turfgrass. *Entomologia Experimentalis et Applicata* 86: 1-11.

Campbell RN (1996) Fungal transmission of plant viruses. *Annual Review of Phytopathology* 34: 87-108.

Cao H, Liang X, Yang Z (1998) Influence of temperature-humidity on the development of *Tetranychus kanzawai*. *Japanese Journal of Applied Entomology and Zoology* 41: 153-156.

Cardoso JM, Felix MR, Clara MI, Oliveira S (2005) The complete genome sequence of a new necrovirus isolated from *Olea europaea* L. *Archives of Virology* 150: 815-823.

Castillo-Pando M, Steel C, Somers T (1999) Fungal bunch rots of grapes in the Hunter and Hastings Valleys. *The Australian Grapegrower and Winemaker* September: 33-36.

Catalogue of Life China (2010) Catalogue of life China 2008 Annual Checklist: *Latrodectus mactans* (Fabricius). http://csvh.org/cnnode/info_about_col.php (Accessed 21 January 2010).

CEIA-CAES (2005) Pest management plans for major crops of Shaanxi project area, World Bank agricultural technology project. http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2005/02/25/000012009_20050225142337/Rendered/INDEX/E10100v20PMP0for0Shaanxi.txt (Accessed 15 April 2008).

Cesati RR, Van Regenmortel MHV (1969) Serological detection of a strain of *Tobacco necrosis virus* in grapevine leaves. *Journal of Phytopathology* 64: 362-366.

CFIA (2009) *Popillia japonica* (Newman): Japanese Beetle. Canadian Food Inspection Agency. http://www.inspection.gc.ca/english/plaveg/pestrava/popjap/popjape.shtml (Accessed 30 November 2009).

Chatasiri S, Ono Y (2008) Phylogeny and taxonomy of the Asian grapevine leaf rust fungus, *Phakopsora euvitis*, and its allies (Uredinales). *Mycoscience* 49: 66-74.

Cheng L (2007) *A laboratory behavioral assessment on predatory potential of the Green lacewing Mallada basalis Walker (Neuroptera: Chrysopidae) on two species of papaya pest mites, Tetranychus kanzawai Kishida and Panonychus citri (McGregor) (Acari: Tetranychidae).* Ph. D., Kansas State University, Manhattan.

Cherepanov AI (1991) *Cerambidae of northern Asia: Laminae*. Nauka Publishers, New Dehli.

Chief Medical Network (2006) *Lactrodectus tredecimguttatus* living habits and the prevention and treatment of bites, Chief medical network, January 31, 2006. http://journal.shouxi.net/html/qikan/lcyx/zhyxsjzz/2006151/yfbj/20080901025211105_127123.html (Accessed 7 January 2010).

China Australia Shipping (2008) Australia - "Mandarin Service" fixed day weekly service. www.cnshipping.com.au (Accessed 25 November 2008).

China Maps (2007) Guizhou climate and weather. http://www.chinamaps.info/Guizhou/Guizhou-Climate.htm (Accessed 5 November 2009).

Choueiri E, Boscia D, Castellano MA, Martelli GP (1996) Some properties of a hitherto undescribed filamentous virus of the grapevine. *Vitis* 35: 91-93.

Chu PWG, Francki RIB, Hatta T (1983) Some properties of tomato ringspot virus isolated from *Pentas lanceolata* in South Australia. *Plant Pathology* 32: 353-356.

Chu Y, Tung CH (1996) The laboratory observations on the attack of oriental fruit fly, *Bactrocera dorsalis* (Hendel) on grapes. *Plant Protection Bulletin (Taichung)* 38: 49-57.

Chung SY (1983) *Popillia quadriguttata Fabricius. In: Forest Science Research Institute (eds)*. China Forest Press, Peking.

CIHEAM (2006) *Directory of infectious diseases of grapevines and viroses and virus-like diseases of the grapevine: bibliographic report 1998- 2004*. 55, Centre International de Hautes Etudes Agronomiques Méditerranéennes, Bari.

CIQSA (2001a) *Report on exportation of apple from P.R. China to Australia (Shandong province) received between 5-9 March 2001*. State Administration for Entry-Exit Inspection and Quarantine of People's Republic of China, Beijing.

CIQSA (2001b) *The document concerning exports of apples of Shaanxi China to Australia received between 5-9 March 2009*. State Administration for Entry-Exit Inspection and Quarantine of People's Republic of China, Beijing.

Clinical Toxinology Resources (2010) Clinical Toxinology Resources: *Latrodectus mactans*. http://www.toxinology.com/fusebox.cfm?fuseaction=main.spiders.display&mode=PrintFriendly&id=SP00071 (Accessed 21 January 2010).

Clinical Toxinology Resources (2007) Clinical Toxinology Resources: *Latrodectus tredecimguttatus*. http://www.toxinology.com/fusebox.cfm?fuseaction=main.spiders.display&mode=PrintFriendly&id=SP00071 (Accessed 21 January 2010).

Coleman HR (2008a) *Ampelocissus* Planch. FloraBase: the Western Australia Flora. http://florabase.calm.wa.gov.au/browse/profile/21741 (Accessed 11 September 2009).

Coleman HR (2008b) *Mallotus* Lour. FloraBase: the Western Australia Flora. http://florabase.calm.wa.gov.au/browse/profile/21698 (Accessed 19 January 2010).

Common IFB (1990) *Moths of Australia*. Melbourne University Press, Carlton.

Cook RP, Dubé AJ (1989) *Host-pathogen index of plant diseases in South Australia*. Field Crops Pathology Group, South Australian Department of Agriculture, Adelaide.

Cooperative Research Centre for Viticulture (2005) The berry development process: phases 1 and 2. *Viti-Notes: Understanding Grapevine Growth* 4: 1-2.

Corrie AM, Van Heeswijck R, Hoffman AA (2003) Evidence for host-associated clones of grape phylloxera Daktulosphaira vitifoliae (Hemiptera: Phylloxeridae) in Australia. *Bulletin of Entomological Research* 93: 193-201.

Cota BB, Rosa LH, Caligiorne RB, Rabello ALT, Alves TMA, Rosa CA, Zani CL (2008) Altenusin, a biphenyl isolated from the endophytic fungus *Alternaria* sp., inhibits trypanothione reductase form *Trypanosoma cruzi*. http://www3.interscience.wiley.com/journal/119878225/abstract?CRETRY=1&SRETRY=0 (Accessed 9 December 2009).

Cranshaw W, Leatherman D, Kondratieff B (1994) *Insects that feed on Colorado trees and shrubs*. Bulletin 506a, Colorado State University, Fort Collins.

CSIRO (1991) *The insects of Australia: a textbook for students and research workers*. Melbourne University Press, Carlton.

CSIRO, DAFF (2004a) Australian insect common names version 1.52. Australian Insect Common Names version 1.53. http://www.ento.csiro.au/aicn/index.html (Accessed 16 September 2006).

CSIRO, DAFF (2004b) *Parthenolecanium corni* (Bouché). Australian Insect Common Names version 1.53. http://www.ento.csiro.au/aicn/system/c_1589.htm (Accessed 19 September 2006).

CSIRO, DAFF (2004c) *Tetranychus kanzawai* Kishida. Australian Insect Common Names version 1.53. http://www.ento.csiro.au/aicn/system/c_235.htm (Accessed 8 December 2009).

DAFF (2004a) *Longan and lychee fruit from the People's Republic of China and Thailand: final import risk analysis report- part a and b*. Department of Agriculture, Fisheries and Forestry, Canberra.

DAFF (2004b) *Mangosteen fruit from Thailand: final import risk analysis report*. Department of Agriculture, Fisheries and Forestry, Canberra.

DAFF (2009) National eradication programs - emergency plant pests. http://www.daff.gov.au/animal-plant-health/pests-diseases-weeds/plant/eradication?SQ_DESIGN_NAME=spaced&SQ_ACTION=set_design_name (Accessed 7 September 2009).

DAFWA (2009a) The WA import requirements manual. http://www.agric.wa.gov.au/PC_93016.html?s=1001 (Accessed 5 November 2009).

DAFWA (2009b) *Viticulture spray guide 2009/2010: wine grapes and table grapes*. Bulletin no. 4774, Department of Agriculture and Food Western Australia, Perth.

Daly A, Hennessy C (2006) Natural infection of a native grape species with grapevine leaf rust. *Agnote* 826: 1-2.

Daly A, Tran-Nguyen L (2008) *Grapevine leaf rust: incursion risk analysis and improvement of PCR diagnostics (Project 1D)*. NT02/01d, Department of Regional Development, Primary Industry, Fisheries and Resources, Australia.

Daly AM, Hennessy CR, Schultz GC (2005) New host record for the grapevine leaf rust fungus, *Phakopsora euvitis*. *Australian Plant Pathology* 34: 415-416.

David'yan GE (2009) *Parthenolecanium corni* Bouche: Interactive Agricultural Ecological Atlas of Russia and Neighbouring Countries: Economic Plants and their Diseases, Pests and Weeds. http://www.agroatlas.ru/en/ (Accessed 3 August 2009).

Davis RS, Vanderwalker ML, Hutcheson PS, Raymond G (2006) Facial angioderma in children due to ladybug *(Harmonia axyrides)* contact: 2 case reports. *Annals of Allergy, Asthma and Immunology* 97: 440-442.

DAWA (2005) *Submission to the revised draft IRA for the importation of fresh table grapes from Chile*. Department of Agriculture, Western Australia.

DAWA (2006) *Draft plant pathology lists of pathogen species. Table one: pathogens (fungi, bacteria, viruses, viroids and nematodes) recorded from Western Australia*. Department of Agriculture Government of Western Australia, Perth.

de Almeida LM, da Silva VB (2002) Primero registro de *Harmonia axyrides* (Pallas) (Coleoptera, Coccinellidae): um coccinelídeo originário da região Paleártica. *Revista Brasileira de Zoologia* 19: 941-944.

de Villiers M (2006) *Development of a pest management system for table grapes in the Hex River valley*. Ph. D., University of Stellenbosch, Stellenbosch.

Deacon J (2005) Fungal biology. http://www.biology.ed.ac.uk/research/groups/jdeacon/FungalBiology/rust.htm (Accessed 2009).

Deighton FC (1976) Three fungi on leaves of *Vitis*. *Transactions of the British Mycological Society* 67: 223-232.

DEWHA (2009) Natural temperate grassland of the southern tablelands of NSW and the Australian Capital Territory. Biodiversity: species profile and threats database. http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=14 (Accessed 15 January 2010).

Díez García F, Laynez Bretones F, Gálvez Contreras MC, Mohd H, Collado Romacho A, Yélamos Rodríguez (1996) Black widow spider (*Latrodectus tredecimguttatus*) bite. Presentation of 12 cases. *Med Clin (Barc)* 106: 344-346.

Dixon GR (2009) *Plasmodiophora brassicae* in its environment. *Journal of Plant Growth Regulation* Unpublished: 1-17.

Doijode SD (2001) Grape: *Vitis vinifera* L. In *Seed storage in fruit crops* pp. 55-59. Haworth, New York.

Douglas SM, Cowles RS (2006) Grape *(Vitis)*. Plant pest handbook: a guide to insects, diseases, and other disorders affecting plants. http://www.caes.state.ct.us/plantpesthandbookfiles/pphP/..%5CpphG%5Cpphgrap.htm (Accessed 7 November 2006).

Downie D, Granett J (1998) A life cycle variation in grape phylloxera *Daktulosphaira vitifoliae* (Fitch). *Southwestern Entomologist* 23: 11-16.

Downie DA (2006) Comment: grape phylloxera and the grapevine: searching for the science. Journal of Experimental Botany. http://jxb.oxfordjournals.org/cgi/eletters/56/422/3029 (Accessed 7 January 2010).

Downie DA, Granett J, Fisher JR (2000) Distribution and abundance of leaf galling and foliar sexual morphs of grape phylloxera (Hemiptera: Phylloxeridae) and Vitis species in the Central and Eastern United States. *Environmental Entomology* 29: 979-986.

DPINT (2008) Pests and diseases. Department of Primary Industries Northern Territory. http://www.nt.gov.au/d/Primary_Industry/index.cfm?newscat1=Quarantine&newscat2=&header=Pests%20and%20Diseases (Accessed 5 October 2008).

DPIW Tasmania (1999) Vintage Report 1999. Department of Primary Industries and Water, Tasmania. http://www.dpiw.tas.gov.au/inter.nsf/WebPages/EGIL-52Y82H?open (Accessed 6 January 2010).

DPIW Tasmania (2009) Publication of plant pests and diseases 2009. Department of Primary Industries and Water, Tasmania. http://www.dpiw.tas.gov.au/inter.nsf/Attachments/LBUN-7T29UG?open (Accessed 16 November 2009).

Drake CR (1990) *Armillaria* and *Clitocybe* root rot. In *Compendium of apple and pear diseases* (eds. Jones AL, Aldwinckle HS) pp. 49-50. The American Phytopathological Society Press, St. Paul.

Drew RAI, Hancock DL (1994) The *Bactrocera dorsalis* complex of fruit flies (Diptera: Tephritidae: Dacinae) in Asia. *Bulletin of Entomological Research* Suppl. 2: 1-68.

Dubey AK, Ko C (2009) A review of the genus *Aleurolobus* Quaintance and Baker (Hemiptera: Aleyrodidae) from Taiwan, based mainly on pupal morphology with a description of a new species. *Entomological Science* 12: 51-66.

Dugan FM, Schubert K, Braun U (2004) Check-list of *Cladosporium* names. *Schelechtendalia* 11: 1-119.

Duma I (2006) *Latrodectus tredecimguttatus* (Rossi, 1790) (Araneae:Theridiide) in Romania. Distribution and ecology. *Travaux du Muséum National d'Histoire Naturelle* XLIX: 75-81.

Ehara S (1963) A new mite of *Oligonychus* from rice, with notes on some Japanese spider mites (Acarina: tetranychidae). *Japanese Journal of Applied Entomology and Zoology* 7: 228-231.

Ellis MA (2008a) Bacterial crown gall of fruit crops. The Ohio State University. http://ohioline.osu.edu/hyg-fact/3000/pdf/HYG_3301_08.pdf (Accessed 6 January 2009).

Ellis MA (2008b) Grape black rot. The Ohio State Univeristy Extension Factsheet. ohioline.osu.edu/hyg-fact/3000/pdf/HYG_3004_08.pdf (Accessed 20 November 2006).

Ellis MA, Erincik O (2005) Phomopsis cane and leaf spot of grape. *The Ohio State University Extension Factsheet* HYG-3031-02: 1-4.

Ellis RH, Hong TD, Roberts EH (1985) Vitaceae. In *Handbook of seed technology for genebanks* p. 1. International Board for Plant Genetic Resources, Rome.

Emmett B (2006) *Preliminary table grape pathogens of concern for China (personal communication)*. Department of Primary Industries, Victoria, Mildura.

Emmett RW, Hamilton RP (1994) Leafroll and other virus diseases. In *Diseases and pests* (eds. Nicholas P, Margery P, Wachtel M) pp. 34-37. Winetitles, Adelaide.

Emmett RW, Buchanan GA, Magarey PA (1992a) Grapevine diseases and pest management. *Australian & New Zealand Wind Industry Journal* 7: 149-171.

Emmett RW, Harris AR, Taylor RH, McGechan JK (1992b) Grape diseases and vineyard protection. In *Viticulture, vol. 2. practices* (eds. Coombe BG, Dry PR) pp. 232-278. Winetitles, Adelaide.

Emmett RW, Margery PA, Magarey RD (1994a) Black spot. In *Diseases and pests* (eds. Nicholas P, Margery P, Wachtel M) pp. 25-27. Winetitles, Adelaide.

Emmett RW, Margery PA, Margery RD (1994b) Powdery mildew. In *Diseases and pests* (eds. Nicholas P, Margery P, Wachtel M) pp. 12-16. Winetitles, Adelaide.

Emmett RW, Nair T, Wicks TJ (1994c) Phomopsis. In *Diseases and pests* (eds. Nicholas P, Margery P, Wachtel M) pp. 22-24. Winetitles, Adelaide.

EPPO (2002) *EPPO reporting service 2002, No. 2*. European and Mediterranean Plant Protection Organization, Paris.

EPPO (2004) Data sheets on forest pests: *Cecidomyia pumila*. European and Mediterranean Plant Protection Organisation. http://www.eppo.org/QUARANTINE/Pest_Risk_Analysis/PRAdocs_insects/draft_ds/DS%20Cecidomyia_pumila%2004-11284.doc (Accessed 11 February 2009).

EPPO (2006a) *Popillia japonica*. *Bulletin OEPP/EPPO Bulletin* 36: 447-450.

EPPO (2006b) PQR database (version 4.5). European and Mediterranean Plant Protection Organization. www.eppo.org (Accessed 2006).

EPPO (2009) *Harmonia axyrides* (Harlequin ladybird): an invasive species which continues to spread within Europe. EPPO Reporting Service. www.eppo.org/ (Accessed 12 January 2010).

Erincik O, Madden LV, Ferree DC, Ellis MA (2001) Effect of growth stage on susceptibility grape berry and rachis tissues to infection by *Phomopsis viticola*. *Plant Disease* 85: 517-520.

Erincik O, Madden LV, Ferree DC, Ellis MA (2002) Infection of grape berry and rachis tissues by *Phomopsis viticola*. http://www.plantmanagementnetwork.org/pub/php/research/phomopsis (Accessed 1 May 2009).

Erkara IP, Asan A, Yilmaz V, Pehlivan S, Okten SS (2008) Airborne *Alternaria* and *Cladosporium* species and relationship with meteorological conditions in Eskisehir city, Turkey. *Environmental Monitoring and Assessment* 144: 31-41.

Eyres N, Wood C, Taylor A (2006) Black rot *Guignardia bidwellii*. *Department of Agriculture, Western Australia Factsheet* 167: 1-2.

Fang ZG, Wu SA, Xu HC (2001) A list of bamboos scale insects in China (Homoptera: Coccoidea). *Journal of Zhejiang Forestry College* 18: 102-110.

FAO (1996) *International Standards for Phytosanitary Measures (ISPM) no. 4: requirements for the establishment of pest free areas*. Secretariat of the International Plant Protection Convention, Food and Agricultural Organization of the United Nations, Rome.

FAO (1999) *International Standards for Phytosanitary Measures (ISPM) no. 10: requirements for the establishment of pest free places of production and pest free production sites*. Secretariat of the International Plant Protection Convention, Food and Agricultural Organization of the United Nations, Rome.

FAO (2003) *International Standards for Phytosanitary Measures (ISPM) no. 18: guidelines for the use of irradiation as a phytosanitary measure*. Secretariat of the International Plant Protection Convention, Food and Agriculture Organisation of the United Nations, Rome.

FAO (2004) *International Standards for Phytosanitary Measures (ISPM) no. 11: pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms*. Secretariat of the International Plant Protection Convention, Food and Agricultural Organization of the United Nations, Rome.

FAO (2006) *International Standards for Phytosanitary Measures (ISPM) no. 26: establishment of pest free areas for fruit flies (Tephritidae)*. Secretariat of the International Plant Protection Convention, Food and Agriculture Organisation of the United Nations, Rome.

FAO (2007) *International Standards for Phytosanitary Measures (ISPM) no. 2: framework for pest risk analysis*. Secretariat of the International Plant Protection Convention, Food and Agriculture Organization of the United Nations, Rome.

FAO (2009) *International Standards for Phytosanitary Measures (ISPM) no. 5: glossary of phytosanitary terms*. Secretariat of the International Plant Protection Convention, Food and Agriculture Organisation of the United Nations, Rome.

Farr DF, Castlebury LA, Rossman AY, Erincik O (2001) *Greeneria uvicola*, cause of bitter rot of grapes, belongs in the Diaporthales. *Sydowia* 53: 185-199.

Farr DF, Rossman AY (2009) Fungal databases. Fungal Databases, Systematic Mycology and Microbiology Laboratory, ARS, USDA. http://nt.ars-grin.gov/fungaldatabases/ (Accessed 30 November 2009).

Farr DF, Rossman AY, Palm ME, McCray EB (2008) Fungal databases, systematic mycology and microbiology laboratory, ARS, USDA. Fungal Databases, Systematic Mycology and Microbiology Laboratory, ARS, USDA. http://nt.ars-grin.gov/fungaldatabases/ (Accessed 18 February 2008).

FCC (1997) Average weather data for cities in China. Families with Children from China (F.C.C.). http://fwcc.org/climate.htm (Accessed May 2009).

Ferreira SA, Boley RA (1991) *Alternaria brassicae*. Crop Knowledge Master. http://www.extento.hawaii.edu/kbase/crop/Type/a_brass1.htm (Accessed 11 September 2009).

Ferrin DM, Ramsdell DC (1977) Ascospore dispersal and infection of grapes by *Guignardia bidwellii*, the causal agent of grape black rot disease. *Phytopathology* 67: 1501-1505.

Ferrin DM, Ramsdell DC (1978) Influence of conidia dispersal and environment on infection of grape by *Guignardia bidwellii*. *Phytopathology* 68: 892-895.

FICCI (2009) FICCI A agribusiness information centre. http://www.ficciagroindia.com/aic/index.asp (Accessed 15 December 2009).

Finlay JR, Teakle DS (1969) The effect of pH on the particle stability of a phosphotungstate-stained *Tobacco necrosis virus*. *Journal of General Virology* 5: 93-96.

Fleming WE (1972) Biology of the Japanese Beetle. *USDA Technical Bulletin* 1499,

Florabank (2010) *Pittosporum angustifolium*. http://www.florabank.org.au/lucid/key/Species%20Navigator/Media/Html/Pittosporum_angustifolium.htm (Accessed 20 January 2010).

FloraBase (2009a) *Clerodendrum* L. http://florabase.calm.wa.gov.au/ (Accessed 15 December 2009).

FloraBase (2009b) *Trifolium hybridum* L. var. *hybridum*. http://florabase.calm.wa.gov.au/ (Accessed 15 January 2010).

Forlani M, Coppola V (1977) The effects of cold storage, gibberellic acid, and temperature on the germination of *Vitis vinifera* seeds. *Revista di Viticoltura di Enologia* 30: 445-451.

Forneck A, Huber L (2009) (A)sexual reproduction: a review of life cycles of grape phylloxera, *Daktulosphaira vitifoliae*. *Entomologia Experimentalis et Applicata* 131: 1-10.

Fresh Plaza (2008) UK black widow's Thame grape escape. www.freshplaza.com/news_detail.asp?id=26936 (Accessed 22 December 2009).

Frolov AN (2009) *Eupoecilia ambiguella* (Hubner): European grape berry moth, Grape berry moth, Grape bud moth, Vine moth, Grape moth. Interactive Agricultural Ecological Atlas of Russia and Neighbouring Countries: Economic Plants and their Diseases, Pests and Weeds. http://www.agroatlas.ru/pests/Eupoecilia_ambiguella_en.htm (Accessed 10 September 2009).

Frolov AN, David'yan GE (2009) *Viteus vitifolii* Filth: Grape phylloxera. Interactive Agricultural Ecological Atlas of Russia and Neighbouring Countries: Economic Plants and their Diseases, Pests and Weeds. http://www.agroatlas.ru/en/ (Accessed 27 October 2009).

Funk L, Gilbert G (2009) *Alternaria spp., A. solani and A. alternata*. Fungal Pathogens at CASFS. http://gis.ucsc.edu/disease/Fungal%20Pathogens/Alternaria/Alternariaportrait.html (Accessed 11 September 2009).

Furness GO (1994) Minor leaf and fruit pests. In *Diseases and pests* (eds. Nicholas P, Margery P, Wachtel M) pp. 62-64. Winetitles, Adelaide.

Furness GO, Charles JG (1994) Mealybug. In *Diseases and pests* (eds. Nicholas P, Margery P, Wachtel M) pp. 54-55. Winetitles, Adelaide.

Gale G (2002) Saving the vine from *Phylloxera*: a never-ending battle. In *Wine: a scientific exploration* (eds. Sandler M, Pinder R) pp. 70-91. Taylor and Francis, London.

Galet P, Morton LT (1988) The family Vitaceae and *Vitis* speciation. In *Compendium of grape diseases* (eds. Pearson RC, Goheen AC) pp. 2-3. The American Phytopathological Society Press, St. Paul.

Galvan TL, Burkness EC, Hutchison WD (2006) Wine grapes in the Midwest: reducing the risk of the multicolored Asian lady beetle. http://www.extension.umn.edu/distribution/horticulture/components/8232grapes.pdf (Accessed 12 November 2009).

Gansu Academy of Agricultural Sciences (2010) *Popillia japonica* Newman. http://www.gsagr.ac.cn/zypt/kongchong/showsoft.asp?id=2693 (Accessed 12 January 2010).

Gao SG, Shu CJ, Ja XJ, Ji HB, Li HP, Jin YH (1999) Occurrence of *Physalospora baccae* and its control. *Shanxi Fruits* 2: 48-49. (Abstract only)

Gibbs A, Harrison B (1976) *Plant virology: the principles*. Edward Arnold, London.

Gill RJ (1988) *Parthenolecanium corni*. Soft Scales Species List. http://www.sel.barc.usda.gov/ScaleKeys/SoftScales/key/Soft_scales/Media/Html/SpeciesListFset.html (Accessed 8 April 2009).

Gillespie P (2006) *WTO SPS notifications from Canada regarding Japanese beetles (personal communication)*. Department of Primary Industry, New South Wales.

Gimpel WF Jr, Miller DR (1996) Systematic analysis of the mealybugs in the *Pseudococcus maritimus* complex (Homoptera: Pseudococcidae). *Contributions on Entomology International* 2: 7-149.

Goetz DW (2009) Seasonal inhalant insect allergy: *Harmonia axyrides* ladybug. *Current Opinion in Allergy and Clinical Immunology* 9: 329-333.

Gomi K, Gotoh T (1996) Host plant preference and genetic compatibility of the Kanzawa spider mite, *Tetranychus kanzawai* Kishida (Acari: Tetranychidae). *Applied Entomology and Zoology* 31: 417-425.

Gotoh T, Gomi K (2000) Population dynamics of *Tetranychus kanzawai* (Acari: Tetranychidae) on hydrangea. *Experimental and Applied Acarology* 24: 337-350.

Gotoh T, Gomi K (2003) Life-history traits of the Kanzawa spider mite *Tetranychus kanzawai* (Acari: Tetranychidae). *Applied Entomology and Zoology* 38: 7-14.

Gould F (1979) Rapid host range evolution in a population of the phytophagous mite *Tetranychus urticae* Koch. *Evolution* 33: 791-802.

Gour TB, Sriramulu M (1992) Grapevine, *Vitis vinifera* Linn.: a new host of castor shoot and capsule borer, *Conogethes punctiferalis* (Guenée). *Tropical Pest Management* 38: 459.

Granett J, Kocsis L, Horvath L, Horvathne EB (2005) Grape phylloxera Gallicole and Radicole activity on grape rootstock vines. *HortScience: a publication of the American Society for Horticultural Science* 40: 150-153.

Granett J, Walker MA, Kocsis L, Omer AD (2001) Biology and management of grape phylloxera. *Annual Review of Entomology* 46: 387-412.

Grapevinewine (2003) Grape rachis brown blight. http://www.grapevinewine.com.cn (Accessed 13 November 2006).

Grichanov IY (2009) *Cossus cossus* L.: Goat moth. Interactive Agricultural Ecological Atlas of Russia and Neighbouring Countries: Economic Plants and their Diseases, Pests and Weeds. http://www.agroatlas.ru/en/content/pests/Cossus_cossus/ (Accessed 6 January 2010).

Grichanov IY, Ovsyannikova EI (2009a) *Aporia crataegi* Linnaeus: Black-veined White. Interactive Agricultural Ecological Atlas of Russia and Neighbouring Countries: Economic Plants and their Diseases, Pests and Weeds. http://www.agroatlas.ru/en/content/pests/Aporia_crataegi/ (Accessed 24 December 2009).

Grichanov IYa, Ovsyannikova EI (2009b) *Hyphantria cunea* Drury: Interactive Agricultural Ecological Atlas of Russia and Neighbouring Countries: Economic Plants and their Diseases, Pests and Weeds. http://www.agroatlas.ru/en/ (Accessed 27 October 2009).

Guo LD, Xui L, Zheng WH, Hyde KD (2004) Genetic variation of *Alternaria alternata*, an endophytic fungus isolated from *Pinus tabulaeformis* as determined by random amplified microsatellites (RAMS). *Fungal Diversity* 16: 53-65.

Gupta BP, Singh YP (1986) New record of *Orgyia postica* Walk. as a pest of mango. *Progressive Horticulture* 18: 273.

Habili N (2009) *Grapevine viruses in Australian states, 16th June, 2009 (personal communication)*. Commonwealth Scientific and Industrial Research Organisation, Adelaide.

Habili N, Rowhani A, Symons RH (2001) Grapevine fanleaf virus: a potential threat to the viticultural industry. *The Australian Grapegrower and Winemaker* 449: 141-143.

Habili N, Symons RH (2000) Grapevine viruses detected by Waite diagnostics in Australia. In *13th ICVG Conference*, pp. 124-126, University of Adelaide, Adelaide.

Hammons DL, Kurtural SK, Newman MC, Potter DA (2009) Invasive Japanese beetles facilitate aggregation and injury by a native scarab pest of ripening fruits. *Proceedings of the National Academy of Sciences of the United States of America* 106: 3686-3691.

Harden GJ (2009) New South Wales Flora Online: family Vitaceae. PlantNET. http://plantnet.rbgsyd.nsw.gov.au/floraonline.htm (Accessed 11 February 2009).

Harpootlian P (2005) Genus *Merhynchites*. http://bugguide.net/node/view/30858 (Accessed 17 February 2009).

Harrison BD (1960) The biology of soil-borne plant viruses. *Advances in Virus Research* 7: 131-162.

Harrison BD (1977) Ecology and control of viruses with soil-inhabiting vectors. *Annual Review of Phytopathology* 15: 331-360.

Hartman JR, Hershman DE (1999) Black rot of grapes. http://www.ca.uky.edu/agc/pubs/ppa/ppa27/ppa27.htm (Accessed 11 February 2006).

Hathaway S (2009) Phylloxera and grape industry board of South Australia. http://www.phylloxera.com.au/ (Accessed 7 August 2009).

Hathaway S (2010) *Costs of replanting after phylloxera (personal communication)*. Phylloxera and Grape Industry Board of South Australia, Adelaide.

Hatzipapas P, Kalosaka K, Dara A, Chritias C (2002) Spore germination and appressorium formation in the entomopathogenic *Alternaria alternata*. *Mycological Research* 106: 1349-1359.

Hawthorne DJ, Dennehy TJ (1991) Reciprocal movement of Grape phylloxera (Homoptera: Phylloxeridae) alates and crawlers between two differentially phylloxera-resistant grape cultivars. *Journal of Economic Entomology* 84: 230-236.

Herbert KS, Unina PA, Mitrovski PJ, Powell KS, Viduka K, Hoffman AA (2010) Clone lineages of grape phylloxera differ in their performance on *Vitis vinifera*. *Bulletin of Entomological Research* Unpublished: 1-4.

Herbison-Evans D, Ashe C (2009) Grapevine family vitiaceae of Australia. http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=fm&name=VITACEAE (Accessed 10 December 2009).

Herbison-Evans D, Lott DM, Crossley S (2009) Pterophoridae of Australia-Plume moths: *Pterophorioidea*. http://linus.it.uts.edu.au/ (Accessed 23 July 2009).

Herrera-Vasquez JA, Cebrian MD, Alfaro-Fernandez A, Cordoba-Selles MD, Jorda C (2009) Multiplex PCR assay for the simultaneous detection and differentiation of *Olpidium bornovanus*, *O. brassicae*, and *O. virulentus*. *Mycological Research* 13: 602-610.

Hetherington SD (2005) Bacterial spot of stone fruit. *Primefacts: Profitable and Sustainable Primary Industries* 76: 1-4.

Hewitt WB (1974) *Rots and bunch rots of grapes*. University of California, Berkeley.

Hewitt WB, Pearson RC (1988) Phomopsis cane and leaf spot. In *Compendium of grape diseases* (eds. Pearson RC, Goheen AC) pp. 17-18. The American Phytopathological Society Press, St. Paul.

Hibben CR, Bozarth RF, Reese J (1979) Identification of tobacco necrosis virus in deteriorating clones of aspen. *Forest Science* 25: 557-567.

Hiramatsu A, Samamaki Y, Kusigemati K (2001) A list of pest-insects feeding on the Kenaf in Kagoshima city with seasonal abundance of some major pest-insects. *Bulletin of the Faculty of Agriculture, Kagoshima University* 51: 1-7.

Hnatiuk RJ (1990) *Census of Australian vascular plants*. Australian Government Publishing Service, Canberra.

Ho C (2000) Spider-mite problems and control in Taiwan. *Experimental and Applied Acarology* 24: 453-462.

Ho CC, Chen WH (1994) Infestation of grape berry by spider mites. *Plant Protection Bulletin* 36: 251-256.

Ho CC, Lo KC, Chen WH (1997) Spider mite (Acari: Tetranychidae) on various crops in Taiwan. *Journal of Agricultural Research of China* 46: 333-346.

Hoffman LE, Wilcox WF (2002) Utilizing epidemiological investigations to optimize management of grape black rot. *Phytopathology* 92: 676-680.

Hoffman LE, Wilcox WF, Gadoury DM, Seem RC (2002) Influence of grape berry age on susceptibility to *Guignardia bidwellii* and its incubation period length. *Phytopathology* 92: 1068-1076.

Holloway JD (2009) The moths of Borneo: parts 15 and 16 family Noctuidae, subfamily Catocalinae. http://www.mothsofborneo.com/part-15-16/ (Accessed 6 January 2010).

Holloway JD, Kibby G, Peggie D (2001) The families of Malesian moths and butterflies. In *Fauna Malesiana handbook 3* p. 458. Brill, Leiden.

Hong Kong Lepidopterists' Society Limited (2004) Hong Kong moths scientific name list: index of moth families recorded in Hong Kong. http://www.hkls.org/mot-list.html (Accessed 24 December 2009).

Hori H (1933) The species and distribution of the Pterophorids attacking grape vines and allied plants in Japan. *Oyo Dobuts Zasshi* 5: 64-71.

Horticulture Australia Limited (2004) *The Australian Horticulture Statistics Handbook 2004*. MODO Pty Ltd, Sydney.

Horticulture Australia Limited (2009) Across industry. http://www.horticulture.com.au/ (Accessed 15 December 2009).

Horticulture Australia Limited, Strawberries Australia (2009) *Strawberry industry: strategic plan 2009-2013*. Strawberries Australia, Sydney.

HortResearch (2010) Citrophilus mealybug: dispersal for all species combined. http://www.hortnet.co.nz/key/keys/info/ecology/mbecol/mb-disp.htm (Accessed 11 February 2009).

Hou BH, Zhang RJ (2005) Potential distribution of the fruit fly *Bactrocera dorsalis* (Diptera: Tephritidae) in China as predicted by CLIMEX. *Acta Ecologica Sinica* 25: 1570-1574.

Hsu JC, Feng H-T (2006) Insecticide resistance and resistance management: development of resistance to spinosad in Oriental fruit fly (Diptera: Tephritidae) in laboratory selection and cross resistance. *Journal of Economic Entomology* 99: 931-936.

Hu CH, Lin YJ (1993) Occurrence of grape stalk black rot. *Fujian Fruits* 2: 30-31.

Hu F, Fang D, Young J, Xie L (1998) Identification of the pathogen caused bacterial blight of kiwifruit in China. *Acta Phytopathologica Sinica* 28: 175-181.

Huang CX, Qin BY, Xi ZX, Mang KI (1984) On the tobacco necrosis virus isolated from hami-melon in Xinjiang and its chemicophysical properties. *Acta Phytopathologica Sinica* 14: 153-158.

Huelsman MF, Jasinski J, Young C, Kovach J (2010) The multicolored Asian lady beetle *Harmonia axyrides:* a nuisance pest in Ohio. Ohio Integrated Pest Management. www.ipm.osu.edu/lady/malpost.htm (Accessed 6 January 2010).

HYPP Zoology (1997) Grape bud moth, Grape cochilis, Vine moth. http://www.inra.fr/hyppz/RAVAGEUR/6eupamb.htm (Accessed 29 October 2009).

IAEA (2003) Trapping guidelines for area-wide fruit fly programmes. International Atomic Energy Agency. http://www.iaea.org/nafa/d4/public/trapping-web.pdf (Accessed 25 November 2009).

Ibrahim RAEA (2004) *Biological control of grape berry moths Eupoecilia ambiguella Hb. and Lobesia botrana Schiff. (Lepidoptera: Tortricidae) by using egg parasitoids of genus Trichogramma.* Ph. D., Institute of Phytopathology and applied Zoology, Justus Liebig University of Giessen, Germany.

INRA (1997) *Eupoecilia ambiguella* Hubner. http://www.inra.fr/hyppz/RAVAGEUR/6eupamb.htm (Accessed 5 November 2009).

INRA (2009) *Viteus vitifoliae* (Fitch) *Dactylosphaera vitifoliae* Fitch, *Viteus vitifolii* (Shimer). Institut national de la recherche agronomique: HYPP zoology. http://www.inra.fr/hyppz/pa.htm (Accessed 12 November 2009).

Integrated Pest Management Center (2007) *Potato leafhopper (Empoasca fabae)*. Michigan State University, Michigan.

Isaacs R (2007) Potato leafhopper. Michigan State University. http://www.grapes.msu.edu/potatoleafhopper.htm (Accessed 7 January 2010).

Isaacs R, van Timmeren S (2009) Potato leafhopper control in winegrapes. Michigan State University. http://dnndev.anr.msu.edu/ (Accessed 7 January 2010).

ISSG (2007) *Hyphantria cunea* (insect). http://www.issg.org/database/species/ecology.asp?si=1201&fr=1&sts=&%20ang=EN&ver=print&prtflag=false (Accessed 16 November 2009).

ITIS (2007) *Merhynchites* Sharp, 1889. Integrated Taxonomic Information System. http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=617209 (Accessed 17 February 2009).

Jailloux F (1992) *In vitro* production of the teleomorph of *Guignardia bidwellii*, causal agent of black rot of grapevine. *Canadian Journal of Botany* 70: 254-257.

Jenkins WA (1941) Angular leaf spot of Muscadines, caused by *Mycosphaerella angulata* n. sp. *Phytopathology* 32: 71-80.

Jiang D, Guo R, Wu Z, Wang H, Li S (2009a) Molecular characterization of a member of a new species of grapevine viroid. *Archives of Virology* 154: 1563-1566.

Jiang D, Peng S, Wu Z, Cheng Z, Li S (2009b) Genetic diversity and phylogenetic analysis of Australian grapevine viroid (AGVd) isolated from different grapevines in China. *Virus Genes* 38: 178-183.

Jones AL (1990) Brown rot diseases. In *Compendium of apple and pear diseases* (eds. Jones AL, Aldwinckle HS) p. 32. The American Phytopathological Society Press, St. Paul.

Kassanis B (1970) Tobacco necrosis virus. Descriptions of Plant Viruses. http://www.dpvweb.net (Accessed 5 August 2009).

Kassanis B, MacFarlane I (1964) Transmission of Tobacco necrosis virus by zoospores of *Olpidium* brassicae. *Journal of General Microbiology* 36: 79-93.

Kawai S (1980) *Scale insects of Japan in colors*. Zenkoku Noson, Tokyo.

Kearns CG, Mossop DW (1984) Detection of nepoviruses of *Vitis vinifera* in New Zealand using enzyme-linked immunosorbent assay (ELISA). *New Zealand Journal of Agricultural Research* 27: 431-435.

Kenis M, Roy HE, Zindel R, Majerus MEN (2008) Current and potential management strategies against *Harmonia axyridis*. *BioControl* 53: 235-252.

Kennedy GG, Smitley DR (1985) Dispersal. In *Spider mites: their biology, natural enemies and control* (eds. Helle W, Sabelis MW) pp. 233-242. Elsevier Science Publishers, Amsterdam.

Ker KW, Carter N (2004) Multicoloured Asian lady beetle (MALB): questions and answers about *Harmonia axyrides* (Pallas). http://www.brocku.ca/ccovi/news/MALB_QA_2004_update.pdf (Accessed 6 January 2010).

Kim JI (1995) Taxonomic study of Korean Rutelidae, II. Genus *Popillia*. *Korean Journal of Entomology* 25: 209-217.

Kim JI (2001) Economic insects of Korea 10, Coleoptera (Scarabaeoidea). Junghaeng-Sa, Seoul.

King PD, Buchanan GA (1986) The dispersal of phylloxera crawlers and spread of phylloxera infestations in New Zealand and Australian vineyards. *American Journal of Enology and Viticulture* 37: 26-33.

Kingston KB, Powell KS, Cooper PD (2009) Grape phylloxera: new investigation into the biology of an old grapevine pest. *ISHS Acta Horticulturae* 816: 63-70.

Kiri-ganai Research Pty Ltd (2006) The Australian wine grape industry taking stock and setting directions final report, December 2006. http://www.wgga.com.au/industry/tssd/TSSD%20final%20report_27Dec2006.pdf (Accessed 15 August 2009).

KISTI (2005) Insect (Lepidoptera) Database. http://insect.ccbb.re.kr/renew/index.php (Accessed 15 October 2009).

Koch FH, Smith WD (2008) Spatio-temporal analysis of *Xyleborus glabratus* (Coleoptera: Circulionidae: Scolytinae) invasion in eastern U.S. forests. *Environmental Entomology* 37: 442-452.

Koch RL (2003) The multicolored Asian lady beetle, *Harmonia axyridis:* a review of its biology, uses in biological control, and non-target impacts. *Journal of Insect Science* 3: 1-16.

Koch RL, Galvan TL (2008) Bad side of a good beetle: the North American experience with *Harmonia axyridis*. *BioControl* 53: 23-35.

Koch RL, Venette RC, Hutchison WD (2006) Invasions by *Harmonia axyridis* (Pallas) (Coleoptera: Coccinellidae) in the Western hemisphere: implications for South America. *Neotropical Entomology* 35: 421-434.

Koltunow AM, Krake LR, Johnson SD, Rezaian MA (1989) Two related viroids cause grapevine yellow speckle disease independently. *Journal of General Virology* 70: 3411-3419.

Koltunow AM, Krake LR, Rezaian MA (1988) Hop stunt viroid in Australian grapevine cultivars: potential for hop infection. *Australasian Plant Pathology* 17: 7-10.

Komai T, Chino M (1969) Observations on geographic and temporal variations in the ladybeetle *Harmonia: ii. Elytrial ridge*. *Proceedings Japan Academy* 45: 289-292.

Kondo A (2004) Colonizing characteristics of two phytoseiid mites, *Phytoseiulus persimilis* Athias-Henriot and *Neoseiulus womersleyi* (Schicha) (Acari: Phytoseiidae) on greenhouse grapevine and effects of their release on the kanzawa spider mite, *Tetranychus kanzawai* Kishida (Acari: Tetranychidae). *Applied Entomology and Zoology* 39: 643-649.

Kondo A, Hiramatsu T, Henmi T (1987) Life-history parameters of grape and bean-adapted populations of the Kanzawa spider mite, *Tetranychus kanzawai* Kishida (Acarina: Tetranychidae) on grape and bean. *Japanese Journal of Applied Entomology and Zoology* 31: 291-296.

Kondo A, Takafuji A (1985) Resource utilization pattern of two species of Tetranychid mites (Acarina: Tetranychidae). *Researches on Population Ecology* 27: 145-157.

Kovach J (2004) Impact of multicoloured Asian lady beetles as a pest of fruit and people. *American Entomologist* 50: 159-161.

Krasnonos LN, Kovalenko AF, Ukolov IP, Ergashev NE (1989) Cases of mass karakurt bites in Uzbekistan. *Meditsinskaia Parazitologiia I Paraztrarnye Bolezni* 4: 39-42.

Ku D, Ahn S, Hong K, Lee S, Kim J (1999) Does the Japanese beetle *(Popillia japonica* Newman): distribute in Korea or not? *Korean Journal of Applied Entomology* 38: 171-176.

Kuang C (1985) Studies on the biology and control of *Peridroma saucia* Hubner. *Insect Knowledge [Kunchong Zhishi]* 22: 61-64. (Abstract only)

Kuang HY (1983) Bionomics and population dynamics of avocado brown mite *Oligonychus punicae* (Hirst) on camphor tree. *Acta Entomologica Sinica* 26: 63-68.

Kucharek T (2000) Alternaria diseases of crucifers. *Plant Pathology Fact Sheet* PP-34: 1-5.

Kulkarni NS, Mani M, Banerjee K (2007) *Management of thrips on grapes*. Extension folder no. 13, National Research Centre for Grapes, Pune.

Kummuang N, Diehl SV, Smith BJ, Graves CH Jr (1996a) Muscadine grape berry rot diseases in Mississippi: disease epidemiology and crop reduction. *Plant Disease* 80: 244-247.

Kummuang N, Smith BJ, Diehl SV, Graves CH Jr (1996b) Muscadine grape berry rot diseases in Mississippi: disease identification and incidence. *Plant Disease* 80: 238-243.

Kungrad.com (2006) Karakurt. www.kungrad.com/nature/fauna/krakurt/ (Accessed 13 January 2010).

Kuo K (2009) Grape diseases and their management in Taiwan. Table Grape Production Technique. public.tactri.gov.tw/pdf/ (Accessed 25 March 2009).

Lack KJ (1989) The spread of apple brown rot *(Monilinia fructigena)* by insects. *Annals of Applied Biology* 115: 221-227.

Lauber HP, Schuepp H (1968) Grape diseases. *Schweizerische Zeitschrift fur Obst* 104: 550-555.

Lawrence JF, Britton EB (1994) *Australian beetles*. Melbourne University Press, Melbourne.

Lee DW, Choo HY, Chung JM, Lee SM, Sagong Y-B (2002) Host plants of *Popillia quadriguttata* (Coleoptera: Scarabaeidae). *Korean Journal of Applied Entomology* 41: 15-19.

Lee DW, Choo HY, Smitley DR, Lee SM, Shin HK, Kaya HK, Park CC, Park JK (2007) Distribution and adult activity of *Popillia quadriguttata* (Coleoptera: Scarabaeidae) on golf courses in Korea. *Journal of Economic Entomology* 100: 103-109.

Lee SC, Yoo JK, Yoo CH (1970) Survey on the kinds of the fruit sucking moths and their damages in Korea. *Korean Journal of Plant Pathology* 9: 37-41.

Legalov AA (2005) Trophic links of leaf-rolling weevils (Coleoptera, Rhynchitidae and Attelabidae). *Entomological Review* 85: 361-370.

Lele VC, Durgapal JC, Agarwal DK, Sethi CI (1978) Crown and root gall of grape *(Vitis vinifera*, L.) in Andhra Pradesh. *Current Science* 47: 280.

Lenz MS, Isaacs R, Flore JA, Howell GS (2009) Vegetative growth responses of Pinot gris *(Vitis vinifera* L.) grapevines to infestation by potato leafhoppers *(Empoasca fabae* Harrois). *American Journal of Enology and Viticulture* 60: 130-137.

Lewis T (1997) *Thrips as crop pests*. CAB International, Wallingford.

Li HY (1984) Preliminary survey report for grape stalk black rot. *Jiangxi Agricultural Science and Technology* 1: 11. (Abstract only)

Li S (2001) Grape production in China. In *Grape production in the Asia-Pacific region* (eds. Papademetriou MK, Dent FJ) pp. 19-27. Food and Agricultural Organization of the United Nations, Regional Office for Asia and the Pacific, Bangkok.

Li S (2008) Catalogue of life, China 2008 annual checklist. http://www.csvh.org/cnnode/browse_taxa.php?path=0;1;106;107;108&selected_taxon=108 (Accessed 15 September 2009).

Li SC, Liu H, Wu HT (2004) The occurrence of Comstock mealybug under bagging apple culture and its control. *China Fruits* 1: 44-51.

Li SF, Guo R, Peng S, Sano T (2007) Grapevine yellow speckle viroid 1 and grapevine yellow speckle viroid 2 isolates from China. *Journal of Plant Pathology* 89: S72.

Li SF, Guo R, Tsuji M, Sano T (2006) Two grapevine viroids in China and the possible detection of a third. *Plant Pathology* 55: 564.

Li X, Zhao X, Gong S, Chen F, Tan T, Cheng A (2008) The population dynamics and its role in controlling *Erisoma lanigerum* of *Harmonias axyridis* (Pallas). *Southwest China Journal of Agricultural Sciences* 21: 1165-1168.

Li ZX (2004) *Control of pests and diseases of table grape*. Jindun, Beijing.

Liang ZC, Zeng ZT (1980) Parasitisation of *Cladosporium cladosporioides* (Fres) De Vries on citrus red mites. *Acta Microbiologica Sinica* 20: 72-75.

Liberato JR, Daly AM, Shivas RG (2007) Grapevine leaf rust (*Phakopsora euvitis*). Pest and Disease Image Library. http://www.padil.gov.au/viewPest.aspx?id=440 (Accessed 2 March 2009).

Lingafelter SW, Hoebeke ER (2002) *Revision of the genus Anoplophora (Coleoptera: Cerambycidae)*. Entomological Society of Washington, Washington, D.C.

Little A, Rezaian MA (2003) Grapevine viroids. In *Viroids* (eds. Hadidi A, Flores R, Randles JW, Semancik JS) pp. 195-206. Commonwealth Scientific and Industrial Research Organisation, Collingwood.

Liu B, Yang H, Fu JF, Xing ZF (2006a) Biological characters of *Macrophoma faocia* causing grape axel blotch. *Journal of Shenyang Agricultural University* 2: 21-25. (Abstract only)

Liu Q, Zheng LY (1994) On the Chinese species of *Plautia* Stal (Hemiptera: Pentatomidae). *Entomotaxonomia* 16: 235-248.

Liu SF, Cheng ZJ, Zhang CX (1996) Study on occurrence and integrated control of *Alternaria viticola*. In *Proceedings of the third national conference of integrated pest management, Beijing, China, 12-15 November 1996*, pp. 341-345, China Science and Technology Press, Beijing.

Liu X, Boscia D, Raimondi T, Broggio M, Chen J, Li HW, Wang JH, Liu J-J (2004) Field investigation and serological detection of grapevine viruses in Sichuan province. *Southwest China Journal of Agricultural Sciences* 17: 52-56.

Liu X, Chen J, Wang J, Liu J-J (2006b) Identification of virus diseases in some grapevine cultivars and evaluation of their sanitary state. *Journal of Fruit Science* 23: 846-849.

Löbl I, Smetana A (2006) *Catalogue of Palaearctic Coleoptera*. Apollo Books, Stenstrup.

Loch A, Slack J (2007) Grape phylloxera: the world's worst grapevine pest. *Primefacts: Profitable and Sustainable Primary Industries* 553: 1-4.

Lommel SA, Martelli GP, Rubino L, Russo M (2005) Family Tombusviridae. In *Virus taxonomy classification and nomenclature: eighth report of the International Committee on Taxonomy of Viruses* (eds. Fauquet CM, Mayo MA, Maniloff J, Desselberger U, Ball LA) pp. 907-936. Elsevier Academic Press, San Diego.

Lopes RB, Tamai MA, Alves SB, Neto SS, de Salvo S (2002) Occurrence of thrips on Niagara table grape and its control with the insecticides Thiacloprid and Methiocarb associated with *Metarhizium anisopliae*. *Rev.Bras.Frutic., Jaboticabal* 24: 269-272.

Lu S, Sun V, Amerson H, Chiang VL (2007) MicroRNAs in loblolly pine (*Pinus taeda* L.) and their association with fusiform rust gall development. *The Plant Journal* 51: 1077-1098.

Lucid (2007) Aleyrodinae. Lucid Key Server. http://www.lucidcentral.org/keys/v3/whitefly/Aleyrodinae/Media/Html/Aleyrodine%20Species%20list.htm (Accessed 9 April 2009).

Luo L, Wen Y, Wu Z (2005) *Description and damage review on 17 pests of grape wine borers in South Guizhou*. South Guizhou Province State Plant Protection Station, China.

Luttrell ES (1946) Black rot of muscadine grapes. *Phytopathology* 36: 905-924.

Ma CS (2006) Pests, diseases and weeds of apples published by Key Laboratory of Agriculture Department, China. Key Laboratory of Agriculture Department. http://www.ecolsafety.org.cn//db/Fruit/login_pg.asp (Accessed 1 September 2006).

Ma J, Zhu X, Zhao L (2004) Preliminary study on spike: stalk brown spot of grape. *Xinjiang Agricultural Sciences* 41: 353-354.

Ma LJ, Sheng MY (1995) The characteristics of grape brown rot disease. *Bulletin of Agricultural Science and Technology* 1: 32.

Maccarone LD, Sivasithamparam K, Barbetti M, Jones RAC (2008) Phylogenetic analysis of *Olpidium virulentus*, *Lettuce big-vein associated virus* and *Mirafiori lettuce big-vein virus* isolates from Western Australia. In *Plant Health Research Symposium 2008*, pp. 1-6, Australian Plant Pathology Society, Western Australia.

MacFarlane CS (1947) The activity of the vlamsiekte organism in soils. *Farming in South Africa* 22: 820-822.

MAF Biosecurity New Zealand (2002) *Spiders associated with table grapes from United States of America (State of California), Australia, Mexico and Chile*. Ministry of Agriculture and Forestry, Wellington.

MAF Biosecurity New Zealand (2009) *Import risk analysis: table grapes (Vitis vinifera) from China Final*. MAF Biosecurity New Zealand, Wellington.

MAF New Zealand (2005) *Interception records for table grapes from Chile to New Zealand up to 2005*. Ministry of Agriculture and Forestry, Wellington.

MAFF (2008) *Pest information sent by Ministry of Agriculture, Forestry and Fisheries, Japan to Biosecurity Australia*. Ministry of Agriculture, Forestry and Fisheries, Tokyo.

Magarey PA, Wachtel MF, Emmett RW (1994) Downy mildew. In *Diseases and pests* (eds. Nicholas P, Margery P, Wachtel M) pp. 5-11. Winetitles, Adelaide.

Magenta Consulting Limited (2008) *The Russian market for table grapes: target market confirmation study (abridged version)*. Magenta Consulting Limited, Singapore.

Majerus M, Strawson V, Roy H (2006) The potential impacts of the arrival of the Harlequin ladybird, *Harmonia axyrides* (Pallas) (Coleoptera: Coccinellidae). *Ecological Entomology* 31: 207-215.

Mamarov P, Ivanov J, Katerov K (1958) The effect of preparation of the grapevine seeds before sowing on their germinating capacity. *Sbornik Ceskoslovenske Akademie Zemedelskych Ved Rostlinna Vyroba* 31: 1211-1216.

Marcelin H (1985) Control of grape tortricids. *Phytoma* 370: 29-32.

Martelli GP (1997) Presentation of the Mediterranean Network on Grapevine Closteroviruses (MNGC) and report of activity 1992-97. *Options Mediterraneennes Series B* 29: 13-29.

Martelli GP, Conti M, Minafra A (2001a) Grapevine virus A. Descriptions of Plant Viruses. http://www.dpvweb.net/dpv/showdpv.php?dpvno=383 (Accessed 6 January 2010).

Martelli GP, Walter B, Pinck L (2001b) Grapevine fanleaf virus. Descriptions of Plant Viruses. http://www.dpvweb.net/dpv/showdpv.php?dpvno=385 (Accessed 22 May 2009).

Martin JH, Gillespie PS (2001) *Aleyrodoidea* (white flies). Australian Biological Resources Study: Australian Faunal Directory. http://www.environment.gov.au/cgi-bin/abrs/fauna/details.pl?pstrVol=ALEYRODOIDEA;pstrTaxa=1;pstrChecklistMode=1 (Accessed 16 October 2006).

Martin JH, Mound LA (2007) *Zootaxa: an annotated check list of the world's whiteflies (Insecta: Hemiptera: Aleyrodidae)*. 1492, Magnolia Press, Auckland.

Martin NA (1999) Whitefly: natural enemies of whitefly and their biology. *Crop and Food Research* 92: 1-7.

Martin RR, Tzanetakis IE (2006) Characterization and recent advances in the detection of strawberry viruses. *Plant Disease* 90: 384-396.

Martins A, Simoes N (1985) Population dynamics of the Japanese beetle (Coleoptera: Scarabaeidae) in Terciera Island: Azores. *Arquipelago* 6: 57-62.

Mathew G (1987) Insect borers of commercially important stored timber in the state of Kerala, India. *Journal of Stored Products Research* 23: 185-190.

Matsumura S (1933) Lymantriidae of Japan empire. *Insecta Matsumurana* 7: 111-154.

Matus JT, Vega A, Loyola R, Serrano C, Cabrera S, Arce-Johnson P (2008) Phytoplasma and virus detection in commercial plantings of *Vitis vinifera* cv. Merlot exhibiting premature berry dehydration. Electronic Journal of Biotechnology. http://www.ejbiotechnology.info/content/vol11/issue5/full/8/# (Accessed 12 November 2009).

Mau RFL, Kessing JLM (1993) *Frankliniella occidentalis (*Pergande). University of Hawaii. http://www.extento.hawaii.edu/kbase/Crop/SciName/cropsci.htm (Accessed 15 October 2009).

Mau RFL, Martin-Kessing JL (1993) Crop knowledge master - Frankliniella occidentalis (Pergande). http://www.extento.hawaii.edu/kbase/Crop/crop.htm (Accessed 18 December 2009).

Mau RFL, Matin JL (2007) *Bactrocera dorsalis* (Hendel). Crop Knowledge Master. http://www.extento.hawaii.edu/ (Accessed 27 October 2009).

McCorkle M (2002) "Latrodectus mactans" (on-line), Animal Diversity Web. http://animaldiversity.ummz.umich.edu/site/accounts/information/Latrodectus_mactans.html (Accessed 23 November 2009).

McDonald JR, Bale JS, Walter KFA (1997) Rapid cold hardening in the Western flower thrips *Frankliniella occidentalis*. *Journal of Insect Physiology* 43: 759-766.

McDougall S (2006) Lettuce IPM. *Primefacts: Profitable and Sustainable Primary Industries* 154: 1-5.

McGrath-Kerr Business Consultants Pty Ltd (2008) *Australian wine grape outlook 2008-12*. Winetitles, Griffith.

McGrew JR (1988) Bitter rot. In *Compendium of grape diseases* (eds. Pearson RC, Goheen AC) pp. 20-22. The American Phytopathological Society Press, St. Paul.

McLaughlin RJ, Wilson CL, Droby S, Ben-Arie R, Chalutz E (1992) Biological control of postharvest diseases of grape, peach, and apple with the yeasts *Kloeckera apiculata* and *Candida guilliermondii*. *Plant Disease* 76: 470-473.

McLeod R (2006) Species *Amphipyra pyramidoides*: Copper underwing-Hodges#9638. BugGuide. http://bugguide.net/node/view/13299 (Accessed 29 March 2007).

McNamara J (1991) Family Rhynchitidae (leaf and bud weevils). In *Checklist of beetles of Canada and Alaska* (ed. Bousquet Y) pp. 1-430. Biosystematics Research Centre, Ottawa.

Meijerman L, Ulenberg SA (2000) *Eupoecilia ambiguella*. Arthropods of Economic Importance. http://nlbif.eti.uva.nl/bis/projects.php (Accessed 5 November 2009).

Meijerman L, Ulenberg SA (2009a) *Eupoecilia ambiguella*. Arthropods of Economic Importance. http://nlbif.eti.uva.nl/bis/ (Accessed 10 November 2009).

Meijerman L, Ulenberg SA (2009b) Eurasian Tortricidae: about Eurasian Tortricidae. Arthropods of Economic Importance. http://nlbif.eti.uva.nl/bis/tortricidae.php?menuentry=inleiding (Accessed 23 December 2009).

Mencarelli F, Bellincontro A (2005) "Grape postharvest operations" with emphasis in developing countries. http://www.fao.org/inpho/content/compend/text/ch34/Ae615e02.htm#TopOfPage (Accessed 29 September 2009).

Merrin SJ, Nair NG, Tarran J (1995) Variation in Phomopsis recorded on grapevine in Australia and its taxonomic and biological implications. *Australasian Plant Pathology* 24: 44-56.

Migeon A, Dorkeld F (2006) Spider mites web: a comprehensive database for the Tetranychidae. http://www.montpellier.inra.fr/CBGP/spmweb (Accessed 31 August 2009).

Migeon A, Dorkeld F (2007) Spider mites web. Centre de Biologie et de Gestion des Populations. http://www1.montpellier.inra.fr/CBGP/spmweb/index.php (Accessed 25 November 2008).

Miller DR, Miller GL, Watson GW (2002) Invasive species of mealybugs (Hemiptera: Pseudococcidae) and their threat to US agriculture. *Proceedings of the Entomological Society of Washington* 104: 825-836.

Miller DR, Rung A, Venable GL, Gill RJ (2007) Scale insects: identification tools for species of quarantine significance. http://www.sel.barc.usda.gov/ScaleKeys/ScaleInsectsHome/ScaleInsectsHome.html (Accessed 7 June 2009).

Ministry of Commerce (2009) Doing business in Yunnan Province of China. Ministry of Commerce of the People's Republic of China. http://english.mofcom.gov.cn/aroundchina/yunnan.shtml (Accessed 29 June 2009).

Ministry of Culture PRoC (2003) Shanxi. http://www.culturalink.gov.cn/gb/en_map/2003-09/24/content_21544.htm (Accessed 29 September 2009).

Mizell RF, III (2007) Impact of *Harmonia axyrides* (Coleoptera: Coccinellidae) on native arthropod predators in pecan and crepe myrtle. *Florida Entomologist* 90: 524-536.

Molnár G, Németh J, Májer CS, Jahnke G (2009) Assessment of phylloxera leaf galling incidence on European grapevines in Badacsony Hungary. *Acta Horticulturae (ISHS)* 816: 97-104.

Momol T, Ritchie L, Dankers H (2007) 2007 Florida plant disease management guide: grape *(Vitis* spp.). Institute of Food and Agricultural Sciences Extension, University of Florida. http://edis.ifas.ufl.edu/pdffiles/PG/PG01100.pdf (Accessed 19 May 2009).

Moon H, Woong K, Choi M, Kwon S, Shin Y, Kim D, Hwang C (2008) Seasonal occurrences of insect pests in watermelon under greenhouses as affected by cropping season. *Korean Journal of Applied Entomology* 47: 345-352.

Moore C, Daly A (2009) How to control grapevine leaf rust. *Agnote* 171: 1-2.

Moore D (2004) Biological control of *Rastrococcus invadens*. *Biocontrol News and Information* 25: 17N-27N.

Morales RZ, Monis J (2007) First detection of *Grapevine leafroll associated virus-7* in California vineyards. *Plant Disease* 91: 465.

Moriya S (1995) Ecological studies on the brown-winged green stink bug, *Plautia stali* Scott, with special reference to its occurrence and adult movement. *Bulletin of the Okinawa Prefectural Agricultural Experimental Station* 5: 1-135.

Morse JG, Hoddle MS (2006) Invasion biology of thrips. *Annual Review of Entomology* 51: 67-89. (Abstract only)

Mostert L, Corus PW, Kang JC (2001) Species of *Phomopsis* and a *Libertella* sp. occurring on grapevines with specific reference to South Africa: morphological, cultural, molecular and pathological characterization. *Mycologia* 93: 146-167.

Mostert L, Crous PW, Petrini O (2000) Endophytic fungi associated with shoots and leaves of *Vitis vinifera,* with specific reference to the *Phomopsis viticola* complex. *Sydowia* 52: 46-58. (Abstract only)

Mound LA (2001) *Frankliniella occidentalis* (Pergande, 1895): western flower thrips. Australian Biological Resources Study: Australian Faunal Directory. http://www.environment.gov.au/cgi-bin/abrs/fauna/details.pl?pstrVol+THYSANOPTER;pstrTaxa=1470pstrChecklistMode=1 (Accessed 6 August 2008).

Mullen GL, Mullen G, Durden LA (2009) *Medical and Veterinary Entomology*. (eds. Mullen GR, Durden LA) Academic Press, San Diego.

Muniz M, Rocha DF, Silveira NSS, Menezes M (2003) Identification of fungi causal agents of postharvest diseases on commercialized fruits in Alagoas, Brazil. *Summa Phytopathologica* 29: 38-42.

Mycobank (2009) Fungal databases nomenclature and species banks online taxonomic novelties submission. http://www.mycobank.org/Mycotaxo.aspx (Accessed 20 April 2009).

Nagarajan S (1990) Long-distance dispersion of rust pathogens. *Annual Review of Phytopathology* 28: 139-153.

Nair NG, Merrin SJ, Tarran J (1994) Studies on *Phomopsis* causing cane and leaf blight of grapevine in Australia. *The Australian Grape Grower and Wine Maker, National Journal of the Grape and Wine Industry: Annual Technical Issue* 366a: 35-42.

NAPIS (2008) Reported status of Japanese beetle: *Popillia japonica*. National Agricultural Pest Information System. http://pest.ceris.purdue.edu/searchmap.php? (Accessed 3 June 2008).

Narai Y, Murai T (2002) Individual rearing of the Japanese mealybug, *Planococcus kraunhiae* (Kuwana) (Homoptera: Pseudococcidae) on germinated broad bean seeds. *Applied Entomology and Zoology* 37: 295-298.

Navajas M, Gutierrez J, Williams M, Gotoh T (2001) Synonymy between two spider mite species, Tetranychus kanzawai and T. hydrangeae (Acari: Tetranychidae), shown by ribosomal ITS2 sequences and cross-breeding experiments. *Bulletin of Entomological Research* 91: 117-123.

NCBI (2009) Necrovirus. National Center for Biotechnology Information. http://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=12052 (Accessed 14 August 2009).

Nel J, Nel A (2003) Contribution to the knowledge of the Lepidoptera of the Crete island (Greece) (Lepodoptera). *Bulletin de la Societe Entomologique de France* 108: 277-282.

Nemeth M (1986) Tobacco necrosis virus. In *Virus, mycoplasma and rickettsia diseases of fruit trees* pp. 572-575. Martinus Nijhoff Publishers, Dordrecht.

NHB (2009) Grape pests, National Horticulture Board, India. http://nhb.gov.in/bulletin_files/fruits/grape/gra008.pdf (Accessed 5 January 2010).

Nicholas P, Magarey PA, Wachtel Me (1994) *Diseases and pests*. Winetitles, Adelaide.

Nielsen ES, Edwards ED, Rangsi TV (1996) *Checklist of the Lepidoptera of Australia*. Commonwealth Scientific and Industrial Research Organisation, Collingwood.

Nienhaus F, Castello JD (1989) Viruses in forest trees. *Annual Review of Phytopathology* 27: 165-186.

Nishikado Y (1921) On a disease of the grape-cluster caused by *Physalospora baccae* Cavara. *Annals of the Phytopathological Society of Japan* 1: 20-41.

NPQS (2007) *PRA materials of grapes from Korea*. National Plant Quarantine Service, Korea.

NRC (2009) Grape profile, National Research Centre for Grapes, Indian Council of Agricultural Research, Pune, India. http://nrcgrapes.nic.in/ (Accessed 5 January 2010).

NSW Government (2006) Plant diseases ACT 1924. http://www.services.nsw.gov.au/advertising/index.html (Accessed 22 December 2006).

NSW Industry & Investment (2010) Summary of Phylloxera movement conditions. Department of Primary Industries, New South Wales. http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/116716/summary-of-phylloxera-movement-conditions-under-P176.pdf (Accessed 5 January 2010).

NTG (2006) Grapevine leaf rust quarantine extended. Northern Territory Government: Regional Development, Primary Industry, Fisheries and Resources. http://www.nt.gov.au/d/news_media_archive_article.cfm?newsid=108&ws=1 (Accessed 11 September 2009).

NTG (2007) Successful eradication of Grapevine leaf rust. Northern Territory Government Media Release. http://newsroom.nt.gov.au/index.cfm?fuseaction=printRelease&ID=2754 (Accessed 11 September 2009).

NTRDPIGR (2009) Pests and diseases. http://www.nt.gov.au/d/Primary_Industry/index.cfm?newscat1=Quarantine&newscat2=&header=Pests%20and%20Diseases (Accessed 16 November 2009).

NVHSC (2004) *National Phylloxera management protocol: movement procedures for phylloxera risk vectors from a Phylloxera Infested Zone (PIZ)*. National Vine Health Steering Committee, South Australia.

NVHSC (2005) *Pest risk analysis for the establishment of a new infestation of phylloxera in Australia as a result of harvest processes*. National Vine Health Steering Committee, South Australia.

NVHSC (2008) *National Phylloxera management protocol: definitions of Phylloxera management zones*. National Vine Health Steering Committee, South Australia.

NYZSW (2009) *Physalospora baccae*. Agricultural Knowledge Website. http://nyzsw.blog.bandao.cn (Accessed 11 October 2009).

NZ Ministry of Health (2002) A health impact assessment relating to venomous spiders entering New Zealand in association with imported table grapes. New Zealand, Ministry of Health, Wellington.

Ocete R, López MÁ, Gallardo A, Arnold C (2008) Comparative analysis of wild and cultivated grapevine *(Vitis vinifera)* in the Basque region of Spain and France. *Agriculture, Ecosystems and Environment* 123: 95-98.

Office of the Gene Technology Regulator (2003) *Application for licence for dealings involving an intentional release into the environment- field trial of GM grapevines: evaluation of berry colour, sugar composition, flower and fruit development and pollen flow study*. DIR 031/2002 Risk Assessment and Risk Management Plan, Department of Health and Ageing, Canberra.

Ohlendorf BLP (2000) Spider mites: integrated pest management in the home garden. *Pest Notes* 7405: 1-3.

Oku K (2008) Role of excreta in predator avoidance by the Kanzawa spider mite, *Tetranychus kanzawai* (Acari: Tetranychidae). *European Journal of Entomology* 105: 619-623.

Oku K, Yano S, Takafuji A (2002a) Different maternal effects on offspring performance in tetranychid mites, *Tetranychus kanzawai* and *T. urticae* (Acari: Tetranychidae). *Applied Entomology and Zoology* 37: 425-429.

Oku K, Yano S, Takafuji A (2002b) Phase variation in the Kanzawa spider mite, *Tetranychus kanzawai* Kishida (Acari: Tetranychidae). *Applied Entomology and Zoology* 37: 431-436.

Oku K, Yano S, Takafuji A (2003) Spider mites use of a refuge during the quiescent stage in the presence of a predator. *Entomologia Experimentalis et Applicata* 108: 71-74.

Oku K, Yano S, Takafuji A (2006) Host plants acceptance by the phytophagous mite *Tetranychus kanzawai* Kishida is affected by the availability of a refuge on the leaf surface. *Ecological Research* 21: 446-452.

Olmo HP (1976) Grapes. In *Evolution of crop plants* (ed. Simmonds NW) pp. 294-298. Longmans, London.

Olsen M (1999) Diseases of urban plants. Plant Disease. http://ag.arizona.edu/pubs/diseases/az1124/ (Accessed 15 December 2008).

Ono Y (2000) Taxonomy of the *Phakopsora ampelopsidis* species complex on vitaceous hosts in Asia including a new species, *P. euvitis*. *Mycologia* 92: 154-173.

Ovsyannikova EI, Grichanov IY (2009) *Mamestra brassicae* L.: Interactive Agricultural Ecological Atlas of Russia and Neighbouring Countries: Economic Plants and their Diseases, Pests and Weeds. http://www.agroatlas.ru/en/ (Accessed 27 October 2009).

OzAnimals (2009a) Plume moth (Pterophoridae family). OzAnimals.com. http://www.ozanimals.com/ (Accessed 20 July 2009).

OzAnimals (2009b) Transverse ladybird (*Coccinella transversalis*). http://www.ozanimals.com/Insect/Transverse-Ladybird/Coccinella/transversalis.html (Accessed 12 January 2010).

PaDIL (2007) Fruit-piercing moth (*Ischyja manlia* Cramer). http://www.padil.gov.au/viewPestDiagnosticImages.aspx?id=806 (Accessed 13 January 2010).

Park E, Choi K, Kim J, Cho S, Kim G (2001) Effect of temperature on development and reproduction of the persimmon fruit moth, *Stathmopoda masinissa* (Lepidoptera: Stathmopodidae). *Korean Journal of Applied Entomology* 40: 297-300.

Park JD, Park IJ, Han KP (1994) Investigation of insect pests and injury characteristics of *Stathmopoda auriferella* (Walker) on kiwi fruit tree. *Korean Journal of Applied Entomology* 33: 148-152.

Pathania PC, Sood R, Rose HS (2009) Oecophorid (Micro Lepidoptera) diversity from Shivalik hills of northwestern Himalaya. *Journal of Threatened Taxa* 1: 385-391.

Payne NM (1928) Cold hardiness in the Japanese beetles, *Popillia japonica* Newman. *The Biological Bulletin* 55: 163-179.

PDI (2003) *Pest and Disease Information Database: pest interception records up to 31 December, 2002*. Department of Agriculture, Fisheries and Forestry, Canberra.

Pearson RC (1993) Common names of plant diseases: diseases of grapes (*Vitis* spp.). APSnet: plant pathology online. http://www.aspect.org/online/common/names/grapes.asp (Accessed 2 December 2008).

Pearson RC, Goheen AC (1988) *Compendium of grape diseases*. (eds. Pearson RC, Goheen AC) The American Phytopathological Society Press, St. Paul.

Pedgley DE (1982) *Windborne pests and diseases: meteorology of airborne organisms*. Ellis Horwood Limited, West Sussex.

Pell JK, Baverstock J, Roy HE, Ware RL, Majerus MEN (2008) Intraguild predation involving *Harmonia axyrides:* a review of current knowledge and future perspectives. *BioControl* 53: 147-168.

Pennycook SR (2009) Comments on the nomenclature and taxonomy of *Physalospora baccae*. pp. 1-2.

Perrone G, Mule G, Susca A, Battilani P, Pietri A, Logrieco A (2006) Ochratoxin A production and amplified fragment length polymorphism analysis of *Aspergillus carbonarius*, *Aspergillus tubingensis*, and *Aspergillus niger* strains isolated from grapes in Italy. *Applied and Environmental Microbiology* 72: 680-685.

Persley DM, Thomas JE, Sharman M (2006) Tospoviruses; an Australian perspective. *Australasian Plant Pathology* 35: 161-180.

Petrovic N, Meng B, Ravnikar M, Mavric I, Gonsalves D (2003) First detection of *Rupestris stem pitting associated virus* particles by antibody to a recombinant coat protein. *Plant Disease* 87: 510-514.

Pezet R, Jermini M (1989) Black rot of grapevine: symptoms, epidemiology and control. *Revue Suisse de Viticulture, d'Arboriculture et d'Horticulture* 21: 27-34.

Pfeiffer DG (2009) Climbing cutworms in grapes. Mid-Atlantic Regional Fruit Loop. http://www.virginiafruit.ento.vt.edu/index.html (Accessed 27 October 2009).

Pfeiffer DG, Schultz PB (1986a) Japanese beetle, *Popillia japonica* Newman on grape. Major Insect and Mite Pests of Grape in Virginia. http://www.virginiafruit.ento.vt.edu/JBGrape.html (Accessed 17 December 2009).

Pfeiffer DG, Schultz PB (1986b) *Major insect and mite pests of grape in Virginia*. VPI and SU Virginia Cooperative Extensive Service, Virginia.

PGIBSA (2003) *A guide to grape phylloxera in Australia*. Phylloxera and Grape Industry Board of South Australia, Australia.

Pham KTK, Lemmers MEC, Van Doorn J, Derks AFLM (2007a) Tobacco necrosis virus A from Hyacinth cv. White Pearl coat protein (CP) gene, partial cds. National Center for Biotechnology Information. http://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=12052 (Accessed 7 July 2009).

Pham KTK, Lemmers MEC, Van Doorn J, Derks AFLM (2007b) Tobacco necrosis virus A from Lily cv. Baria Blanca coat protein (CP) gene, partial cds. National Center for Biotechnology Information. http://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?id=12052 (Accessed 7 July 2009).

Pickering GJ, Lin J, Raynolds A, Soleas G, Riesen R (2006) The evaluation of remedial treatments for wine affected by *Harmonia axyridis*. *International Journal of Food Science and Technology* 41: 77-86.

Pickering GJ, Spink M, Kotserides Y, Brindle ID, Sears M, Inglis D (2008) Morbidity of *Harmonia axyridis* mediates ladybug taint in red wine. *Journal of Food, Agriculture and Environment* 6: 133-137.

Pittaway AR, Kitching IJ (2006) Sphingidae of the eastern Palaearctic. http://tpittaway.tripod.com/china/china.htm (Accessed 29 September 2006).

Plant Health Australia (2009) *Industry Biosecurity Plan for the viticulture industry*. Version 2.0, Plant Health Australia, Canberra.

PlantNet (2009) *Mallotus claoxyloides* (F.Muell.) Muell.Arg. New South Wales Flora Online. http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Mallotus~claoxyloides (Accessed 19 January 2010).

PlantPro (2005) Thrips. http://www.plantprotection.hu/modulok/angol/grapes/index.htm (Accessed 19 November 2009).

Podleckis EV (2003) *Chinese fragrant pears memo: information memo for the record*. United States Department of Agriculture, United States of America.

Poole MC (2008) *An annotated catalogue of insect and allied species of economic significance or of potential export quarantine concern for Western Australian primary and related industries*. Department of Agriculture and Food, Western Australia, Perth.

Potter DA, Held DW (2002) Biology and management of the Japanese beetle. *Annual Review of Entomology* 47: 175-205.

Potter MF, Bessin R, Townsend L (2005) Asian lady beetle infestation of structures. University of Kentucky EntFact-416. http://www.ca.uky.edu/entomology/entfacts/entfactpdf/ef416.pdf (Accessed 7 January 2010).

Powell K (2008a) *Travel scholarship to attend the 4th international Phylloxera symposium, University of Pannonia, Keszthely, Hungary: a final report on project GWT 06/14*. GWRDC final report GWT 06/14, Department of Primary Industries, Victoria.

Powell KS (2008b) Grape Phylloxera: an overview. In *Root feeders an ecosystem perspective* (eds. Johnson SN, Murray PJ) pp. 1-221. CAB International, Cambridge.

Pratt C (1988) Grapevine structure and growth stages. In *Compendium of grape diseases* (eds. Pearson RC, Goheen AC) pp. 3-7. The American Phytopathological Society Press, St. Paul.

Pscheidt JW, Pearson RC (1991) Phomopsis cane and leaf spot of grape. http://www.nysipm.cornell.edu/factsheets/grapes/diseases/phomopsis.pdf (Accessed 12 February 2010).

Public Health SaKC (2006) Pest control: gypsy moth and the use of *Bacillus thuringiensis kurstaki* (B.t.k.) pesticide. Public Health: Seattle and King Country. http://www.kingcounty.gov/ (Accessed 2008).

QDEEDI-PIF (2009) Establishing a vineyard or winery. Department of Employment, Economic Development and Innovation, Primary Industries and Fisheries, Queensland. http://www.dpi.qld.gov.au/26_6160.htm (Accessed 7 January 2010).

QDPIF (2008) Pre-harvest treatment and inspection of table grapes. Department of Primary Industries and Fisheries, Queensland. http://www2.dpi.qld.gov.au/extra/ICA/Procedures/ICA/ICA-20/ICA-20.pdf (Accessed 5 November 2009).

Qi H-X, Zhang J, Qi Y, Wang T, Li S (2007) Research of the pests in free-pollutant culture wine grape orchard. *Northern Horticulture* 8: 202-204.

Quirk L, Somers T (2009) *Grapevine management guide 2009-10*. Department of Industry and Investment, New South Wales.

Rahman KA, Bhardwaj NK (1937) The grape-vine Thrips *(Rhipiphorothrips cruentatus* Hood) [Thripidae: Terebrantia: Thysanoptera]. *Indian Journal of Agricultural Sciences* 7: 633-651.

Ramsdell DC, Milholland RD (1988) Black rot. In *Compendium of grape diseases* (eds. Pearson RC, Goheen AC) pp. 15-17. American Phytopathological Society Press, St. Paul.

Rawnsley B, Wicks TJ (2002) *Phomopsis viticola: pathogenicity and management.* SAR 99/1, South Australian Research and Development Institute, Australia.

Reddy GVP, Cruz ZT, Muniappan R (2007) Attraction of fruit-piercing moth *Eudocima phalonia* (Lepidoptera: Noctuidae) to different fruit baits. *Crop Protection* 26: 664-667.

Reding ME, Krause CR (2005) Management of Japanese beetle and other beetles of quarantine significant in nursery crops. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Center for Plant Health Science and Technology. http://www.reeis.usda.gov/web/crisprojectpages/406954.html (Accessed 18 January 2010).

Ren J (2006) Studies on the biology and control of *Frankliniella occidentalis* (Pergande). MSc thesis, Northwest Agriculture and Forestry University, China. http://epub.cnki.net/grid2008/detail.aspx?filename=2006179890.nh&dbname=CMFD2007 (Accessed 12 November 2009).

Ribeiro GP, Saldarelli P, Hong N, Xiang BC, Zhang XL, Wang GP, Martelli GP (2004) First record of three grapevine viruses in the Chinese Province on Sinkiang. *Journal of Plant Pathology* 86: 263-264.

Richmond DS, Grewal PS, Cardina J (2004) Influence of Japanese beetle *Popillia japonica* larvae and fungal endophytes on competition between turfgrass and dandelion. *Crop Science* 44: 600-606.

Ridings WH, Clayton CN (1970) *Melanconium fuligineum* and the bitter rot disease of grape. *Phytopathology* 60: 1203-1211.

Robert V, Stegehuis G, Stalpers J (2009) The mycobank engine and related databases. Fungal Databases, Nomenclature and Species Banks Online Taxonomic Novelties Submission. www.mycobank.org (Accessed 15 January 2009).

Robinson GS, Ackery PR, Kitching IJ, Beccaloni GW, Hernández LM (2001) *Hostplants of the moth and butterfly caterpillars of the oriental region*. The Natural History Museum, London.

Robinson GS, Ackery PR, Kitching IJ, Beccaloni GW, Hernández LM (2007a) HOSTS - A database of the host plants of the world's Lepidoptera. Department of Entomology. The Natural History Museum, London. http://www.nhm.ac.uk/entomology/hostplants/ (Accessed 20 December 2007a).

Robinson GS, Ackery PR, Kitching IJ, Beccaloni GW, Hernández LM (2007b) Hosts: a database of the world's Lepidopteran hostplants. Natural History Museum. http://www.nhm.ac.uk/ (Accessed 5 November 2009).

Robinson GS, Ackery PR, Kitching IJ, Beccaloni GW, Hernández LM (2008) Hosts: a database of the host plants of the world's Lepidoptera hostplants. The Natural History Museum, London. http://www.nhm.ac.uk/entomology/hostplants/ (Accessed 10 April 2008).

Rochon D, Kakani K, Robbins M, Reade R (2004) Molecular aspects of plant virus transmission by Olpidium and Plasmodiophorid vectors. *Annual Review of Phytopathology* 42: 211-241.

Roditakis E, Roditakis NE (2007) Assessment of the damage potential of three thrips species on white variety table grapes: *in vitro* experiments. *Crop Protection* 26: 476-483.

Roehrich R, Boller E (1991) Tortricids in other crops. http://www.elsevier.com/wps/find/bookdescription.cws_home/505537/description?navopenmenu=4 (Accessed 21 October 2009).

Rombough L (2002) *The grape grower: a guide to organic viticulture*. Chelsea Green Publishing Company, White River Junction.

Roques A (2006) *Frankliniella occidentalis* (Pergande, 1895) . Delivering Alien Invasive Species Inventories for Europe. http://www.europe-aliens.org/ (Accessed 31 October 2006).

Ross CF, Weller K (2007) Sensory evaluation of suspected *Harmonia axyridis* tainted red wine using untrained panelists. *Journal of Wine Research* 18: 187-193.

Ross HCG (1988) A record of the black widow spider *(Latrodectus mactans* (Fabricius) (Araneae: Theridiidae)) in Ireland. *Irish Naturalists' Journal* 22: 12-537. (Abstract only)

Roy H, Roy D (2008) *Harmonia axyrides:* delivering alien invasive species inventories for Europe. http://www.europe-aliens.org/speciesFactsheet.do?speciesId=50711 (Accessed 4 January 2010).

Saeki K, Takahashi Y, Oh-oka H, Umeoka T, Oda Y, Fukuyama K (2001) Primary structure and phylogenetic analysis of the coat protein of a Toyama isolate of Tobacco necrosis virus. *Bioscience, Biotechnology and Biochemistry* 65: 719-724.

Saeki Y, Kruse KC, Switzer PV (2005) The social environment affects mate guarding behavior in Japanese beetles, *Popillia japonica*. *Journal of Insect Science* 5: 1-6.

SAG-USDA (2006) *Interception records for table grapes from Chile to USA in 2006*. United States Department of Agriculture, United States of America.

Sanchez FF, Laigo FM (1968) Notes on the cacao tussock moth, *Orgyia australis postica* Walker (Lymantriidae, Lepidoptera). *Philippine Entomologist* 1: 67-71.

Sang XW (1979) Studies on the bionomics and control of *Popillia quadriguttata* F. *Acta Entomologica Sinica* 22: 478-480.

Sasaya T, Koganezawa H (2006) Molecular analysis and virus transmission tests place *Olpidium virulentus*, a vector of Mirafiori lettuce big-vein virus and tobacco stunt virus, as a distinct species rather than a strain of *Olpidium brassicae*. *Journal of General Plant Pathology* 72: 20-25.

Savela M (2009) Calpinae. http://www.funet.fi/pub/sci/bio/life/insecta/lepidoptera/ditrysia/noctuoidea/noctuidae/calpinae/calyptra/index.html (Accessed 29 October 2009).

Schenone H, Correa LE (1985) Some practical knowledge on the biology of the spider *Latrodectus mactans* and the latrodectism syndrome in Chile. *Boletin Chileno de Parasitologia* 40: 18-23.

Schilder A (2006) Black rot. http://www.grapes.msu.edu/blackrot.htm (Accessed 20 November 2006).

Schwinghamer M, Schilg M, Moore K, Knights T, Bambach R, Southwell R, Kumari S, Srivastava M, Wratten K (2007) Virus situation in chickpea, faba beans and canola. Grains Research and Development Corporation. http://www.grdc.com.au/director/events/onfarmtrials?item_id=4829BB0CA9AC5A109CF7A53B484E5905&pageNumber=2 (Accessed 7 January 2010).

Scott DH, Ink DP (1950) Grape seed germination experiments. *Proc.Am.Soc.Hort.Sci.* 56: 134-139.

Sergeeva V, Nair T, Spooner-Hart R (2001) *Fungi recorded on grapevines during the course of an industry service on Botrytis monitoring and fungicide resistance*. Annual Technical Issue, Australian and New Zealand Grapegrower and Winemaker, South Australia.

Sergeeva V, Priest M, Nair NG (2005) Species of *Pestalotiopsis* and related genera occurring on grapevines in Australia. *Australian Plant Pathology* 34: 255-258.

Shang ZH, Zhang XH, Liu YS, Xia HL (2000) A survey of the damage to fruit trees caused by longhorn beetles and the methods for the control of the pests. *Ningxia Journal of Agricultural and Forestry Science and Technology* 2: 10-12. (Abstract only)

Shanghai Insect Science Network (2009) Shanghai Insects Online. http://www.insects.cn/ (Accessed 29 October 2009).

Sharma K, Muldoon SB, Potter MF, Pence HL (2006) Ladybug hypersensitivity among residents of homes infested with ladybugs in Kentucky. *Journal of Allergy and Clinical Immunology* 117: 530.

Shih CIT, Hwang SM, Shieh JN (1978) Biology, life table and intrinsic rate of increase of *Tetranychus kanzawai* (Kishida). *Plant Protection Bulletin (Taiwan)* 20: 181-190.

Shih CT (1979) The influences of age of female *Tetranychus kanzawai* on sex ratio and life cycle of its progeny. *Recent advances in acarology* 1: 511-517.

Shin KC, Moon JY, Choi JS, Kim SB (1984) Studies on the causes of grape stalk necrosis. *South Korea Horticulture Research Reports* 26: 10-14. (Abstract only)

Shivas RG (1989) Fungal and bacterial diseases of plants in Western Australia. *Journal of the Royal Society of Western Australia* 72: 1-62.

Singh RP, Ready KFM, Nie X (2003) Biology. In *Viroids* (eds. Hadidi A, Flores R, Randles JW, Semancik JS) pp. 30-48. Commonwealth Scientific and Industrial Research Organisation, Collingwood.

Singh SN (1961) Germination of grape *(Vitis vinifera* L.) hybrid seeds by chilling. *Current Science* 30: 62.

Skinkis P, Walton V, Kaiser C (2009) Grape phylloxera biology and management in the Pacific northwest. Oregon State University Extension Service. http://extension.oregonstate.edu/catalog/pdflec/ec1463-e.pdf (Accessed 13 June 2009).

Skuhravá M (1991) Gall midges (Diptera: Cecidomyiidae) in forest ecosystems. In *Forest insect guilds: patterns of interaction with host trees* (eds. Baranchikov YN, Mattson WJ, Hain FP, Payne TL) pp. 293-297. United States Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, Radnor.

Smith IM, Dunez J, Lelliot RA, Phillips DH, Archer SA (1988) *European handbook of plant diseases*. Blackwell Scientific Publications, Oxford.

Smith PR, Campbell RN, Fry PR (1969) Root discharge and soil survival of viruses. *Phytopathology* 59: 1678-1687.

Snare L (2006) *Pest and disease analysis in hazelnuts*. Project no: NTO5002, Department of Primary Industries, New South Wales.

Spangler SM, Agnello A (1991) Comstock mealybug: *Pseudococcus comstocki* (Kuwana). New York state integrated pest management program. http://www.nysipm.cornell.edu/ (Accessed 29 July 2008).

Spence NJ (2001) Fungal transmission of plant viruses. In *Biotic interactions in plant-pathogen associations* (eds. Jeger MJ, Spence NJ) pp. 23-24. CAB International, Wallingford.

Spotts RA (1977) Effect of leaf wetness duration and temperature on the infectivity of *Guignardia bidwellii* on grape leaves. *Phytopathology* 67: 1378-1381.

Spotts RA (1980) Infection of grape by *Guignardia bidwellii:* factors affecting lesion development, conidial dispersal, and conidial populations on leaves. *Phytopathology* 70: 252-255.

Spradbery JP (1973) *Wasps: an account of the biology and natural history of solitary and social wasps*. Sidgwick and Jackson, London.

Stace-Smith R (1984) Tomato ringspot virus. Descriptions of Plant Viruses. http://www.dpvweb.net/dpv/showdpv.php?dpvno=290 (Accessed 6 January 2010).

Stansbury C, McKirdy SJ, Power G (2000) *Grapevine fanleaf virus- Nepovirus: exotic threat to Western Australia*. Department of Agriculture, Western Australia.

Steel CC (2007) *Management of non-Botrytis bunch rots: final report to Grape and Wine Research and Development Corporation, Hunter Valley Vineyard Association, Mid-North Coast Winegrape Growers Associations*. CSU 03/01, National Wine and Grape Industry Centre, Wagga Wagga.

Steffek R, Reisenzein H, Zeisner N (2007) Analysis of the pest risk from grapevine flavescence doree to Austrian viticulture. *OEPP/EPPO Bulletin* 37: 191-203.

Stevenson AB, Jubb GL, Jr. (1976) Grape phylloxera: seasonal activity of Alates in Ontario and Pennsylvania vineyards. *Environmental Entomology* 5: 549-552.

Stewart-Ward SM, Lawrie AC, Bruzzese E (1998) An Australian isolate of *Alternaria crassa* shows potential as a mycoherbicide to control the weed *Datura stramonium*. *Australian Plant Pathology* 27: 186-197.

Stocks IC, Lindsey DE (2008) Acute corrosion of the oral mucosa in a dog due to ingestion of multicolored Asian lady beetles *(Harmonia axyridis:* Coccinellidae). *Toxicon* 52: 389-391.

Strahan R (2006) Vineyard Farm Analysis. www.agbiz.com.au/tools/whole%20Form/viticulture/vineyard%20Economics.xls (Accessed 15 September 2009).

Strawberries Australia (2009) Facts and figures and other information. Strawberries Australia Inc.: the National Strawberry Peak Industry Body. http://www.strawberriesaustralia.com.au/6860050/strawberries-australia-facts-figures.htm (Accessed 15 July 2009).

Su W, Michaud JP, Runzhi Z, Fan Z, Shuang L (2009) Seasonal cycles of assortative mating and reproductive behaviour in polymorphic populations of *Harmonia axyrides* in China. *Ecological Entomology* 34: 483-494.

Suhag LS, Kaushik JC (1982) Studies on four pathogenic fungi on grapevine in North India. *Indian Phytopathology* 35: 344-346.

Summerfruit Australia (2009) About us: state and regional bodies. http://www.summerfruit.com.au/ (Accessed 21 January 2010).

Sun Q, Chen Y, Wang H, Downie DA, Zhai H (2009) Origin and genetic diversity of grape phylloxera in China. *Acta Entomologica Sinica* 52: 885-894.

Sutton BC, Gibson IAS (1977) *Greeneria uvicola . I.M.I.Descriptions of Pathogenic Fungi and Bacteria* 54: 1. (Abstract only)

Swart AE, Lennox CL, Holz G (1995) Infection of table grape bunches by *Alternaria alternata*. *South African Journal of Enology and Viticulture* 16: 3-5.

Sydney Postharvest Laboratory and Food Science Australia (2001) *Optimal fresh: the fruit, vegetable and fresh produce expert system*. Commonwealth Scientific and Industrial Research Organisation, Sydney.

Tai FL (1979) *Sylloge Fungorum sinicorum*. Science Press, Academia Sinica, Peking.

Takafuji A, Hinomoto N (2008) The distribution and geographic variation in diapause capacity among populations of two Tetranychus species (Acari: Tetranychidae) in East and Southeast Asia. *Journal of the Acarological Society of Japan* 17: 1-15.

Takafuji A, Ishii T (1989) Inheritance of sex ratio in the Kanzawa spider mite, Tetranychus kanzawai Kishida. *Researches on Population Ecology* 31: 123-128.

Takafuji A, Morishita M (2003) Comparative ecology of *Tetranychus urticae* and *T. kanzawai* (Acari: Tetranychidae). *Journal of the Acarological Society of Japan* 12: 1-10.

Takafuji A, Ozawa A, Nemoto H, Gotoh T (2000) Spider mites of Japan: their biology and control. *Experimental and Applied Acarology* 24: 319-355.

Takafuji A, Santoso S, Hinomoto N (2001) Host-related differences in diapause characteristics of different geographical populations of the Kanzawa spider mite, *Tetranychus kanzawai* Kishida (Acari: Tetranychidae), in Japan. *Japanese Society of Applied Entomology and Zoology* 36: 177-184.

Takafuji A, Santoso S, Hinomoto N, Shih C, Ho C, Gotoh T (2003) Diapause characteristics of two species of tetranychid mites (Acari: Tetranychidae) in southern Japan and Taiwan. *Applied Entomology and Zoology* 38: 225-232.

Takafuji A, Tajima R, Amano H (2007) The overwintering ecology and diapause capacity of *Tetranychus kanzawai* Kishida (Acari: Tetranychidae) in west-central Taiwan. *Journal of the Acarological Society of Japan* 16: 29-34.

Takahashi R (1954) *Aleurolobus* of Japan (Aleyrodidae, Homoptera). *The Entomological Society of Japan* 20: 49-54.

Tan SD, Wei JD, Lan RX (1998) Analysis on the similarity of the structure of the litchi and longan pest communities. *Guangxi Science and Technology of Tropical Crops* 69: 4-10.

Tarabaev C (1991) Karakurt (spider genus *Latrodectus*) in Kazakhstan: distribution and problem of victim registration. *Bulletin de la Societe des Sciences Naturelles de Neuchatel* 116: 237-240.

Tarabajev C (1990) Winter frosts and late frosts as the reason of karakurt (Black widow *Lactrodectus tredecimguttatus*) depression in Kazakhstan. Caomptes rendus du XIIeme Colloque Europeen d'Arachnologies Paris (France). http://www.european-arachnology.org/proceedings/12th/Tarabajev.pdf (Accessed 12 January 2010).

Teakle DS (1988) Tobacco necrosis necrovirus. In *Viruses of Plants in Australia* (eds. Buchen-Osmond C, Crabtree K, Gibbs A, McLean G) pp. 490-491. Australian National University Printing Service, Canberra.

Tenbrink VL, Hara AH, Diez JM (2007) *Pinnaspis strachani* (Cooley). http://www.extento.hawaii.edu/kbase/Corp/Type/p_strach.htm (Accessed 31 August 2009).

Ternois V (2009) *Harmonia axyridis* (Pallas, 1773): observatoire permanent pour le suivi de la *Coccinelle asiatique* en France. http://pagesperso-orange.fr/vinc.ternois/cote_nature/Harmonia_axyridis/index.htm (Accessed 18 January 2010).

TFREC (2008) Noctuid pests in Washington orchards: spotted cutworm (*Xestia c-nigrum*). http://entomology.tfrec.wsu.edu/noctuid/id.html (Accessed 16 November 2009).

The National People's Congress (2009) Food safety law of the People's Republic of China. http://members.wto.org/crnattachments/2009/sps/CHN/09_3358_00_e.pdf (Accessed 25 October 2009).

Thomas K (2010) *Phylloxera information received from K. Powell and K. Leamon (DPI Victoria) (personal communication)*. Biosecurity Australia, Canberra.

Tomlinson JA, Faithful EM, Webb MJW, Fraser RSS, Seeley ND (1983) Chenopodium necrosis: a distinctive strain of tobacco necrosis virus isolated from river water. *Annals of Applied Biology* 102: 135-147.

Trethowan CJ, Powell KS (2007) Rootstock-Phylloxera interactions under Australian field conditions. *ISHS Acta Horticulturae* 733: 115-122.

Tsai SM, Kung KS, Shih CI (1989) The effect of temperature on life history and population parameters of Kanzawa spider mite, *Tetranychus kanzawai* Kishida (Acarina: Tetranychidae), on tea. *Plant Protection Bulletin (Taiwan)* 31: 119-130.

Tsuruta K, White IM, Bandara HMJ, Rajapakse H, Sundaraperuma SAH, Kahawatta SBMUC, Rajapakse GBJP (1997) A preliminary notes on the host-plants of fruit flies of the tribe Dacini (Diptera, Tephritidae) in Sri Lanka. *Esakia* 37: 149-160.

UC (1999) FAQs about whiteflies. Silverleaf Whitefly Information Page. http://www.uckac.edu/ (Accessed 30 July 2009).

UCANR (2008a) Grape cutworms. http://www.ipm.ucdavis.edu/PMG/r302300511.html (Accessed 15 September 2009).

UCANR (2008b) Grape: year-round IPM program for wine and raisin grapes. UC IPM Online: Statewide integrated pest management program, University of California, Agriculture and Natural Resources. http://www.ipm.ucdavis.edu/index.html (Accessed 20 November 2009).

Uchida JY (2009) *Alternaria gomphrenae*. Crop Knowledge Master. http://www.extento.hawaii.edu/Kbase/Crop/Type/a_gomph.htm (Accessed 11 September 2009).

Uecker FA (1988) *A world list of Phomopsis names with notes on nomenclature, morphology, and biology*. J. Cramer, Berlin.

Ullasa BA, Rawal RD (1986) Studies on American rot of grapes due to *Greenaria uvicola* from Bangalore, India. *Indian Journal of Plant Pathology* 4: 154-161.

Ullrich CI, Kleespies RG, Enders M, Koch E (2009) Biology of the black rot pathogen, *Guignardia bidwellii*, its development in susceptible leaves of grapevine *Vitis vinifera*. *Journal Fur Kulturflanzen* 61: 82-90.

Umina PA, Corrie AM, Herbert KS, White VL, Powell KS, Hoffmann AA (2007) The use of DNA markers for pest management: clonal lineages and population biology of Grape phylloxera. *Acta Horticulturae (ISHS)* 733: 183-195.

United States Environmental Protection Agency (2004) Importation of fruits and vegetables. Federal Register Environmental Documents. http://www.epa.gov/fedrgstr/EPA-IMPACT/2004/November/Day-10/i25042.htm (Accessed October 2006).

University of California (1992) *Grape pest management*. (eds. Flaherty DL, Christensen LP, Lanini WT, Marois JJ, Phillips PA, Wilson LT) University of California, Oakland.

University of California (2003) Grape notes. University of California Cooperative Extension. http://cesanluisobispo.ucdavis.edu/newsletterfiles/Grape_Notes3214.pdf (Accessed 20 April 2009).

University of Illinois (2001) Black rot of grape. *Report on Plant Disease* 703: 1-4.

University of Minnesota (2007) Introduction to mealybugs. CUES: Center for Urban Ecology and Sustainability. http://www.entomology.umn.edu/cues/ (Accessed 30 July 2009).

USDA (2002) *Expansion of the importation of fresh unshu orange fruit (Citrus reticulata blanco var. unshu Swingle) from the Republic of Korea in citrus producing states of the continental United States: a pathway-initiated pest risk assessment*. United States Department of Agriculture, United States of America.

USDA (2004) Managing the Japanese beetle: a homeowner's handbook. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Center for Plant Health Science and Technology. http://www.aphis.usda.gov/lpa/pubs/pub_phjbeetle04.pdf (Accessed 15 January 2010).

USDA (2005) *Qualitative pathway-initiated risk assessment of the importation of fresh table grapes Vitis vinifera L. from Namibia into the United States*. Animal and Plant Health Inspection Service, United States Department of Agriculture, Raleigh.

USDA (2006) World grape situation and outlook. United States Department of Agriculture. http://www.fas.usda.gov/htp/Hort_Circular/2006/04-06/Table%20Grape%20Situation%20and%20Outlook%202006.pdf (Accessed 15 September 2009).

USDA (2007) Data sets: China agricultural and economic data- provincial data results. United States Department of Agriculture, Economic Research Service. http://www.ers.usda.gov/Data/ (Accessed 25 June 2009).

USDA (2009a) *Fresh deciduous fruit (apples, pears, and grapes) and apple juice concentrate: world markets and trade*. United States Department of Agriculture, United States of America.

USDA (2009b) *Meliosma myriantha* Siebold & Zucc. United States Department of Agriculture, Agricultural Research Service, National Genetic Resources Program, Germplasm Resources Information Network. http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?315913 (Accessed 11 September 2009).

USDA (2009c) Multicolored Asian lady beetle *Harmonia axyridis* (Pallas). United States Department of Agriculture, National Pest Alert. http://www.hgic.umd.edu/_media/documents/publications/asian_lady_beetle.pdf (Accessed 12 January 2010).

USDA (2010a) Germplasm Resources Information Network. http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?41847_ (Accessed 7 January 2010).

USDA (2010b) Japanese beetle program manual for airports. United States Department of Agriculture. http://www.aphis.usda.gov/import_export/plants/manuals/domestic/downloads/japanese_beetle.pdf (Accessed 19 January 2010).

USDA (2010c) Treatment schedules: T100-schedules for fruit, nuts, and vegetables. http://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/treatment_pdf/05_05_t400schedules.pdf (Accessed 5 January 2010).

Uyemoto JK (1975) A severe outbreak of virus-induced grapevine decline in cascade grapes in New York. *Plant Disease Reporter* 59: 98-101.

Uyemoto JK (1981) Tobacco necrosis and satellite viruses. In *Handbook of plant virus infections and comparative diagnosis* (ed. Kurstak E) pp. 123-146. Elsevier North-Holland Biomedical Press, Amsterdam.

Uyemoto JK, Gilmer RM (1972) Properties of tobacco necrosis virus strains isolated from apple. *Phytopathology* 62: 478-481.

Van Niekerk J, Crous P, Fourie P, Groenewald E, Halleen F (2000) Botryosphaeria canker and dieback of grapevines. Wynboer: a technical guide for wine producers. http:www.wynboer.co.za/ (Accessed 3 October 2008).

Van Vloten-Doting L, Gibbs AJ (1996) Alfalfa mosaic alfamovirus. In *Viruses of plants, descriptions and lists from the VIDE database* pp. 78-83. CAB International, Wallingford.

Vasquez C, Aponte O, Morales J, Sanabria ME, Garcia G (2008) Biological studies of *Oligonychus punicae* (Acari: Tetranychidae) on grapevine cultivars. *Experimental and Applied Acarology* 45: 59-69.

Vekesciaghin BV (1933) Agencies injurious to the vine and their control (according to observations in Bessarabia from 1931 to 1932). CAB Abstracts plus. http://www.cababstractsplus.org/DMPD/Index.asp (Accessed 12 November 2009).

Visarathanonth N, Kakishima M, Harada Y (1988) Brown rot of grape berry caused by *Monilinia fructicola*. *Annals of Phytopathology Society of Japan* 54: 238-241.

Waisel Y, Ganor E, Glikman M, Epstein V, Brenner S (1997) Airborne fungal spores in the coastal plain of Israel: a preliminary survey. *Aerobiologia* 13: 281-287.

Waite GK (2009) Diagnostic methods for oriental fruit fly: *Bactrocera dorsalis*. PaDIL: Pests and Diseases Image Library. http://www.padil.gov.au/pbt (Accessed 18 September 2009).

Walker GE, Wicks TJ (1994) Root rots. In *Diseases and pests* (eds. Nicholas P, Margery P, Wachtel M) pp. 37-39. Winetitles, Adelaide.

Wang LQ (2009) Integrated control of grape rachis brown blotch. *Hebi Fruits* 1: 1-3.

Ware RL, Majerus MEN (2008) Intraguild predation of immature stages of British and Japanese coccinellids by the invasive ladybird Harmonia axyrides. *BioControl* 53: 169-188.

Warren LO, Tadic M (1970) The fall webworm, *Hyphantria cunea* (Drury). http://arkansasagnews.uark.edu/1318.htm (Accessed 15 September 2009).

Waterhouse DF (1993) *The major arthropod pests and weeds of Agriculture in southeast Asia*. The Australian Centre for International Agricultural Research, Canberra.

Watson GW (2006) Arthropods of economic importance: Diaspididae. http://nlbif.eti.uva.nl/bis/diaspididae.php (Accessed 31 August 2009).

Weeden CR (2009) Biological control: a guide to natural enemies in North America. Biological control: a guide to natural enemies in North America. www.nysaes.cornell.edu/ent/biocontrol/predators/harmonia.html (Accessed 12 January 2010).

Weinert MP, Shivas RG, Pitkethley RN, Daly AM (2003) First record of grapevine leaf rust in the Northern Territory, Australia. *Australasian Plant Pathology* 32: 117-118.

Wharton PS, Kirk W (2007) *Early blight*. MSU Extension bulletin E-2991, Department of Plant Pathology, Michigan State University, Michigan.

White IM, Elson-Harris MM (1992) *Fruit flies of economic significance: their identification and bionomics*. CAB International, Wallingford.

Whitelaw-Weckert MA, Curtin SJ, Huang R, Steel CC, Blanchard CL, Roffey PE (2007) Phylogenetic relationships and pathogenicity of *Colletotrichum acutatum* isolates from grapes in subtropical Australia. *Plant Pathology* 56: 448-463.

Wilcox WF (2003) Grapes: black rot (*Guignardia bidwellii* (Ellis) Viala and Ravaz). http://www.nysipm.cornell.edu/factsheets/grapes/diseses/grape_br.pdf (Accessed 15 November 2006).

Wilkie JP, Dye DW, Watson DRW (1973) Further hosts of *Pseudomonas viridiflava*. *New Zealand Journal of Agricultural Research* 16: 315-323.

Willets HJ, Harada Y (1984) A review of apothecial production by *Monilinia* fungi in Japan. *Mycologia* 76: 314-325.

Williams DJ (1985) Australian mealybugs. British Museum (Natural History), London.

Williams DJ (2004) *Mealybugs of Southern Asia*. Natural History Museum and Southdene, Kuala Lumpur.

Williams DJ, Granara de Willink MC (1992) *Mealybugs of Central and South America*. CAB International, Wallingford.

Williams RN, Fickle DS, Welty C, Ellis M (2006) Grape tube gallmaker, *Cecidomyia viticola* Osten-Sacken. Insects and Mite Pests of Grapes in Ohio and the Midwest. http://www.oardc.ohio-state.edu/grapeipm/grape_tube_gallmaker.htm (Accessed 15 February 2007).

World News Network (2009) World port distances. http://www.distances.com/distance.php (Accessed 18 October 2009).

Wormald H (1954) *The brown rot diseases of fruit trees*. Technical bulletin of the Ministry of Agriculture no. 3, Her Majesty's Stationery Office (HMSO), London.

WTO (1995) *Agreement on the application of sanitary and phytosanitary measures*. World Trade Organization, Switzerland.

Wu L, Huang ZY (1986) Studies on the bionomics of *Bhima undulosa* Walker and its control. *Entomological Knowledge* 23: 211-212.

Wu X, Zhang HR, Li ZY (2009) Occurrence and seasonal pattern of western flower thrips, *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae) in Yunnan province. *Acta Phytopathologica et Entomologica Hungarica* 44: 135-146.

Wu Y (2005) Geographical distribution model of oriental fruit fly. *Journal of Fujian Agricultural University* 34: 168-171.

Wu Z, Li S (1998) Biological characteristics and control of *Pterophorus periscelidactylus* Fitch. *Plant Protection Bulletin* 24: 24-26.

Xi D, Li J, Han C, Li D, Yu J, Zhou X (2008) Complete nucleotide sequence of a new strain of *Tobacco necrosis virus A* infecting soybean in China and infectivity of its full-length cDNA clone. *Virus Genes* 36: 259-266.

Yamazaki K, Sugiura S (2003) Gall-feeding habits in Lepidoptera of Japan: ii. a cecidophagous stathmopodid moth attacking the gall of a tortricid moth on the Japanese mugwort. *Transaction of the Lepidopteralogical Society of Japan* 54: 143-146.

Yan D, Jianmei C, Wei Y (2007) Six cases of black widow spider sting poisoning rescue and care. Xinjiang Medical Journal. http://d.wanfangdata.com.cn/Periodical_xjykdxxb200103046.aspx (Accessed 12 January 2010).

Yan R, Zhao Y, Rui D, Li G, Guo Q (1998) The integrated management system for the control of grape diseases in the southern part of Jiangsu province. *South China Fruits* 27: 47.

Yang J, Duan ZG, Zhou H, Yan XJ, He XZ, Wang XC, Liang SP (2007) Biological characterization of venom from spider *Latrodectus tredecimguttatus*. *Acta Zoologica Sinica* 53: 682-688.

Yang P, Carey JR, Dowell RV (1994) Temperature influences on the development and demography of *Bactrocera dorsalis* (Diptera: Tephritidae) in China. *Environmental Entomology* 23: 971-974.

Yang ZQ, Cao HG, Chen FY (1991) A preliminary study on *Tetranychus kanzawai*. *Acta Agriculturae Universitatis Jiangxiensis* 13: 129-133.

Yano K (1963) Notes on South Pacific Pterophoridae. *Pacific Insects* 5: 849-871.

Yano S, Kanaya M, Takafuji A (2003) A method of manipulating dispersal cost in microcosms. *Entomologia Experimentalis et Applicata* 106: 67-70.

Yatabe Y, Murakami N (2003) Recognition of cryptic species in the *Asplenium nidus* complex using molecular data - a progress report. *Telopea* 10: 487-496.

Ye H, Liu J (2005) Population dynamics of the oriental fruit fly, *Bactrocera dorsalis* (Diptera: Tephritidae) in the Kunming area, southwestern China. *Insect Science* 12: 387-392.

YFAO (2007) Climate: Yunnan, China. The Foreign Affairs Office of the People's Government of Yunnan Province. http://www.yfao.gov.cn/ewindows/Climate.html (Accessed 27 January 2010).

Zaspel JM, Kononenko VS, Goldstein PZ (2007) Another blood feeder?: experimental feeding of a fruit-piercing moth species on human blood in the Primorye territory of far eastern Russia (Lepidoptera: Noctuidae: Calpinae). *Journal of Insect Behavior* 20: 437-451.

Zhang J (2005a) *An overview of the Chinese table grape industry and market*. Victorian Department of Primary Industries, Victoria.

Zhang L (2008) *Biology and pest management of spider mites*. ENT4, Department of Regional Development, Northern Territory.

Zhang L, French R, Langenberg WG (1993) Molecular cloning and sequencing of the coat protein gene of a Nebraskan isolate of tobacco necrosis virus: the deduced coat protein sequence has only moderate homology with those of strain A and strain D. *Archives of Virology* 132: 291-305.

Zhang R, Wang SF, Cui JQ, Sun GY, Gleason ML (2008) First report of Bitter rot caused by *Colletotrichum acutatum* on apple in China. *Plant Disease* 92: 1474. (Abstract only)

Zhang S, Wei J, Hu A, Ji G, Chen X, Huang Q (1999) Diversity of ice nucleation active bacteria of plants in Yunnan province. *Acta Phytopathologica Sinica* 29: 256-260.

Zhang Y (2005b) *Identification and control of pests and diseases of table grape (with colour plates)*. Jindun, Beijing.

Zhang Y, Lin J, Chi Y, Chen W, Lin S (1996a) Biocontrol of *Tetranychus kanzawai* (Acari: Tetranychidae) using Phytoseiulus (Acari: Phytoseiidae) in open-air strawberry gardens. *Systematic and Applied Acarology* 1: 29-34.

Zhang Y, Yu D, Chen W, Chi Y, Lin J (1996b) Study on the spatial distribution and temporal dynamics of *Tetranychus kanzawai* (Acari: Tetranychidae) in open-air strawberry gardens. *Systematic and Applied Acarology* 1: 73-76.

Zhang ZQ (2003) *Mites of greenhouses identification, biology and control*. CABI Publishing, Wallingford.

Zhang ZQ (2007) *21 November, 2007 (personal communication)*. Landcare Research, Auckland.

Zhao XZ (2002) The differences among grape white rot, black rot disease and grape axle blotch and the control measures. *Tianjin Agricultural Sciences* 3: 2-3.

Zheng DL, Li WQ, Song SB, Kang ZX (1993) A preliminary study on the grape plume moth *Nippoptilia vitis*. *Plant Protection Bulletin* 19: 15-16.

Zhou X (2002) Broad bean wilt virus 2. Descriptions of Plant Viruses. http://www.dpvweb.net/dpv/showdpv.php?dpvno=392 (Accessed 4 December 2008).

Zhou ZL (1991) Studies on the behaviour and control measures of grape clear-wing moth. *Acta Phytophylactica Sinica* 18: 45-48.

Zhu LZ, Li Y, Li JF, Chen ZZ (2006) Prevention and control of grape spike-stalk brown spot *(Alternaria viticola)* in the southeast areas of Shandong province. *Sino-overseas Grapes and Grapevine* 1: 1. (Abstract only)

Zhuang W (2001) *Higher fungi of tropical China*. Mycotaxon Limited, Ithaca.

Zhuang W (2005) *Fungi of northwestern China*. Mycotaxon Limited, Ithaca.

Zimmerman EC (1994) *Australian weevils (Coleoptera: Curculionoidea)*. Commonwealth Scientific and Industrial Research Organisation, Canberra.

Zitikaite I, Staniulis J (2009) Isolation and characterization of tobacco necrosis virus detected on some vegetable species. *Biologija* 55: 35-39.

Zohary D (1996) The domestication of the grapevine *Vitis vinifera* L. in the Near East. In *The origins and ancient history of wine* (eds. McGovern PE, Fleming SJ, Katz SH) pp. 23-30. Gordon and Breach Publishers, London.