



Australian Government  
Department of Agriculture,  
Fisheries and Forestry

# Final report for the review of biosecurity import requirements for fresh Persian lime fruit from Mexico

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May 2023



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#### **Acknowledgement of Country**

We acknowledge the Traditional Custodians of Australia and their continuing connection to land and sea, waters, environment and community. We pay our respects to the Traditional Custodians of the lands we live and work on, their culture, and their Elders past and present.

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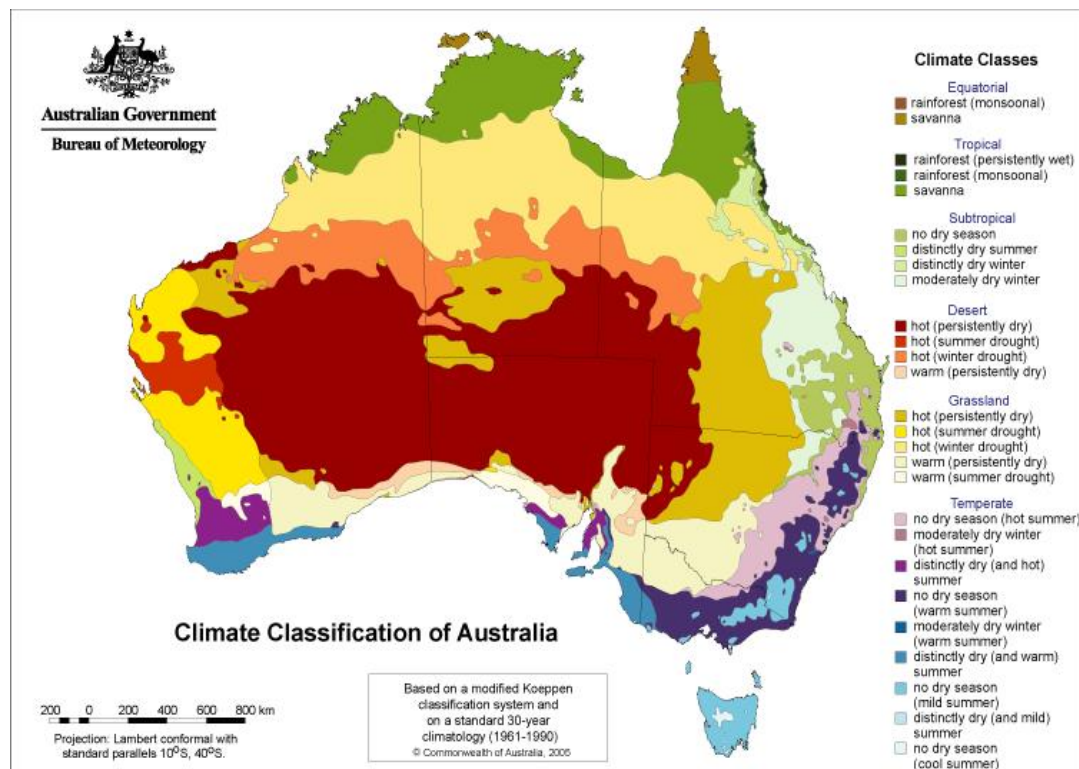
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Map 1 Map of Australia



Map 2 A guide to Australia's bio-climatic zones



## Acronyms and abbreviations

Term or abbreviation	Definition
ACT	Australian Capital Territory
ALOP	Appropriate level of protection
BA	Biosecurity Advice
BICON	Australia's Biosecurity Import Conditions System
BIRA	Biosecurity Import Risk Analysis
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EP	Existing policy
FAO	Food and Agriculture Organization of the United Nations
FSANZ	Food Standards Australia New Zealand
GP	Group policy
IPPC	International Plant Protection Convention
ISPM	International Standard for Phytosanitary Measures
MRLs	Maximum residue limits
NSW	New South Wales
NPPO	National Plant Protection Organisation
NT	Northern Territory
PRA	Pest risk analysis
Qld	Queensland
SA	South Australia
SENASICA	Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria (English: National Service of Food Safety and Agriculture Quality)
SOP	Standard operating procedures
SPS Agreement	WTO agreement on the Application of Sanitary and Phytosanitary Measures
Tas.	Tasmania
the department	The Department of Agriculture, Fisheries and Forestry
ULDs	Unit Loading Devices
URE	Unrestricted risk estimate
USA	United States of America
Vic.	Victoria
WA	Western Australia
WTO	World Trade Organization



## Summary

The Australian Government Department of Agriculture, Fisheries and Forestry (the department) has prepared this final report to assess the proposal by Mexico for market access to Australia for fresh Persian lime fruit (*Citrus latifolia*) for human consumption. In Mexico, *Citrus latifolia* is commonly referred to as Persian lime. However, it is also commonly known as Tahitian lime in many countries, including Australia.

Australia currently permits the importation of fresh lime fruit for human consumption from the Cook Islands, Egypt, New Caledonia, Niue, New Zealand, Samoa, Spain, Tonga, the United States of America and Vanuatu, provided Australian biosecurity import conditions are met.

This final report recommends that the importation of commercially produced fresh Persian lime fruit to Australia from all commercial production areas of Mexico be permitted, subject to a range of biosecurity requirements.

This final report contains details of pests that are of biosecurity concern to Australia that are potentially associated with the importation of commercially produced fresh Persian lime fruit from Mexico. Also included are the risk assessments for these identified quarantine pests and regulated articles, and, where required the recommended risk management measures to reduce the biosecurity risk to an acceptable level, that is to achieve the appropriate level of protection (ALOP) for Australia.

Seventeen pests have been identified in this risk analysis as requiring further assessment in a pest risk assessment to determine the level of biosecurity risk associated with these pests, and whether risk management measures are required to reduce the risk to an acceptable level.

An additional 3 species have been identified in this risk analysis as requiring further assessment as regulated articles as they are capable of harbouring and spreading (vectoring) viruses that are of biosecurity concern to Australia.

The 17 quarantine pests are:

- Armoured scales: *Chrysomphalus dictyospermi* (Spanish red scale), *Parlatoria cinerea* (tropical grey chaff scale), *Parlatoria pergandii* (chaff scale), *Pinnaspis aspidistrae* (fern scale), *Pseudaonidia trilobitiformis* (trilobite scale) and *Unaspis citri* (citrus snow scale).
- Mealybugs: *Dysmicoccus neobrevipes* (grey pineapple mealybug), *Paracoccus marginatus* (papaya mealybug) and *Pseudococcus maritimus* (grape mealybug).
- Moth: *Marmara gulosa* (citrus peelminer)
- Thrips: *Caliothrips fasciatus* (Californian bean thrips), *Frankliniella bispinosa* (Florida flower thrips) and *Scirtothrips citri* (California citrus thrips).
- Spider mite: *Panonychus citri* (red citrus mite)
- Fungal pathogen: *Elsinoë fawcettii* (citrus scab)
- Viruses: *Citrus leprosis virus C* (CiLV-C) and *Orchid fleck dichorhavirus – Citrus strain* (OFV-citrus/OFV-Cit1).



The 3 regulated articles are:

- Flat mites: *Brevipalpus californicus* (citrus flat mite), *Brevipalpus papayensis* (flat mite) and *Brevipalpus yothersi* (flat mite).

The unrestricted risk estimate (URE) for all 17 pests and 3 regulated articles achieved the ALOP for Australia, taking into consideration commercial production practices already in place in Mexico. Specific commercial production practices are therefore recommended to be mandatory to ensure pests and regulated articles are managed to an acceptable level and the biosecurity standards are met. These commercial production practices include:

- In-field pest management practices: monitoring for insects and mites using in-field surveillance and trapping, monitoring for pathogens, and when necessary, application of in-field controls.
- Packing house practices: application of washing, brushing, disinfection, waxing, grading/sorting and quality inspection in the packing house.

A system of operational procedures is also required for the assurance, maintenance and verification of phytosanitary status of imported Persian lime fruit from Mexico.

The report recommends the specific commercial production practices and operational system (described in section 5.2) are implemented and documented in an operational plan, to ensure pests are managed on the Persian lime fruit from Mexico pathway to an acceptable level.

Before trade commences, Mexico must be able to demonstrate to the department that procedures and processes are in place to implement the in-field pest management and packing house requirements, and operational system. The processes and procedures are to be approved and verified by the department to ensure safe trade in fresh Persian lime fruit from Mexico. Import conditions can then be published in the Australian Government's Biosecurity Import Conditions (BICON) system on the department's website, which can be accessed at [bicon.agriculture.gov.au/BiconWeb4.0](https://bicon.agriculture.gov.au/BiconWeb4.0).

Written comments on the draft report were received from 12 stakeholders. The department has made changes to the risk analysis following consideration of the stakeholder comments on the draft report and a subsequent review of literature. These changes include:

- amendments to Chapter 3 'Mexico's commercial production practices for Persian limes' to enhance clarity on commercial production and pest management practices, and include additional information obtained during the in-country visit in August 2022.
- amendments to Chapter 4 'Pest risk assessments for quarantine pests'
  - Inclusion of pest risk assessments (PRA) for armoured scales, mealybugs, citrus peelminer, thrips and red citrus mite. These pests are all assessed as achieving the ALOP for Australia on the fresh Persian lime fruit from Mexico pathway.
  - Extension of the PRA for *Orchid fleck virus – citrus strain* (OFV-citrus) to include *Citrus leprosis virus C* (CiLV-C), now in a combined PRA for citrus leprosis disease.
  - Inclusion of *Brevipalpus papayensis* as a potential mite vector in the PRA for citrus leprosis disease.
- amendments to Chapter 5: 'Pest risk management' for clarity and consistency with recent risk analysis reports.

- amendments to 'Appendix A: Initiation and categorisation for pests of fresh Persian lime fruit from Mexico' to include additional information and references.
  - *Marmara gulosa* (citrus peelminer) has been added, and was assessed as requiring further assessment in a PRA.
  - Revision of text referring to 'contaminating pests' for clarity, as the use of the term in this context was causing misinterpretation.
  - Change to the header of the potential pathway association column to indicate that while the pest may be on the fruit, the assessment considers whether the pest will be associated on the fruit at the time of importation into Australia. This change is consistent with more recent risk analysis reports published after the Persian limes from Mexico draft report.
  - Clarification of pathway association for a number of pest entries, which resulted in a change to the assessment of some of these pests as now having the potential to enter on the pathway thus requiring further assessment in the pest categorisation process.
  - Corrected a pest entry error; *Guignardia mangiferae* was removed, as records of this non-pathogenic fungus on citrus are referring to its current accepted name, *Phyllosticta capitalensis*, which has been added to the table.
- updates to various sections of the report, where relevant, to reflect the changes to the number of pests now identified in 'Appendix A: Initiation and categorisation for pests of fresh Persian lime fruit from Mexico' as requiring further assessment in a PRA.
- addition of Appendix B 'Issues raised in stakeholder comments', which summarises the key technical issues raised by stakeholders, and how the issues have been considered by the department in this final report.
- minor corrections, rewording and editorial changes for consistency, accuracy, clarity and web-accessibility.
- updates to weblinks to cited references where appropriate.

# 1 Introduction

## 1.1 Australia's biosecurity policy framework

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

The risk analysis process is an important part of Australia's biosecurity policies. It enables the Australian Government to formally consider the level of biosecurity risk that may be associated with proposals to import goods into Australia. If the biosecurity risks do not achieve the appropriate level of protection (ALOP) for Australia, risk management measures are recommended to reduce the risks to an acceptable level. If the risks cannot be reduced to an acceptable level, the goods will not be imported into Australia until suitable measures are identified.

Successive Australian Governments have maintained a stringent, but not a zero risk, approach to the management of biosecurity risks. This approach is expressed in terms of the ALOP for Australia, which is defined in the *Biosecurity Act 2015* as providing a high level of protection aimed at reducing risk to a very low level, but not to zero.

Australia's risk analyses are undertaken by the department using technical and scientific experts in relevant fields, and involve consultation with stakeholders at various stages during the process.

Risk analyses may take the form of a biosecurity import risk analysis (BIRA) or review of biosecurity import requirements (such as scientific review of existing policy and import conditions, pest-specific assessments, weed risk assessments, biological control agent assessments or scientific advice).

Further information about Australia's biosecurity framework is provided in the *Biosecurity Import Risk Analysis Guidelines 2016* located on the Department of Agriculture, Fisheries and Forestry website at [agriculture.gov.au/biosecurity-trade/policy/risk-analysis/guidelines](http://agriculture.gov.au/biosecurity-trade/policy/risk-analysis/guidelines).

## 1.2 This risk analysis

### 1.2.1 Background

Mexico's Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria (SENASICA, National Service of Food Safety and Agriculture Quality) formally requested market access to Australia for fresh Persian limes for human consumption in a submission received in August 2005. In July 2017, Mexico sent an updated submission, which included information on the pests associated with lime crops in Mexico, including the plant part(s) affected. Information was also provided on the standard commercial production practices for fresh Persian lime fruit grown in Mexico for export.

On 18 May 2018, the department notified stakeholders of the decision to progress a request for market access for fresh Persian lime (*Citrus latifolia*) fruit from Mexico as a review of biosecurity import requirements. This analysis is conducted in accordance with the *Biosecurity Act 2015*.

In August 2018, officers from the department visited lime production areas in Mexico. The objective of the visit was to observe commercial production, pest management and procedures for the export of fresh Persian lime fruit. A further visit was undertaken in August 2022 to gather information to assist with addressing issues raised by stakeholders during the public consultation period.

### 1.2.2 Scope

The scope of this risk analysis is to consider the biosecurity risk that may be associated with the pathway of fresh Persian lime (*C. latifolia*) fruit grown in Mexico using standard commercial production practices (which include in-field pest management practices and packing house processes of washing, brushing, disinfection, waxing, grading/sorting and quality inspection as described in Chapter 2), for human consumption. The analysis does not consider other species of limes, for example, key lime (*C. aurantiifolia*, also known as Mexican lime and West Indian lime), kaffir lime (*C. hystrix*), rangpur lime (*C. limonia*), sweet lime (*C. limetta*) or other citrus species.

*Citrus latifolia* is known by many common names, including Persian lime, Persian lemon, seedless lime, Bearss lime, Tahiti lime and Tahitian lime. Persian lime is the common name used in the market access request from Mexico's SENASICA, and therefore is the common name used in this report. *Citrus latifolia* is commonly referred to as Tahitian lime in Australia, and is the most commonly grown variety of lime.

For the purposes of this risk analysis, fresh Persian lime fruit is defined as seedless individual whole fruit with the rind (skin), flesh, calyx, and potentially a small portion of the peduncle (fruit stalk), but no other plant parts such as leaves (Figure 1). This risk analysis covers all commercially produced fresh Persian lime fruit from all regions of Mexico in which they are grown for export and have undergone in-field pest management practices and post-harvest processes of washing, brushing, disinfection, waxing, grading/sorting and quality inspection.

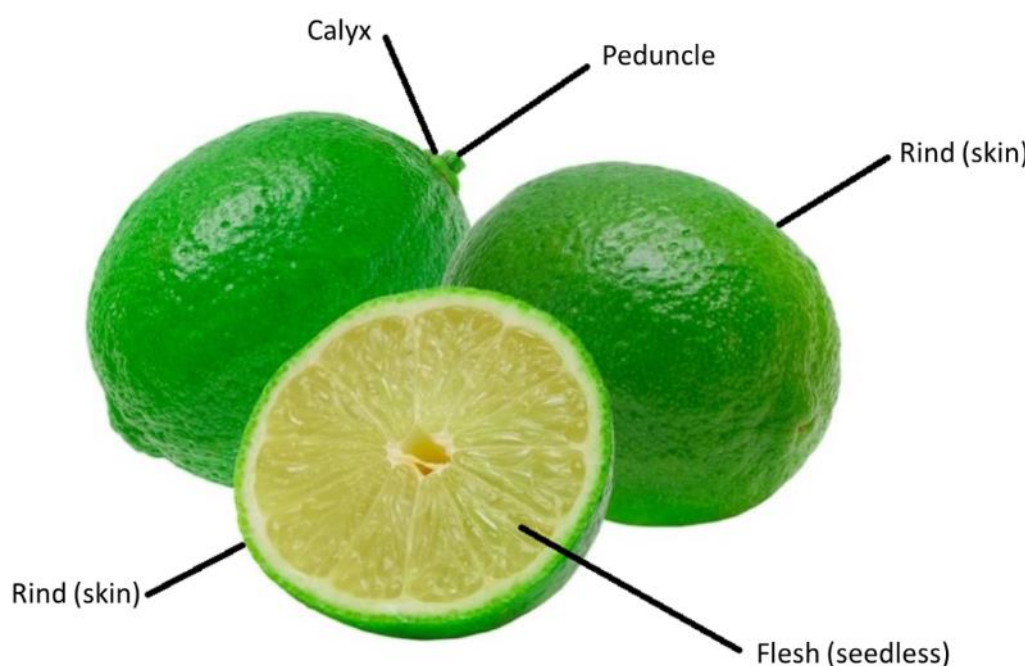
### 1.2.3 Existing policy

#### International policy

Import policy exists for fresh Tahitian limes (*C. latifolia*) from New Caledonia, Egypt, New Zealand, Spain, the USA and the Pacific Islands (Cook Islands, Niue, Samoa, Tonga, Vanuatu). Australia also has biosecurity import conditions for other Mexican horticultural commodities, these being table grapes and mangoes.

The biosecurity import conditions for these commodity pathways can be found at the department's Biosecurity Import Conditions (BICON) system on the [department's website at bicon.agriculture.gov.au/BiconWeb4.0](https://bicon.agriculture.gov.au/BiconWeb4.0).

A preliminary assessment has identified that the potential pests of biosecurity concern for fresh Persian lime fruit from Mexico are the same as, or similar to, pests that have been assessed previously by the department in risk analyses for limes (and other horticultural commodities) for which appropriate measures are already established.

**Figure 1 Diagram of lime fruit**

Source: Modified from [panlasangpinoy.com/benefits-of-limes-on-your-health/](http://panlasangpinoy.com/benefits-of-limes-on-your-health/)

The department has reviewed all the pests and pest groups previously identified in existing policies and, where relevant, the information in those assessments has been considered in this risk analysis. The department has also reviewed the latest scientific literature and other relevant information, such as pest interception data for existing trade in limes, to ensure that information in previous assessments are still valid.

The biosecurity risk posed by thrips and the orthospoviruses they transmit was previously assessed for all countries in the *Final group pest risk analysis for thrips and orthospoviruses on fresh fruit, vegetable, cut-flower and foliage imports* (thrips Group PRA) (DAWR 2017). The biosecurity risk posed by mealybugs, and the viruses they transmit, was previously assessed for all countries in the *Final group pest risk analysis for mealybugs and the viruses they transmit on fresh fruit, vegetable, cut-flower and foliage imports* (mealybugs Group PRA) (DAWR 2019). The biosecurity risk posed by soft and hard scale insects was previously assessed for all countries in the *Final group pest risk analysis for soft and hard scale insects on fresh fruit, vegetable, cut-flower and foliage imports* (scales Group PRA) (DAWE 2021).

These Group policies are applicable for the fresh Persian lime fruit from Mexico pathway. The department has determined that the information in those policies can be adopted for the species under consideration in this risk analysis, unless specified otherwise in a specific pest risk assessment.

### **Domestic arrangements**

The Australian Government is responsible for regulating the movement of goods such as plants and plant products into and out of Australia. However, the state and territory governments are responsible for plant health controls within their individual jurisdiction. Legislation relating to resource management or plant health may be used by state and territory government agencies

to control interstate movement of plants and their products. After imported plants and plant products have been cleared by Australian Government biosecurity officers, they may be subject to interstate movement regulations/arrangements. It is the importer's responsibility to identify and ensure compliance with all requirements.

#### **1.2.4 Contaminating pests**

In addition to the pests of Persian limes from Mexico that are assessed in this risk analysis, there are other organisms that may arrive with the imported commodity. These organisms may include pests considered not to be associated with the fruit pathway, pests of other crops, or predators and parasitoids of other arthropods. The department considers these organisms to be contaminating pests that could pose sanitary risks (to human or animal life or health) or phytosanitary risks (to plant life or health). These risks are identified and addressed using existing operational procedures that require an inspection of all consignments during processing and preparation for export. Consignments will also undergo another inspection on arrival in Australia. The department will investigate whether any pest identified through import verification processes may be of biosecurity concern to Australia, and may thus require remedial action.

#### **1.2.5 Consultation**

On 18 May 2018, the department notified stakeholders, in Biosecurity Advice 2018/09, of the commencement of a review of biosecurity import requirements for fresh Persian lime fruit from Mexico.

Prior to, and after the commencement of this risk analysis, the department engaged with Australian citrus growers regarding the processes and technical aspects of this risk analysis.

The department also consulted with Mexico's SENASICA, as well as Australian state and territory governments, during the preparation of the draft report.

The draft report was released on 6 April 2021 (Biosecurity Advice 2021/06) for comment by stakeholders. This public consultation period concluded on 7 June 2021.

The department received 12 written submissions on the draft report. All submissions received, and issues raised by stakeholders during meetings about the draft report, were carefully considered and, where relevant, changes were made to the final report. A summary of key technical stakeholder comments and how they were considered is provided in Appendix B.

#### **1.2.6 Next Steps**

The final report will be published on the department's website along with a notice advising stakeholders of its release. The department will also notify the proposer, the registered stakeholders and the World Trade Organization (WTO) Secretariat about the release of the final report. Publication of the final report represents the end of the risk analysis process.

Before any trade in Persian limes from Mexico commences, the department will verify that Mexico can implement the pest risk management measures, and the system of operational procedures for the assurance, maintenance and verification of the phytosanitary status of Persian limes for export to Australia (as specified in Chapter 5 'Pest risk management' of this

report. On verification of these requirements, the import conditions for Persian limes from Mexico will be published in the department's Biosecurity Import Conditions (BICON) system.



## 2 Method for pest risk analysis

This chapter sets out the method used for the pest risk analysis (PRA) in this report. The department has conducted this PRA in accordance with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for pest risk analysis* (FAO 2019a) and ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2019b) that have been developed under the SPS Agreement (WTO 1995).

A PRA is ‘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 2022a). A pest is ‘any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products’ (FAO 2022a). This definition is also applied in the *Biosecurity Act 2015*.

Biosecurity risk consists of 2 major components: the likelihood of a pest entering, establishing and spreading in Australia from imports; and the consequences should this happen. These 2 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, the department 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 or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests’ (FAO 2022a).

A glossary of the terms used in the risk analysis is provided at the end of this report.

The PRAs are conducted in the following 3 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.

Appendix A of this risk analysis report lists the pests with the potential to be associated with the exported commodity produced using commercial production and packing house procedures. 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. 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 National Plant Protection Organisation (NPPO) or where the cited literature used a different scientific name.

For this risk analysis, 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 the department in other risk assessments and for which import conditions already exist, this risk analysis considered 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 in this risk analysis. The outcomes of group pest risk analyses for thrips and mealybugs have also been adopted for this report, as explained in Section 2.2.7.

## **2.2 Stage 2 Pest risk assessment**

A pest risk assessment (for quarantine pests) is the 'evaluation of the probability of the introduction and spread of a pest and of the magnitude of the associated potential economic consequences' (FAO 2022a).

The following 3, consecutive steps were used in pest risk assessment:

### **2.2.1 Pest categorisation**

Pest categorisation identifies which of the pests with the potential to be on the commodity are quarantine pests for Australia and require pest risk assessment. A 'quarantine pest' is a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO 2022a).

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

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

The results of pest categorisation are set out in Appendix A. The quarantine pests identified during categorisation were carried forward for pest risk assessment and are listed in Table 4.1.

### **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 2019b). The SPS Agreement (WTO 1995) uses the term 'likelihood' rather than 'probability' for these estimates. In qualitative PRAs, the department uses the term 'likelihood' for the descriptors it uses for its estimates of likelihood of entry, establishment and spread. The use of the term 'probability' is limited to the direct quotation of ISPM definitions.

A summary of this process is given here, followed by a description of the qualitative methodology used in this risk analysis.

### **Likelihood of entry**

The likelihood of entry describes the likelihood 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 likelihood 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 Chapter 3. These practices are taken into consideration by the department when estimating the likelihood of entry.

For the purpose of considering the likelihood of entry, the department divides this step into 2 components:

- **Likelihood of importation**—the likelihood that a pest will arrive in Australia when a given commodity is imported.
- **Likelihood of distribution**—the likelihood 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 to be considered in the likelihood of importation may 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 (for example, 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 lifecycle 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 (for example, refrigeration) applied to consignments during transport and storage in the country of origin, and during transport to Australia.

Factors to be considered in the likelihood of distribution may include:

- commercial procedures (for example, 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 (for example, for planting, processing or consumption)
- risks from by-products and waste.

**Likelihood of establishment**

Establishment is defined as the ‘perpetuation for the foreseeable future, of a pest within an area after entry’ (FAO 2022a). In order to estimate the likelihood of establishment of a pest, reliable biological information (for example, lifecycle, host range, epidemiology, and survival) 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 likelihood of establishment.

Factors to be considered in the likelihood of establishment in the PRA area may 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.

**Likelihood of spread**

Spread is defined as ‘the expansion of the geographical distribution of a pest within an area’ (FAO 2022a). The likelihood 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 likelihood 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 likelihood of spread.

Factors to be considered in the likelihood of spread may 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 likelihoods for entry, establishment and spread

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). 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 and are not used beyond this purpose in qualitative PRAs. These indicative probability ranges provide guidance to the risk analyst and promote consistency between different pest risk assessments.

**Table 2.1 Nomenclature of likelihoods**

<b>Likelihood</b>	<b>Descriptive definition</b>	<b>Indicative range</b>
High	The event would be very likely to occur	$0.7 < \text{to} \leq 1$
Moderate	The event would occur with an even likelihood	$0.3 < \text{to} \leq 0.7$
Low	The event would be unlikely to occur	$0.05 < \text{to} \leq 0.3$
Very low	The event would be very unlikely to occur	$0.001 < \text{to} \leq 0.05$
Extremely low	The event would be extremely unlikely to occur	$0.000001 < \text{to} \leq 0.001$
Negligible	The event would almost certainly not occur	$0 < \text{to} \leq 0.000001$

### Combining likelihoods

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 likelihood of importation is assigned a descriptor of 'low' and the likelihood of distribution is assigned a descriptor of 'moderate', then they are combined to give a likelihood of 'low' for entry. The likelihood for entry is then combined with the likelihood assigned for establishment of 'high' to give a likelihood for entry and establishment of 'low'. The likelihood for entry and establishment is then combined with the likelihood assigned for spread of 'very low' to give the overall likelihood for entry, establishment and spread of 'very low'. This can be summarised as:

importation x distribution = entry [E]

**low x moderate = low**

entry x establishment = [EE]

**low x high = low**

[EE] x spread = [EES]

**low x very low = very low**

**Table 2.2 Matrix of rules for combining likelihoods**

	High	Moderate	Low	Very low	Extremely low	Negligible
High	High	Moderate	Low	Very low	Extremely low	Negligible
Moderate		Low	Low	Very low	Extremely low	Negligible
Low			Very low	Very low	Extremely low	Negligible
Very low				Extremely low	Extremely low	Negligible
Extremely low					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.

The department 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 difference 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.

The use of a one year volume of trade has been taken into account when setting up the matrix that is used to estimate the risk and therefore any policy based on this analysis does not simply apply to one year of trade. Policy decisions that are based on the department'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. If there are substantial changes in the volume and nature of the trade in specific commodities then the department will review the risk analysis and, if necessary, provide updated policy advice.

In assessing the volume of trade in this risk analysis, the department 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 potential 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 2022a) and ISPM 11 (FAO 2019b).

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
- domestic trade
- international trade
- non-commercial and environmental.

For each of these 6 criteria, the consequences were estimated over 4 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 4 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 4 geographic levels were translated into a qualitative impact score (A-G) using Table 2.3. 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 4 geographic scales**

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

Note: In earlier qualitative PRAs, the scale for the impact scores went from A to F and did not explicitly allow for the rating 'indiscernible' at all 4 levels. This combination might be applicable for some criteria. In this report, the impact scale of A to F has been changed to become B-G and a new lowest category A ('indiscernible' at all 4 levels) was added. The rules for combining impacts in Table 2.4 were adjusted accordingly.

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.

**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 assessment of the likelihood of entry, establishment and spread and for potential consequences 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 likelihood of entry, establishment and spread and the overall consequences of pest establishment and spread. Therefore, risk is the combination of likelihood and consequence.

When interpreting the risk estimation matrix, note the descriptors for each axis are similar (for example, 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	Consequences 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

## 2.2.5 The appropriate level of protection (ALOP) for Australia

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.

Like many other countries, Australia expresses its ALOP in qualitative terms. The ALOP for Australia, 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 the ALOP for Australia.

## 2.2.6 Adoption of outcomes from previous assessments

Outcomes of previous risk assessments have been adopted in this assessment for pests for which the risk profile is assessed as comparable to previously assessed situations.

The prospective adoption of previous risk assessment ratings is considered on a case-by-case basis by comparing factors relevant to the current commodity/country pathway with those assessed previously. For assessment of the likelihood of importation, factors considered/compared include the commodity type, the prevalence of the pest and commercial production practices, whereas for assessment of the likelihood of distribution of a pest the factors include the commodity type, the time of year when importation occurs, and the availability and susceptibility of hosts at that time. After comparing these factors and reviewing the latest literature, previously determined ratings may be adopted if the department considers the likelihoods to be comparable to those assigned in the previous assessment(s).

The likelihoods of establishment and of spread of a pest species in the PRA area (in this instance, Australia) will be comparable between risk assessments, regardless of the commodity/country pathway through which the pest is imported, as these likelihoods relate specifically to conditions and events that occur in the PRA area, and are independent of the import pathway. Similarly, the estimate of potential consequences associated with a pest species is also independent of the

import pathway. Therefore, the likelihoods of establishment and of spread of a pest, and the estimate of potential consequences, are directly comparable between assessments, and may be adopted with confidence.

### 2.2.7 Application of Group PRAs to this risk analysis

Risk estimates derived from a Group PRA are 'indicative' in character. This is because the likelihood of entry (the combined likelihoods of importation and distribution) can be influenced by a range of pathway-specific factors, as explained in Section 2.2.6. Therefore, the indicative likelihood of entry from a Group PRA needs to be verified on a case-by-case basis.

In contrast, and as noted in Section 2.2.6, the risk factors considered in the likelihoods of establishment and spread, and the potential consequences associated with a pest species are not pathway-specific, and are therefore comparable across all import pathways within the scope of the Group PRA. This is because at these latter stages of the risk analysis the pest is assumed to have already found a host within Australia at or beyond its point of entry. Therefore, a Group PRA assessment can be applied as the default outcome for any pest species on a plant import pathway once the previously assigned likelihood of entry has been verified.

In a scenario where the likelihood of entry for a pest species on a commodity is assessed as different to the indicative estimate, the Group PRA-derived likelihoods of establishment and spread and the estimate of consequences can still be used, but the overall risk rating may change.

Group PRAs applied to this risk analysis are:

- the *Final group pest risk analysis for thrips and orthotospoviruses on fresh fruit, vegetable, cut-flower and foliage imports* (DAWR 2017) (the thrips Group PRA)
- the *Final group pest risk analysis for mealybugs and the viruses they transmit on fresh fruit, vegetable, cut-flower and foliage imports* (DAWR 2019) (the mealybug Group PRA).
- the *Final group pest risk analysis for soft and hard scale insects on fresh fruit, vegetable, cut-flower and foliage imports* (DAWE 2021) (scales Group PRA).

## 2.3 Stage 3 Pest risk management

Pest risk management describes the process of identifying and implementing phytosanitary measures to manage risks to achieve the ALOP for Australia, 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 does not achieve the ALOP for Australia, 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 the ALOP for Australia. The effectiveness of any proposed phytosanitary measures (or combination of measures) is evaluated, using the same approach as used to evaluate the unrestricted risk, to ensure the restricted risk for the relevant pest or pests achieves the ALOP for Australia.

ISPM 11 (FAO 2019b) 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 likelihood of entry of the pest.

Examples given of measures commonly applied to traded commodities include:

- options for consignments—for example, 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—for example, 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—for example, pest-free area, pest-free place of production or pest-free production site
- options for other types of pathways—for example, consider natural spread, measures for human travellers and their baggage, cleaning or disinfestations of contaminated machinery
- options within the importing country—for example, surveillance and eradication programs
- prohibition of commodities—if no satisfactory measure can be found.

Risk management measures are identified to reduce the level of biosecurity risk to achieve the ALOP for Australia. These are presented in Chapter 5: Pest risk management, of this report.

### 3 Mexico's commercial production practices for Persian limes

This chapter provides information on the pre-harvest, harvest and post-harvest practices, considered to be standard in Mexico for the production of fresh Persian lime fruit for export. The export capability of Mexico is also outlined.

#### 3.1 Considerations used in estimating unrestricted risk

Mexico's Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria (National Service of Food Safety and Agriculture Quality, SENASICA), provided Australia with information on the standard commercial practices used in the production of Persian limes in different regions of Mexico. This information has been complemented with data from other sources, such as published literature and observations during visits to Mexico to observe Persian lime production, all of which have been taken into consideration when estimating the unrestricted risks of pests that may be associated with the import of this commodity.

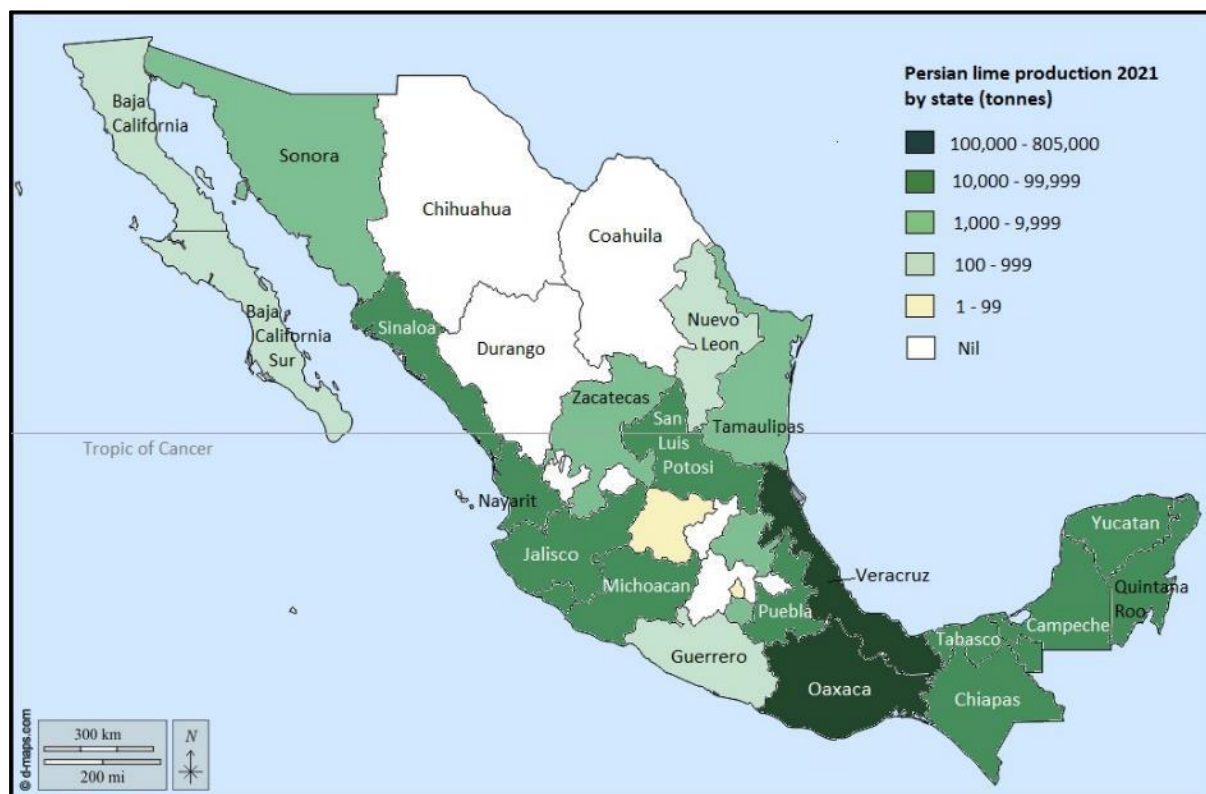
In August 2018, officers from the department visited lime production areas in Mexico, in the states of Veracruz, Puebla and Jalisco. A follow-up visit was undertaken in August 2022. The objective of these visits was to observe the commercial Persian lime production system, pest management, harvesting, processing, packing and associated export practices. The observations by the department and additional information provided by Mexico, confirmed the production and processing procedures described in this chapter as standard commercial production practices for Persian lime fruit for export.

In estimating the likelihood of pest introduction, it was considered that the pre-harvest, harvest and post-harvest commercial production practices for fresh Persian limes, as described in this chapter, are implemented for all regions and for all fresh Persian limes.

#### 3.2 Persian lime production areas

Persian limes (*Citrus latifolia*) are the second most commonly grown citrus species in Mexico, behind sweet oranges (*C. sinensis*). Persian lime cultivation occupied 106,772 hectares of farmland in 2021 (SIAP-SAGARPA 2022). Twenty-three states in Mexico grow Persian limes, with the largest volumes produced in the states of Veracruz, Oaxaca, Jalisco, Yucatán and Tabasco. Persian lime producing states in Mexico are shown in Map 3.

Map 3 Persian lime producing states in Mexico



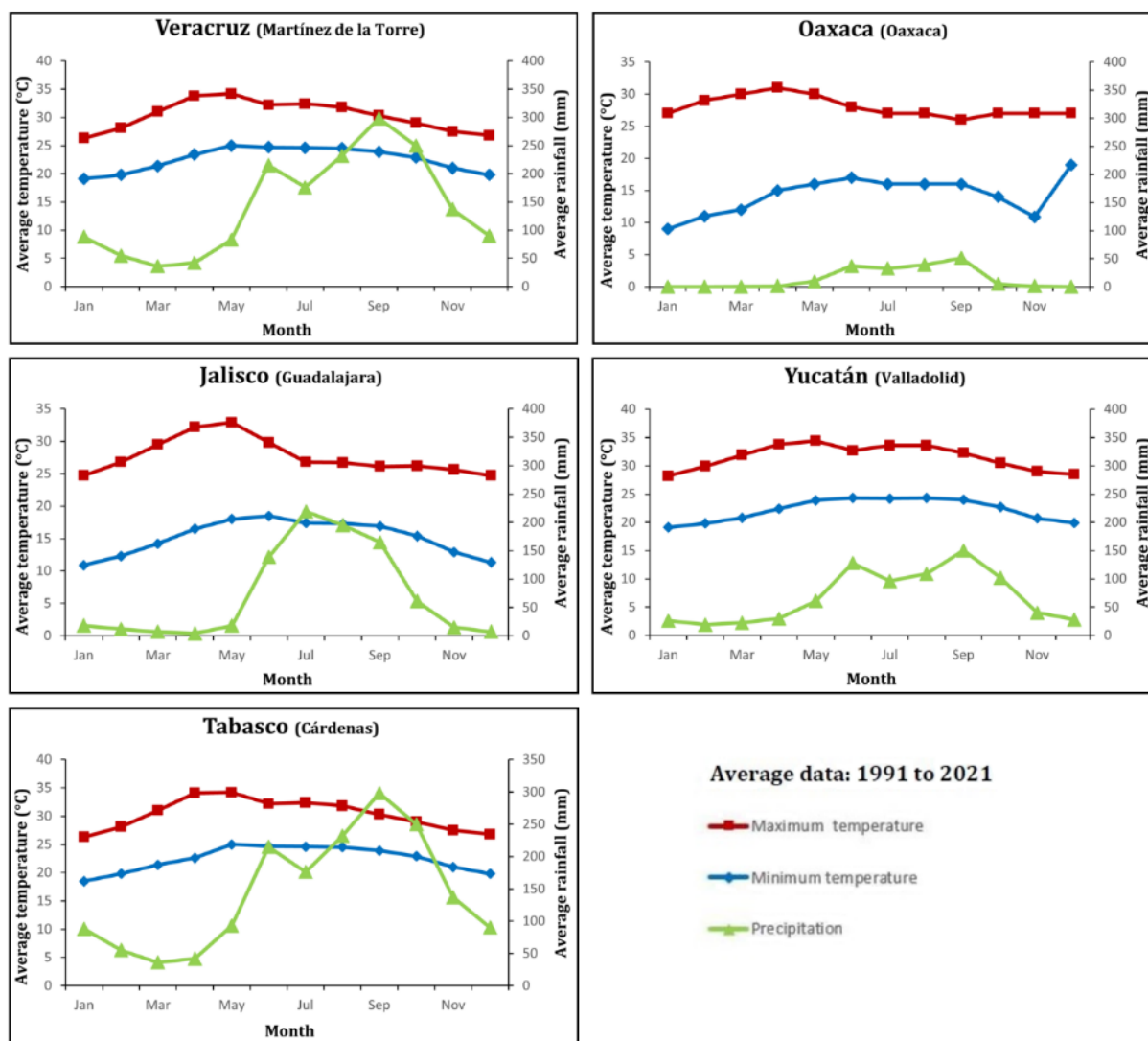
Data source: SIAP-SAGARPA (2022)

### 3.3 Climate in production areas

Mexico is situated on the Tropic of Cancer and, as such, has a mostly tropical climate, particularly in the main lime production areas in southern Mexico (SENASICA 2017). Inter-seasonal temperature variation is generally low. Differences in temperature are mostly dictated by elevation, with cooler conditions in regions with higher elevations. Hurricanes are common in the coastal regions. Rainfall north of the Tropic of Cancer is low and northern Mexico is dominated by deserts, whilst tropical rainforests are present in the southern states (SENASICA 2017; Willey et al. 2017).

Figure 2 presents the average maximum and minimum temperatures and rainfall by month in the 5 major lime producing states of Mexico.

**Figure 2** Average maximum/minimum temperatures and rainfall in Mexico's major lime producing states



Source: Climate-data.org (2022)

### 3.4 Pre-harvest

#### 3.4.1 Cultivar

The origins of the Persian lime are unclear, but it is likely to be a hybrid of key lime (*C. aurantiifolia*) and citron (*C. medica*) (Morton 1987). Previously it was considered to be a cultivar or subspecies of *C. aurantiifolia* and was not recognised as a separate species until 1951 (Grayum, Hammel & Madrigal 2012). It was probably introduced to the Mediterranean region from Persia (Iran) and later brought to Brazil by Portuguese traders. It was subsequently introduced to Australia from Brazil in 1824 (Morton 1987). *Citrus latifolia* was introduced to California from Tahiti (French Polynesia) around 1850, purportedly grown from seeds extracted from imported fruit (Barnidge-McIntyre 2010), hence the common name of Tahitian lime being used in some countries.

The Persian lime tree is medium to large in size, growing up to six metres in height, with nearly thornless, widespread, drooping branches (Morton 1987). Mature Persian lime fruit are typically 5.5–8.0 cm long and 5.0–7.5 cm wide (Grayum, Hammel & Madrigal 2012). The fruit is seedless,



small oval, obovate or short-elliptical in shape, usually rounded at the base, containing 9–12 segments with a pale green pulp encased in a darker green, 2–3 mm thick, smooth leathery skin (Morton 1987; SENASICA 2017).

Persian lime fruit are juicy, acidic fruits, with a distinctive flavour and aroma. Mature fruits typically have a juice content of 40–60% and a minimum diameter of around 45 mm. Persian lime fruit typically reach this stage 90–120 days after flowering, depending on the climatic conditions and agronomic management. However, Persian limes will continue to grow on the tree until they reach a length of 9 cm and a diameter of 7 cm (SENASICA 2017).

Standard maturation of Persian lime fruit is technically defined by Mexico in accordance with standards established by the United States Department of Agriculture (USDA). The standard requires that Persian limes have a minimum juice content of 42% in volume and a minimum fruit diameter of 45 mm before the fruit is considered mature. Fruit with these dimensions weigh approximately 54 g and display good green colour (USDA 2006).

### **3.4.2 Cultivation practices**

#### **Orchard planning and plantation**

Planting stock is obtained by growers from nurseries. Orchards supplying limes for export must obtain certified rootstock and budwood from nurseries registered with SENASICA (SENASICA 2002). Persian limes are commonly planted in a square or rectangular-based formation to ensure each tree receives appropriate aeration and direct sunlight. Other factors such as the quality of the soil within an orchard will also determine the planting density (the distance between each tree) (Curti Díaz et al. 2000; SENASICA 2017).

#### **Irrigation**

Irrigation of lime orchards in Mexico depends on several factors such as tree size, temperature, type of soil, ground slope and rainfall. Irrigation is generally not required in areas with high rainfall, whereas orchards in drier regions make use of below-ground drip irrigation systems. In areas where irrigation is required, adult trees receive water 1–2 times per week, for 6–10 hours (SENASICA 2017).

#### **Application of fertiliser**

In orchards one year old or less, fertilisation per tree per year is typically 0.4:0.2:0.2 kg of Nitrogen (N), Phosphorus (P) and Potassium (K) respectively. Fertiliser is applied at time of planting (0.2 kg each of N, P and K), and at 6 months an additional 0.2 kg N is applied per tree. Fertiliser is then applied annually in plantations older than one year at a dose of 1.2:0.6:0.6 kg of N:P:K respectively (SENASICA 2017).

#### **Pruning**

Pruning of lime orchards in Mexico varies depending on the age and vigour of the plantation (SENASICA 2017). The 3 stages of pruning used in lime orchards are:

- *Pruning during formation stage:* this is usually carried out when establishing an orchard, just before planting, just after planting or when grafts have grown approximately 35 cm from the graft site. This pruning method aims to increase the mechanical resistance in new plants to resist wind and to support the weight of branches laden with fruit during peak production times.

- *Pruning during development stage:* this is a light pruning to remove excessive vegetative growth that could decrease fruit production. Vigorous vegetative shoots are removed because they compete with other branches for water and nutrients.
- *Pruning during production stage:* this pruning method is carried out in older orchards to improve the health of the tree's crown, helping it to recover lost foliage, which is directly related to fruit production and quality, as well as controlling the size of the trees in the orchard. This practice also helps with pest management by removing potential inoculum of pathogens and/or infected branches (SENASICA 2017).

### 3.4.3 Pest management

The majority of in-field pest control measures are carried out during the flowering and fruit set stages (SENASICA 2018) (see Table 3.1). Orchards are monitored for signs of pest infestation. Pesticide sprays are employed when populations of aphids, Asian citrus psyllid (*Diaphorina citri*), or signs of any other arthropod damage or symptoms of infestation are detected (SENASICA 2018). Biological control of arthropod pests with parasitoids, as well as weed control practices are also used to manage arthropod pests in orchards (SENASICA 2018). Non-host plants for mites and other wind-dispersed pests may be grown around orchards as windbreak barriers to minimise these pests entering or spreading within the orchard (SENASICA 2017).

Fungicide sprays are employed during the flowering and fruit set stage to protect the blooms from various fungal diseases. Chemical sprays are generally not used during the fruit growth stage. Control of pests at this stage is usually done with mineral oils and beneficial organisms (for example, *Tamarixia radiata*, *Paecilomyces fumosoroseus*, *Aphytis chrysomphali* and *Neoseiulus californicus*) (SENASICA 2018) or by cultural control methods such as removal of disease inoculum sources and covering of fruit with plastic or paper bags (SENASICA 2017). However, as all 3 stages of growth—flowering, fruit set and fruit growth—may be present simultaneously within an orchard, and occasionally on the same tree, chemical sprays may be used at any time.

**Table 3.1 Example of Mexico's pest control practices for commercially produced Persian limes**

Stage of growth	Pest/pathogen	Control measures
Flowering (Bloom)/Fruit set	Insect and mite pests	Chemical control (e.g., azinphos-methyl, diazinon) Biological control (e.g., <i>Tamarixia radiata</i> , <i>Paecilomyces fumosoroseus</i> , <i>Aphytis chrysomphali</i> , <i>Neoseiulus californicus</i> )
	Pathogenic fungi	Chemical control (e.g., azoxystrobin, trifloxystrobin) Cultural control (e.g., pruning)
Fruit growth	Insect and mite pests	Sprays with mineral oils Biological control Chemical control (only if necessary)
	Pathogenic fungi	Cultural control (e.g., removal of inoculum sources/covering fruit with bags) Chemical control (only if necessary)

Source: SENASICA (2017, 2018)

SENASICA oversees the national domestic control campaigns for significant lime diseases such as citrus leprosis and huanglongbing (and their arthropod vectors). The campaigns focus on monitoring and trapping programs, as well as public education campaigns. In the case of citrus leprosis and huanglongbing, and in other instances if deemed necessary, strict controls on the movement of host material between states in Mexico are also in place. Citrus leprosis disease (caused by either cytoplasmic-type or nuclear-type viruses) is managed by controlling the vector mites through chemical and biological control programs. SENASICA, through Dirección General de Sanidad Vegetal (Plant Health General Directorate; DGSV), is responsible for the implementation of these programs (SENASICA 2017).

SENASICA's Mediterranean fruit fly eradication program (Programa Moscamed), implemented with support from the InterAmerican Institute for Cooperation on Agriculture (IICA) for over 30 years, is a successful program that uses an integrated pest management approach (such as sterile insect technique, bait spraying, trapping and fruit sampling) to eradicate and maintain freedom for Mediterranean fruit fly (*Ceratitis capitata*). SENASICA maintains an extensive country-wide surveillance network for early detection of Mediterranean fruit fly (Enkerlin et al. 2015) and activates the National Emergency Device program upon detection to prevent Mediterranean fruit fly from establishing.

### 3.5 Harvesting and handling procedures

As part of SENASICA's phytosanitary certification system, orchards and packing houses intending to export fruit must be registered with SENASICA through the Dirección General de Sanidad Vegetal (Plant Health General Directorate; DGSV). All Persian limes produced in Mexico for export are subject to a system of traceability. Whilst the level of traceability may vary between lime production companies, the ability to trace back to at least the orchard and packing house for any lime fruit packed for export is required and is already in place for all export packing houses registered with SENASICA.

Harvest starts when the lime fruit reaches physiological maturity. Some growers measure the turgor pressure of a sample of fruit in the orchard to ascertain their readiness for harvest. The fruit must be of a marketable size (minimum diameter of 45 mm) and shape, with good juice content and an acidity of 4–7%. The permissible minimum juice content at the point of harvest is 42% (SENASICA 2017). These standards are defined in accordance with standards established by the USDA (USDA 2006).

To aid harvesting efficiency, lime trees are pruned in such a way that fruiting occurs at the lower parts of the tree, removing the need for ladders. The general practice is for pickers to harvest the lime fruit by cutting the peduncle using specialised scissors that are designed not to puncture the fruit. After the fruit is removed from the tree, the remaining peduncle may be further cut to be flush with the calyx end (SENASICA 2017). Harvested fruit are collected in the orchard in vegetable fibre sacks, each of which has the capacity to hold 20–25 limes. Once the harvesting sacks are full the limes are emptied into plastic harvesting crates, able to hold a capacity of 21–22 kg. Harvesting crates are not filled completely, to prevent limes at the bottom from being crushed. Harvesting crates remain in the field for the least time possible, and if required, for a maximum of 3 hours (SENASICA 2018). The harvesting crates are covered to protect the fruit from sun exposure and may be covered with mesh when being transported from the orchard to packing or processing facilities (SENASICA 2018).

### 3.6 Post-harvest

SENASICA, through Dirección General de Sanidad Vegetal (Plant Health General Directorate; DGSV), is responsible for carrying out export inspections, registering of treatment facilities, certifying phytosanitary treatments (if treatment is required), and issuing of phytosanitary certificates (SENASICA 2017).

#### 3.6.1 Packing house

Packing houses intending to export Persian lime fruit must be registered and approved by SENASICA.

##### Fruit receival

Trucks and utility vehicles (depending on the volume of limes harvested) transport limes to a loading dock at the packing house. The loading docks of registered export packing houses are separated from the internal sorting, processing and packing facilities by a wall or screen.

Depending on the specific equipment used in the packing house, the fruit may be mechanically emptied directly from the field crates onto the processing line to minimise handling, or alternatively they may first be transferred into larger bins, which are only used at the packing house (Figure 3). Each bin is labelled so that limes can be traced back to a specific orchard (Figure 4). Mats may be used to cushion the limes when being loaded into the bins to prevent bruising.

**Figure 3 Fruit transferred from harvesting crates to larger bins at packing house**



**Figure 4 Traceability information on bin****First stage of sorting**

The lime fruit are mechanically emptied onto a conveyor, where they are slowly moved up a positive gradient by rollers (Figure 5). When unloading larger containers of limes, a padded mat may be used to cushion the limes from the initial drop onto the rollers, whilst smaller containers may be slowly poured directly onto the conveyor. Leaves, small twigs and other trash are removed mechanically as they pass through the rollers.

At some facilities the fruit may first be emptied into a chlorine dump tank to reduce the likelihood of carrying spores of postharvest spoilage pathogens into secure areas where fruit are being packed after washing. The fruit are then lifted out of the tank on the conveyor.

Preliminary screening to manually remove obviously cracked, damaged, undersized or excessively yellow-coloured fruit, as well as fruit with excessive stem occurs at this stage. The rollers then bring the limes into the secure area of the packing house for processing, grading and packing.



**Figure 5 Preliminary screening of limes****Second stage of sorting**

Upon entry into the secure sorting area, limes showing abnormalities and/or damage are identified and removed by packing house employees. The removed limes are either sold on the domestic market or used for juicing.

All limes for export are subjected to a soap wash, brushing with roller brushes, disinfection and application of a wax coat on the fruit. All export packing houses are registered and approved by SENASICA as meeting these requirements.

**Washing and brushing**

Soap is first dripped onto the limes as foam, then washed off with a row of water nozzles. Limes are brushed by being rolled over stiff bristle brush rollers (Figure 6).

**Figure 6 Soaping, washing and brushing stage****Drying**

After washing and brushing the fruit pass under a series of fans to dry the fruit surface so they can be waxed. Some facilities may apply additional heat (up to 50°C for 6 minutes was observed at one packinghouse) to assist this process, but this is not a standard step across all packing houses.

**Disinfection**

All limes are subject to a disinfection stage, which includes the use of fungicides or sodium hypochlorite to remove spoilage microorganisms that can cause postharvest fruit rots (Figure 7). These can be applied via a bath dip, spray or added to wax. Fungicides approved by SENASICA, such as those with imazalil or azoxystrobin + fludioxonil as active constituents, are used according to label requirements.



**Figure 7 Fungicide bath****Waxing**

Waxing of limes is either applied via multiple nozzles in a row (Figure 8), or by dripping wax onto a fast-rotating disc that spreads the wax across the width of the rollers (Figure 9). Wax is first applied onto the rollers at the start of each run to ensure an even spread of wax over the entire surface of each lime.

**Figure 8 Application of wax in a fine mist via nozzles**

**Figure 9 Application of wax on rotating disc****Final sorting and quality inspection**

After undergoing the processing steps, limes are mechanically sorted by size (Figure 10). Limes are quality-inspected and any fruit with abnormalities, damage and/or signs of infestation, and any remaining peduncle material, are removed by packing house employees.

**Figure 10 Lime fruit being sorted by size**



### Packing and storage

Export limes are packed into plastic or cardboard cartons where further quality checks and inspection are conducted by packing house employees while the fruit is being packed (Figure 11 and Figure 12). Traceability information is attached to each carton (Figure 13).

Figure 11 Quality inspection of packed limes



Figure 12 Packing of export limes and removal of substandard fruit



Figure 13 Traceability sticker on packed carton of limes



Packed limes are palletised (Figure 14), and stored securely for up to 5 days, under controlled conditions with an average temperature of 7°C to 9°C and an average relative humidity of 98% (SENASICA 2018).

Figure 14 Palletised Persian limes in storage



Trucks are used to transport limes to the chosen freight consignment option (sea or air freight). The truck loading areas of packing houses are physically separated from the storage areas, usually by large doors (Figure 15). Prior to loading, trucks are sprayed with insecticide to prevent infestation by contaminant pests.

Phytosanitary pre-export inspection is performed by officers approved by SENASICA at dedicated areas in the packing house (Figure 16). Phytosanitary certification is undertaken by SENASICA – a phytosanitary certificate is only printed if a consignment is approved as meeting the importing country's requirements.

**Figure 15 Loading area of a packing house**



**Figure 16 Phytosanitary inspection area**



### 3.6.2 Transport

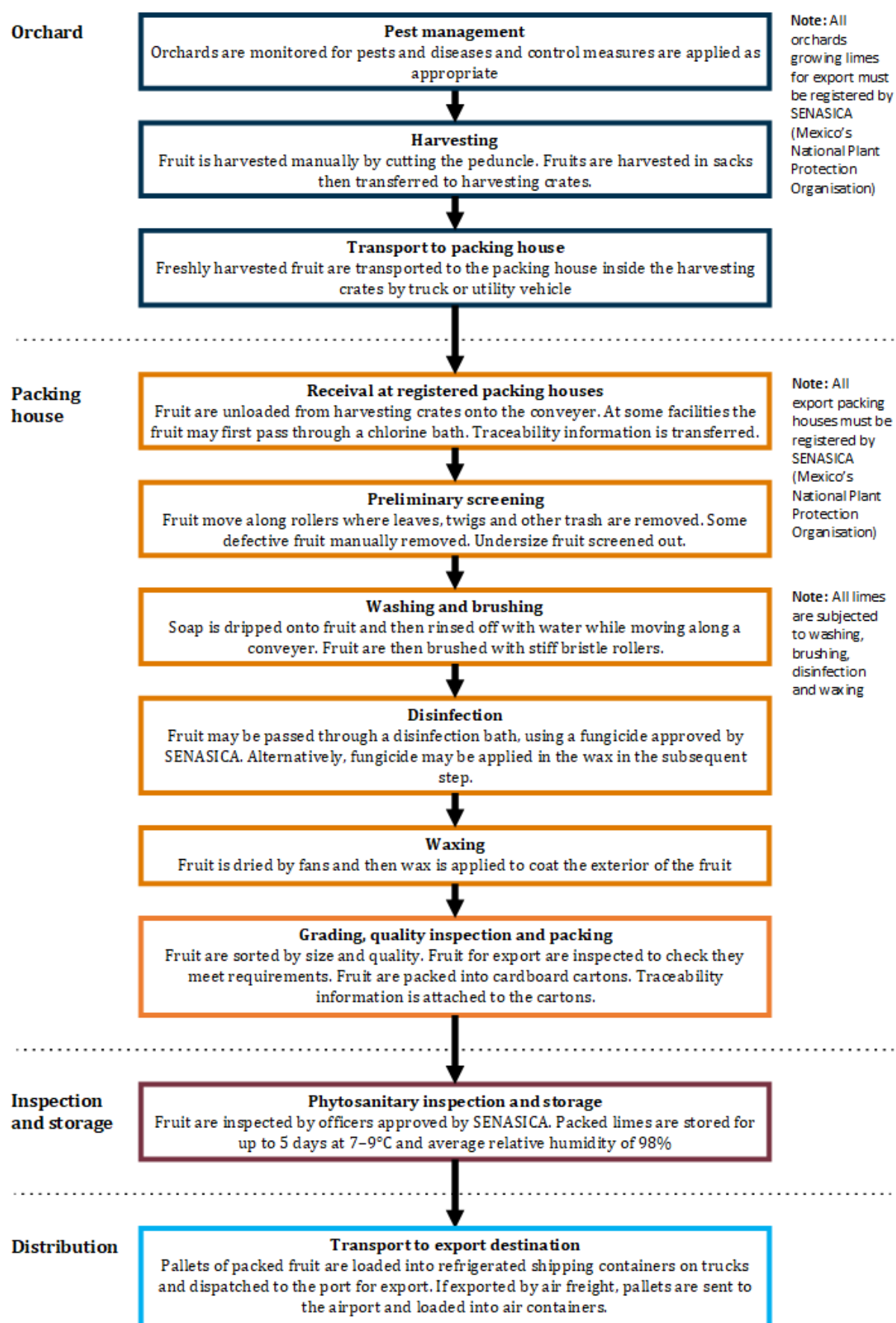
Persian limes from Mexico can be exported to Australia by sea or air. Limes exported by ship are kept in refrigerated containers at a temperature of 7°C to 8°C and a relative humidity of 95–97% both during truck transport to the port of Manzanillo and during shipping. The entire transport period is expected to be between 20 and 30 days (SENASICA 2018).

For exports to Australia by air, Persian limes are transported to Mexico City in non-refrigerated trucks for a duration of approximately 6–8 hours, before being loaded into air freight containers or pallets and onto an aeroplane where they are kept at ambient temperatures; for this option the entire transport period is expected to be between 3 and 5 days (SENASICA 2018).

Figure 17 summarises the operational steps from harvesting to export of Persian lime fruit in Mexico.



Figure 17 Summary of orchard and post-harvest steps for Persian limes grown in Mexico for export



## 3.7 Export capability

### 3.7.1 Production statistics

Mexico's total planted area for Persian limes in Mexico in 2021 was 106,772 hectares, with total Persian lime fruit production of 1,528,331 tonnes (SIAP-SAGARPA 2022). In the major growing areas, limes are harvested year-round. Twenty-three states in Mexico produce limes, with the largest volumes produced in the states of Veracruz, Oaxaca, Jalisco, Yucatán and Tabasco, which collectively accounted for 85% of Mexico's total production in 2020. A breakdown of total lime production volumes of the larger lime producing states in Mexico is given in Table 3.2.

**Table 3.2 Persian lime production of the larger production states of Mexico in 2018 and 2021**

State	Production 2018 (tonnes)	Production 2021 (tonnes)
Veracruz	583,835	804,602
Oaxaca	180,908	219,653
Tabasco	76,958	87,368
Jalisco	75,567	95,552
Yucatan	52,449	94,170
Quintana Roo	31,410	31,765
Puebla	30,610	38,997
Nayarit	19,535	29,335
Michoacán	20,377	31,878
Campeche	14,809	16,393

Source: SIAP-SAGARPA (2022)

### 3.7.2 Export statistics

Mexico is a major exporter of limes globally. In 2020, Mexico exported 266,568 tonnes of limes. The main destination market was the United States of America, which accounted for 98% of Mexico's Persian lime exports. The balance was exported to the European Union, Japan, South Korea, Russia and Guatemala. A breakdown of Mexico's lime export markets and the volumes exported in 2020 is provided in Table 3.3.

**Table 3.3 Annual export volumes of Persian limes from Mexico by destination market**

Export market	Export volume (tonnes)
United States of America	261,795
European Union	3,117
Japan	924
South Korea	555
Russia	155
Guatemala	22
<b>Total</b>	<b>266,568</b>

Source: SENASICA (2022)



### **3.7.3 Export season**

While Persian lime production and peak harvest times vary between regions due to climatic differences and other factors, limes are produced and exported in Mexico all year round (SENASICA 2017).

## 4 Pest risk assessments for quarantine pests

This chapter assesses for each of the pests identified in Table 4.1 the likelihoods of entry (importation and distribution), establishment and spread, and the magnitude of the associated potential economic (including environmental) consequences these species may cause if they were to enter, establish and spread in Australia.

Twenty pests of biosecurity concern for Australia associated with commercially produced, export-quality lime fruit produced in Mexico were identified in the pest categorisation process as requiring further pest risk assessment (Appendix A: Initiation and categorisation for pests of fresh Persian lime fruit from Mexico). Table 4.1 summarises the pests of biosecurity concern for Australia associated with fresh Persian lime fruit from Mexico.

- 17 of these species are quarantine pests
- 3 species are regulated articles as they are capable of harbouring and spreading (vectoring) viruses that are of biosecurity concern to Australia.
- 6 of the 20 species have been recorded in some regions of Australia but, due to interstate quarantine regulations and their enforcement, are considered regional quarantine pests. The acronym for the state or territory for which the regional quarantine pest status is considered, such as 'WA' (Western Australia), is used to identify these pests.

All the pest groups considered here have been assessed previously by the department. Twelve of the pest species have been assessed previously in Group PRAs.

- The biosecurity risk posed by thrips and the orthotospoviruses they transmit from all countries was previously assessed in the *Final group pest risk analysis for thrips and orthotospoviruses on fresh fruit, vegetable, cut-flower and foliage imports* (DAWR 2017).
- The biosecurity risk posed by mealybugs from all countries was previously assessed in the *Final group pest risk analysis for mealybugs, and the viruses they transmit on fresh fruit, vegetable, cut-flower and foliage imports* (DAWR 2019).
- The biosecurity risk posed by armoured scales from all countries was previously assessed in the *Final group pest risk analysis for soft and hard scale insects on fresh fruit, vegetable, cut-flower and foliage imports* (scales Group PRA) (DAWE 2021).

These Group PRAs have been applied to this risk analysis for fresh Persian limes from Mexico. The acronym 'GP' is used to identify species assessed previously in a Group PRA and for which the Group PRA was applied. The application of the Group PRAs to this risk analysis is outlined in Section 2.2.7. A summary of assessment from the Group PRA is presented for the relevant quarantine pests in this chapter for convenience.

In addition to the 12 pest species assessed in Group PRAs, a further 3 species have been assessed previously in other import policies. Where appropriate, the outcomes of previous assessments for these pests have been adopted for this risk analysis, unless new information is available that suggests the risk would be different. The acronym 'EP' is used to identify species assessed previously and for which import policy already exists. The adoption of outcomes from previous assessments is outlined in Section 2.2.6.

**Table 4.1 Quarantine pests and regulated articles associated with fresh Persian lime fruit from Mexico requiring further assessment**

<b>Pest</b>	<b>Common name</b>
<b>Armoured scales (Hemiptera: Diaspididae)</b>	
<i>Chrysomphalus dictyospermi</i> (GP, WA)	Spanish red scale
<i>Parlatoria cinerea</i> (GP)	Tropical grey chaff scale
<i>Parlatoria pergandii</i> (GP, WA)	Chaff scale
<i>Pinnaspis aspidistrae</i> (GP, WA)	Fern scale
<i>Pseudaonidia trilobitiformis</i> (GP, WA)	Trilobite scale
<i>Unaspis citri</i> (GP, WA)	Citrus snow scale
<b>Mealybugs (Hemiptera: Psuedococcidae)</b>	
<i>Dysmicoccus neobrevipes</i> (GP)	Grey pineapple mealybug
<i>Paracoccus marginatus</i> (GP)	Papaya mealybug
<i>Pseudococcus maritimus</i> (GP)	Grape mealybug
<b>Moths [Lepidoptera: Gracillariidae]</b>	
<i>Marmara gulosa</i> (EP)	Citrus peelminer
<b>Thrips (Thysanoptera: Thripidae)</b>	
<i>Caliothrips fasciatus</i> (GP)	Californian bean thrips
<i>Frankliniella bispinosa</i> (GP)	Florida flower thrips
<i>Scirtothrips citri</i> (GP)	California citrus thrips
<b>Spider mites (Trombidiformes: Tetranychidae)</b>	
<i>Panonychus citri</i> (EP, WA)	Citrus red mite
<b>Fungus</b>	
<i>Elsinoë fawcettii</i> (EP)	Citrus scab
<b>Viruses</b>	
<i>Citrus leprosis virus C</i> (CiLV-C)	Citrus leprosis disease
<i>Orchid fleck dichorhavirus – Citrus strain</i> (OFV-Cit1)	Citrus leprosis disease
<b>Flat mite vectors of viruses [Trombidiformes: Tenuipalpidae]</b>	
<i>Brevipalpus californicus</i> (RA)	Citrus flat mite
<i>Brevipalpus papayensis</i> (RA)	Flat mite
<i>Brevipalpus yothersi</i> (RA)	Flat mite

**EP:** Species has been assessed previously and import policy already exists. **GP:** Species has been assessed previously in a Group PRA, and the Group PRA has been applied. **RA:** Regulated article, refer to Section 4.7.2 for definition of a regulated article. **WA:** Regional quarantine pest for Western Australia

## 4.1 Armoured scales

***Chrysomphalus dictyospermi* (GP, WA), *Parlatoria cinerea* (GP), *Parlatoria pergandii* (GP, WA), *Pinnaspis aspidistrae* (GP, WA), *Pseudaonidia trilobitiformis* (GP, WA), *Unaspis citri* (GP, WA)**

Six armoured scale species that are quarantine pests for Australia, or regional quarantine pests for parts of Australia, were identified on the Persian lime fruit from Mexico pathway as requiring further pest risk assessment: *Chrysomphalus dictyospermi*, *Parlatoria cinerea*, *Parlatoria pergandii*, *Pinnaspis aspidistrae*, *Pseudaonidia trilobitiformis* and *Unaspis citri*.

*Chrysomphalus dictyospermi*, *Parlatoria pergandii*, *Pinnaspis aspidistrae*, *Pseudaonidia trilobitiformis* and *Unaspis citri* are not present in Western Australia and are pests of regional quarantine concern for that state.

The biological characteristics and behaviours on the importation pathway of these species are considered sufficiently similar to justify combining them into a single assessment.

The indicative likelihood of entry for armoured scales is assessed in the scales Group PRA (DAWE 2021) as Moderate, which is comprised of indicative likelihoods of importation and distribution of High and Moderate, respectively. The indicative likelihood of importation of High from the scales Group PRA may not be appropriate for the armoured scales on the Persian lime fruit from Mexico pathway. Commercial packing house procedures in Mexico, which include washing, brushing, disinfection and waxing of fruit, are likely to reduce the likelihood of these pests being present on lime fruit exported to Australia. Therefore, the likelihood of importation of armoured scales on Persian lime fruit from Mexico pathway is assessed here.

### 4.1.1 Likelihood of entry

The likelihood of entry is considered in 2 parts, the likelihood of importation and likelihood of distribution, which consider pre-border and post-border issues, respectively.

#### Likelihood of importation

The likelihood that armoured scales will arrive in Australia with the importation of fresh Persian lime fruit from Mexico is assessed as: **Moderate**.

The following information provides supporting evidence for this assessment.

These armoured scale species are present in Mexico and could be associated with Persian lime fruit.

- *Citrus latifolia* is known to be a host of *Parlatoria cinerea*, *Parlatoria pergandii* (Martins et al. 2022), *Pinnaspis aspidistrae* (Cassino & Rodrigues 2005), *Pseudaonidia trilobitiformis* (Mille et al. 2016) and *Unaspis citri* (Martins et al. 2022). These scales are present in Mexico (García Morales et al. 2022).
- *Chrysomphalus dictyospermi* is a minor pest of citrus in Mexico, although recognised as a serious pest in some countries. It is reported to attack the leaves and fruit of citrus hosts (Rosen & DeBach 1978). No host records for *Chrysomphalus dictyospermi* on *Citrus latifolia* have been identified, although it is possible some older records from *Citrus aurantiifolia* were referring to *Citrus latifolia*. Given the highly polyphagous feeding behaviour and the

extensive list of other citrus hosts for this species, the potential for infesting Persian limes is possible, but the incidence on limes is likely to be relatively low.

- These scale species are mainly found on leaves but can also infest the fruit of hosts (Miller & Davidson 2005; Watson 2022).

There is a history of these scale species being found on fruit being processed at citrus packing facilities or detected in quarantine inspections of imported citrus fruit.

- *Parlatoria pergandii* and *Chrysomphalus dictyospermi* were among the arthropod pests most frequently identified on citrus fruit at 4 packing facilities in Spain (Meliá 1976).
- *Parlatoria cinerea*, *Parlatoria pergandii*, *Pinnaspis aspidistrae* and *Unaspis citri* have been intercepted on citrus fruit in trade (Suh 2016), although no reports of interceptions specifically on Persian lime fruit have been identified.

Some armoured scales may not be removed from the fruit during packing house processes.

- Armoured scales are more difficult to remove from fruit than other arthropod pests such as mealybugs, thrips, mites, springtails and leafroller eggs (Griffin et al. 2014; Whiting et al. 1998a).
- First instar nymphs (crawlers) are likely to be removed during washing, brushing and waxing, but the sessile stages of these insects tightly affix to the fruit by their long piercing mouthparts and may be difficult to dislodge (Burger & Ulenberg 1990; Fasulo & Brooks 2010).
- Washing, brushing and waxing of Persian lime fruit prior to export are likely to reduce numbers of armoured scales on the fruit surface, but those processes may not be fully efficacious, particularly if scales are located around the calyx or protected in indentations in the fruit rind.
- Standard commercial fruit washing where fruit pass over a roller brush bed without spraying with high-pressure water jets was demonstrated to remove 27–62% of another armoured scale species (*Aonidiella aurantii*) on navel oranges (Walker, Morse & Arpaia 1996). Although not necessarily representative of the likely efficacy for removing the assessed scale species from Persian lime fruit, it does illustrate the potential for some scales to remain on the fruit after washing and brushing.
- High pressure washing is significantly more effective at removing armoured scales from lime fruit than immersion washing in a dump tank (Griffin et al. 2014). High pressure washing removed more than 90% of scales (*Lepidosaphes* spp.) from lime fruit in a packhouse in New Caledonia (Griffin et al. 2014). However, it is understood that few facilities processing lime fruit for export in Mexico currently use high pressure washing.
- Scales are visible to the naked eye, although they can be cryptic. Limes undergo quality inspection prior to packing. Scales visible on the fruit are likely to be detected and removed from the pathway.

These armoured scales are likely to survive conditions during pre-export storage in Mexico and transport to Australia.

- After packing, conditions during storage and transit to Australia are unlikely to adversely affect the viability of armoured scales. Temperatures typically experienced during storage and transit would not be lethal to armoured scales.
- Armoured scales are capable of overwintering in cool conditions, although depending on the species, diapause may be limited to particular life stages (McClure 1990).
- Lime fruit are not typically stored at low temperatures for long periods due to their susceptibility to chilling injury, so there may be no appreciable impact on armoured scale feeding and development in transit.

These armoured scale species are present in Mexico, although there is no information to suggest they are prevalent or significant pests of Persian lime production in Mexico. Packing house processes of washing, brushing and waxing may not remove or kill all scales that could be present on the fruit. Infested fruit are likely to be detected in the packing house and removed from the pathway prior to packing. However, if any live scales are present on fruit packed for export, they are likely to survive conditions during transit to Australia. For these reasons, the indicative likelihood of importation of High for all armoured scales in the Group PRA is not considered to be appropriate for scales on the Persian limes from Mexico pathway. The likelihood estimate for importation of armoured scales on the Persian limes from Mexico pathway is assessed as Moderate.

#### Likelihood of distribution

The indicative likelihood of distribution for all armoured scales is assessed as Moderate in the scales Group PRA. The likelihood that *Chrysomphalus dictyospermi*, *Parlatoria cinerea*, *Parlatoria pergandii*, *Pinnaspis aspidistrae*, *Pseudaonidia trilobitiformis* and *Unaspis citri* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of Persian lime fruit from Mexico, and subsequently transfer to a susceptible part of a host is considered to be similar to scale insects on other fresh fruit, vegetable, cut-flower and foliage imports. The likelihood of distribution of **Moderate** was verified as appropriate for these scales on this pathway (Table 4.2).

#### Overall likelihood of entry

The overall likelihood of entry is determined as **Low** by combining the assessed likelihood of importation of Moderate with the verified likelihood of distribution of Moderate, using the matrix of rules in Table 2.2.

A summary of the risk assessment for these armoured scale species is presented in Table 4.2 for convenience.

**Table 4.2 Risk estimates for armoured scales**

Risk component	Rating for armoured scales in the scales Group PRA	Rating for armoured scales on Persian limes from Mexico
Likelihood of entry (importation x distribution)	Moderate (High x Moderate) (indicative)	Low (Moderate x Moderate)
Likelihood of establishment	High	High (a)
Likelihood of spread	High	High (a)
Overall likelihood of entry, establishment and spread	Moderate	Low

Consequences	Low	Low (a)
<b>Unrestricted risk</b>	<b>Low</b>	<b>Very Low</b>

(a): risk estimates adopted from the scales Group PRA (DAWE 2021)

#### 4.1.2 Unrestricted risk estimate

Based on the likelihood of importation of Moderate for armoured scales on the fresh Persian lime fruit from Mexico pathway, the unrestricted risk estimate of these scales on this pathway is assessed as **Very Low**, which achieves the ALOP for Australia. Therefore, no specific risk management measures are required for armoured scales on the fresh Persian lime fruit from Mexico pathway.

## 4.2 Mealybugs

### *Dysmicoccus neobrevipes* (GP), *Paracoccus marginatus* (GP), *Pseudococcus maritimus* (GP)

Three mealybug species were identified on the Persian lime fruit from Mexico pathway as quarantine pests for Australia that require further pest risk assessment: *Dysmicoccus neobrevipes*, *Paracoccus marginatus* and *Pseudococcus maritimus*.

The biological characteristics and behaviours on the importation pathway of these species are considered sufficiently similar to justify combining them into a single assessment.

The indicative likelihood of entry for mealybugs is assessed in the mealybugs Group PRA (DAWR 2019) as Moderate, which is comprised of indicative likelihoods of importation and distribution of High and Moderate, respectively. The indicative likelihood of importation of High may not be appropriate for the mealybugs on the Persian lime fruit from Mexico pathway. Commercial packing house procedures in Mexico, which include washing, brushing, disinfection and waxing of fruit, are likely to reduce the likelihood of these pests being present on Persian lime fruit exported to Australia. Therefore, the likelihood of importation of mealybugs on Persian lime fruit from Mexico pathway is assessed here.

#### 4.2.1 Likelihood of entry

The likelihood of entry is considered in 2 parts, the likelihood of importation and likelihood of distribution, which consider pre-border and post-border issues, respectively.

##### Likelihood of importation

The likelihood that mealybugs will arrive in Australia with the importation of fresh Persian lime fruit from Mexico is assessed as: **Low**.

The following information provides supporting evidence for this assessment.

These mealybug species are present in Mexico and could infest Persian lime fruit.

- *Dysmicoccus neobrevipes*, *Paracoccus marginatus* and *Pseudococcus maritimus* have been recorded in Mexico (García Morales et al. 2022).
- *Dysmicoccus neobrevipes* is a highly polyphagous species that can feed on citrus, including lemon, lime (*Citrus aurantiifolia*) (Williams & Watson 1988), mandarin and orange (Sirisena et al. 2013). It feeds on many parts of host plants, including the fruit (Beardsley 1965; CABI 2022a). Therefore, it is considered likely that Persian lime fruit could be susceptible to infestation by *Dysmicoccus neobrevipes*.
- *Paracoccus marginatus* has been reported from more than 55 host plants in more than 25 genera (Walker, Hoy & Meyerdirk 2014), including orange, grapefruit and lemon (García Morales et al. 2022). It feeds on above ground parts of host plants, including fruit (Walker, Hoy & Meyerdirk 2014). Therefore, it is considered likely that Persian lime fruit could be susceptible to infestation by *Paracoccus marginatus*.
- *Pseudococcus maritimus* has been reported on citrus including lemon, pomelo and kumquat (García Morales et al. 2022). It occurs on most parts of host plants and can infest the fruit (Miller et al. 2014). Therefore, it is considered likely that Persian lime fruit could be susceptible to infestation by *Pseudococcus maritimus*.



- *Pseudococcus maritimus* has been intercepted on citrus fruit in trade (Suh 2019), although no reports of interceptions specifically on Persian lime fruit have been identified.
- The absence of reports of these mealybug species on Persian limes suggests it is not a preferred host, so their presence in orchards may be uncommon.

Packing house procedures will likely remove most of the mealybugs present on imported fruit.

- Washing and brushing of lime fruit prior to export will remove most mealybugs on the fruit surface. However, those processes may be less effective at removing mealybugs sheltering around the calyx or in indentations in the fruit rind.
- Exposed mealybugs are relatively easy to remove with high pressure washing (Griffin et al. 2014). Other washing processes used in citrus packing houses are also likely to remove mealybugs but may be less effective.
- Around 60% of mealybugs (*Pseudococcus viburni*) present on apple fruit in a commercial packing facility remained after immersion in a dump tank followed by brushing (Whiting et al. 1998b). While not directly comparable to limes due to the different fruit morphology and greater protection for mealybugs provided by the apple calyx and stem cavity, Whiting (1998b) demonstrated that washing and brushing may not remove all mealybugs, even from relatively exposed parts of the fruit.
- While Persian lime fruit typically have relatively smooth skin, mealybugs on the fruit may not be dislodged by brushing, particularly if they are present under the fruit calyx or sheltering in depressions in the rind.
- Limes undergo quality inspection prior to packing. Mealybugs visible on the surface of the fruit are likely to be detected and removed from the pathway. However, mealybugs under the calyx would be less readily identified.

These mealybugs are likely to survive conditions during pre-export storage in Mexico and transport to Australia.

- After packing, conditions during storage and transit to Australia are unlikely to adversely affect the viability of mealybugs.
- Temperatures typically experienced during storage and transit would not be lethal to mealybugs but may slow development.
- Mealybugs may survive exposure to cold conditions, with many capable of overwintering as second-instar nymphs (Miller 2005). *Pseudococcus maritimus* overwinters in the egg and crawler stages in California (Geiger & Daane 2001).

These mealybug species are present in Mexico, although there is no information to suggest they are prevalent or significant pests of Persian lime production in Mexico. Packing house processes of washing and brushing are likely to remove or kill most mealybugs if present on the fruit. Infested fruit are likely to be detected in the packing house and removed from the pathway. For these reasons, the indicative likelihood of importation of High for all mealybug species in the Group PRA is not considered to be appropriate for mealybugs on the Persian limes from Mexico pathway. The likelihood estimate for importation of mealybugs on the Persian limes from Mexico pathway is assessed as Low.

### Likelihood of distribution

The indicative likelihood of distribution for all mealybugs is assessed as Moderate in the mealybugs Group PRA. The likelihood that *Dysmicoccus neobrevipes*, *Paracoccus marginatus* and *Pseudococcus maritimus* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of Persian lime fruit from Mexico, and subsequently transfer to a susceptible part of a host is considered to be similar to mealybugs on other fresh fruit, vegetable, cut-flower and foliage imports. The likelihood of distribution of **Moderate** was verified as appropriate for these mealybugs on this pathway (Table 4.3).

### Overall likelihood of entry

The overall likelihood of entry is determined as **Low** by combining the assessed likelihood of importation of Low with the verified likelihood of distribution of Moderate, using the matrix of rules in Table 2.2.

A summary of the risk assessment for these mealybugs is presented in Table 4.3 for convenience.

**Table 4.3 Risk estimates for mealybugs**

Risk component	Rating for mealybugs in the mealybugs Group PRA	Rating for mealybugs on Persian limes from Mexico
Likelihood of entry (importation x distribution)	Moderate (High x Moderate) (indicative)	Low (Low x Moderate)
Likelihood of establishment	High	High (a)
Likelihood of spread	High	High (a)
Overall likelihood of entry, establishment and spread	Moderate	Low
Consequences	Low	Low (a)
<b>Unrestricted risk</b>	<b>Low</b>	<b>Very Low</b>

(a): risk estimates adopted from the mealybugs Group PRA (DAWR 2019)

#### 4.2.2 Unrestricted risk estimate

Based on the likelihood of importation of Low for mealybugs on the fresh Persian lime fruit from Mexico pathway, the unrestricted risk estimate of these mealybugs on this pathway is assessed as **Very Low**, which achieves the ALOP for Australia. Therefore, no specific risk management measures are required for mealybugs on the fresh Persian lime fruit from Mexico pathway.

### 4.3 Citrus peelminer

#### ***Marmara gulosa* (EP)**

*Marmara gulosa* belongs to the Gracillariidae family, also known as 'leaf blotch miner moths'. It has been recorded from Cuba, Peru, some southern states of the USA and northern Mexico (Ayquipa Aycho et al. 2014; Guerrero et al. 2012a; Stelinski 2019). Hosts of *M. gulosa* include apple, cherry, cotton, olive, plum and multiple citrus species (Grousset et al. 2016; Guerrero et al. 2012a), although it favours grapefruit and navel oranges (Grafton-Cardwell et al. 2021; Stelinski 2019).

*Marmara gulosa* lays eggs directly on the fruit surface or stems of its hosts. Larvae feed in tunnels in the outer layer of the fruit peel (Stelinski 2019). The larvae dig out a winding tunnel within the skin, leading to cosmetic damage to the fruit (Grafton-Cardwell et al. 2021; Stelinski 2019). Larvae leave the fruit to pupate on the exterior of a leaf, bark or occasionally fruit (Grafton-Cardwell et al. 2021; Stelinski 2019).

*Marmara gulosa* is a pest of several cultivated plants in California (Kirkland 2009). However, *M. gulosa* populations in Sonora, Mexico do not migrate between crops and increase at the same rate as the Californian populations (Semet 2010). This is hypothesised to be due to harsher environmental conditions in Sonora, and wider expanses of unsuitable environment between orchards than in California (Semet 2010).

The risk scenario of concern is that *M. gulosa* eggs or larvae may be present on or in the skin of fresh Persian lime fruit imported from Mexico.

*Marmara gulosa* has been assessed previously in the *Final non-regulated analysis of existing policy for Californian table grapes to Western Australia* (DAFF 2013). In that policy the unrestricted risk estimate for *M. gulosa* was assessed as Very Low, which achieves the ALOP for Australia. Therefore, no specific risk management measures are required for this pest on that pathway. That assessment was subsequently adopted for table grapes from Sonora, Mexico (DAWR 2016).

The department assessed the likelihood of importation of *M. gulosa* on the table grapes from California pathway as Moderate (DAFF 2013), as the moth is present in California throughout the year and is known to be associated with grape bunches. However, there are differences in pest prevalence, host preference and host structure between lime production areas in Mexico and the previously assessed table grape from California pathway. It is therefore necessary to reassess the likelihood that *M. gulosa* will be imported into Australia on the Persian lime fruit from Mexico pathway.

The previous assessment of *M. gulosa* on table grapes from California rated the likelihood of distribution as High (DAFF 2013). Persian lime fruit from Mexico is expected to be distributed throughout Australia in a similar way to grapes from California. Most fruit waste is disposed of via municipal waste facilities, but some may be discarded in the environment. Any *M. gulosa* present on the waste may disperse to hosts in Australia. If a larva is able to emerge from the skin of an infested fruit and successfully pupate, the resulting adult moth will have the same capacity to fly in search of a new host regardless of the host the larva was reared from. For these reasons, the rating of High for the previously assessed import pathway of table grapes from California has been adopted for the Persian lime fruit from Mexico pathway.

The likelihoods of establishment and spread of *M. gulosa* in Australia from the Persian lime fruit from Mexico pathway have been assessed as similar to those of the previous assessments of High and Moderate respectively for table grapes from California (DAFF 2013). These likelihoods relate specifically to events that occur in Australia and are essentially independent of the import pathway. The consequences of entry, establishment and spread of *M. gulosa* are also independent of the import pathway and have been assessed as similar to the previous risk assessment of Low (DAFF 2013). The previous assessment noted that infestation by *M. gulosa* could potentially result in economic losses on fruit hosts where skin blemishes would affect marketability, but may have little economic impact on other hosts. Therefore, the existing ratings for the likelihoods of establishment and spread, and the rating for the overall consequences of *M. gulosa* in the previous assessment for table grapes from California have been adopted for the Persian lime fruit from Mexico pathway.

In addition, the department has reviewed the latest literature—for example, Ayquipa Aycho et al. (2014), Eiseman et al. (2017), Stelinski (2019) and Grafton-Cardwell et al. (2021). No new information has been identified that would significantly change the risk ratings for distribution, establishment, spread or consequences as set out for *M. gulosa* in the existing policy for table grapes from California.

#### 4.3.1 Likelihood of entry

The likelihood of entry is considered in 2 parts, the likelihood of importation and likelihood of distribution, which consider pre-border and post-border issues, respectively.

##### Likelihood of importation

The likelihood that *M. gulosa* will arrive in Australia with the importation of fresh Persian lime fruit from Mexico is assessed as: **Low**.

The following information provides supporting evidence for this assessment.

*Marmara gulosa* is only recorded from some areas of Mexico.

- *Marmara gulosa* has been recorded from the north-western state of Sonora, which evidence suggests is the southern boundary of its natural range (Semet 2010). It is unlikely to be present in most lime production areas, which are predominantly in southern Mexico.

*Marmara gulosa* could be associated with Persian lime fruit in Mexico.

- All citrus and their hybrids are identified as hosts of *M. gulosa* (Guerrero et al. 2012a).
- While there are no reports that it is associated with Persian limes in Mexico, it has been recorded from other varieties of lime in Mexico (Semet 2010).

Eggs are laid directly onto the surface of the host fruit and can be difficult to detect.

- Eggs are laid directly onto the plant surface, such as the fruit of hosts (Guerrero et al. 2012a; Stelinski 2019).
- *Marmara gulosa* eggs are light in colour and small in size, only 0.41 mm long and 0.28 mm wide (Guerrero et al. 2012a). Eggs are laid individually on host fruit (Grafton-Cardwell et al. 2008). Such a small egg by itself on the skin of a lime fruit may go undetected.

- Eggs on the fruit surface may be removed or damaged by washing, brushing and waxing procedures in the packing house.

Once larvae begin feeding the damage will be evident and infested fruit are likely to be removed during harvest and post-harvest processes.

- Larvae feed by digging mines through the skin of their host fruit (Grafton-Cardwell et al. 2021), causing cosmetic damage (Stelinski 2019).
- Damage to infested lime fruit is likely to be obvious. Larvae form mines on the surface of the fruit, creating a winding tunnel that grows wider as the larvae moults and grows (Grafton-Cardwell et al. 2021). Such fruit is likely to be culled during harvesting and in the packing house prior to packing.

Citrus peelminer is present in Mexico but is only recorded from some Persian lime production areas in the north. Unhatched eggs may be difficult to detect, however feeding by larvae produces clearly visible scarring of the fruit rind. Fruit with such visible injuries would likely be removed during packing house practices. For the reasons outlined, the likelihood of importation of *M. gulosa* on imported Persian lime fruit from Mexico is assessed as Low.

#### Likelihood of distribution

The likelihood that *M. gulosa* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of Persian limes from Mexico, and subsequently transfer to a susceptible part of a host is considered to be similar to *M. gulosa* on previously assessed table grapes from California pathway. Therefore, the same rating of **High** for the likelihood of distribution for *M. gulosa* on the previously assessed pathway is adopted for *M. gulosa* assessed on the Persian lime fruit from Mexico pathway.

#### Overall likelihood of entry

The overall likelihood of entry is determined as **Low** by combining the re-assessed likelihood of importation of Low with the adopted likelihood of distribution of High, using the matrix of rules in Table 2.2.

#### 4.3.2 Likelihood of establishment and spread

The likelihoods of establishment and spread for *M. gulosa* are independent of the import pathway and are considered similar to those in the previously assessed pathway.

Based on the existing import policies for table grapes from California (DAFF 2013) the likelihoods of establishment and spread are assessed as **High** and **Moderate** respectively.

#### 4.3.3 Overall likelihood of entry, establishment and spread

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

The overall likelihood that *M. gulosa* will enter Australia as a result of trade in Persian lime fruit from Mexico, be distributed in a viable state to a susceptible part of a host, establish in Australia and subsequently spread within Australia is assessed as **Low**.

#### 4.3.4 Consequences

The potential consequences of the entry, establishment and spread of *M. gulosa* in Australia are similar to those in the previous assessment for *M. gulosa* for table grapes from California (DAFF 2013), which were assessed as Low (DAFF 2013). The overall consequences for *M. gulosa* on the Persian lime fruit from Mexico pathway are also assessed as **Low**.

#### 4.3.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the overall likelihood of entry, establishment and spread with the outcome of overall consequences. The likelihood and consequences are combined using the risk estimation shown in Table 2.4.

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<b>Unrestricted risk estimate for <i>Marmara gulosa</i></b>	
Overall likelihood of entry, establishment and spread	Low
Consequences	Low
Unrestricted risk	Very Low

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The unrestricted risk estimate for *M. gulosa* on the Persian lime fruit from Mexico pathway is assessed as Very Low, which achieves the ALOP for Australia. Therefore, no specific risk management measures are required for *M. gulosa* on this pathway.

## 4.4 Thrips

### *Caliothrips fasciatus* (GP), *Frankliniella bispinosa* (GP), *Scirtothrips citri* (GP)

Three thrips species that are quarantine pests for Australia were identified on the Persian lime fruit from Mexico pathway as requiring further pest risk assessment: *Caliothrips fasciatus*, *Frankliniella bispinosa* and *Scirtothrips citri*.

The biological characteristics and behaviours on the importation pathway of these species are considered sufficiently similar to justify combining them into a single assessment.

The indicative likelihood of entry for thrips is assessed in the thrips Group PRA (DAWR 2017) as Moderate, which is comprised of indicative likelihoods of importation and distribution of High and Moderate, respectively. The indicative likelihood of importation of High may not be appropriate for the thrips on the Persian lime fruit from Mexico pathway. Commercial packing house procedures in Mexico, which include washing, brushing, disinfection and waxing of fruit, are likely to reduce the likelihood of these pests being present on lime fruit exported to Australia. Therefore, the likelihood of importation of thrips on the Persian lime fruit from Mexico pathway is assessed here.

#### 4.4.1 Likelihood of entry

The likelihood of entry is considered in 2 parts, the likelihood of importation and likelihood of distribution, which consider pre-border and post-border issues, respectively.

##### Likelihood of importation

The likelihood that thrips will arrive in Australia with the importation of fresh Persian lime fruit from Mexico is assessed as: **Low**.

The following information provides supporting evidence for this assessment.

These thrips species are present in Mexico and are associated with Persian lime fruit.

- *Caliothrips fasciatus* is native to Western Mexico and other parts of North America (DAWR 2017). While not specifically a pest of citrus, it has a history of interceptions on imported citrus fruit, especially navel oranges (Hoddle, Stosic & Mound 2006). *Caliothrips fasciatus* has also occasionally been found on mandarins, lemons and tangelos, and has been intercepted at least once on lime fruit imported into Australia over the last 20 years. An additional pest detected on lime fruit, identified only as *Caliothrips* sp., is considered likely to also have been *C. fasciatus*.
- *Frankliniella bispinosa* is present in Mexico, and its hosts include all *Citrus* species and their hybrids (Guerrero et al. 2012a). It is reported as a pest of *C. latifolia* (Childers & Beshear 1992).
- *Scirtothrips citri* is present in Mexico (Hoddle, Mound & Paris 2012; Mound & Hoddle 2016), and is considered a pest in Persian lime orchards in Mexico (Almaguer-Vargas & Ayala-Garay 2014).

Thrips are typically associated with immature or young Persian lime fruit, but could be present on harvested fruit.

- On citrus hosts, *S. citri* first instar larvae actively feed on tender leaves and fruit, especially under the sepals of young fruit (Kerns, Wright & Loghry 2001).
- Although *F. bispinosa* feeds exclusively on flowers and developing fruit of hosts, both adults and larvae can be found in orchards on mature citrus fruit, twigs and leaves (Childers & Nakahara 2006), therefore thrips could be present on fruit when it is harvested.
- *Scirtothrips citri* eggs are inserted individually into young, soft tissues of leaves, stems and immature citrus fruit (Kerns, Wright & Loghry 2001). Lewis (1973) reported that *S. citri* eggs are embedded deeply into the plant tissues. Typically, the eggs would have hatched before fruit has reached maturity and been harvested.
- While overwintering of *S. citri* eggs in the tissues of citrus leaves, stems, and twigs is reported (Tanigoshi & Nishio-Wong 1982), it is not clear from the available information whether larvae could successfully emerge from overwintered eggs in mature fruit after several months in the rind of growing fruit. In the related species *S. aurantii*, more than half the larvae attempting to hatch from eggs in mature citrus fruit died, unable to fully emerge from the eggshell (Lewis 1973).

Packing house procedures will likely remove most of the thrips present on the fruit.

- Washing, brushing and waxing of lime fruit prior to export will remove most thrips on the fruit surface. However, those processes may be less effective at removing thrips sheltering around the calyx or in depressions in the fruit rind.
- While Persian lime fruit typically have relatively smooth skin, thrips on the fruit may not be dislodged by brushing, particularly if they are present under the fruit calyx or sheltering in depressions in the rind.
- Limes undergo quality inspection prior to packing. Thrips visible on the surface of the fruit are likely to be detected and infested fruit removed from the pathway. However, thrips under the calyx would be less readily identified.

These thrips are likely to survive conditions during pre-export storage in Mexico and transport to Australia.

- After packing, the conditions during storage and transit to Australia are unlikely to adversely affect the viability of thrips. Temperatures typically experienced during storage and transit are unlikely to be lethal to the assessed thrips species, although development may be slowed.
- *Scirtothrips citri* can overwinter in the egg stage, although the eggs are not in diapause as hatching can readily be induced by incubating them at room temperature (Tanigoshi & Nishio-Wong 1982). *Scirtothrips citri* eggs develop and hatch at temperatures above 18.3°C (Tanigoshi and Nishio-Wong 1982).
- *Caliothrips fasciatus* can overwinter in the adult stage, and while they typically have poor survival when subject to cold storage conditions for shipping of oranges to Australia at 2.78°C for 18–24 days (Hoddle, Stosic & Mound 2006), they are more likely to survive the milder conditions experienced during export of fresh lime fruit.

These thrips species are present in Mexico and may be associated with Persian limes. They do not typically feed on mature fruit, but it is feasible that small numbers may occasionally be on



the fruit when it is harvested. Packing house processes of washing, brushing and waxing would remove or kill most thrips if present on the fruit. Infested fruit are likely to be detected during packing house quality inspection and removed from the pathway. However, if live thrips are present on fruit packed for export they are likely to survive pre-export storage and conditions in transit to Australia. For these reasons, the indicative likelihood of importation of High for all thrips species in the Group PRA is not considered to be appropriate for thrips on the Persian lime fruit from Mexico pathway. The likelihood estimate for importation of thrips on the Persian lime fruit from Mexico pathway is assessed as Low.

### Likelihood of distribution

The indicative likelihood of distribution for all thrips is assessed as Moderate in the thrips Group PRA. The likelihood that *C. fasciatus*, *F. bispinosa* and *S. citri* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of Persian lime fruit from Mexico, and subsequently transfer to a susceptible part of a host is considered to be similar to thrips on other fresh fruit, vegetable, cut-flower and foliage imports. The likelihood of distribution of **Moderate** was verified as appropriate for these thrips on this pathway (Table 4.4).

### Overall likelihood of entry

The overall likelihood of entry is determined as **Low** by combining the assessed likelihood of importation of Low with the verified likelihood of distribution of Moderate, using the matrix of rules in Table 2.2.

A summary of the risk assessment for these thrips is presented in Table 4.4 for convenience.

**Table 4.4 Risk estimates for thrips**

Risk component	Rating for thrips in the thrips Group PRA	Rating for thrips on Persian limes from Mexico
Likelihood of entry (importation x distribution)	Moderate (High x Moderate) (indicative)	Low (Low x Moderate)
Likelihood of establishment	High	High (a)
Likelihood of spread	High	High (a)
Overall likelihood of entry, establishment and spread	Moderate	Low
Consequences	Low	Low (a)
<b>Unrestricted risk</b>	<b>Low</b>	<b>Very Low</b>

(a): risk estimates adopted from the thrips Group PRA (DAWR 2017)

### 4.4.2 Unrestricted risk estimate

Based on the likelihood of importation of Low for thrips on the fresh Persian lime fruit from Mexico pathway, the unrestricted risk estimate of these thrips on this pathway is assessed as **Very Low**, which achieves the ALOP for Australia. Therefore, no specific risk management measures are required for thrips on the fresh Persian lime fruit from Mexico pathway.

## 4.5 Citrus red mite

### *Panonychus citri* (EP, WA)

*Panonychus citri* is not present in Western Australia and is a pest of regional concern for that state.

The citrus red mite, *P. citri*, is a member of the Tetranychidae family, which are commonly referred to as spider mites due to their habit of spinning silken webbing on host plants. It is distributed throughout the world and is recorded from at least 105 plant species including citrus, avocado, grapes, apple, pear, papaya, banana, pumpkin, and stone fruit (Vacante 2016).

Economic damage caused by *P. citri* is mainly reported on citrus, which is the major host (Jeppson 1989). *Panonychus citri* mainly becomes a problem when broad-spectrum insecticides are used to control other pests that are predators of *P. citri* (McMurtry 1985). Damage to host plants is largely dependent on infestation levels. At low levels, slight leaf or fruit scarring may occur (NSW DPI 2017). Large populations cause premature fruit drop and leaf fall, affect plant functions by reducing gas exchange and photosynthetic activity in damaged leaves, and cause fruit scarring which significantly reduces fruit quality (Zanardi et al. 2015).

*Panonychus citri* was first detected in Australia in 1966, in an isolated lemon orchard in northern Sydney (Gibson 1968). It was found in a Valencia orange orchard on the NSW Central Coast in 1968 (Gutierrez & Schicha 1983), less than 50 km from the initial detection site. Subsequent detections have been confined to this region. While there have been some restrictions on commercial movement of citrus trees and propagating material out of this region (Beattie & Gellatley 2003), which may have reduced opportunities for human-assisted movement of *P. citri*, there has been no natural spread of this mite despite suitable hosts being relatively common in many parts of Australia.

*Panonychus citri* was previously assessed in the risk analysis for sweet oranges from Italy (Biosecurity Australia 2005). In that policy the unrestricted risk estimate for *P. citri* was assessed as Very Low, which achieves the ALOP for Australia. Therefore, no specific measures are required for *P. citri* on the sweet oranges from Italy pathway.

However, there may be differences in the fruit structure, pest prevalence and production practices, between the previously assessed sweet oranges from Italy pathway, and Persian lime fruit from Mexico. These potential differences make it necessary to re-assess the likelihood that *P. citri* will be imported into Australia in a viable state on the Persian lime fruit from Mexico pathway.

The assessment of *P. citri* on the sweet oranges from Italy pathway rated the likelihood of distribution as Low. Persian lime fruit from Mexico is expected to be distributed in Western Australia in a similar way to the previously assessed oranges from Italy pathway. Most fruit waste is disposed of via municipal waste facilities and any spider mites on imported limes disposed of through managed waste systems are unlikely to find a suitable host plant. Some lime fruit waste may be discarded in urban and rural environments, or in natural environments. *Panonychus citri* adults and nymphs can crawl short distances, but their ability to move from fruit waste to a suitable host plant is limited. *Panonychus citri* is capable of aerial dispersal, 'ballooning' from the canopy of one plant to another on silken threads carried by the wind (Demard & Qureshi 2022). Spider mites ballooning from fruit waste on the ground would likely

be dispersed over shorter distances and be less likely to land on a suitable host plant. On this basis, the same rating of Low for the likelihood of distribution for *P. citri* on the previously assessed pathway is adopted for *P. citri* on the Persian lime fruit from Mexico pathway.

The likelihoods of establishment and spread of *P. citri* in Western Australia from the Persian lime fruit from Mexico pathway have also been assessed as similar to those of the previous assessments of Moderate and Moderate, respectively for the sweet oranges from Italy pathway. Those likelihoods relate specifically to events that occur in Western Australia and are essentially independent of the import pathway. The consequences of the entry, establishment and spread of *P. citri* in Western Australia are also independent of the import pathway and have been assessed as being similar to the previous risk assessment of Low. The existing ratings for the likelihoods of establishment and spread, and the rating for the overall consequences for *P. citri* in the previous assessment have been adopted for the Persian lime fruit from Mexico pathway.

In addition, the department has reviewed the latest literature—for example, Zanardi et al. (2015) and Demard and Qureshi (2022). No new information has been identified that would significantly change the risk ratings for distribution, establishment, spread and consequences as set out for *P. citri* in the existing policy.

The risk scenario of biosecurity concern is that *P. citri* eggs, larvae and adults may be imported on the Persian lime fruit from Mexico pathway.

#### 4.5.1 Likelihood of entry

The likelihood of entry is considered in 2 parts, the likelihood of importation and likelihood of distribution, which consider pre-border and post-border issues, respectively.

##### Likelihood of importation

The likelihood that *Panonychus citri* will arrive in Western Australia with the importation of fresh Persian lime fruit from Mexico is assessed as: **Moderate**.

The following information provides supporting evidence for this assessment.

*Panonychus citri* is present in Mexico and may be present in Persian lime production areas.

- *Citrus latifolia* is a host of *P. citri*, and the mite is reported as a pest of *C. latifolia* (Childers & Abou-Setta 1999). While *P. citri* can feed on all citrus species, differences in mite population numbers between host citrus species have been reported (Childers & Fasulo 1995). Mite numbers in Persian lime orchards are likely to be lower than in orchards of more preferred hosts such as lemon, grapefruit and orange.
- *Panonychus citri* is present in Mexico, where it is reported as a pest of citrus, including oranges and Mexican lime (*C. aurantiifolia*) (Estrada-Venegas et al. 2013). No information suggesting *P. citri* is a significant pest in Persian lime production in Mexico has been found.
- The development of *P. citri* is influenced by temperature and relative humidity, with populations adversely affected by high humidity and temperature, or extreme dry conditions (Demard & Qureshi 2022). Susceptibility to extremes of both temperature and humidity limit the distribution of the mite (Vacante 2016), and the mite may not be prevalent in many production areas, particularly those in humid coastal tropical regions such as Veracruz and Tabasco.

*Panonychus citri* may be present on lime fruit harvested for export.

- On citrus hosts, *P. citri* develops on leaves, as well as immature and mature fruit and twigs (Vacante 2016). Therefore, *P. citri* could be on lime fruit at time of harvest.
- *Panonychus citri* has occasionally been intercepted on citrus fruit imported into Australia, indicating that mature citrus fruit can be a pathway for importation.

Packing house procedures in Mexico are likely to remove most of the spider mites present on fruit.

- It is possible that washing, brushing and waxing may not always be fully effective, and small numbers of mites could remain on the fruit, particularly if mites are protected under the calyx.
- Limes undergo quality inspection prior to packing. Adult female *P. citri* are deep red to purple in colour (Vacante 2016), so spider mites on the surface of the fruit are likely to be detected and infested fruit removed from the pathway.
- Adult females of *P. citri* are only 350-400 µm long, and males and immature stages are even smaller (Vacante 2016), so spider mites sheltering under the calyx may be less readily identified.

*Panonychus citri* may survive conditions during pre-export storage in Mexico and transport to Australia.

- While development of *P. citri* only occurs at temperatures above 10°C (Zhang 2003), the conditions during storage and transport to Australia are not expected to significantly affect the viability of mites on lime fruit.
- Persian lime fruit may be stored at 7°C to 9°C prior to export, and if transported by sea freight will likely be in refrigerated containers kept at 7°C to 8°C for up to 30 days.

*Panonychus citri* can infest Persian lime fruit. Washing, brushing and waxing of lime fruit in the packing house will likely remove most *P. citri* from the fruit prior to export. It is feasible that some mites may survive if they are present under the calyx, which would be difficult to detect given their small size, so infested fruit may not be removed from the packing line. If *P. citri* is present on packed fruit, they are likely to survive the conditions during storage in Mexico prior to export and transport to Australia. However, *C. latifolia* does not appear to be a major host, and infestation levels in orchards may be relatively low, particularly in regions that experience higher humidity conditions that are less favourable to this species. For these reasons, the likelihood of importation of *P. citri* on imported Persian lime fruit from Mexico is rated as Moderate.

#### **Likelihood of distribution**

The likelihood that *P. citri* will be distributed within Western Australia in a viable state as a result of the processing, sale or disposal of Persian lime fruit from Mexico, and subsequently transfer to a susceptible part of a host, is likely to be similar to *P. citri* on previously assessed sweet oranges from Italy pathway. Therefore the same rating of **Low** for the likelihood of distribution for *P. citri* on the previously assessed pathway is adopted for *P. citri* on the Persian lime fruit from Mexico pathway.

### Overall likelihood of entry

The overall likelihood of entry is determined as **Low** by combining the re-assessed likelihood of importation of Moderate with the adopted likelihood of distribution of Low, using the matrix of rules in Table 2.2.

#### 4.5.1 Likelihoods of establishment and spread

The likelihoods of establishment and spread for *P. citri* are independent of the import pathway and are considered similar to those previously assessed for the sweet oranges from Italy pathway.

Based on the existing import policy for sweet oranges from Italy (Biosecurity Australia 2005), the likelihoods of establishment and spread for *P. citri* are assessed as **Moderate** and **Moderate**, respectively.

#### 4.5.2 Overall likelihood of entry, establishment and spread

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

The overall likelihood that *P. citri* will enter Western Australia as a result of trade in Persian lime fruit from Mexico, be distributed in a viable state to a susceptible part of a host, establish in Western Australia and subsequently spread within Western Australia is assessed as **Low**.

#### 4.5.3 Consequences

The potential consequences of the entry, establishment and spread of *P. citri* in Western Australia are similar to those in the previous assessment for *P. citri* on the sweet oranges from Italy pathway, which were assessed as Low (Biosecurity Australia 2005). The overall consequences for *P. citri* on the Persian lime fruit from Mexico pathway are also assessed as **Low**.

#### 4.5.4 Unrestricted risk estimate

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

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<b>Unrestricted risk estimate for <i>Panonychus citri</i></b>	
Overall likelihood of entry, establishment and spread	Low
Consequences	Low
Unrestricted risk	Very Low

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The unrestricted risk estimate for *P. citri* on the Persian lime fruit pathway is assessed as **Very Low**, which achieves the ALOP for Australia. Therefore, no specific risk management measures are required for *P. citri* on this pathway.

## 4.6 Citrus scab

### *Elsinoë fawcettii* (EP)

Citrus scab is caused by *Elsinoë fawcettii* (anamorph *Sphaceloma fawcettii*), and sweet orange scab is caused by *E. australis* (anamorph *S. australis*) (Hou et al. 2014). The previously described *S. fawcettii* var. *scabiosa* is now considered to be a pathotype of *E. fawcettii* and is no longer a valid name (Timmer, Garnsey & Graham 2000).

*Citrus latifolia* (Persian limes) is a host of both *E. fawcettii* and *E. australis* (Gopal et al. 2014; Kunta et al. 2013). However, *E. australis* is not present in Mexico (Gopal et al. 2014) and therefore is not included in this risk assessment.

Several *E. fawcettii* pathotypes have been identified worldwide, determined by host range and genetic studies (Hou et al. 2014; Hyun et al. 2009). The Tryon's and lemon pathotypes are present in Australia, but have a restricted distribution (only in NSW, NT and Qld) (Hyun et al. 2009; Miles et al. 2015; Tan et al. 1996). Many pathotypes are not known to be present in Australia, such as SRGC (satsuma, rough lemon, grapefruit, clementine) (Hyun et al. 2009), 'Florida broad host range' (FBHR), 'Florida narrow host range' (FNHR), and 'Jingoul' (Hyun et al. 2009), and other unnamed pathotypes more recently identified in China (Hou et al. 2014).

Additional undefined pathotypes may be discovered with more extensive sampling (Hyun et al. 2009), including in Australia. Records of *Elsinoë fawcettii* isolated in Australia from kumquat (recorded as *Fortunella* sp.), sweet orange (*C. sinensis*), karna (*Citrus × aurantium*), Rangpur lime (recorded as *C. aurantiifolia*, but likely *Citrus × limonia*), Volkamer lemon (*Citrus × limonia*) (Queensland Government Department of Agriculture and Fisheries 2013), Indian wild orange (*C. indica*), Taiwanica sour orange (*Citrus × aurantium*) and tangerine (*C. reticulata*) (Donovan, Barkley & Hardy 2009), indicate some susceptibility in a broad range of citrus hosts, which suggests a wider range of pathotypes may be present in Australia (Jeffress et al. 2020).

*Elsinoë fawcettii* is present in Mexico, where it mainly affects sour orange (*Citrus × aurantium*) in areas of high relative humidity, particularly rootstock reared in the nursery prior to grafting (Rocha-Peña & Peña del Río 2009). It is reported to occur in Persian lime and grapefruit orchards in the states of Veracruz, Tabasco, San Luis Potosí and to a lesser extent, Yucatán (Orozco-Santos et al. 2013), but it is uncommon and not associated with significant economic losses (SENASICA 2018). To date there have been no studies identifying the pathotypes that may be present in Mexico (SENASICA 2018), but records of the hosts affected, including grapefruit, pomelo and tanger (Farr & Rossman 2022), may suggest that Mexico has a different citrus scab pathotype to those present in Australia.

The risk scenario of concern is that exotic *E. fawcettii* pathotypes may be present on fresh Persian lime fruit imported from Mexico, and that the establishment of new pathotypes in Australia could affect citrus fruit and nursery production.

*Elsinoë fawcettii* has been assessed previously in the *Import risk analysis for Tahitian limes from New Caledonia* (as *S. fawcettii*) (Biosecurity Australia 2006), and the *Final report for the review of biosecurity import requirements for Tahitian limes from the Cook Islands, Niue, Samoa, Tonga and Vanuatu* (Pacific Islands) (DAWR 2018).

In the existing policy for Tahitian limes from the Pacific Islands, the unrestricted risk estimate for exotic pathotypes of *E. fawcettii* was assessed as Very Low, which achieves the ALOP for Australia, and no specific risk management measures are required for this pest on this pathway.

The department assessed the likelihood of importation of exotic pathotypes of *E. fawcettii* on the Pacific Island pathway as Moderate (DAWR 2018), as scab pustules can be present on the rind of citrus fruit, which may not be detected during in-field and post-harvest practices. However, there are differences in pest prevalence, and in the standard commercial production practices (such as in-field pest management and packing house processes) between lime production areas in Mexico and the previously assessed areas in the Pacific Islands. It is therefore necessary to reassess the likelihood of importation of exotic pathotypes of *E. fawcettii* associated with the Persian lime fruit from Mexico pathway.

Previous assessments of exotic pathotypes of *E. fawcettii* on limes from New Caledonia and the Pacific Islands pathways rated the likelihood of distribution as Low (Biosecurity Australia 2006; DAWR 2018). Persian lime fruit from Mexico is expected to be distributed throughout Australia for retail sale in a similar way to limes from New Caledonia and the other Pacific Islands assessed previously. Opportunities for *E. fawcettii* present on infected fruit to be distributed to the vicinity of suitable host plants is likely to be similar to the previous assessments. The specific conditions required to initiate spore dispersal from the scab pustules and the poor survival of *E. fawcettii* conidia are not reported to significantly differ between pathotypes. While there may be some variability in the host ranges of different *E. fawcettii* pathotypes, the likelihood of the pathogen being transferred to a suitable host will not significantly differ from the previous assessments. It is acknowledged that the availability of suitable hosts could potentially be greater if a pathotype with a broader host range was imported with Persian lime fruit from Mexico. However, this is not considered to significantly increase the probability of successful transmission. Therefore, the rating of Low for the likelihood of distribution for exotic pathotypes of *E. fawcettii* on the New Caledonia and Pacific Islands pathway is also adopted for exotic pathotypes of *E. fawcettii* on the Persian lime fruit from Mexico pathway.

The likelihoods of establishment and spread of exotic pathotypes of *E. fawcettii* in Australia from the Persian lime fruit from Mexico pathway have been assessed as similar to those of the previous assessments of Moderate for New Caledonia and Pacific Islands pathway (Biosecurity Australia 2006; DAWR 2018). These likelihoods relate specifically to events that occur in Australia and are principally independent of the import pathway. In the previous assessments, spread of *E. fawcettii* in Australia was considered to be moderated by local climatic conditions that affect survival of the pathogen. There is no information to suggest that different pathotypes vary in their capacity to establish and spread in regions with drier climates. Additionally, most citrus types have wide distributions around Australia so while there may be some variability in the host ranges of different citrus scab pathotypes, that is unlikely to significantly affect the likelihood of spread. Therefore, the existing ratings for the likelihoods of establishment and spread of Moderate have been adopted for the Persian lime fruit from Mexico pathway.

The consequences of entry, establishment and spread of exotic pathotypes of *E. fawcettii* are also independent of the import pathway and have been assessed as being similar between risk assessments and rated as Low (Biosecurity Australia 2006; DAWR 2018). The previous assessment for the Pacific Islands acknowledged that the introduction of new pathotypes could potentially result in impacts on some citrus species that are presently unaffected in Australia,

but also recognised that the disease would not establish, or would be of little importance, in citrus growing areas with a dry climate. The consequences of exotic pathotypes from Persian lime fruit from Mexico is not expected to differ significantly from that of the previous assessment for the Pacific Islands pathways. Therefore, the existing rating for the overall consequence of Low has also been adopted for the Persian lime fruit from Mexico pathway.

#### 4.6.1 Likelihood of entry

The likelihood of entry is considered in 2 parts, the likelihood of importation and likelihood of distribution, which consider pre-border and post-border issues, respectively.

##### Likelihood of importation

The likelihood that exotic pathotypes of *E. fawcettii* will arrive in Australia with the importation of fresh Persian lime fruit from Mexico is assessed as: **Low**.

The following information provides supporting evidence for this assessment.

*Elsinoë fawcettii* is present in some areas of Mexico and is associated with mature lime fruit.

- Citrus scab is an uncommon disease in Mexico (SENASICA 2018), and is present in some Persian lime orchards in Veracruz, Tabasco and San Luis Potosí (Orozco-Santos et al. 2013). Therefore, citrus scab could potentially be on Persian lime fruit harvested for export.
- Persian limes are reported to be susceptible to *E. fawcettii* (Hyun et al. 2009). However, limes typically appear to have low susceptibility to citrus scab infection (Chung 2011).
- The susceptibility of *C. latifolia* fruit to citrus scab infection may vary, depending on the citrus scab pathotype(s) present. SENASICA (2018) informed Australia that no studies have been conducted to determine the pathotype(s) present in Mexico. Therefore, the pathotypes in Mexican Persian lime orchards may be different to the pathotypes in Australia.
- Fruit are infected when they are immature, and susceptible to infection until fruit are around 3 cm in diameter. Fruit become more resistant as they mature (Tsatsia & Jackson 2017). Fruit infected when young produce exterior blemishes that are prominent and highly visible on the skin by the time the fruit is ready for harvest. Such fruit are unlikely to be harvested.

In-field pest management and control practices are likely to limit disease incidence in commercial orchards.

- Growers use fungicide sprays and cultural controls to manage pathogenic fungi in the field (SENASICA 2017, 2018). This will mitigate the incidence of fungal disease such as citrus scab in commercial orchards.

Symptomatic fruit are highly visible and likely to be detected during harvesting and post-harvest processing.

- Scabs are produced on leaves, stems and fruit (Tsatsia & Jackson 2017) of citrus hosts. Infected citrus fruit have raised pustules, which are evident on the skin at the time of harvest (CABI EPPO 1997; Chung 2011; Whiteside 1988). Therefore, infected Persian lime fruit with visible scab symptoms are unlikely to be harvested, and likely to be removed



during the commercial packing house procedures of grading, quality inspection and packing operations.

- Packing house procedures, particularly washing, brushing, waxing, and surface disinfection with fungicide dip are expected to reduce the viability of propagules that may be present on the fruit surface. Similar procedures were considered effective in reducing the viability of conidia of the related species *E. australis* on lemons imported into the USA from Argentina (USDA-APHIS 2016).

Citrus scab is present in Mexico but only in some Persian lime production areas. Standard commercial in-field practices of fungicide application would likely reduce the incidence of the disease in the orchard. Fruit are susceptible when immature and become more resistant as they mature. Symptoms on mature fruit are visible and infected fruit are unlikely to be harvested. In addition, any harvested fruit infected with *E. fawcettii* and with visible blemishes would likely be removed during standard commercial packing house practices; these practices are also likely to reduce the viability of any propagules present on fruit surface. For the reasons outlined, the likelihood of importation of exotic pathotypes of *E. fawcettii* on imported Persian lime fruit from Mexico is assessed as Low.

#### 4.6.2 Likelihood of entry, establishment and spread, and the consequence

Based on the re-assessed likelihood rating for importation, the likelihood rating for entry (importation and distribution) is assessed as Very Low. Based on the existing policies for limes from New Caledonia and Pacific Islands, the likelihoods of establishment and spread are both assessed as Moderate. The consequence of entry, establishment and spread are assessed as Low.

When these likelihoods and consequence ratings are combined using the rules presented in Table 2.2 and Table 2.5, the unrestricted risk is determined to be Negligible. All likelihood ratings are set out in Table 4.6.

#### 4.6.3 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihoods of entry, establishment and spread with the estimate of consequences.

<b>Unrestricted risk estimate for <i>Elsinoë fawcettii</i></b>	
Overall likelihood of entry, establishment and spread	Very Low
Consequences	Low
Unrestricted risk	Negligible

As indicated, the unrestricted risk estimate for *E. fawcettii* from the Persian lime fruit from Mexico pathway is assessed as **Negligible**, which achieves the ALOP for Australia. Therefore, no additional specific risk management measures are required for *E. fawcettii* on this pathway.

## 4.7 Citrus leprosis

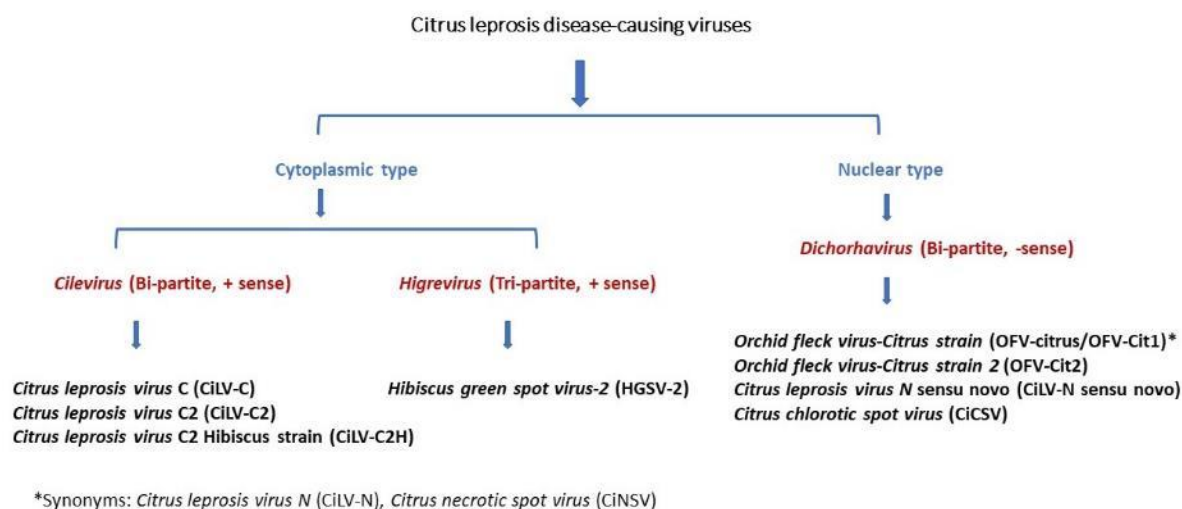
### *Citrus leprosis virus cytoplasmic type (CiLV-C) and Orchid fleck dichorhavirus – Citrus strain (OFV-citrus)*

#### Citrus leprosis disease and the viruses which cause it

Citrus leprosis disease is one of the most important emerging citrus diseases in South and Central America. It has caused substantial economic losses in countries such as Argentina, Brazil, Colombia, Costa Rica, Mexico, Paraguay, Uruguay and Venezuela (Cruz-Jaramillo et al. 2014; León 2012). Citrus leprosis disease is caused by several leprosis-associated viruses that affect the leaves, stem, and fruit of citrus plants. The severity of symptoms depends on the type of citrus, and is visible as lesions on affected plant parts, progressing to severe defoliation, branch dieback, premature fruit drop, and a reduction in fruit yield and quality. Infection of young citrus trees may occasionally result in death of the plants (Ramos-González et al. 2017).

Viruses that have been identified as causing citrus leprosis disease in various citrus cultivars are shown in Figure 18. Two types of virions, one in the cytoplasm (cytoplasmic type) and the other in the nucleus (nuclear type) have been reported from citrus leprosis-symptomatic tissues of citrus plants (Cruz-Jaramillo et al. 2014; Roy et al. 2013). The disease is caused by several viruses belonging to 3 distinct genera: (1) bi-partite positive sense RNA viruses of the genus *Cilevirus*, (2) tri-partite positive sense RNA viruses from *Higrevirus* and (3) bi-partite negative sense RNA viruses from *Dichorhavirus* (Dietzgen et al. 2018; Ramos-González et al. 2017; Roy et al. 2015a).

Figure 18 Characterisation of citrus leprosis-causing viruses



As indicated in Figure 18, 4 cytoplasmic viruses have been identified as causing citrus leprosis disease: *Citrus leprosis virus C* (CiLV-C), *Citrus leprosis virus C2* (CiLV-C2)—both from the genus *Cilevirus*, *Hibiscus green spot virus 2* (HGSV-2) from the genus *Higrevirus* (Roy et al. 2015a), and a recently described cytoplasmic type hibiscus strain *Citrus leprosis virus C2H* (CiLV-C2H) also from the genus *Cilevirus* (Roy et al. 2018).

Several viruses causing the nuclear type of citrus leprosis have also been identified. The 2 viruses previously identified as *Citrus leprosis virus N* (CiLV-N) (Roy et al. 2014) and *Citrus necrotic spot virus* (CiNSV), are both members of the genus *Dichorhavirus* (Roy et al. 2015a).

More recently CiLV-N and CiNSV have both been reclassified as a citrus strain of *Orchid fleck dichorhavirus* (OFV-citrus) in the latest taxonomic review of the order *Mononegavirales* (Amarasinghe et al. 2018).

In 2020, another dichorhavirus causing citrus leprosis nuclear disease in Mexico was described. The virus was isolated from leaf lesions on sweet orange, sour orange, grapefruit, key lime, sweet lime and Royal lemon, and was named orchid fleck virus citrus strain 2 (OFV-Cit2) (Roy et al. 2020). The previously described OFV-citrus (Roy et al. 2015b) was renamed as OFV-Cit1 (Roy et al. 2020). For consistency with nomenclature previously used in the draft report, the name 'OFV-citrus' will also be used in this final report for OFV-Cit1.

In 2017 Ramos-González et al. (2017) identified a novel *Dichorhavirus*, distinct from OFV that was isolated from citrus plants displaying citrus leprosis symptoms in Brazil, and also gave it the name *Citrus leprosis virus N*. Jeger et al. (2017b) refer to this virus as *Citrus leprosis virus N* sensu novo, to avoid confusion with the existing CiLV-N. According to Chabi-Jesus et al. (2018), *Citrus chlorotic spot virus* (CiCSV) is a new member of the genus *Dichorhavirus* associated with leprosis-like symptoms in *C. sinensis* in Brazil. Both CiLV-N sensu novo and CiCSV display distinct distances in their phylogenetic relationships with OFV-citrus, with sequence identities between the 2 viruses and OFV-citrus of less than 65% (Ramos-González et al. 2018).

While the citrus leprosis cytoplasmic and nuclear viruses are genetically distinct, they are all characterised by an unusual and common biology. Their most striking characteristic is that, unlike most other plant-infecting viruses, they are unable to systemically invade their host plants (Cruz-Jaramillo et al. 2014; Roy et al. 2015a). This means that the virus remains close to the point of infection instead of spreading throughout the plant. The second characteristic shared by citrus leprosis viruses is that they are all persistently transmitted by flat mites of the genus *Brevipalpus* (or suspected to be in the case of HGSV-2) (Jeger et al. 2017b; Ramos-González et al. 2018).

At least one strain of orchid fleck virus, OFV-Orc1, is present and widespread in Australia, and has been recorded from many host plants, including members of the Orchidaceae, Amaranthaceae (subfamily Chenopodiaceae) and Asparagaceae plant families (Gibbs et al. 2000; Roy et al. 2020). The OFV-citrus and OFV-Cit2 strains are not known to be present in Australia and are regulated as viruses of quarantine concern.

### **Citrus leprosis viruses in Mexico**

Of the known citrus leprosis disease-causing viruses, only 3 virus species, the cilevirus CiLV-C, and the dichorviruses OFV-citrus (OFV-Cit1) and OFV-Cit2, have been recorded in Mexico.

CiLV-C was first reported from Tabasco and Chiapas states in southern Mexico (Izquierdo Castillo et al. 2011) and OFV-citrus (formerly as CiLV-N) from Querétaro state in central Mexico (Roy et al. 2014). Recently, a novel citrus strain of OFV was isolated from several symptomatic citrus plants from Querétaro state in central Mexico and named OFV-Cit2 (Roy et al. 2020).

Citrus leprosis viruses are associated with different citrus hosts and *Brevipalpus* mite vectors. The citrus hosts and vectors of the three viruses that are present in Mexico are summarised in Table 4.5. CiLV-C mostly affects sweet orange and some varieties of mandarin, although many other citrus species have at least some susceptibility to infection (Bastianel et al. 2018). As indicated in the table, OFV-citrus has been reported to naturally infect a number of citrus species

causing leprosis disease, including Persian lime (*C. latifolia*). Three *Brevipalpus* species, *B. californicus*, *B. papayensis* and *B. yothersi*, have been confirmed to be able to transmit citrus leprosis viruses (Beltran-Beltran et al. 2020; Dietzgen et al. 2018; Ferreira et al. 2020; García-Escamilla et al. 2018). Although OFV-Cit2 is known to cause citrus leprosis disease in some citrus species, there are currently no records to suggest it naturally infects Persian limes (Roy et al. 2015a; Roy et al. 2020).

**Table 4.5 Citrus leprosis viruses in Mexico**

<b>Virus Species</b>	<b>Citrus host</b>	<b>Vector</b>
<i>Citrus leprosis virus C</i> (CiLV-C)	<i>Citrus sinensis</i> ; <i>C. paradisi</i> ; <i>C. reticulata</i> ; <b><i>C. latifolia</i></b> (Beltran-Beltran et al. 2020; Lovisolo, Colariccio & Masenga 2000; Rodríguez-Ramírez et al. 2019; Roy et al. 2015a)	<i>Brevipalpus californicus</i> (Beltran-Beltran et al. 2020); <i>B. papayensis</i> (Nunes et al. 2018); <i>B. yothersi</i> (Rodríguez-Ramírez et al. 2019; Roy et al. 2015a)
<i>Orchid fleck dichorhavirus</i> – citrus strain (OFV-citrus/OFV-Cit1)	<i>C. aurantiifolia</i> ; <i>C. aurantium</i> ; <b><i>C. latifolia</i></b> ; <i>C. limetta</i> ; <i>C. limon</i> ; <i>C. paradisi</i> ; <i>C. reticulata</i> ; <i>C. sinensis</i> (Ramos-González et al. 2018; Roy et al. 2015a; Roy et al. 2020)	<i>B. californicus</i> (Dietzgen et al. 2018; García-Escamilla et al. 2018); <i>B. yothersi</i> (Beltran-Beltran et al. 2020)
<i>Orchid fleck dichorhavirus</i> – citrus strain 2 (OFV-Cit2)	<i>C. aurantium</i> ; <i>C. sinensis</i> (Roy et al. 2020). Detected in mixed infections with OFV-citrus in <i>C. aurantium</i> , <i>C. sinensis</i> , <i>C. limetta</i> , <i>C. limon</i> and <i>C. paradisi</i> (Roy et al. 2020).	<i>B. californicus</i> (Roy et al. 2020)

The term ‘citrus leprosis viruses’ is used in this assessment to collectively refer to the viruses CiLV-C and OFV-citrus. The specific virus name or strain is used where information is applicable to that organism.

#### **Pest risk assessment of citrus leprosis viruses**

Citrus leprosis virus infections are non-systemic, regardless of type (Cruz-Jaramillo et al. 2014; Roy et al. 2015a). Therefore, symptoms of the disease or viruliferous (virus-carrying) mite vectors must be present on harvested fruit for there to be any potential for transmission (Andrade et al. 2018). However, due to the time lag between mite infestation and virus symptom development (17–60 days), limes infected shortly before harvest may not have developed distinct external symptoms and are therefore unlikely to be removed from the export pathway. Thus, citrus leprosis viruses may be present in infected fresh Persian lime fruit imported from Mexico.

Citrus leprosis viruses may also be carried by vector mites, *B. californicus*, *B. papayensis* and *B. yothersi*, which may be present on the surface of fresh Persian lime fruit imported from Mexico (Beltran-Beltran et al. 2020; Dietzgen et al. 2018; García-Escamilla et al. 2018). Viruliferous *Brevipalpus* mites may move from imported infected limes after entry and disperse directly onto citrus plants in Australia, which could then be infected by the feeding of those mites.

This pest risk assessment will therefore consider the 2 means of entry: (1) Persian lime fruit infected with citrus leprosis viruses, and (2) Persian lime fruit infested with viruliferous mites. As the likelihood of entry estimates may differ for these 2 means of entry, they are considered separately. The likelihoods of establishment and spread of citrus leprosis viruses, and the

potential consequences they may cause, are not assessed separately as they relate specifically to events that occur in Australia. These are independent of the import pathway so will be the same, irrespective of how the viruses enter Australia.

#### 4.7.1 Likelihood of entry – fruit infected with citrus leprosis viruses

The likelihood of entry is considered in 2 parts, the likelihood of importation and the likelihood of distribution, which consider pre-border and post-border issues, respectively. Here the likelihood of entry for Persian lime fruit infected with citrus leprosis viruses will be considered.

##### Likelihood of importation

The likelihood that citrus leprosis viruses will arrive in Australia with the importation of fresh Persian lime fruit from Mexico is assessed as: **Low**.

The following information provides supporting evidence for this assessment.

Citrus leprosis viruses are associated with Persian lime (*C. latifolia*) and are present in Mexico.

- CiLV-C was first reported from Tabasco and Chiapas states in southern Mexico in 2005 (Izquierdo Castillo et al. 2011), and has subsequently been detected in at least 25 states during phytosanitary surveillance surveys (Ramírez y Ramírez, SENASICA, pers. comm 17 December 2020).
- *Citrus latifolia* is considered a host of CiLV-C (Lovisolo, Colariccio & Masenga 2000), and CiLV-C has been reported from *C. latifolia* in the Mexican state of Quintana Roo (Ramírez y Ramírez, SENASICA, pers. comm 17 December 2020). Beltran-Beltran et al. (2020) detected CiLV-C in *Brevipalpus* spp. mites collected from lime leaves in Mexico. Rodríguez-Ramírez et al. (2019) demonstrated that *C. latifolia* was susceptible to infection with CiLV-C by viruliferous mites, although infection rates were lower than in sweet orange and mandarin.
- OFV-citrus was first reported (as CiLV-N) from Querétaro, Mexico in 2013, with leprosis symptoms observed on a number of naturally infected citrus species, including grapefruit, key lime, lemon, mandarin, sour orange, sweet lime and sweet orange (Roy et al. 2015b). Symptoms on Persian limes were not observed at that time.
- However, Persian lime leaves showing symptoms of citrus leprosis (distinct necrotic rings surrounded by a yellow halo) were found during a survey conducted in June 2014 in Querétaro, Mexico (Roy et al. 2015a). Symptomatic Persian lime leaves collected were tested, and RT-PCR confirmed presence of OFV-citrus, thus confirming Persian limes as a host of OFV-citrus (Roy et al. 2015a).

*Brevipalpus* mites, which are vectors of citrus leprosis viruses, are present in citrus growing regions of Mexico.

- Mites in the genus *Brevipalpus* are vectors of citrus leprosis viruses (Beltran-Beltran et al. 2020). *Brevipalpus yothersi* is known to transmit CiLV-C (Rodríguez-Ramírez et al. 2019). *Brevipalpus papayensis* can also transmit CiLV-C, although less efficiently than *B. yothersi* (Ferreira et al. 2020). *Brevipalpus californicus* and *B. yothersi* have been reported to transmit OFV-citrus (Beltran-Beltran et al. 2020; Dietzgen et al. 2018; García-Escamilla et al. 2018).
- *Brevipalpus* mites are known to feed on *C. latifolia*, although they are found more commonly on other varieties of citrus (Salinas-Vargas et al. 2016).

- *Brevipalpus californicus*, *B. papayensis* and *B. yothersi* are present in Mexican citrus orchards (Sánchez-Velázquez et al. 2015). *Brevipalpus yothersi* is the most abundant mite species (Salinas-Vargas et al. 2016). While *B. papayensis* has been found in an orange orchard in the state of Chiapas in southern Mexico (Sánchez-Velázquez et al. 2015), there is no information to indicate it is prevalent or widespread.
- Management of leprosis disease and *Brevipalpus* vectors in Mexico limit disease incidence in commercial orchards and will greatly reduce the chance of infected fruit being exported to Australia.
- SENASICA oversees domestic control campaigns for significant lime diseases such as citrus leprosis to prevent the introduction and spread of the disease to citrus orchards. Campaigns focus on controlling mites through monitoring and trapping programs and in strict movement controls on host material between states (SENASICA 2017).
- There are a number of regulations established to prevent the introduction and spread of citrus leprosis disease in orchards across Mexico (SENASICA 2019a).
- Commercial orchards are required to use citrus propagative material in accordance with official Mexican regulations: Norma Oficial Mexicana NOM-079-FITO-2002. These regulations stipulate that planting material is to be virus free and movement of nursery stock is controlled.
- Activities are carried out in commercial orchards as per the requirements of the Phytosanitary Epidemiological Surveillance program to ensure early detection of citrus leprosis (SENASICA 2019a). Under the program, samples of any suspicious plant material showing visual signs of citrus leprosis are sent to Centro Nacional de Referencia Fitosanitaria (CNRF) for identification (SENASICA 2019a).
- If the disease is detected in an orchard, the diseased branches and/or trees are removed (SENASICA 2019b).
- Existing in-field insect pest control practices, such as orchard monitoring and application of pesticide sprays, will also control *Brevipalpus* mites that vector citrus leprosis (SENASICA 2019b).
- Integrated pest management practices are also applied in commercial orchards to control arthropod pests, including *Brevipalpus* mites. This includes application of miticides, pruning, planting of windbreaks to prevent the introduction of airborne mites, removing weeds, and controlling the access of people and equipment (SENASICA 2017, 2019b).

Symptoms of leprosis disease are highly visible, and infected fruit are likely to be detected during harvest or post-harvest processing.

- Leprosis is a localised infection which develops on leaves, twigs and fruits of citrus (Bastianel et al. 2010). The virus has been isolated from localised lesions of citrus fruit (Roy et al. 2015a). Each lesion is an infection caused by viruliferous mites of the genus *Brevipalpus* as they feed on a suitable host for the virus (Freitas Astúa et al. 2018).
- Leaf lesions vary in colour from light yellow to dark brown, and are often circular, ranging in size from 5 to 12 mm in diameter (Bastianel et al. 2010).

- On fruit, the lesions are circular and 2–12 mm in diameter. On unripe fruit the spots initially have a yellow halo with a green centre, which turns dark brown as the fruit matures, often forming a depression in the rind (León 2012). These lesions are obvious to the naked eye. Additionally, fruit affected by leprosis may ripen prematurely (León 2012). Therefore, symptomatic infected fruit are unlikely to be packed for export.
- Viruses associated with citrus leprosis are non-systemic in citrus hosts (Cruz-Jaramillo et al. 2014; Roy et al. 2015a). Therefore, citrus tissues with no visible citrus leprosis symptoms are unlikely to contain the viruses.

It may be possible for asymptomatic infected fruit to be harvested and remain undetected during post-harvest and packing processes.

- Symptoms of the infection appear 17–60 days after mite infestation in citrus hosts, with most symptoms appearing 21–30 days after infestation (Chiavegato & Salibe 1984). Persian lime fruit infected shortly prior to harvesting may not have developed distinct external symptoms. Therefore, fruit carrying very early stages of infection are unlikely to be detected and discarded during harvest or packing house sorting.

Citrus leprosis viruses may survive storage and transport to Australia.

- In general, virus survival depends on temperature, humidity and its physico-chemical characteristics.
- Lovisolo, Colariccio and Masenga (2000) studied the infectivity of citrus leprosis virus and concluded that the virus would remain infective for up to 45 months in dried leaf material stored in freezing temperatures, and three days in sap from infected plants stored at room temperature.
  - Citrus leprosis viruses in Persian lime fruit are likely to remain viable for some time.
  - Citrus leprosis viruses are likely to survive air and sea freight as the transportation temperatures involved are not likely to be lethal to the virus.
- While virus multiplication may be inhibited during cold transport, the virus is likely to resume normal replication once the lime fruit are removed from the cold and exposed to room temperature.

Although citrus leprosis viruses are present in Mexico, Persian lime is reported to be less susceptible to citrus leprosis than other citrus species. Orchard monitoring for disease symptoms, controls for mite vectors, restrictions on movement of host material, and removal of fruit with leprosis symptoms from the export pathway in the packinghouse would reduce the likelihood of Persian lime fruit infected with a leprosis virus being imported into Australia. However, it is feasible that fruit infected with a citrus leprosis virus shortly before harvest may be asymptomatic and be packed for export to Australia. The virus could survive storage and transport temperatures. For the reasons outlined, the likelihood of importation of citrus leprosis viruses on imported fresh Persian lime fruit from Mexico is assessed as Low.

#### **Likelihood of distribution**

The likelihood that citrus leprosis viruses will be distributed within Australia in a viable state as a result of the processing, sale or disposal of fresh Persian lime fruit from Mexico, and subsequently transfer to a susceptible host is assessed as: **Extremely Low**.

The following information provides supporting evidence for this assessment.

Persian lime imported from Mexico will be distributed throughout Australia for retail sale. Infected fruit showing symptoms of citrus leprosis disease are likely to be removed from distribution, but some symptomless fruit may be sold.

- Imported Persian lime fruit will be distributed throughout Australia via the wholesale and retail trade for sale for human consumption. The major population centres are likely to receive most of the imported fruit.
- Packed Persian lime fruit may not be processed or handled until they arrive at the retail points. Any fruit showing symptoms of citrus leprosis infection at this point are likely to be removed from further distribution and discarded via managed waste systems and disposed of in municipal landfills. Commercial waste of imported Persian lime fruit may also be generated prior to or during retail sale and discarded in the same way. Potential exposure to suitable host plants from waste discarded into managed waste systems is unlikely.
- However, some Persian lime fruit infected with citrus leprosis viruses may not show symptoms and may remain present as latent infections, and therefore may be sold to consumers.

Some fruit waste infected with citrus leprosis viruses may be discarded into the environment near a suitable host.

- Persian lime fruit are intended for human consumption. Fruit waste would typically be discarded into managed waste systems, including municipal landfills. Potential exposure to suitable host plants from waste discarded in this way is unlikely.
- However, consumers may discard small quantities of lime fruit waste in a variety of urban, rural and natural environments, including in domestic compost. Some of this waste could be discarded near suitable host plants.
- Infected fruit or fruit tissues discarded as waste may carry the virus. However, infected fruit will degrade due to saprophyte damage in wet conditions and desiccate when exposed to the environment.

Seed transmission or mechanical transfer of citrus leprosis viruses from infected Persian lime fruit to a nearby host plant is very unlikely.

- There is no evidence that citrus leprosis viruses can be transmitted through seeds (Rodrigues et al. 2003) and Persian limes, being a triploid (Ollitrault, Curk & Krueger 2020), produce seedless fruit.
- Mechanical transmission of citrus leprosis virus from citrus to citrus and from citrus to several herbaceous plants has been demonstrated through inoculation but found to occur at a very low rate (Colariccio et al. 1995).
- Lovisolo, Colariccio and Masenga (2000) also achieved mechanical inoculation of citrus leprosis virus (CiLV) in several species including non-citrus hosts but failed in transmission of the virus back to citrus plants. It is extremely unlikely for mechanical transmission from an imported fruit to naturally occur.



Effective natural movement of the virus from fruit waste to a suitable host is only possible via a vector.

- Citrus leprosis viruses are transmitted by *Brevipalpus* mites (Beltran-Beltran et al. 2020; Dietzgen et al. 2018; García-Escamilla et al. 2018).
- *Brevipalpus californicus*, *B. papayensis* and *B. yothersi* have been reported to transmit citrus leprosis viruses (Beltran-Beltran et al. 2020; Dietzgen et al. 2018; Ferreira et al. 2020; García-Escamilla et al. 2018).
- Both *B. californicus* and *B. yothersi* are present and widespread in Australia (APPD 2022; Beard et al. 2015b). *Brevipalpus papayensis* is present in Australia, but likely has a more restricted distribution, and to date has only been found in Queensland (Beard et al. 2015b).
- For successful transmission to occur, a *Brevipalpus* mite would need to feed on infected fruit waste, acquire the virus and transfer it to a new host in Australia.
- There is no evidence of mites acquiring the virus from fruit after harvest. It is considered extremely unlikely that mites in Australia could acquire citrus leprosis viruses from imported lime fruit.
  - It is unlikely that *Brevipalpus* mites would feed on discarded and desiccating fruit waste (Huberty & Denno 2004). However, in the event that mites were to feed on desiccating, infected fruit rind, the acquired virus would be at very low levels.
  - Rodríguez-Ramírez et al. (2019) postulated that *Brevipalpus* mites preferred to feed on portions of the citrus leaf where the cells were not in an advanced state of infection. The viral concentration in these areas would be lower, and the acquired viral load would also be lower.

Infected Persian lime fruit waste will be disposed of in managed waste systems, but some may be discarded into the environment near suitable hosts. Citrus leprosis viruses could be present in discarded rinds of infected fruit, though it is unlikely the viruses would persist over time while the waste desiccates. The viruses can only be transmitted via *Brevipalpus* vectors, as seed or mechanical transmission from imported lime fruit is unlikely. Although *Brevipalpus* mite vectors are present in Australia, fruit waste is a poor feeding substrate for mites and desiccating waste is even less favourable. Therefore, it is very unlikely that citrus leprosis viruses could successfully be vectored by mites to a nearby host. For the reasons outlined, the likelihood of distribution of citrus leprosis viruses on imported fresh Persian lime fruit from Mexico is assessed as 'Extremely Low'.

#### **4.7.2 Likelihood of entry – vector mites (*B. californicus*, *B. papayensis* and *B. yothersi*) on fruit**

*Brevipalpus californicus*, *B. papayensis* and *B. yothersi* are present in Australia and not under official control, and therefore are not considered to be quarantine pests for Australia. However, juveniles and adults of these mites are capable of harbouring and spreading citrus leprosis viruses (Beltran-Beltran et al. 2020; Dietzgen et al. 2018; Ferreira et al. 2020; García-Escamilla et al. 2018), which are not present in Australia. Viruliferous (virus-carrying) *Brevipalpus* mites

may be present on imported Persian lime fruit. Therefore, they are assessed here as potential regulated articles.

A regulated article is defined by the IPPC as ‘Any plant, plant product, storage place, packaging conveyance, container, soil and any other organisms, object or material capable of harbouring or spreading pests, deemed to require phytosanitary measures, particularly where international transportation is involved’ (FAO 2022a).

The likelihood of entry is considered in 2 parts, the likelihood of importation and the likelihood of distribution, which consider pre-border and post-border issues, respectively. Here the likelihood of entry for Persian lime fruit carrying the vector mites *B. californicus*, *B. papayensis* and *B. yothersi* will be considered.

### Likelihood of importation

The likelihood that citrus leprosis viruses will arrive in Australia by vector mites present on imported fresh Persian lime fruit from Mexico is assessed as: **Low**.

The following information provides supporting evidence for this assessment.

The mites *B. californicus*, *B. papayensis* and *B. yothersi* may acquire citrus leprosis viruses in Persian lime orchards in Mexico.

- Viruliferous *B. californicus* and *B. yothersi* carrying citrus leprosis viruses have both been found in citrus orchards in Mexico (Beltran-Beltran et al. 2020).
- *Brevipalpus californicus*, *B. papayensis* and *B. yothersi* are known to feed on Persian lime, although they are found more commonly on other varieties of citrus (Beard et al. 2015b; Salinas-Vargas et al. 2016).
- *Brevipalpus* mites are reported to transmit CiLV-C in a persistent-circulative relationship (Kitajima & Alberti 2014), meaning the virus does not replicate in the mite. After the virus is acquired via feeding on infected tissue, it quickly passes through the anterior midgut and anterior podocephalic gland barrier before reaching the median salivary and stylet canals, where it then be injected into healthy tissues (Kitajima & Alberti 2014).
- *Brevipalpus* mites transmit OFV-citrus in a persistent-circulative-replicative relationship (Kitajima & Alberti 2014), meaning that after acquisition the virus replicates in the mite. Viruliferous mites are likely to remain infective throughout their life.
- Even on citrus plants that are infected with citrus leprosis viruses, relatively few mites may carry the virus.
- The incidence of OFV-citrus in *B. californicus* was found to be 20.8%, while the incidence in *B. yothersi* was 10.3% (Beltran-Beltran et al. 2020). No reports of *B. papayensis* carrying or transmitting OFV-citrus have been identified.
- In a study by García-Escamilla et al. (2018) OFV-citrus was acquired by up to one third of *B. californicus* nymphs and adults after 48–72 hours of feeding on infected plants. *Brevipalpus yothersi* did not acquire OFV-citrus after 72 hours of feeding on infected plants (García-Escamilla et al. 2018).

- The same study found up to two thirds of adult *B. yothersi* acquired CiLV-C after 24 hours of feeding on infected plants, and up to one third of *B. yothersi* nymphs and larvae each acquired CiLV-C after 24-48 hours of feeding (García-Escamilla et al. 2018). *Brevipalpus californicus* did not acquire CiLV-C after 72 hours of feeding on infected plants (García-Escamilla et al. 2018).

Control measures applied for *Brevipalpus* mites in Persian lime orchards are likely to limit the numbers of these mites on fruit at the time of harvest.

- Integrated pest management is used to control *Brevipalpus* mites throughout the year in Persian lime orchards in Mexico. This includes monitoring and control for pests by the application of miticides, pruning, planting of windbreaks to reduce dispersal of airborne mites, removing weeds, and controlling the access of people and equipment to orchards (SENASICA 2017).

Acquisition of citrus leprosis viruses by mites is unlikely to occur post-harvest.

- *Brevipalpus* mites feed on fruit, leaves, stems, twigs, and bud tissues of numerous plants including citrus (Childers et al. 2003; Rodrigues & Childers 2013). *Brevipalpus* mites can acquire viruses from these primary feeding sites.
- There is no evidence of mites acquiring the virus from fruit after harvest.

Standard packing house procedures of limes for export are likely to remove most mites from the fruit.

- *Brevipalpus* mites can be difficult to detect as they are small (0.2–0.41 mm) and sluggish (Childers, French & Rodrigues 2003; Childers et al. 2001; Vacante 2016).
- *Brevipalpus* mites are dorso-ventrally flattened, making them less susceptible to physical removal than many other mites, such as spider mites.
- Around half the juvenile period is spent in the inactive chrysalis phase (Haramoto 1966). As well as being anchored by its mouthparts, the chrysalis is glued to the plant surface by an adhesive substance and is not easily dislodged (Childers, French & Rodrigues 2003; Childers & Rodrigues 2011; Haramoto 1966; Vacante 2016).
- Standard commercial packing house procedures Persian limes for export include washing, brushing, disinfection, drying and waxing (SENASICA 2018). These practices will dislodge most *Brevipalpus* mites from the fruit. Grading and quality inspection may identify infested fruit, which can be removed from the export pathway (EFSA 2013; Rodrigues et al. 2003). However, some sessile stages are less readily removed by these practices and may remain on the fruit surface (Childers & Rodrigues 2011).
  - Peña et al. (2015) found that a combination of washing, brushing and waxing reduced the densities of live adults of a related *Brevipalpus* species on lemons by 88–100% and eggs by 64–91%. However, only 59–73% of immatures were killed or removed using these measures.

Storage and transport temperatures are unlikely to kill all remaining mites, but juvenile mortality is likely to be high during storage and transport.

- After packing, the limes may be kept in storage for up to 5 days at an average temperature of 7°C to 9°C and average relative humidity of 98% (SENASICA 2018).

- Persian lime fruit will be transported to Australia via air or sea freight. Air freighted limes are kept in unrefrigerated conditions for 3–5 days during transport (SENASICA 2018), and temperatures in the hold of the aircraft may fluctuate considerably (Emond, Mercier & Nunes 1999; Singh et al. 2010; Syversen, Pineda & Watson 2008). When not being transported air-freighted limes will usually be stored at 7°C to 9°C and an average relative humidity of 98% (SENASICA 2018). Limes sent by sea are transported at 7°C to 8°C and 95–97% relative humidity for 20–30 days (SENASICA 2018).
- When fruit are subjected to periods of lower temperatures during transport and storage, mite development is likely to be inhibited (Amaral et al. 2018; Haramoto 1966; Trindade & Chiavegato 1994).
- *Brevipalpus* mites can survive for a week at 10°C and recover when conditions improve (Haramoto 1966).
  - Juvenile mortality is significant and rapid at 0°C to 2°C under laboratory conditions (Jadue et al. 1996). In the study by Jadue et al. (1996), 80% of *B. chilensis* juveniles kept at 0°C to 2°C died after 1 day, compared to 4.96% kept at 20°C to 25°C. Adults were much less susceptible, with 77% mortality after 19 days, compared to 53.6% of adults kept at 20°C to 25°C.
- It is expected that being kept at 7°C to 8°C for 3–4 weeks during storage and transport would prevent development and may kill many juveniles.

*Brevipalpus californicus*, *B. papayensis* and *B. yothersi* may be present in commercial citrus orchards, but Persian lime is a poor host compared to other citrus, so heavy infestations of fruit would not be expected. Among mites that feed on plants infected with a citrus leprosis virus, only a small proportion may acquire the virus. Management practices are likely to reduce mite numbers in orchards to a very low prevalence, and standard packing house procedures of washing, brushing, disinfection, drying, waxing, grading/sorting and quality inspection of limes, are likely to remove most *Brevipalpus* mites from the pathway. The temperatures and conditions involved in storage and transport from Mexico to Australia may not kill all mites remaining on the fruit, but juvenile mortality is likely to be high. For the reasons outlined, the likelihood of importation of citrus leprosis viruses by vector mites on imported fresh Persian lime fruit from Mexico is assessed as 'Low'.

### Likelihood of distribution

The likelihood that viruliferous mites carrying citrus leprosis viruses will be distributed within Australia in a viable state as a result of the processing, sale and disposal of fresh Persian lime fruit from Mexico and subsequently transfer to a susceptible host is assessed as: **Very Low**.

The following information provides supporting evidence for this assessment.

Persian lime fruit imported from Mexico will be distributed throughout Australia for retail sale. *Brevipalpus californicus*, *B. papayensis* and *B. yothersi* carrying citrus leprosis viruses may survive transportation conditions during distribution within Australia.

- Development and survival rates of *Brevipalpus* mites are strongly dependent on temperature and relative humidity, as well as host plant. These mites are relatively long-lived, though it should be noted that lifecycle studies conducted under artificial conditions may not accurately reflect longevity in the field (Childers & Rodrigues 2011).

- When fruit are subjected to periods of lower temperatures during transport and storage, mite development is likely to be inhibited (Amaral et al. 2018; Haramoto 1966; Trindade & Chiavegato 1994).
- Small numbers of *Brevipalpus* mite larvae can survive for up to a week at 10°C and revitalise when conditions improve, while some adults were able to survive at least 23 days at 10°C (Haramoto 1966).
- Juvenile mortality is significant and rapid at 0°C to 2°C under laboratory conditions (Jadue et al. 1996). In the study by Jadue et al. (1996), 80% of *B. chilensis* juveniles kept at 0°C to 2°C died after 1 day, compared to 4.96% kept at 20°C to 25°C. Adults were much less susceptible, with 77% mortality after 19 days, compared to 53.6% of adults kept at 20°C to 25°C.
- Imported fruit carrying viruliferous mites would be distributed within Australia via normal commercial transport. Temperatures during commercial transport may not kill all life stages of mites.

*Brevipalpus* mites are unlikely to enter the environment from this pathway.

- Persian lime fruit are intended for human consumption. Any fruit waste is likely to be discarded into managed waste systems and disposed in municipal landfills. Potential exposure to suitable host plants from waste discarded in this way is unlikely.
- However, consumers may discard small quantities of lime fruit waste in urban, rural and natural environments, including in domestic compost. Some of this waste could be discarded near suitable host plants.
- Discarded fruit waste will deteriorate rapidly, or be consumed by wildlife, which would likely result in the death of any mites present on the fruit waste.
  - Mites without a food source do not live for more than 3 days, and exposure to the elements leaves them vulnerable to death by desiccation as well as predation by ants, spiders or other predators (Childers & Rodrigues 2011; Haramoto 1966).

It is very unlikely that mites carrying citrus leprosis viruses would successfully transfer from discarded lime waste to a nearby susceptible host plant.

- Wind dispersal is common among mites, including *Brevipalpus* species (Childers & Rodrigues 2011).
- While wind alone may not easily dislodge actively feeding mites, conditions such as the decay of the food source and exposure to heat and sun are likely to trigger dispersal behaviour, allowing the mites to be more readily dislodged from the fruit (Childers & Rodrigues 2011). However, wind dispersal from waste on the ground is likely to occur less frequently than from the tree canopy because of lower wind speeds closer to the ground.
- There is limited capacity for the independent dispersal of *Brevipalpus* mites, so the natural rate of spread of these mites from discarded infected fruit would be relatively slow.
  - In a study of dispersal of *Brevipalpus phoenicis* under experimental conditions, out of 6000 mites released, only 3% were captured 40 cm or more from the release point after 7 days (Alves, Casarin & Omoto 2005).

- Susceptible hosts of citrus leprosis (Jeger et al. 2017b) are grown in commercial and domestic cultivation, as well as being present elsewhere in the environment in Australia. Most of these host species are woody or perennial and are grown year-round in tropical and temperate Australia.
- *Brevipalpus californicus* and *B. yothersi* are polyphagous, with wider host plant ranges than those of the viruses they vector (Beard et al. 2015a; Childers et al. 2001). For example, *B. californicus* has been reported on 316 host plant species from 33 families (Childers, Rodrigues & Webourn 2003). *Brevipalpus papayensis* is also likely polyphagous, but the extent of its host range is not yet known. However, the host ranges of citrus leprosis viruses, which are vectored by these *Brevipalpus* mites, are restricted to only a few *Citrus* species. While a viruliferous mite may find a suitable plant host, that plant may not be susceptible to citrus leprosis viruses carried by the mite.

*Brevipalpus californicus*, *B. papayensis* and *B. yothersi* are likely to survive commercial transport. Therefore, if they are viruliferous, they could feasibly distribute citrus leprosis viruses. Most lime fruit waste will be disposed in managed waste systems, but some may be discarded into the environment near a suitable host. It is very unlikely that viruliferous mites on discarded lime fruit waste would successfully transfer to a host susceptible to citrus leprosis viruses. Mite dispersal by crawling is highly inefficient and requires a susceptible host plant to be within very close proximity. For the reasons outlined, the likelihood of distribution of *B. californicus*, *B. papayensis* and *B. yothersi* carrying citrus leprosis viruses on imported fresh Persian lime fruit from Mexico is assessed as 'Very Low'.

### Overall likelihood of entry

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

The likelihoods that citrus leprosis viruses will enter Australia via the 2 means of entry covered in this assessment are summarised here.

Means of entry	Likelihood of importation	Likelihood of distribution	Overall likelihood of entry
Fruit infected with citrus leprosis viruses	Low	Extremely Low	Extremely Low
Vector mites on fruit	Low	Very Low	Very Low

### 4.7.3 Likelihood of establishment

The likelihood that citrus leprosis viruses will establish within Australia based on a comparison of factors in the source and destination areas that affect pest survival and reproduction is assessed as: **High**.

The following information provides supporting evidence for this assessment.

Natural hosts of citrus leprosis viruses are present in many parts of Australia.

- Citrus is commercially grown across Australia, with major growing areas situated in Queensland, Victoria and South Australia. Smaller scale commercial production occurs in all other states except Tasmania (Citrus Australia 2021), including in the border ranges of south east Queensland and northern New South Wales (Hardy et al. 2010).

- Australia has native species of citrus (Hardy et al. 2010), and citrus trees are commonly grown in home gardens around Australia.
- Non-rutaceous hosts of citrus leprosis viruses, such as *Dieffenbachia* spp. (Jeger et al. 2017b; Roy et al. 2015a), are also present in Australia.

Climatic conditions in Australia may be favourable for establishment of citrus leprosis viruses.

- Citrus leprosis viruses have been reported in several Latin American countries, including Brazil, Colombia, Mexico and Panama (Jeger et al. 2017b). Parts of Australia may experience similar climatic conditions and may be suitable for the establishment of citrus leprosis viruses.
- While research suggests OFV-citrus prefers higher elevations with a cooler and drier climate (Roy et al. 2015a; 2020), the distribution of citrus leprosis viruses suggests these viruses are capable of surviving and establishing in a wide variety of climatic conditions.

*Brevipalpus* mite vectors of citrus leprosis viruses are already present in Australia.

- *Brevipalpus californicus* and *B. yothersi* are present and widespread in Australia (Akyazi, Ueckermann & Liburd 2017; APPD 2022; Beard et al. 2015b). *Brevipalpus papayensis* is also present in Australia (Queensland) (Beard et al. 2015a). Vectors present in Australia may feed on host plants infected with a citrus leprosis virus and transmit the virus to another host.
- Citrus leprosis infections are non-systemic (Bastianel et al. 2010; Freitas Astúa et al. 2018). Mechanical transmission of citrus leprosis has only been known to occur under laboratory conditions (Colariccio et al. 1995; Lovisolo, Colariccio & Masenga 2000). Additionally, there is no evidence that citrus leprosis viruses can be transmitted through seeds (Rodrigues et al. 2003). Therefore, citrus leprosis virus can only establish through vector transmission.

Existing pest monitoring and control measures in Australia may be effective in managing *Brevipalpus* mites in commercial citrus orchards and in detecting symptoms of leprosis disease.

- Citrus leprosis symptoms appear 17–60 days after inoculation, with most symptoms developing between 21–30 days (Chiavegato & Salibe 1984). Once symptoms have developed, damage to the leaves and fruit is visible. Once symptoms are apparent and recognisable, citrus leprosis would be detected in citrus orchards through routine in-field monitoring practices.
- In the Americas, control of citrus leprosis tends to be based on targeted control of its vectors (Bastianel et al. 2006). Whilst other mite species are often listed as significant pests of citrus in Australia, *Brevipalpus* mite vectors are not among the species specifically targeted for control. Conventional insecticides to control other mites may be effective in controlling *Brevipalpus* mites present in commercial orchards.
- While pest control activities in commercial orchards may limit or prevent establishment of citrus leprosis vectors, such controls are less likely to be applied in urban areas.
- Natural predators are also utilised to control pests in Australian citrus orchards (Beattie & Gellatley 2003; DPIRD 2020; Hardy 2004). However, the efficacy of these predators in reducing population numbers of *Brevipalpus* mites is not known.

- A citrus leprosis infection in a backyard garden or natural environment where suitable vector mites were present may go undetected for some time, increasing the likelihood of establishment in Australia.

There are suitable hosts present in many parts of Australia, which may enable the establishment of citrus leprosis viruses. Climatic conditions in many parts of Australia may also be favourable for the establishment of the virus. *Brevipalpus* mite vectors, *B. californicus*, *B. papayensis* and *B. yothersi*, are present and widespread in Australia. Citrus leprosis symptoms are likely to be detected during in-field monitoring in citrus orchards. Existing conventional insecticides and natural predators may be effective in controlling mite populations, however mites and symptoms of citrus leprosis disease may go undetected in public and private gardens and native citrus. For the reasons outlined, the likelihood of citrus leprosis viruses establishing in Australia from imported Persian limes from Mexico is assessed as 'High'.

#### 4.7.4 Likelihood of spread

The likelihood that citrus leprosis 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 assessed as: **Moderate**.

The following information provides supporting evidence for this assessment.

There are suitable hosts available in Australia.

- Citrus leprosis viruses affect a wide range of citrus species, including grapefruit, lemon, mandarin, sweet orange and several lime species, including Persian limes (Ramos-González et al. 2018). These citrus species are commercially grown across Australia (Citrus Australia 2021).
- Australia has native species of citrus trees (Hardy et al. 2010) and citrus trees are commonly grown in suburban environments around Australia.
- Non-rutaceous hosts, such as *Dieffenbachia* spp. (Jeger et al. 2017b; Roy et al. 2015a), are also present in Australia.

Suitable vectors required for transmission of citrus leprosis viruses are present in Australia.

- *Brevipalpus californicus*, *B. papayensis* and *B. yothersi* are known to transmit citrus leprosis viruses and these vectors are present in Australia.

*Brevipalpus* mite vectors, *B. californicus*, *B. papayensis* and *B. yothersi*, that transmit citrus leprosis viruses are polyphagous, and the presence of abundant and widely distributed host plants across Australia would support the spread of *Brevipalpus* mites within Australia.

- *Brevipalpus* mites are polyphagous. For example, the host range of *B. californicus* encompasses 316 host plant species from 33 families (Childers, Rodrigues & Webourn 2003) and many of these host plants are present in Australia.

Natural dispersal of viruliferous *Brevipalpus* mites is likely to be slow, but human-assisted movement of viruliferous mites on host material may aid the spread of citrus leprosis viruses in Australia.



- Bastianel et al. (2010) reviewed the movement of citrus leprosis disease into new areas in the Americas and proposed it could be due to the introduction of plants infected by the viruses or plants carrying viruliferous mites, in particular sweet orange plants that are highly susceptible to the disease.
- There are no specific interstate phytosanitary measures in place to prevent movement of *Brevipalpus* mites on host plants such as citrus within Australia, as these mites are already present in most states (Akyazi, Ueckermann & Liburd 2017; APPD 2022; Beard et al. 2015b).
- Viruliferous mites present on fruit and planting material may go undetected due to their small size and are likely to survive typical transport and storage conditions. Movement of plant parts infected with viruliferous mites may facilitate the spread of citrus leprosis viruses within Australia.

Citrus leprosis requires a vector for transmission. Known vectors *B. californicus*, *B. papayensis* and *B. yothersi*, are present and widespread in Australia. Human-assisted movement of viruliferous mites on host plants through domestic trade could facilitate the spread of citrus leprosis viruses within Australia, however natural spread would be less likely due to the limited mobility of vector mites. For these reasons, the likelihood of spread of citrus leprosis viruses is assessed as 'Moderate'.

#### 4.7.5 Overall likelihood of entry, establishment and spread

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

The overall likelihood that citrus leprosis viruses will enter Australia via infected fresh Persian lime fruit imported from Mexico, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is assessed as Extremely Low.

The overall likelihood that citrus leprosis viruses will enter Australia via viruliferous vector mites present on fresh Persian lime fruit imported from Mexico, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is assessed as **Very Low**.

#### 4.7.6 Consequences

The potential consequences of the establishment of citrus leprosis viruses in Australia have been estimated according to the methods described in Table 2.3

Based on the decision rules described in Table 2.3 that is, where the potential consequences of a pest with respect to one or more criteria are 'E', the overall consequences are estimated to be **Moderate**.

Criterion	Estimate and rationale
<b>Direct</b>	
Plant life or health	E – Significant at the regional level Citrus leprosis viruses affect a wide range of citrus species, including grapefruits, lemons, limes, mandarins, sweet oranges and Persian limes causing Citrus leprosis disease (Ramos-González et al. 2018). Citrus leprosis is one of the most destructive diseases of <i>Citrus</i> spp. in South and Central America (Roy et al. 2020; Roy et al. 2015b).

	<p>Citrus leprosis viruses cause a non-systemic infection that produces necrotic spots in leaves, stems and fruits, reducing citrus crop yield and leading to the death of younger trees (Ramos-González et al. 2018; Roy et al. 2015a).</p> <p>Leprosis symptoms may vary according to the host species and the stage of development of the affected plant. Sweet orange is the most susceptible species and can be severely damaged, resulting in premature fruit drop, and reduced quality and aesthetic value of fruit for fresh consumption (Jeger et al. 2017b).</p> <p>Australia grows over 28,000 ha of citrus nationally (Citrus Australia 2021) with a combined production value of over \$940 million for the year ending June 2020 (Horticulture Innovation Australia 2020). During this period 51% of orange and 46% of grapefruit production occurred in NSW, while 54% of lemon/lime and mandarin production occurred in Qld. Other important citrus producing states were SA and Vic. (Horticulture Innovation Australia 2020). Thus, citrus leprosis disease would have a significant impact at the regional level in citrus production.</p> <p>It is currently not known if native citrus could be susceptible to citrus leprosis infection. Finger limes (<i>Citrus australasica</i>) are the most commonly grown Australian native citrus species (Hardy et al. 2010). The commercial production in 2012 was around 10 tonnes per year, with an industry farm gate value of approximately \$420,000 (Clarke 2012).</p>
Other aspects of the environment	<p>A – Indiscernible at the local level</p> <p>Direct impacts are limited to effects on plant health. No other direct impacts on the environment associated with citrus leprosis viruses have been reported.</p>
<b>Indirect</b>	
Eradication, control	<p>D – Significant at the district level</p> <p>Implementation of control measures would result in an increase in the cost of production. In Brazil, 24% of production cost is attributed to the control of citrus leprosis disease and an estimated US\$80–100 million is invested annually for chemical control of the mite vectors alone (Bastianel et al. 2010). Additional costs are related to reduction of inoculum by constant monitoring and pruning of infected trees, as well as vector control via natural enemies of the <i>Brevipalpus</i> vectors (Rodrigues &amp; Childers 2013). This strategy was found to be successful in keeping the disease spread in check in Brazil (Rodrigues &amp; Childers 2013).</p> <p>An issue of concern is the development of miticide-resistance by vector mites, and the limited number of miticides available. It is necessary to apply these miticides in rotations to prevent resistance, which would render the miticide ineffective (Rodrigues et al. 2003).</p> <p>Citrus leprosis, although once a major citrus disease problem in Florida, may have been eradicated from Florida in the late 1960s (Roy et al. 2015a). There have been no reports of citrus leprosis in the United States since 1968 (Roy et al. 2015b). Genome sequence data from a herbarium sample of the original strain collected in 1948 in Florida revealed that it was a nuclear-type leprosis virus which is a distantly related strain of OFV (Hartung et al. 2015; Roy et al. 2020).</p>
Domestic trade	<p>D – Significant at the district level</p> <p>The introduction of citrus leprosis viruses into commercial citrus production areas would have a significant effect as interstate trade restrictions may be imposed to limit the spread of this virus on citrus hosts.</p>

International trade	<p>D– Significant at the district level:</p> <p>During 2019–20, Australia exported approximately 285,000 tonnes of fresh citrus fruit, netting nearly \$510 million, with 201,000 tonnes being oranges, corresponding to \$310 million (Horticulture Innovation Australia 2020). During 2019–20, Australian citrus exports were mainly to Japan (60% of grapefruit and 18% of orange exports), Indonesia (42% of lemon/lime exports), China (32% of mandarin and 23% of orange exports), Canada (17% of lemons/limes and 13% of grapefruit exports) and Thailand (17% of mandarin exports) (Horticulture Innovation Australia 2020).</p> <p>Citrus leprosis viruses are currently restricted to South and Central America (Kondo et al. 2017; Roy et al. 2020). Therefore, it is possible that Australian citrus exports may be affected as most of Australian trading partners are not currently affected by this disease, and these countries may impose phytosanitary measures. However, some of these countries currently import citrus from countries such as Mexico and Brazil where citrus leprosis is present.</p>
Non-commercial and environmental	<p>Impact score: B – Minor impact at the local level</p> <p>There are no known indirect effects of OFV-citrus on the natural environment.</p> <p>Mite control could affect the environment, but it is not expected to have any greater effect than the present use of agrochemicals. Indirect effects on native plants from control of mites could have minor consequences at the local level.</p>

#### 4.7.7 Unrestricted risk estimate

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

Likelihood being assessed	Fruit infected with OFV-citrus	Vector mites on fruit
Overall likelihood of entry, establishment and spread	Extremely Low	Very Low
Consequences	Moderate	Moderate
Unrestricted risk	Negligible	Very Low

As indicated, the unrestricted risk estimate for citrus leprosis viruses associated with Persian lime fruit infected with these viruses has been assessed as **Negligible**. The unrestricted risk estimate for citrus leprosis viruses associated with the vector mites on Persian lime fruit has been assessed as **Very Low**. For both means of entry the unrestricted risk estimate for citrus leprosis viruses achieves the ALOP for Australia. Therefore, no additional specific risk management measures are required for citrus leprosis viruses on the Persian lime fruit from Mexico pathway.

## 4.8 Pest risk assessment conclusions

Table 4.6 Summary of unrestricted risk estimates for quarantine pests and regulated articles associated with fresh Persian lime fruit from Mexico

Pest name	Likelihood of						Consequences	URE
	Entry			Establishment	Spread	EES		
	Importation	Distribution	Overall					
Armoured scales [Hemiptera: Diaspididae]								
<i>Chrysomphalus dictyospermi</i> , (GP, WA)	Moderate	Moderate	Low	High	High	Low	Low	Very Low
<i>Parlatoria cinerea</i> (GP)	Moderate	Moderate	Low	High	High	Low	Low	Very Low
<i>Parlatoria pergandii</i> (GP, WA)	Moderate	Moderate	Low	High	High	Low	Low	Very Low
<i>Pinnaspis aspidistrae</i> (GP, WA)	Moderate	Moderate	Low	High	High	Low	Low	Very Low
<i>Pseudaonidia trilobitiformis</i> (GP, WA)	Moderate	Moderate	Low	High	High	Low	Low	Very Low
<i>Unaspis citri</i> (GP, WA)	Moderate	Moderate	Low	High	High	Low	Low	Very Low
Mealybugs [Hemiptera: Pseudococcidae]								
<i>Dysmicoccus neobrevipes</i> , (GP)	Low	Moderate	Low	High	High	Low	Low	Very Low
<i>Paracoccus marginatus</i> (GP)	Low	Moderate	Low	High	High	Low	Low	Very Low
<i>Pseudococcus maritimus</i> (GP)	Low	Moderate	Low	High	High	Low	Low	Very Low
Moths [Lepidoptera: Gracillariidae]								
<i>Marmara gulosa</i> (EP)	Low	High	Low	High	Moderate	Low	Low	Very Low
Thrips [Thysanoptera: Thripidae]								
<i>Caliothrips fasciatus</i> (GP)	Low	Moderate	Low	High	High	Low	Low	Very Low
<i>Frankliniella bispinosa</i> (GP)	Low	Moderate	Low	High	High	Low	Low	Very Low
<i>Scirtothrips citri</i> (GP)	Low	Moderate	Low	High	High	Low	Low	Very Low
Spider mites [Trombidiformes: Tetranychidae]								
<i>Panonychus citri</i> (EP, WA)	Moderate	Low	Low	Moderate	Moderate	Low	Low	Very Low
Fungi								
<i>Elsinoë fawcettii</i> (EP)	Low	Low	Very Low	Moderate	Moderate	Very Low	Low	Negligible

Pest name	Likelihood of						Consequences	URE
	Entry			Establishment	Spread	EES		
	Importation	Distribution	Overall					
Viruses								
Citrus leprosis viruses (CiLV-C, OFV-citrus)								
Fruit infected with citrus leprosis viruses	Low	Extremely Low	Extremely Low	High	Moderate	Extremely Low	Moderate	Negligible
Vector mites ( <i>Brevipalpus californicus</i> , <i>B. papayensis</i> and <i>B. yothersi</i> ) present on the fruit (RA)	Low	Very Low	Very Low	High	Moderate	Very Low	Moderate	Very Low

**EES:** Overall likelihood of entry, establishment and spread. **EP:** Species has been assessed previously and import policy already exists. **GP:** Species has been assessed previously in a Group PRA (thrips, mealybugs and scales Group PRA) and the Group PRA has been applied. **RA:** Regulated article, refer to Section 4.7.2 for definition of a regulated article. **WA:** Pest of quarantine concern for Western Australia. **URE:** Unrestricted risk estimate. This is expressed in an ascending scale from negligible to extreme.

## 4.9 Summary of assessment of quarantine pests and regulated articles of concern

This section provides a summary of the process of assessment of potential quarantine pests and regulated articles (shown in Figure 19).

The pest categorisation process (Appendix A: Initiation and categorisation for pests of fresh Persian lime fruit from Mexico) identified 102 pests. Of these 102 pests:

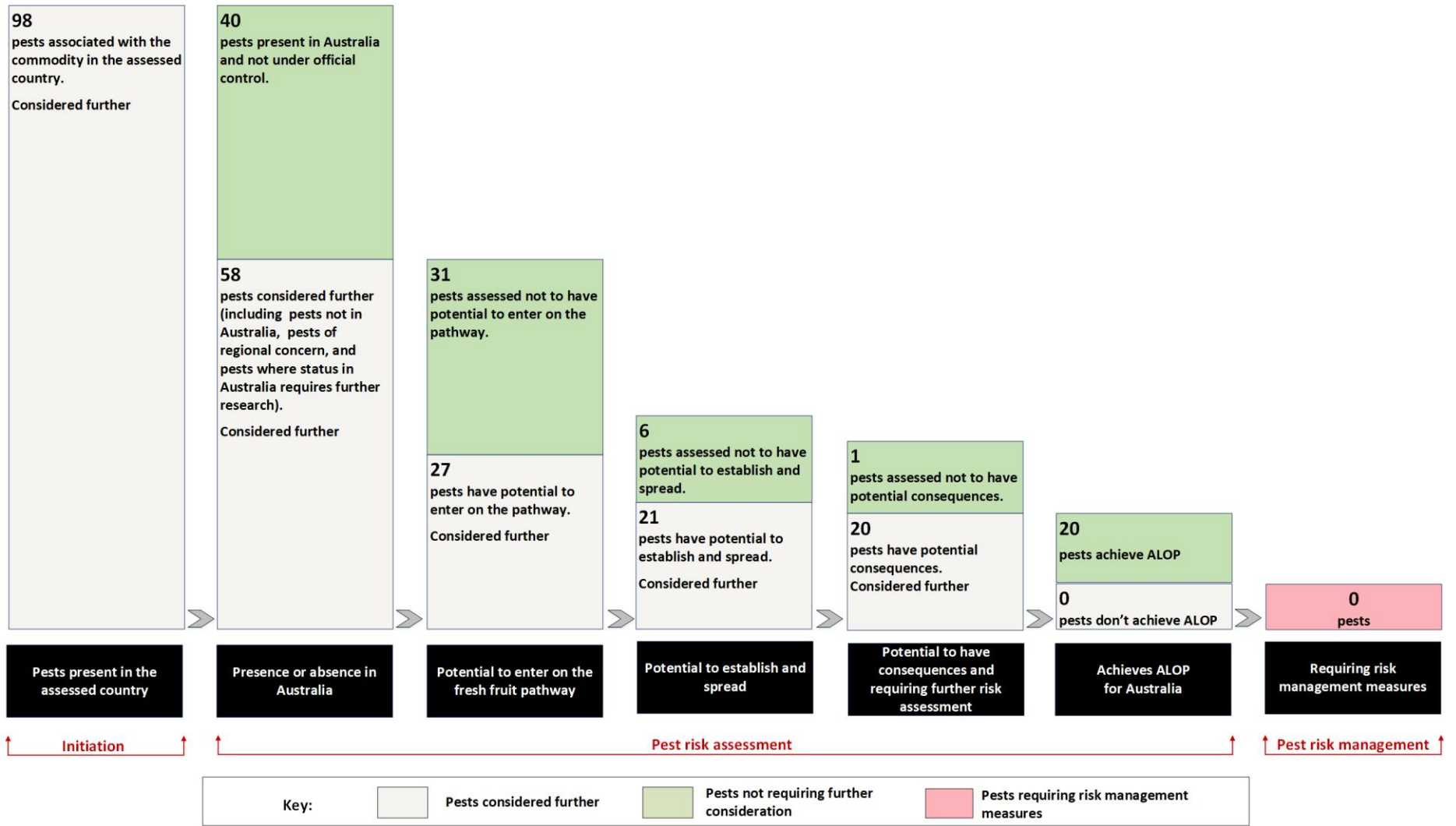
- 3 pests (*Brevipalpus phoenicis*, *Ceratitis capitata* and *Phyllosticta citricarpa*) were determined not to be present in Mexico, as the pest has since been reclassified as a different species, has been eradicated, or historic reports are now considered unreliable.
- one pest (*Xanthomonas citri* subsp. *citri*) is transient, actionable and under eradication in Mexico, and therefore was not considered further
- 40 pests are already present in Australia, and not under official control, and therefore were not considered further
- 31 pests were assessed as not having potential to be on the fresh Persian lime fruit pathway when standard commercial in-field management, as well as packing house practices of washing, brushing, disinfection, waxing, grading/sorting and inspection are in place, and therefore did not undergo further assessment
- 6 pests were assessed as not having potential to establish in Australia if imported via the fresh Persian lime fruit pathway, and therefore did not undergo further assessment
- one pest (*Lorryia formosa*) was assessed as not having potential for economic consequences. *Lorryia formosa* is not a plant pest and does not adversely affect plant health. This species therefore did not undergo further assessment.

The outcome of the above process identified 20 pests (17 quarantine pests and 3 regulated articles) that required further consideration, that is, a pest risk assessment. Pest risk assessments (PRAs) for these 20 quarantine pests and regulated articles were subsequently completed. All 20 quarantine pests and regulated articles were assessed as achieving the ALOP for Australia.

The estimated unrestricted risks, which take into consideration standard commercial production practices for Persian limes in Mexico, for the 20 quarantine pests and regulated articles achieve the ALOP for Australia. Therefore, no specific risk management measures are required for these pests on this pathway. These pests are:

- Armoured scales (*Chrysomphalus dictyospermi*, *Parlatoria cinerea*, *P. pergandii*, *Pinnaspis aspidistrae*, *Pseudaonidia trilobitiformis* and *Unaspis citri*).
- Mealybugs (*Dysmicoccus neobrevipes*, *Paracoccus marginatus* and *Pseudococcus maritimus*)
- Citrus peelminer (*Marmara gulosa*)
- Thrips (*Caliothrips fasciatus*, *Frankliniella bispinosa* and *Scirtothrips citri*)
- Red citrus mite (*Panonychus citri*)
- Citrus scab (*Elsinoë fawcettii*)
- Citrus leprosis viruses (*Citrus leprosis virus C* and *Orchid fleck dichorhavirus-Citrus strain*)
- Flat mites (*Brevipalpus californicus*, *B. papayensis* and *B. yothersi*)

Figure 19 Summary of assessment of pests of biosecurity concern



Four species (*Brevipalpus phoenicis*, *Ceratitis capitata*, *Xanthomonas citri* subsp. *citri* and *Phyllosticta citricarpa*) were determined not to be present, or to be transient, actionable and under eradication in Mexico. Therefore, these species are not included in Figure 19.



The application of existing standard commercial production practices of in-field pest management and controls, as well as the post-harvest practices of washing, brushing, disinfection, waxing, grading/sorting and quality inspection, were a key consideration in the assessment of risk for many pests assessed in this report. Consequently, these practices are considered a requirement for managing any potential risk of pests associated with Persian lime fruit produced in Mexico to ensure the biosecurity risks have been managed to meet Australia's appropriate level of protection (ALOP).

These in-field pest management practices and post-harvest practices must therefore be in operation for all Persian lime fruit produced in Mexico for export to Australia. The requirements for the implementation and verification of these practices are detailed in Chapter 5.

## 5 Pest risk management

This chapter provides information on the requirements of imported fresh Persian lime fruit from Mexico to ensure pests are managed on this pathway to an acceptable level.

The chapter recommends that, when the commercial production practices described in Chapter 3 of this report (as summarised in Section 5.1.2) are adhered to, the unrestricted risk for the pests assessed in Chapter 4 (listed in Table 4.6) will achieve the appropriate level of protection (ALOP) for Australia. This chapter also describes the operational system (Section 5.2) that is required for the maintenance and verification of the phytosanitary status of fresh Persian lime fruit from Mexico for export to Australia.

### 5.1 Pest risk management measures and phytosanitary procedures

This section describes the specific commercial production practices that are mandatory for the 17 quarantine pests and 3 regulated articles, as these practices were taken into consideration in assessing the unrestricted risk estimate of these pests as achieving the ALOP for Australia.

#### 5.1.1 Analysis of pest interception data to date

Fresh lime fruit have been imported into Australia from the United States (Arizona and California), Egypt, New Zealand, New Caledonia, Spain and various other nations. The total quantity of fresh lime fruit imported from 2007-2016 was approximately 1,300 tonnes. There has been no import of limes into Australia since 2016. Data for imports indicated the occasional presence of certain phytosanitary pests (scales, mealybugs, moths, thrips and mites) and contaminant organisms (fungus gnats, gall midges, brine flies and moulds). All of the organisms intercepted at the Australian border were managed under existing policy.

#### 5.1.2 Pest risk management for quarantine pests and regulated articles

Specified commercial production practices are recommended for the 17 quarantine pests and 3 regulated articles, as these practices were taken into consideration in assessing the unrestricted risk estimate of these pests as achieving the ALOP for Australia.

The department recommends the following specific commercial production practices as mandatory:

- In-field pest management practices: monitoring for insects and mites using in-field surveillance and trapping, monitoring for pathogens and, when necessary, application of in-field controls.
- Packing house practices: application of washing, brushing, disinfection, waxing, grading/sorting and quality inspection in the packing house.

To ensure these practices are followed, all growers and packing houses involved in the export of Persian limes to Australia must be registered with SENASICA. SENASICA must ensure that only growers and facilities that can meet these practices are registered.

Details of the specific commercial production practices, which are mandatory to meet Australian import requirements as part of the operational system, are to be agreed by the department before trade commences.

Should the currently agreed production practices be changed by Mexico in the future, Australia will need to be consulted in order to establish new conditions to be applied to Persian limes for export to Australia.

### **Specific commercial production practices mandatory for quarantine pests and regulated articles**

Specified existing commercial production practices are mandatory for all Persian lime fruit produced for export to Australia as these practices were taken into consideration in the pest risk assessments, which rated the unrestricted risk estimate of these pests as achieving the ALOP for Australia.

#### *Recommended mandatory in-field pest management requirements*

All Persian lime fruit consignments for export to Australia must be sourced from orchards in Mexico that have been registered by SENASICA as meeting required in-field pest management practices. Orchards are to be monitored for insects and mites using in-field surveillance and trapping, and monitored for pathogens. When signs of arthropod damage or symptoms of arthropod infestation or pathogen infection are detected, in-field controls (such as chemicals effective against the targeted pest – insecticides, miticides or fungicides – or use of biological and cultural control practices) as outlined in Table 3.2 are to be applied.

#### *Recommended mandatory packing house practices requirements*

All Persian lime fruit consignments for export to Australia must be processed and packed in a facility that has been registered by SENASICA as meeting the required packing house practices of washing, brushing, disinfection, waxing, grading/sorting and quality inspection. Any fruit that are cracked, damaged or do not meet export quality standards are to be removed during quality inspection.

### **5.1.3 Consideration of alternative measures**

Consistent with the principle of equivalence detailed in ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2019b), the department will consider any alternative measure proposed by SENASICA, providing that it demonstrably manages the target pest(s) to achieve the ALOP for Australia. Evaluation of any such measure will require a technical submission from SENASICA that details the proposed measure, including information to support the claimed efficacy, for consideration by the department.

## **5.2 Operational system for the maintenance and verification of phytosanitary status**

A system of operational procedures is necessary to ensure the mandatory commercial production practices (Section 5.1) are effectively applied, the phytosanitary status of Persian limes from Mexico is maintained, and that these can be verified. This is to ensure that biosecurity requirements have been met and are maintained.

### **5.2.1 A system of traceability to source orchards**

The objectives of this recommended procedure are to ensure that:

- Persian lime fruit are sourced only from registered orchards producing commercial export-quality fruit in Mexico.

- Orchards from which Persian lime fruit are sourced can be identified so that any investigation and corrective action can be targeted in the event that pests of biosecurity concern to Australia are intercepted.
- Orchards are capable of applying in-field pest controls as outlined in Table 3.2 (for example, monitoring for pests and applying appropriate sprays if they are detected).

Export orchards are to be registered with SENASICA before commencement of each harvest season and registered orchards must pass an audit by SENASICA, that is to be conducted prior to the commencement of harvest. The list of registered orchards must be kept by SENASICA. SENASICA must ensure that fresh Persian limes for export to Australia can be traced back to a registered orchard in Mexico. SENASICA is required to ensure the registered orchards are suitably equipped and have a system in place to carry out the specified phytosanitary activities. SENASICA will be responsible for ensuring that growers of Persian limes for export are aware of pests of biosecurity concern to Australia and of the in-field requirements. Records of SENASICA's audits must be made available to the department upon request. Records of orchard monitoring/management must be made available upon request.

### 5.2.2 Registration of packing houses and auditing of procedures

The objective of this recommended procedure is to ensure that:

- Commercial quality Persian lime fruit are sourced only from registered packing houses that have been approved by SENASICA.

Export packing houses must be registered with SENASICA before the commencement of each harvest season. SENASICA is required to ensure that the registered packing houses are suitably equipped and have a system in place to carry out the specified phytosanitary activities (washing, brushing, disinfestation, waxing, sorting, grading and quality inspection). The list of registered packing houses and records of SENASICA audits must be made available to the department upon request.

### 5.2.3 Registration of treatment providers and auditing of procedures

The objectives of this recommended procedure are to ensure that:

- If treatment options for Persian lime fruit are required, treatments are applied by providers that are capable of applying a treatment that suitably manages the target pests, and have been approved by SENASICA.

In circumstances where Persian lime fruit undergo treatment prior to export, this process must be undertaken by treatment providers that have been registered with and audited by SENASICA for that purpose. Records of SENASICA registration requirements and audits must be made available to the department upon request.

Approval of treatment providers is subject to use of suitable systems to ensure compliance with the treatment requirements. These should include:

- documented procedures to ensure Persian lime fruit are appropriately treated and safeguarded post-treatment
- staff training to ensure compliance with procedures

- record-keeping procedures
- suitability of facilities and equipment
- SENASICA's system of oversight of treatment application.

Site visits may be required for the Australian NPPO to have assurance that the treatment can be applied accurately and consistently.

#### 5.2.4 Packaging, labelling and containers

The objectives of this recommended procedure are to ensure that:

- Persian lime fruit intended for export to Australia, and associated packaging, are not contaminated by quarantine pests or regulated articles (as defined in ISPM 5: *Glossary of phytosanitary terms* (FAO 2022a)).
- Unprocessed packaging material is not imported with Persian lime fruit, as it may vector pests identified as not being on the pathway, or pests not known to be associated with Persian lime fruit.
- All wood material associated with the consignment used in packaging and transport of fresh Persian lime fruit from Mexico complies with the department's import requirements, as published on BICON.
- Secure packaging is used for export of fresh Persian lime fruit from Mexico to Australia to prevent re-infestation during storage and transport and prevent escape of pests during clearance procedures on arrival in Australia. Packaging must meet Australia's secure packing options published on BICON.
- Consignments are made insect-proof and secure, by using at least one of the following secure consignment options:
  - **Integral cartons:** produce may be packed in integral (fully enclosed) cartons (packages) with boxes having no ventilation holes and lids tightly fixed to the bases.
  - **Ventilation holes of cartons covered:** cartons (packages) with ventilation holes must have the holes covered/sealed with a mesh/screen of no more than 1.6 mm pore size and not less than 0.16 mm strand thickness. Alternatively, the vent holes could be taped over.
  - **Polythene liners:** vented cartons (packages) with sealed polythene liners/bags within are acceptable (folded polythene bags are acceptable).
  - **Meshed or shrink wrapped pallets or Unit Loading Devices (ULDs):** ULDs transporting cartons with open ventilation holes/gaps, or palletised cartons with ventilation holes/gaps must be fully covered or wrapped with polythene/plastic/foil sheet or mesh/screen of no more than 1.6 mm diameter pore size and not less than 0.16 mm strand thickness.
  - **Produce transported in fully enclosed containers:** cartons (packages) with holes as loose boxes or on pallets may be transported in fully enclosed containers. Enclosed containers include 6-sided container with solid sides, or ULDS with tarpaulin sides that have no holes or gaps. The container must be transported to the inspection point intact.
- Packaged Persian lime fruit from Mexico are labelled with sufficient identification for the purposes of traceability. This should include:

- for Persian lime fruit where in-field controls are required: the orchard's reference number
- for Persian lime fruit where packing house requirements are applied: the packing house reference/number
- for treated product: the treatment facility name/number and treatment identification reference/number.

Export packing houses and treatment providers (where applicable) ensure packaging and labelling are suitable to maintain phytosanitary status of the export consignments.

### 5.2.5 Specific conditions for storage and movement

The objective of this recommended procedure is to ensure that the quarantine integrity of the commodity is maintained during storage and movement.

Treated and/or inspected Persian lime fruit for export to Australia must be kept secure and segregated at all times from any fruit for domestic or other markets, and from untreated/non pre-inspected product, to prevent mixing or cross-contamination. The area set aside for goods to Australia must be clearly identified with signage.

### 5.2.6 Freedom from trash

The objective of this recommended procedure is to ensure that Persian lime fruit for export are free from trash (for example, loose stem and leaf material, seeds, soil, animal matter/parts or other extraneous material) and foreign matter.

Freedom from trash will be confirmed by the inspection procedures. Export lots or consignments found to contain trash or foreign matter should be withdrawn from export unless approved remedial action such as reconditioning is available and applied to the export consignment and then re-inspected.

### 5.2.7 Pre-export phytosanitary inspection and certification by SENASICA

The objective of this recommended procedure is to ensure that Australia's import conditions have been met. All consignments of Persian lime fruit for export to Australia must be inspected by SENASICA regulatory officials and found free of pests of biosecurity concern for Australia. Pre-export visual inspection must be undertaken by SENASICA regulatory officials in accordance with ISPM 23: *Guidelines for inspection* (FAO 2019c) and consistent with the principles of ISPM 31: *Methodologies for sampling of consignments* (FAO 2016). The inspection technique must be capable of detecting all life stages of these pests.

All consignments must be inspected in accordance with official procedures for all visually detectable quarantine pests and regulated articles (including trash). Sampling and inspection methods should be consistent ISPM 23 (FAO 2019c) and ISPM 31: *Methodologies for sampling consignments* (FAO 2016), and provide a 95% level of confidence that infestation greater than 0.5% will be detected. For a consignment equal to or greater than 1,000 units (one unit being a single Persian lime fruit), this is equivalent to a 600-unit sample randomly selected across the consignment.

A phytosanitary certificate must be issued for each consignment upon completion of pre-export inspection to verify that the required risk management requirements have been undertaken prior to export and the consignment meets Australia's import requirements.

Each phytosanitary certificate must include:

- a description of the consignment (including traceability information)
- any other statements that may be required, such as identification of the consignment as being sourced from registered orchards and packing houses.

### **5.2.8 Phytosanitary inspection by the Department of Agriculture, Fisheries and Forestry**

The objectives of this recommended procedure are to ensure that:

- consignments comply with Australian import requirements
- consignments are as described on the phytosanitary certificate
- quarantine integrity has been maintained.

On arrival in Australia, the department will:

- assess documentation to verify that the consignment is as described on the phytosanitary certificate, that required phytosanitary actions have been undertaken, and that product security has been maintained
- verify that the biosecurity status of consignments of Persian lime fruit from Mexico meet Australia's import conditions. When inspecting consignments, the department will use random samples of 600 units, or equivalent, per phytosanitary certificate and inspection methods suitable for the commodity.

### **5.2.9 Remedial action(s) for non-compliance**

The objectives of remedial action(s) for non-compliance are to ensure that:

- any quarantine pest or regulated article, including trash, is addressed by remedial action, as appropriate
- non-compliance with import requirements is addressed, as appropriate.

Any consignment that fails to meet Australia's import requirements will be subject to suitable remedial treatment where an effective treatment is available for the identified biosecurity risks. Where an effective treatment is not available, the imported consignment will be exported or destroyed.

Other actions, including partial or complete suspension of the import pathway, may be taken depending on the identity and/or importance of the pest intercepted, for example citrus pathogens (fungi and viruses) of economic importance.

In the event that consignments of Persian lime fruit from Mexico are repeatedly non-compliant, the department may require enhanced risk management measures, including mandatory phytosanitary treatment. The department reserves the right to suspend imports (either all imports, or imports from specific pathways) and conduct an audit of the risk management

systems. Imports will be allowed to recommence only when the department is satisfied that appropriate corrective action has been undertaken.

### 5.3 Uncategorized pests

If an organism that has not been categorised, including a contaminant pest, is detected on Persian lime fruit on-arrival in Australia, it will require assessment by the department to determine its quarantine status and whether phytosanitary action is required.

Assessment is also required if the detected species was categorised as not having the potential 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 the ALOP for Australia, then it may require reassessment. The detection of pests assessed as being managed by standard commercial production practices may trigger a reassessment of the effectiveness of these practices at removing pests from the pathway. The detection of any pests of biosecurity 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 the existing measures continue to provide the ALOP for Australia.

## 5.4 Review of processes

### 5.4.1 Verification of protocol

Prior to or during the first season of trade, the department will verify the implementation of the agreed import requirements including registration, operational procedures and treatment providers, where applicable. For example, for measures conducted offshore, the department may require information about standard operating procedures (SOPs). This may involve representatives from the department visiting areas in Mexico that produce Persian lime fruit for export to Australia.

### 5.4.2 Review of policy

The department will review the import policy after a suitable volume of trade has been achieved to ensure import requirements continue to be appropriate to the biosecurity risk of the pathway. In addition, the department reserves the right to review the import policy as deemed necessary. This may include if there is reason to believe that the pest or phytosanitary status in Mexico has changed, or where alternative risk management or compliance-based intervention options become available.

SENASICA must inform the department immediately on detection of any new pests of Persian lime fruit in Mexico that might be of potential biosecurity concern to Australia, or when the phytosanitary status of a pest has changed, in accordance with ISPM 8: *Determination of pest status in an area* (FAO 2021).

## 5.5 Meeting Australia's food laws

In addition to meeting Australia's biosecurity laws, imported food for human consumption must comply with the requirements of the *Imported Food Control Act 1992*, as well as Australian state and territory food laws. Among other things, these laws require all food, including imported food, to meet the standards set out in the Australia New Zealand Food Standards Code (the Code).



Food Standards Australia New Zealand (FSANZ) is responsible for developing and maintaining the Code. The Code is available at [foodstandards.gov.au/code/Pages/default.aspx](http://foodstandards.gov.au/code/Pages/default.aspx).

The department administers the *Imported Food Control Act 1992* which *supports the inspection and testing of imported food to verify its safety and compliance with Australia's food standards, including the Code*. This is undertaken through a risk-based border inspection program, the Imported Food Inspection Scheme. More information about this scheme is available at [agriculture.gov.au/biosecurity-trade/import/goods/food/inspection-testing/ifis](http://agriculture.gov.au/biosecurity-trade/import/goods/food/inspection-testing/ifis).

Standards 1.1.1, 1.1.2 and 1.4.4 of the Code specify that a food for sale must not consist of, or have as an ingredient or a component, a prohibited or restricted plant or fungus, unless expressly permitted by the Code. The prohibited and restricted plants and fungi are listed in Schedules 23 and 24 of the Code, respectively.

Standard 1.4.2 and Schedules 20, 21 and 22 of the Code set out the maximum residue limits and extraneous residue limits for agricultural or veterinary chemicals that are permitted in foods for sale, including imported food. Standard 1.1.1 of the Code specifies that a food must not have, as an ingredient or a component, a detectable amount of an agvet chemical, or a metabolite or a degradation product of the agvet chemical; unless expressly permitted by the Code.

Certain imported food, including some minimally processed horticulture products, must be covered by a food safety management certificate to be imported into Australia. The certificate provides evidence that a food has been produced through a food safety management system. This system must have appropriate controls in place to manage food safety hazards. More information about the foods that require a food safety management certificate and how to comply is available at [agriculture.gov.au/biosecurity-trade/import/goods/food/lodge/safety-management-certificates](http://agriculture.gov.au/biosecurity-trade/import/goods/food/lodge/safety-management-certificates).

## 6 Conclusion

This final risk analysis report was conducted to assess the proposal by Mexico for market access to Australia for Persian lime fruit for human consumption.

The risk analysis was conducted in accordance with Australia's method for pest risk analysis (Chapter 2), which is consistent with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for pest risk analysis* (FAO 2019a) and ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2019b), and the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (WTO 1995).

In conclusion, this final report recommends that the importation of commercially produced fresh Persian lime fruit to Australia from all commercial production areas of Mexico be permitted, subject to a range of biosecurity requirements outlined in Chapter 5.

The findings of this final report are based on a comprehensive analysis of scientific literature and other relevant information.

The Department of Agriculture, Fisheries and Forestry considers that the risk management measures recommended in this report will provide an appropriate level of protection against the quarantine pests and regulated articles identified as associated with the trade of fresh, Persian lime fruit from Mexico.

All fresh fruit, including Persian lime fruit from Mexico, have been determined by the Director of Biosecurity to be conditionally non-prohibited goods under s174 of the *Biosecurity Act 2015*. Conditionally non-prohibited goods cannot be brought or imported into Australia unless they meet specific import conditions.

This report, upon its finalisation, provides the basis for import conditions for fresh Persian lime fruit from Mexico for human consumption. The import conditions will be communicated on BICON. The publication of import conditions on BICON is subject to Mexico being able to demonstrate that processes and procedures are in place to implement the mandatory specific commercial production practices.

## Appendix A: Initiation and categorisation for pests of fresh Persian lime fruit from Mexico

The table identifies pests that have the potential to be present on fresh Persian limes grown in Mexico using standard commercial production and packing house procedures, and intended to be imported into Australia.

The steps in the initiation and categorisation process are considered sequentially, with the assessment terminating at 'Yes' for column 3 (except for pests that are present but under official control), or at the first 'No' in any of the columns 4, 5 or 6.

In the final column of the table (column 7) the acronyms 'EP', 'GP', RA and 'WA' are used. The acronym 'EP' (existing policy) is used for pests that have previously been assessed by Australia and for which import policy exists. The acronym 'GP' (Group policy) is used for pests that have been assessed by Australia in a Group policy. The acronym for the state or territory for which regional pest status is considered, such as 'WA' (Western Australia) is used to identify organisms that have been recorded in some regions of Australia, but due to interstate quarantine regulations are considered regional quarantine pests.

The *Final group pest risk analysis for thrips and orthotospoviruses on fresh fruit, vegetable, cut-flower and foliage imports* (DAWR 2017), the *Final group pest risk analysis for mealybugs and the viruses they transmit on fresh fruit, vegetable, cut-flower and foliage imports* (DAWR 2019) and the *Final group pest risk analysis for soft and hard scale insects on fresh fruit, vegetable, cut-flower and foliage imports* (DAWE 2021) have been applied in this risk analysis.

Details of the method used in this risk analysis are given in Chapter 2: Method for pest risk analysis.

For the purposes of pest categorisation, the table does not provide a comprehensive list of all pest species associated with the Persian lime plant, but concentrates on pests that could be on the fresh Persian lime fruit import pathway. Identification of soil-borne nematodes, soil-borne pathogens, wood-borer pests, root pests or pathogens, and secondary pests have not been listed, on the basis that they are not directly related to the import pathway of fresh Persian lime fruit and would be addressed by Australia's current approach to contaminating pests.

The department is aware of the recent changes in fungal nomenclature that ended the separate naming of different states of fungi with a pleomorphic life cycle. However, as the nomenclature for these fungi is in a phase of transition and many priorities of names are still to be resolved, this report uses the generally accepted names and provides alternatively used names as synonyms, where required. The department is also aware of the changes in nomenclature of arthropod species based on the latest morphological and molecular reviews. As official lists of accepted names become available, these names will be adopted.

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b>ARTHROPODS</b>						
<b>Coleoptera</b>						
<i>Naupactus cervinus</i> Boheman, 1840 [Curculionidae] Fuller's rose weevil	Yes (Sumano López, Arias López & Capetillo Concepción 2014)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (ALA 2022; APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No
<b>Diptera</b>						
<i>Anastrepha fraterculus</i> (Wiedemann, 1830) [Tephritidae] South American fruit fly	Yes (Tang et al. 2007)	No records found	No. <i>Citrus latifolia</i> has not been recorded as a natural host for <i>A. fraterculus</i> (Hernández-Ortiz, Barradas-Juanz & Díaz-Castelazo 2020). Whilst <i>A. fraterculus</i> has been shown to be capable of ovipositing in harvested <i>C. latifolia</i> fruit in forced laboratory trials (Sousa et al. 2020) the species has not been recorded ovipositing in the field and there have been no records of infestation of commercially produced <i>C. latifolia</i> fruit. In the Chiapas region of Mexico, <i>A. fraterculus</i> was not found in <i>Citrus</i> sp. hosts (Aluja et al. 1987) and the species is not considered to be a pest of commercial citrus in Mexico, including for Valencia oranges and Ruby Red grapefruit (Aluja et al. 2003). Field collection of <i>C. latifolia</i> fruit in areas where <i>A. fraterculus</i> is present in Brazil did not find any evidence of infestation (Lemos et al. 2017; Raga et al. 2004) supporting the conclusion that	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
			freshly harvested, commercially produced <i>C. latifolia</i> is not a host for <i>A. fraterculus</i> .			
<i>Anastrepha ludens</i> (Loew, 1862) [Tephritidae] Mexican fruit fly	Yes (Arredondo et al. 2015)  However, Australia recognises the states of Sonora, Baja California Sur, Chihuahua and 5 municipalities of Sinaloa (Ahome, El Fuerte, Choix, Guasave and Sinaloa) as free of <i>A. ludens</i> (DAFF 2022).	No records found	No. While a very low number of viable adults were reared from eggs laid in <i>Citrus latifolia</i> under forced laboratory conditions, no natural infestation of <i>C. latifolia</i> fruit by <i>Anastrepha ludens</i> occurred in the field or under laboratory conditions (Arredondo et al. 2015). Therefore, freshly harvested, commercially produced <i>C. latifolia</i> is not considered a host for this species.	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Ceratitis capitata</i> (Wiedemann, 1824) [Tephritidae] Mediterranean fruit fly	No. Pest eradicated (Enkerlin et al. 2015).  In the past this pest was considered to be “transient, actionable, and under eradication in Mexico” (EPPO 2005). However, this pest is now considered eradicated from Mexico.  Mexico maintains a national surveillance and eradication program (the Moscamed Program) to maintain freedom for <i>C. capitata</i> in line with international standards. Mexico will be required to notify Australia when area freedom for <i>C. capitata</i> is suspended due to an outbreak. The export of <i>C. latifolia</i> fruit from areas subject to an outbreak of Mediterranean fruit fly will not be permitted unless a suitable quarantine measure has been applied.	Yes. Under official control (National). Present in WA (Government of Western Australia 2022)	Assessment not required	Assessment not required	Assessment not required	No
<b>Hemiptera</b>						

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Aleurocanthus woglumi</i> Ashby, 1915 [Aleyrodidae] Citrus blackfly	Yes (Myartseva 2005)	No records found	No. The eggs of this species are laid on the undersides of leaves (Nguyen, Hamon & Fasulo 2010) and larvae feed exclusively on leaves throughout their development (Enkerlin 1976). No reports suggesting an association with mature fruit have been identified.	Assessment not required	Assessment not required	No
<i>Aleurothrixus floccosus</i> (Maskell, 1896) [Aleyrodidae] Woolly whitefly	Yes (CABI 2022a)	No records found	No. Woolly whitefly usually infests leaves (Soto, Ohlenschlaeger & Garcia-Mari 2002; Umeh & Adeyemi 2011) and only occasionally infests fruit, and twigs (Nega, Getu & Hussein 2014). Eggs are generally laid on leaves (Alford 2012). in rings in a pile of waxy secretions (Vulić & Beltran 1977), which makes them visually obvious. Any pests present on the fruit at the time of harvest would likely fly away when disturbed (CABI 2022a) or will be removed by packing house procedures.	Assessment not required	Assessment not required	No
<i>Aonidiella aurantii</i> (Maskell, 1879) [Diaspididae] Red scale	Yes (SENASICA 2017)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (APPD 2022; James, Stevens & O'Malley 1997)	Assessment not required	Assessment not required	Assessment not required	No
<i>Aonidiella citrina</i> (Coquillett, 1891) [Diaspididae] California red scale	Yes (CABI & EPPO 1997)	Yes. NSW, SA, Vic., WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Ceroplastes cirripediformis</i> Comstock, 1881 [Coccidae] Barnacle scale	Yes (García Morales et al. 2022)	No records found	No. This species feeds on leaves and stems (Bakr et al. 2010; Pencheva & Yovkova 2016). No reports suggesting an association with fruit have been identified.  Reported as a pest of citrus, but no records on Persian lime have been identified. This is a large and conspicuous scale, which is unlikely to be present on commercial fruit in trade.	Assessment not required	Assessment not required	No
<i>Chrysomphalus dictyospermi</i> (Morgan, 1889) [Diaspididae] Spanish red scale	Yes (CABI 1969; Miller & Davidson 2005)	Yes. Under official control (regional). Present in NSW, NT, Qld (APPD 2022).  Regulated as a Declared Pest (Prohibited - s12) by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).	Yes. This species is known to be associated with citrus species (Miller & Davidson 2005; Ramos-Portilla & Caballero 2017). The preferred feeding location is the upper surface of leaves, but it may also infest fruit (Miller & Davidson 2005). Scales may not be removed in the packing house.	Yes. Assessed in the scales Group PRA (DAWE 2021).	Yes. Assessed in the scales Group PRA (DAWE 2021).	Yes (GP, WA)
<i>Coccus hesperidum</i> Linnaeus, 1758 [Coccidae] Brown soft scale	Yes (CABI 2022a)	Yes. NSW, NT, Qld, SA, Vic., WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No
<i>Coccus viridis</i> (Green, 1889) [Coccidae] Green scale	Yes (Arriola Padilla et al. 2016)	Yes. NSW, NT, Qld, WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No



Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Diaphorina citri</i> Kuwayama, 1908 [Liviidae] Asian citrus psyllid	Yes (López-Collado et al. 2013)	No. Previous detections have since been eradicated, as demonstrated by surveys (Bellis, Hollis & Jacobson 2005).	No. Eggs of <i>D. citri</i> are reportedly laid exclusively on young flush (Hall et al. 2013), and are not present on fruit. Adults and nymphs feed on the stems, leaves and shoots of their hosts (Hall et al. 2013; Qureshi & Stansly 2009). If adults and nymphs are present on fruit, they will leap or fall off when disturbed during harvest (Ruan et al. 2015) or are likely removed during standard packing house practices. However, because the species is a quarantine pest of significance to Australia, if it is detected at pre-export or on-arrival in Australia, the existing policy (DAFF 2011) will apply.	Assessment not required	Assessment not required	No
<i>Dysmicoccus neobrevipes</i> Beardsley, 1959 [Pseudococcidae] Grey pineapple mealybug	Yes (García Morales et al. 2022; Martin Kessing & Mau 2007)	No records found	Yes. <i>Dysmicoccus neobrevipes</i> feeds on a wide range of host plants including citrus species (CABI 2022b). It may be found on aerial parts of host plants including the fruit (CABI 2022b).	Yes. Assessed in the mealybugs Group PRA.	Yes. Assessed in the mealybugs Group PRA	Yes (GP)
<i>Hemiberlesia cyanophylli</i> (Signoret, 1869) Synonym: <i>Abgrallaspis cyanophylli</i> Signoret, 1869 [Diaspididae] Cyanophyllum scale	Yes (Arriola Padilla et al. 2016; Miller & Davidson 2005)	Yes. Under official control (regional). Present in NSW, NT, Qld, SA, Tas. (APPD 2022) Regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).	No. <i>Citrus</i> spp. are reported as hosts of <i>H. cyanophylli</i> (Claps, Wolff & Gonzalez 2001), and may occasionally be present on the fruit of hosts (Dao et al. 2018; Watson 2022). However, reports on citrus are rare, and there is no information to suggest this species is a pest in Mexico's lime production. It is considered unlikely to be imported on Persian lime fruit from Mexico.	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Homalodisca vitripennis</i> (Germar, 1821) Synonym: <i>Homalodisca coagulate</i> (Say) [Cicadellidae] Glassywinged sharpshooter	Yes (Takiya, McKamey & Cavichioli 2006)	No records found	No. Adults feed and lay eggs on leaves (Irvin, Hoddle & Castle 2007; Rathe et al. 2014). Oviposition is generally into the leaves of plants, forming blister-like patches. In heavy infestations, egg masses can be laid into the rind of immature host fruit. The eggs hatch in 1–2 weeks (Blua, Phillips & Redak 1999), so viable eggs are unlikely to be present on mature fruit at harvest. Old, hatched egg masses appear as grey or tan scars on surface of the rind (Blua, Phillips & Redak 1999). Scarred fruit are typically unmarketable, and will likely be discarded at harvest or in pre-export sorting and handling.	Assessment not required	Assessment not required	No
<i>Icerya purchasi</i> Maskell, 1878 [Monophlebidae] Cottony cushion scale	Yes (CABI 2022a)	Yes. NSW, NT Qld, Tas., Vic., WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No
<i>Lepidosaphes beckii</i> (Newman, 1869) Synonym: <i>Cornuaspis beckii</i> Newman, 1868 [Diaspididae] Purple scale	Yes (Myartseva, Ruíz-Cancino & Coronado-Blanco 2012)	Yes. NSW, NT, Qld, SA (APPD 2022) WA (Government of Western Australia 2022)	Assessment not required	Assessment not required	Assessment not required	No
<i>Lepidosaphes gloverii</i> (Packard, 1869) [Diaspididae] Glover scale	Yes (CABI 2022a; García Morales et al. 2022)	Yes. NSW, NT, Qld, Vic. (APPD 2022) WA (Government of Western Australia 2022)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Lopholeucaspis cockerelli</i> (Grandpré and Charmoy, 1899) [Diaspididae] Cockerell scale	Yes (García Morales et al. 2022)	No. Listed as present in Australia by ScaleNet (García Morales et al. 2022), however, no primary records of presence in Australia found.	No. While this species can be found on lime trees, it feeds on leaves and is not considered to be associated with the fruit export pathway (Stout 1982). No evidence was found that associates this species with fruit.	Assessment not required	Assessment not required	No
<i>Morganella longispina</i> (Morgan, 1889) [Diaspididae] Maskell scale	Yes (García Morales et al. 2022; Miller 1996)	Yes. Under official control (regional). Present in Qld (APPD 2022). Regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).	No. This species feeds on many hosts, including <i>Citrus</i> spp. (García Morales et al. 2022). There are historic records of <i>Morganella longispina</i> being intercepted several times in 1964 on citrus fruit from Haiti (Hamon 1981). However, there is no evidence to suggest it is a citrus pest of any significance in Mexico and no records found of <i>M. longispina</i> being associated with <i>Citrus latifolia</i> .	Assessment not required	Assessment not required	No
<i>Parabemisia myricae</i> (Kuwana, 1927) [Aleyrodidae] Bayberry whitefly	Yes (Evans 2007)	Yes. Under official control (regional). Present in Qld (APPD 2022) Regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).	No. This species is a known pest of citrus and feeds primarily on leaves (Ministry of Jihad-e-Agriculture 2014). Rose, DeBach and Woolley (1981) note that adults have been known to feed and lay eggs on fruit. Furthermore, this study also notes that the presence of this species results in large amounts of honeydew and sooty mould. Given this, and that feeding damage is evident, the pests and affected fruit will likely be removed from the pathway during standard packing house practices.	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Paracoccus marginatus</i> Williams and Granara de Willink, 1992 [Pseudococcidae] Papaya mealybug	Yes (García Morales et al. 2022; Mani, Shivaraju & Shylesha 2012)	No records found	Yes. <i>Paracoccus marginatus</i> feeds on a wide range of host plants, including citrus, and can be found on the fruit of hosts (CABI 2022a).	Yes. Assessed in the mealybugs Group PRA.	Yes. Assessed in the mealybugs Group PRA	Yes (GP)
<i>Parlatoria cinerea</i> Hadden ex Doane & Hadden, 1909 [Diaspididae] Tropical grey chaff scale	Yes (García Morales et al. 2022; Miller 1996)	No records found	Yes. This species is known to feed on citrus (Ramos-Portilla & Caballero 2017), including Persian lime (García Morales et al. 2022). It can feed on fruit of hosts, with damage becoming obvious as the fruit matures (Gerson & Applebaum 2022). Scales may not be removed during packing house procedures.	Yes. Assessed in scales Group PRA (DAWE 2021).	Yes. Assessed in scales Group PRA (DAWE 2021).	Yes (GP)
<i>Parlatoria pergandii</i> Comstock, 1881 [Diaspididae] Chaff scale	Yes (CABI 2022a; García Morales et al. 2022; Miller 1996)	Yes. Under official control (regional). Present in NT, Qld, Vic. (APPD 2022)  Regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).	Yes. <i>Parlatoria pergandii</i> was collected from <i>Citrus latifolia</i> leaves during a survey in Brazil. <i>Citrus latifolia</i> is considered to be a host (Bock & Tarrago 1995). Although no reports of this species feeding on <i>Citrus latifolia</i> fruit have been identified, it is known to feed on other citrus fruit (García Morales et al. 2022; Watson 2022). Scales may not be removed during packing house procedures.	Yes. Assessed in the scales Group PRA (DAWE 2021).	Yes. Assessed in the scales Group PRA (DAWE 2021).	Yes (GP, WA)

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pinnaspis aspidistrae</i> (Signoret, 1869) [Diaspididae] Fern scale	Yes (García Morales et al. 2022; Miller 1996)	Yes. Under official control (regional). Present in NSW, NT, Qld, SA (APPD 2022)  Regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).	Yes. This species is known to feed on <i>Citrus</i> spp. (García Morales et al. 2022), including <i>Citrus latifolia</i> (Cassino & Rodrigues 2005). It is usually found on leaves but may be present on fruit of hosts (Miller & Davidson 2005) and is occasionally intercepted on citrus fruit in trade (Suh 2016). Scales may not be removed during packing house procedures.	Yes. Assessed in the scales Group PRA (DAWE 2021).	Yes. Assessed in the scales Group PRA (DAWE 2021).	Yes (GP, WA)
<i>Pseudaonidia trilobitiformis</i> (Green, 1896) [Diaspididae] Trilobite scale	Yes (Miller & Davidson 2005)	Yes. Under official control (regional). Present in NT, Qld (APPD 2022)  Regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).	Yes. <i>Pseudaonidia trilobitiformis</i> is known to feed on <i>Citrus</i> spp. (García Morales et al. 2022) and has been recorded on <i>Citrus latifolia</i> fruit (Mille et al. 2016). Scales may not be removed during packing house procedures.	Yes. Assessed in the scales Group PRA (DAWE 2021).	Yes. Assessed in the scales Group PRA (DAWE 2021).	Yes (GP, WA)
<i>Pseudococcus maritimus</i> (Ehrhorn, 1900) [Pseudococcidae] Grape mealybug	Yes (García Morales et al. 2022)	No records found	Yes. <i>Pseudococcus maritimus</i> is a polyphagous species and mainly a pest of grapes but citrus species are a host (García Morales et al. 2022). Feeding occurs primarily on the leaves of host plants (García Morales et al. 2022), but it has been intercepted on citrus fruit in trade (Suh 2019).	Yes. Assessed in the mealybugs Group PRA (DAWR 2019).	Yes. Assessed in the mealybugs Group PRA (DAWR 2019).	Yes (GP)

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Saissetia neglecta</i> De Lotto, 1969 [Coccidae] Caribbean black scale	Yes (García Morales et al. 2022; Myartseva, Ruiz-Cancino & Coronado-Blanco 2004)	Yes. Under official control (regional). Present in Qld (APPD 2022)  Regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).	No. <i>Citrus</i> spp. are hosts of <i>Saissetia neglecta</i> (García Morales et al. 2022), which is a pest of citrus production (Fasulo & Brooks 2010; Mossler & Nesheim 2010). <i>Saissetia neglecta</i> early instars feed on leaves, but later migrate to small twigs, particularly those bearing fruit (Fasulo & Brooks 2010). The Coccidae do not typically feed on citrus fruit (Gill 1997). No reports suggesting a likely association with fruit have been found.	Assessment not required	Assessment not required	No
<i>Singhiella citrifolii</i> (Morgan, 1893) [Aleyrodidae] Cloudy winged whitefly	Yes (CABI 2022a; Evans 2007)	No records found	No. This species feeds on the underside of leaves of its hosts (CABI 2022a). No records of presence on fruit have been found.	Assessment not required	Assessment not required	No
<i>Toxoptera aurantii</i> (Boyer de Fonscolombe, 1841)  Synonym: <i>Aphis aurantii</i> (Boyer de Fonscolombe, 1841) [Aphididae] Camellia aphid	Yes (CABI 2022a; Cortez-Madrigal et al. 2003)	Yes. NSW, NT, Qld, Tas., Vic., WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Toxoptera citricida</i> (Kirkaldy, 1907) Synonym <i>Toxoptera citricidus</i> [Aphididae] Brown citrus aphid	Yes (CABI 2022a; Yokomi 2009)	Yes. NSW, Qld, Tas. (APPD 2022).  However, this species is known to be a potential vector of <i>Citrus tristeza virus</i> (CTV) (CABI 2022a). Some CTV strains are absent from Australia and of quarantine concern.	No. <i>Toxoptera citricida</i> feeds on the leaves and stems of citrus plants and it is not associated with mature fruit, so is unlikely to be present on lime fruit when it is harvested (CABI 2022a). If aphids were present on lime fruit entering the packing house, they would be removed by washing, brushing and waxing of the fruit prior to packing for export.	Assessment not required	Assessment not required	No
<i>Unaspis citri</i> (Comstock, 1883) [Diaspididae] Citrus snow scale	Yes (Bautista-Martinez et al. 1998; CABI 2022a)	Yes. Under official control (regional). Present in NSW, NT, Qld (APPD 2022)  Regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).	Yes. Citrus snow scale is a pest of <i>Citrus latifolia</i> (SENASICA 2017). It primarily feeds on the trunk and tree limbs of older citrus trees but may also be found on leaves and fruit during high infestation levels (Buckley & Hodges 2013). Scales may not be removed during packing house procedures.	Yes. Assessed in the scales Group PRA (DAWE 2021).	Yes. Assessed in the scales Group PRA (DAWE 2021).	Yes (GP, WA)
<b>Lepidoptera</b>						
<i>Amorbia cuneana</i> (Walsingham, 1879) [Tortricidae] Western avocado leafroller	Yes (Gilligan & Epstein 2014; Juárez-Gutiérrez et al. 2015)	No records found	No. Eggs are laid on the upper surfaces of leaves (Oatman & Platner 1985). <i>Amorbia cuneana</i> feeds predominantly on leaves, occasional feeding on fruit causes scarring and is accompanied by obvious webbing (Gilligan & Epstein 2014), leaving fruit unmarketable. Feeding damage is obvious and infested fruit likely to be removed during packing house procedures.	Assessment not required	Assessment not required	No

<b>Pest</b>	<b>Present in Mexico</b>	<b>Present within Australia</b>	<b>Potential to enter on pathway</b>	<b>Potential for establishment and spread</b>	<b>Potential for economic consequences</b>	<b>Pest risk assessment required</b>
<i>Amyelois transitella</i> Walker, 1863 [Pyralidae] Navel orangeworm	Yes (Lara-Villalón et al. 2017; Parra-Pedrazzoli & Leal 2006)	No records found	No. This species causes surface damage to citrus fruits (Business Queensland 2019). Eggs are laid on the skin of damaged citrus fruit, near or in splits (Wade 1961) Damaged fruit are likely to be removed during harvest and standard packing house practices.	Assessment not required	Assessment not required	No
<i>Clepsis peritana</i> (Clemens, 1860) [Tortricidae] Garden tortrix	Yes (Gilligan & Epstein 2009)	No records found	No. This species feeds mostly on dead and decaying leaves and constructs obvious silk tubes to inhabit (Gilligan & Epstein 2014).	Assessment not required	Assessment not required	No
<i>Cryptoblabes gnidiella</i> Millière, 1867 [Pyralidae] False blossom moth	Yes (Molet 2016)	No records found	No. Larvae may feed on the rind of immature fruit, causing premature yellowing and fruit drop (Silva & Mexia 1999). While this species can be found on lime species, the larvae spin obvious webbing (Stout 1982) and infested fruit is likely to be removed during harvesting and standard packing house practices.	Assessment not required	Assessment not required	No



Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Marmara gulosa</i> Guillén & Davis, 2001 [Gracillariidae] Citrus peelminer	Yes (Guerrero et al. 2012a; Kirkland 2009)	No records found	Yes. Eggs can be laid on the surface of fruit (Grousset et al. 2016) and are less than 1 mm across (Guerrero et al. 2012a). Larvae bore into the epidermal layer of the fruit peel (Stelinski 2019).	Yes. <i>Marmara gulosa</i> has a wide host range, which includes all citrus species, apple, cherry, cotton, olive, and plum (Grousset et al. 2016; Guerrero et al. 2012a), which are wide spread in Australia. This species is widespread in the tropical regions of North America (Guerrero et al. 2012a) in climates similar to parts of Australia.	Yes. Larval feeding produces cosmetic damage in fruit skin, making the fruit unmarketable (Grousset et al. 2016).	Yes
<i>Papilio cresphontes</i> Cramer, 1777 [Papilionidae] Eastern giant swallowtail	Yes (Encyclopedia of Life 2022)	No records found	No. This species primarily feeds on leaves of citrus trees (Fadamiro et al. 2010) and eggs are also laid on the leaves (Encyclopedia of Life 2022).	Assessment not required	Assessment not required	No
<i>Phyllocnistis citrella</i> Stainton, 1856 [Gracillariidae] Citrus leaf miner	Yes (Bautista-Martinez et al. 1998)	Yes. NSW, NT, Qld (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Platynota stultana</i> Walsingham, 1884 [Tortricidae] Omnivorous leafroller	Yes (Brown 2004; Groenen & Baixeras 2013)	No records found	No. This species is known to be highly polyphagous and larvae feed on leaves, buds and developing fruits (Bentley et al. 2008; Groenen & Baixeras 2013) from within webbed-together leaves (Bentley et al. 2008; Gilligan & Epstein 2014). Webbing is visibly obvious and infested fruit will likely be removed during harvesting or during standard packing house practices.	Assessment not required	Assessment not required	No
<b>Thysanoptera</b>						
<i>Caliothrips fasciatus</i> (Pergande, 1895) [Thripidae] Californian bean thrips	Yes (Hoddle 2006). (ThripsWiki 2022)	No records found	Yes. While <i>Caliothrips fasciatus</i> does not feed on citrus, it can be present in citrus orchards, often migrating from neighbouring weed hosts or legume crops. This species is known to take shelter within the navels of orange and mandarin fruit (Guerrero et al. 2012b; Rugman-Jones et al. 2012). Thrips could be present on harvested lime fruit, sheltering under the calyx, and these thrips may not be removed in the packing house.	Yes. Assessed in the thrips Group PRA (DAWR 2017).	Yes. Assessed in the thrips Group PRA (DAWR 2017).	Yes (GP)

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Frankliniella bispinosa</i> (Morgan, 1913) [Thripidae] Florida flower thrips	Yes (Guerrero et al. 2012a)	No records found	Yes. <i>Frankliniella bispinosa</i> is known to be associated with Tahitian (Persian) lime (Childers et al. 1990). This species mainly feeds on the flowers and buds of citrus hosts (Guerrero et al. 2012a). Feeding on young fruit results in scarring of tissues near the stem (Guerrero et al. 2012a). This thrips can be present in the orchard all year round, and although they feed exclusively on flowers and developing fruit, both adults and larvae can be found on mature fruit, twigs and leaves (Childers & Nakahara 2006). Thrips could be present on harvested lime fruit, sheltering under the calyx, and these thrips may not be removed in the packing house.	Yes. Assessed in the thrips Group PRA (DAWR 2017).	Yes. Assessed in the thrips Group PRA (DAWR 2017).	Yes (GP)

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Scirtothrips citri</i> (Moulton, 1909) [Thripidae] California citrus thrips	Yes (CABI 2022a)	No records found	Yes. <i>Scirtothrips citri</i> is a pest in Persian lime orchards (Almaguer-Vargas & Ayala-Garay 2014). It is known to feed on immature citrus fruit, causing scarring of fruit tissue (Guerrero et al. 2012a). Eggs are laid into soft young tissues, including immature fruit (EFSA Panel on Plant Health (PLH) et al. 2018). <i>Scirtothrips citri</i> can overwinter in the egg stage (Lewis 1973), but there is no information to suggest they can successfully hatch from mature fruit. <i>Scirtothrips citri</i> does not feed on mature citrus fruit and would not typically be present on fruit at the time of harvest, so commercial fruit is an unlikely entry pathway for this pest (EFSA Panel on Plant Health (PLH) et al. 2018). It is possible that thrips could occasionally be present on harvested fruit sheltering under the calyx, and these thrips may not be removed in the packing house.	Yes. Assessed in the thrips Group PRA (DAWR 2017).	Yes. Assessed in the thrips Group PRA (DAWR 2017).	Yes (GP)

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b>Trombidiformes</b>						
<i>Brevipalpus californicus</i> (Banks, 1904) [Tenuipalpidae] Citrus flat mite	Yes (Beltran-Beltran et al. 2020; García-Escamilla et al. 2018; Salinas-Vargas et al. 2016; Sánchez-Velázquez et al. 2015)	Yes. NSW, NT, Vic., WA (APPD 2022)  However, this species is known to be a potential vector of <i>Orchid fleck dichoravirus</i> – <i>Citrus strain</i> (OFV-citrus) (Dietzgen et al. 2018), which is not present in Australia.	Yes. <i>Brevipalpus californicus</i> infests fruits and leaves of Persian limes in Mexico (Beltran-Beltran et al. 2020; Salinas-Vargas et al. 2013; Salinas-Vargas et al. 2016). <i>Brevipalpus californicus</i> feeds directly on citrus fruit and the population increases as fruit matures (Mata et al. 2010). Unlike spider mites, tenuipalpid mites have flattened bodies (Vacante 2016) that keep them closer to the fruit surface. Immature <i>Brevipalpus</i> mites are known to anchor themselves to the host (Childers, French & Rodrigues 2003; Haramoto 1966; Vacante 2016). <i>Brevipalpus</i> mites may not be removed during packing house processes (Peña et al. 2015).	<i>Brevipalpus californicus</i> is already successfully established in Australia. However, the quarantine virus OFV-citrus vectored by <i>B. californicus</i> has potential for establishment and spread in Australia as hosts of the virus, such as <i>Citrus</i> , is present in many parts of Australia.	Not applicable to vector. However, OFV-citrus vectored by <i>B. californicus</i> has potential for economic consequences.	Assessed as a regulated article in the citrus leprosis PRA.

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Brevipalpus obovatus</i> Donnadieu, 1875 [Tenuipalpidae] Privet mite	Yes. There are numerous records of <i>B. obovatus</i> being present in Mexico. However, some historical host association and distributional data for <i>B. obovatus</i> could be erroneous as it has been regularly misidentified as <i>B. phoenicis</i> s. lat. or vice versa (Beard et al. 2015b).  Taxonomy of the <i>Brevipalpus phoenicis</i> species complex has been reviewed (Beard et al. 2015b) and some specimens previously assigned as <i>B. obovatus</i> have been redescribed. <i>Brevipalpus obovatus</i> has previously been reported as present in Mexico (CABI EPPO 1988).	Yes. NSW, Vic., WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Brevipalpus papayensis</i> Baker, 1949 [Tenuipalpidae] False spider mite	Yes (Sánchez-Velázquez et al. 2015)	Yes. Qld (Beard et al. 2015b). However, this species is known to be a potential vector of <i>Citrus leprosis virus C</i> (CiLV-C) (Ferreira et al. 2020), which is not present in Australia.	Yes. <i>Citrus latifolia</i> is a host of <i>B. papayensis</i> , and the mite has been collected from citrus fruit (Beard et al. 2015b). <i>Brevipalpus</i> mites are known to anchor themselves to the host (Childers, French & Rodrigues 2003; Haramoto 1966; Vacante 2016). <i>Brevipalpus</i> mites may not be removed during packing house processes (Peña et al. 2015).	<i>Brevipalpus papayensis</i> is already successfully established in Australia. However, the quarantine virus CiLV-C, which can be vectored by <i>B. papayensis</i> has potential for establishment and spread in Australia as hosts of the virus, such as citrus and common bean, are present in many parts of Australia.	Not applicable to vector. However, the virus CiLV-C vectored by <i>B. papayensis</i> has potential for economic consequences.	Assessed as a regulated article in the citrus leprosis PRA.
<i>Brevipalpus phoenicis</i> sensu stricto (Geijskes, 1939) [Tenuipalpidae] Red and black flat mite	No records found There are numerous records of <i>B. phoenicis</i> in Mexico. In a recent taxonomic review, Beard et al. (2015b) considered that <i>B. phoenicis</i> s. lat. is a species complex made up of 8 species, including 4 new mite species redescribed from specimens previously identified as <i>B. phoenicis</i> s. lat. or <i>B. obovatus</i> . <i>Brevipalpus phoenicis</i> sensu stricto is not recognised as present in Mexico (Beard et al. 2015b; Roy et al. 2015a).	Historically this species was recorded in NT, NSW, Qld, SA, Vic., WA (APPD 2022; Smiley & Gerson 1995). However, <i>Brevipalpus phoenicis</i> sensu stricto is not currently recognised as present in Australia (Beard et al. 2015b).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Brevipalpus yothersi</i> Baker, 1949 [Tenuipalpidae] Flat mite	Yes (Beltran-Beltran et al. 2020; García-Escamilla et al. 2018; Salinas-Vargas et al. 2016; Sánchez-Velázquez et al. 2015)	Yes. NT, Qld, WA (Akyazi, Ueckermann & Liburd 2017; Beard et al. 2015b)  However, this species is known to be a vector of <i>Citrus leprosis virus C</i> (CiLV-C) and <i>Orchid fleck</i> strain (OFV-citrus) (Beltran-Beltran et al. 2020), which are not present in Australia.	Yes. <i>Brevipalpus yothersi</i> infects fruits and leaves of Persian limes in Mexico (Akyazi, Ueckermann & Liburd 2017; Beard et al. 2015b; Beltran-Beltran et al. 2020; Salinas-Vargas et al. 2016). <i>Brevipalpus</i> mites feed directly on citrus fruit and increases in number as fruit matures (Mata et al. 2010). Maximum density of 10–20 mites per fruit has been reported (Mata et al. 2010). Unlike spider mites, tenuipalpid mites have flattened bodies (Vacante 2016) that keep them closer to the fruit surface, and immature <i>Brevipalpus</i> species are known to anchor themselves to the host (Haramoto 1966; Vacante 2016). <i>Brevipalpus</i> mites are capable of remaining on fruit and may not be removed during standard packing house processes (Peña et al. 2015).	<i>Brevipalpus yothersi</i> is already successfully established in Australia. However, the quarantine viruses CiLV-C and OFV-citrus, which are vectored by <i>B. yothersi</i> , have potential to establish and spread in Australia as hosts of the viruses, such as <i>Citrus</i> , are present in parts of Australia. <i>Brevipalpus yothersi</i> is capable of retaining and spreading <i>Citrus leprosis virus</i> for up to 10 days after virus acquisition (Tassi et al. 2017).	Not applicable to vector. However, OFV-citrus vectored by <i>B. yothersi</i> has potential for economic consequences.	Assessed as a regulated article in the citrus leprosis PRA



Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Eotetranychus lewisi</i> (McGregor, 1943) [Tetranychidae] Lewis spider mite	Yes (Vacante 2010)	No records found	No. <i>Eotetranychus lewisi</i> is known to preferentially feed on immature citrus fruit causing visible surface scarring on the rind (Vacante 2010). Eggs are laid in surface depressions of citrus fruit (EPPO 2022). It is unlikely to be present on mature fruit at the time of harvest (Jeger et al. 2017a). Research on postharvest treatments considered postharvest washing, brushing and waxing to be effective in dislodging spider mites from infested citrus fruit (Jeger et al. 2017a). There is no history of interceptions of <i>E. lewisi</i> linked to trade in citrus fruit (Jeger et al. 2017a).	Assessment not required	Assessment not required	No
<i>Eotetranychus yumensis</i> (McGregor, 1934) [Tetranychidae] Yuma spider mite	Yes (Vacante 2010)	No records found	No. No reports associating this species with <i>Citrus latifolia</i> have been identified. This mite primarily feedson the underside of citrus leaves, but can move onto the fruit in high infestations (Kerns, Wright & Loghry 2004b; Vacante 2010). Although present in Mexico, it prefers arid desert regions (Jeppson, Keifer & Baker 1975; Vacante 2009), so is unlikely to be found in lime growing regions.	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Eutetranychus banksi</i> (McGregor, 1914) [Tetranychidae] Texas citrus mite	Yes (Flechtman & Baker 1970)	No records found	No. This mite can be a pest of <i>Citrus latifolia</i> (Rocha Da Silva et al. 2017). There is no information to suggest it is prevalent in lime orchards in Mexico, perhaps due to its preference for dry conditions with low relative humidity (Vacante 2010). While it typically feeds on the upper leaf surface, it can infest citrus fruit (Muma 1965) and will occasionally feed on the rind of citrus fruit if mite densities are high (Kerns, Wright & Loghry 2004a; Rocha Da Silva et al. 2017). In-field pest management practices are likely to reduce the presence of <i>E. banksi</i> in the orchard as it is highly susceptible to pesticide spraying (Rocha Da Silva et al. 2017).	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Lorryia formosa</i> Cooreman, 1958 [Tydeidae] Yellow mite	Yes (Ueckermann & Smith-Meyer 1979)	No records found	Yes. Although this species is found on citrus fruit (Aguilar, Childers & Welbourn 2001), it typically feeds on sooty mould growing on the fruit surface, rather than the fruit itself (Glime 2017; Mendel & Gerson 1982).	Yes. This species is often found on <i>Citrus</i> spp., but also on other hosts that are common in Australia including <i>Gardenia</i> spp. and <i>Capsicum annuum</i> (Monjarás-Barrera et al. 2021). It is capable of reproducing via thelytokous parthenogenesis, producing female offspring from unfertilised eggs (Hernandes, Feres & Nomura 2006), increasing the likelihood of successful establishment.	No. <i>Lorryia formosa</i> feeds on fungi and pollen (Wiggers et al. 2005), but considered unlikely to have any discernible impacts on the environment. Historic reports suggesting that this mite may be phytophagous are erroneous (Wiggers et al. 2005). It is considered to be a beneficial species as it reduces development of sooty mould (Mendel & Gerson 1982).	No
<i>Oligonychus peruvianus</i> (McGregor, 1917) [Tetranychidae]	Yes (Vacante 2010)	No records found	No. This species feeds on the undersides of leaves (Vacante 2009) and no records of it feeding on fruit have been found.	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Panonychus citri</i> (McGregor, 1916) [Tetranychidae] Citrus red mite	Yes (SENASICA 2017)	Yes. Under official control (regional). Present in NSW (APPD 2022; Gutierrez & Schicha 1983; Halliday 2019)  Domestic restrictions for the movement of host material of this pest into Vic. and SA only include planting material, not fruit (DJPR 2019; PIRSA 2019).  Regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).	Yes. The citrus red mite is a pest of <i>Citrus latifolia</i> (Childers & Abou-Setta 1999) that feeds on leaves and fruit, resulting in pale stippling of the rind (Smith, Beattie & Broadley 1997). Most mites will be removed by packinghouse procedures prior to export, but some mites could still be present if sheltering under the calyx (EFSA 2008).	Yes. <i>Panonychus citri</i> is distributed throughout the world including Asia, Europe, Africa and North and South America (Bolland, Gutierrez & Flechtmann 1998; Migeon & Dorkeld 2017). This species has already established around Sydney in eastern Australia. Suitable host plants, including citrus, apple, avocado, rose, almond, pear, peach, cherry and several broadleaf evergreen ornamentals (Alford 2007; Bolland, Gutierrez & Flechtmann 1998; Shinkaji 1979), are common in many parts of Australia.	Yes. <i>Panonychus citri</i> has a wide host range, although damage is mostly limited to citrus (EFSA 2008). High levels of attack before fruit maturity may cause fruit drop (Vacante 2010).	Yes (WA)
<i>Phyllocoptruta oleivora</i> (Ashmead, 1879) [Eriophyidae] Citrus rust mite	Yes (Landeros et al. 2003)	Yes. NT, NSW (APPD 2022), WA (Government of Western Australia 2022)	Assessment not required	Assessment not required	Assessment not required	No
<i>Polyphagotarsonemus latus</i> (Banks, 1904) [Tarsonemidae] Broad mite	Yes (Valencia-Domínguez et al. 2011)	Yes. NT, NSW, Qld, SA, Vic., WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Tenuipalpus sanblasensis</i> De Leon, 1957 [Tenuipalpidae]	Yes (Vacante 2010)	No records found	No. There is little information about this species. It has been collected on citrus in Mexico (Vacante 2010), but its pest status is unknown. No records of its presence on <i>Citrus latifolia</i> fruit have been found.	Assessment not required	Assessment not required	No
<i>Tetranychus gloveri</i> Banks, 1900 [Tetranychidae] Cotton red spider mite	Yes (Vacante 2010)	Yes. NT, Qld (QDAF 2014)	Assessment not required	Assessment not required	Assessment not required	No
<i>Tetranychus mexicanus</i> (McGregor, 1950) [Tetranychidae]	Yes (Vacante 2010)	No records found	No. This species feeds exclusively on leaves and does not feed on fruit (da Silva et al. 2016; Quiros-Gonzalez 2000).	Assessment not required	Assessment not required	No
<i>Tetranychus pacificus</i> McGregor, 1919 [Tetranychidae] Pacific mite	Yes (CABI 2022a; Vacante 2010)	No records found	No. This species is known to be a minor pest of citrus in Mexico (Vacante 2010). This mite feeds on leaves and stems of host plants (CABI 2022a), and no reports indicating an association with mature lime fruit have been identified.	Assessment not required	Assessment not required	No
<i>Tetranychus urticae</i> Koch, 1835 [Tetranychidae] Two-spotted spider mite	Yes (CABI 2022a)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b>BACTERIA</b>						
' <i>Candidatus</i> Liberibacter asiaticus' Jagoueix et al., 1994 (CLas) [Rhizobiales: Phyllobacteraceae] Huanglongbing (HLB)/citrus greening	Yes (Flores-Sánchez et al. 2011)	No records found	Yes. <i>Candidatus</i> Liberibacter asiaticus infects <i>Citrus latifolia</i> in Mexico (Flores-Sánchez et al. 2011; Flores-Sánchez et al. 2015; Flores-Sánchez et al. 2017). Although HLB symptoms were visible on lime leaves in Mexico, fruits were asymptomatic (Flores-Sánchez et al. 2015). As HLB is a systemic infection, citrus fruit sourced from infected plants may carry the bacterium. Ding et al. (2015) confirmed the presence of CLas in the phloem vessels of the peduncle, receptacle and seed coat of sweet orange fruit.	No. It is not considered feasible for <i>Candidatus</i> Liberibacter asiaticus to spread from infected fruit to a suitable host plant without a vector. <i>Candidatus</i> Liberibacter asiaticus is spread via the vectors <i>Diaphorina citri</i> and <i>Trioza erytreae</i> (Suaste-Dzul et al. 2017). Both vectors are absent from Australia, significantly reducing the likelihood of transmission of the bacterium from infected imported limes. In addition, seed transmission of HLB in citrus has not been proven (Hilf & Lewis 2016), and <i>Citrus latifolia</i> typically does not have seeds. It is considered highly unlikely <i>Candidatus</i> Liberibacter asiaticus will be able to spread from an infected imported lime fruit to suitable hosts in Australia.	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Xanthomonas citri</i> subsp. <i>citri</i> (Gabriel et al., 1989) Schaad et al., 2007 Synonyms: <i>Xanthomonas axonopodis</i> pv. <i>citri</i> (Hasse) Vauterin et al., 1995 <i>Xanthomonas citri</i> (ex Hasse, 1915) Gabriel et al., 1989 <i>Xanthomonas campestris</i> pv. <i>citri</i> (Hasse) Dye, 1978 [Xanthomonadales: Xanthomonadaceae] Citrus canker ('XCC'); Asiatic canker	Transient, actionable, and under eradication (EPPO Reporting Service 2020). <i>Xanthomonas citri</i> was detected on four <i>Citrus aurantiifolia</i> trees growing in a non-commercial area in April 2020 (EPPO Reporting Service 2020; NAPPO 2020) during surveillance activities conducted by the National System for Phytosanitary Epidemiological Surveillance in Mexico. Currently under eradication and controls implemented to prevent spread.	No, eradicated. Citrus canker was detected in Darwin, NT, in April 2018, and in northern WA in May 2018. Following extensive surveillance, tracing and destruction activities throughout 2018 and 2019, WA was officially declared free of citrus canker on 22 November 2019 (DPIRD 2019) and NT was officially declared free on 12 April 2021 (Northern Territory Government 2021).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Xylella fastidiosa</i> subsp. <i>fastidiosa</i> Schaad et al., 2009 [Xanthomonadales: Xanthomonadaceae] Pierce's disease Almond leaf scorch	Yes. Restricted distribution and under official control (SENASICA 2017). <i>Xylella fastidiosa</i> subsp. <i>fastidiosa</i> has been recorded on grapevines in the states of Baja California, Coahuila and in the municipality of Ezequiel Montes (Querétaro state) in Mexico (SENASICA 2017). However, there are no records of the bacterium infecting <i>Citrus</i> spp. in Mexico. The subspecies which mainly infects <i>Citrus</i> spp. ( <i>Xylella fastidiosa</i> subsp. <i>pauca</i> ) causing Citrus Variegated Chlorosis is absent in Mexico (SENASICA 2016).	No records found	No. <i>Xylella fastidiosa</i> subsp. <i>fastidiosa</i> mainly causes Pierce's disease in grapevines and almond leaf scorch in almond. Although it was considered by some authors citrus could be an alternative host of this species (Hopkins 1989), there is no scientific evidence suggesting it causes disease on any citrus species, including <i>Citrus latifolia</i> . Fruit is not considered to be a pathway for introduction of <i>Xylella fastidiosa</i> , as transmission from infected fruit to new hosts is deemed unlikely (EFSA 2015).	Assessment not required	Assessment not required	No
<b>CHROMALVEOLATA</b>						
<i>Phytophthora citrophthora</i> (R.E. Sm. & E.H. Sm.) Leonian [Peronosporales: Peronosporaceae] Collar rot/ <i>Phytophthora</i> root rot	Yes (CABI 1995)	Yes. NSW, Qld, SA, Vic., WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No



Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Phytophthora nicotianae</i> Breda de Haan [Peronosporales: Peronosporaceae] Synonym: <i>Phytophthora parasitica</i> Dastur; <i>Phytophthora nicotianae</i> var. <i>parasitica</i> (Dastur) G.M. Waterhouse Citrus gummosis/ Brown rot	Yes (Acosta-Pérez et al. 2012)	Yes. NSW, NT, Qld, SA, Vic., WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No
<b>FUNGI</b>						
<i>Alternaria alternata</i> (Fr.) Keissl. Synonym: <i>Alternaria tenuis</i> Nees [Pleosporales: Pleosporaceae] Alternaria leaf spot	Yes (Espinoza-Verduzco et al. 2012).	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Alternaria limicola</i> E.G. Simmons & M.E. Palm [Pleosporales: Pleosporaceae] Mancha foliar	Yes (David 1995; Farr & Rossman 2022; Palm & Civerolo 1994; Simmons 1990)	No records found	No. While this fungus is known to infect <i>Citrus latifolia</i> in Mexico (Farr & Rossman 2022; Palm & Civerolo 1994), it is primarily a pathogen of young shoots and leaves (Palm & Civerolo 1994; Simmons 1990). Small raised lesions are produced on fruit, which disappear as the fruit develops (Akimitsu, Peever & Timmer 2003; Timmer et al. 2003). In-field pest management practices applied in Mexico, are likely to control this pest on lime plants. Furthermore, it is very unlikely that there will infectious spores associated with fruit at time of harvest.	Assessment not required	Assessment not required	No
<i>Armillaria mellea</i> (Vahl:Fr.) P. Kumm [Agaricales: Physalacriaceae] Armillaria root rot	Yes (Elías-Román et al. 2013; Farr & Rossman 2022)	No. This pest is considered to be absent from Australia. While historic Australian records of this root rot were attributed to <i>A. mellea</i> (Simmonds 1966), Armillaria root rot in Australia is now attributed to <i>Armillaria leuteobubalina</i> (Donovan 2007; Washington 2010).	No. This fungus infects <i>Citrus latifolia</i> (Farr & Rossman 2022). However, it damages root systems, trunks and limbs of citrus trees (Donovan 2007; Farr & Rossman 2022).	Assessment not required	Assessment not required	No
<i>Aspergillus flavus</i> Link:Fr. [Eurotiales: Aspergillaceae]	Yes (Ortega-Beltran & Cotty 2018)	Yes. NSW, Qld, Vic. (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Botryosphaeria dothidea</i> (Moug:Fr.) Ces. & de Not. [Botryosphaeriales: Botryosphaeriaceae]	Yes (Valencia-Botín et al. 2003)	Yes. NSW, Qld, Vic., WA, (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No
<i>Botrytis cinerea</i> Pers. [Helotiales: Sclerotiniaceae]	Yes (Nieto-López et al. 2014)	Yes. NSW, Qld, SA, Tas., Vic., WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No
<i>Capnodium citri</i> Mont. Synonyms: <i>Aithaloderma citri</i> (Briosi & Pass.) Woron; <i>Limacinia citri</i> (Briosi & Pass.) Sacc.) <i>Chaetothyrium citri</i> (G. Arnaud) E.E. Fisher [Capnodiales: Capnodiaceae] Sooty mould	Yes (Farr & Rossman 2022)	No records found	No. Although <i>Capnodium citri</i> has been recorded on <i>Citrus latifolia</i> (Farr & Rossman 2022), it is a sooty mould that grows only on the surface of the host where honeydew from sap-feeding insects is present (Cooke, Persley & House 2009; Reynolds 1999). Limes infested with sooty moulds are likely to be removed through standard packing house practices (Cooke, Persley & House 2009).	Assessment not required.	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Colletotrichum abscissum</i> Pinho & Pereira Synonym: <i>Colletotrichum acutatum</i> Slow-growing orange (SGO) form J.H. Simmonds [Glomerellales: Glomerellaceae] Postbloom fruit drop (PFD)	Yes (Peres et al. 2008)	No records found ' <i>Colletotrichum acutatum</i> ' has been recorded on a number of different plant hosts but not on <i>Citrus</i> (Plant Health Australia 2021).	No. <i>Colletotrichum abscissum</i> has recently been recognised as the main causal agent of postbloom fruit drop (PFD) disease in citrus (Jayawardena et al. 2016; Savi et al. 2019). PFD has been recorded on <i>Citrus latifolia</i> (Peres et al. 2008). It attacks flowers of <i>Citrus latifolia</i> (Peres et al. 2005), causing reddish brown lesions on petals and necrotic lesions on stigmas (Martínez et al. 2009; Savi et al. 2019). <i>Colletotrichum abscissum</i> does not initiate infection of the fruit tissues, but conidia can be splashed from infected flowers and settle on the fruit surface. Conidia are unlikely to be present or remain viable after fruit has been washed, brushed, dried and waxed prior to export.	Assessment not required	Assessment not required	No
<i>Colletotrichum gloeosporioides</i> (Penz.) Penz. & Sacc. Synonym: <i>Glomerella cingulata</i> (Stonem.) Spaulding & H. Schrenk [Glomerellales: Glomerellaceae] Anthracnose	Yes (Farr & Rossman 2022; Munaut, Hamaide & Maraite 2002)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (APPD 2022; Cooke, Persley & House 2009; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Diaporthe citri</i> F.A. Wolf Synonym: <i>Phomopsis citri</i> H.S. Fawc. [Diaporthales: Diaporthaceae]	Yes (Farr & Rossman 2022; Udayanga et al. 2014)	Yes. NSW, Qld, WA (APPD 2022; Government of Western Australia 2022; Hyde & Alcorn 1993; Liang et al. 2007; Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No
<i>Diaporthe foeniculina</i> (Sacc.) D. Udayanga & L.A. Castlebury [Diaporthales: Diaporthaceae]	Yes (Udayanga et al. 2014)	Yes. Qld (Golzar et al. 2012; Simmonds 1966; Udayanga et al. 2014) Tas., Vic., WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No
<i>Diplodia seriata</i> De Not Synonym: <i>Botryosphaeria obtusa</i> (Schwein.) Shoemaker. [Botryosphaeriales: Botryosphaeriaceae]	Yes (Farr & Rossman 2022; Úrbez-Torres et al. 2008)	Yes. NSW, Qld, SA, Tas., Vic., WA, (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Elsinoë fawcettii</i> Bitancourt & Jenkins (pathotypes absent from Australia) [Myriangiales: Elsinoaceae] Citrus scab	Yes. Restricted distribution (EPPO 2022; Gopal et al. 2014)	No. There are exotic pathotypes not known to be present in Australia.  At least 2 pathotypes have been reported in Australia (Tryon's and lemon) (Timmer et al. 1996), which are present in NSW and Qld (APPD 2022).	Yes. <i>Elsinoë fawcettii</i> is known to infect <i>Citrus latifolia</i> , causing fruit blemishes (Gopal et al. 2014). While some cultivars of <i>C. latifolia</i> are rarely affected by <i>E. fawcettii</i> (CABI EPPO 1997), others are highly susceptible (Gopal et al. 2014). The fungus overwinters in scab pustules on the leaves, fruit and twigs (Chung 2011).	Yes. Establishment of exotic pathotypes may only be possible in wet subtropical or cooler tropical parts of Australia, as citrus scab usually does not establish in areas of low rainfall and long, hot summers (Gopal et al. 2014). Some pathovars of the species have already established in cooler, subtropical parts of Australia (Timmer et al. 1996). Natural spread would be slow and localised as plants in the Rutaceae family (mostly <i>Citrus</i> spp.) are the only known hosts (Gopal et al. 2014). The fungus can spread short distances by water splash during rain, overhead irrigation or spraying operations (Gopal et al. 2014; Timmer, Garnsey & Graham 2000). Long distance spread is via the movement of infected host plants for planting and fresh fruit (Gopal et al. 2014; Timmer, Garnsey & Graham 2000).	Yes. Citrus scab affects all <i>Citrus</i> spp. causing economic losses worldwide (Gopal et al. 2014). Due to blemishes, scars and distortions on the fruit, market value is reduced by up to 50% (Chung 2011; Hyun et al. 2009). Losses are largely dependent on local and seasonal variations in the weather and the pathotype involved (Gopal et al. 2014). The disease can affect susceptible rootstock in the nursery, making them stunted, bushy and difficult to bud (Gopal et al. 2014). The fungus can be controlled by using resistant cultivars and application of fungicides (Timmer, Garnsey & Graham 2000; Whiteside 1990).	Yes (EP)

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Eremothecium coryli</i> (Kurtzman) Synonym: <i>Nematospora coryli</i> Peglion [Saccharomycetales: Eremotheciaceae] Citrus dry rot	Yes (EPPO 2022)	Yes. Qld, NSW, (APPD 2022)  Regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).  However, routine visual inspection is not considered to be an adequate measure to verify freedom from this pest, as dry rot-affected citrus fruit display no external symptoms (Cooke, Persley & House 2009). Additionally, there are no specific measures or treatment requirements in place to manage its entry into WA for similar or higher risk hosts or pathways from NSW and Queensland where this pathogen is present (DPIRD 2022).	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium solani</i> (Mart.) Sacc. [Hypocreales: Nectriaceae]	Yes (Morales-Rodríguez, Yañez-Morales & Silva-Rojas 2007)	Yes. NSW, Qld, SA, Tas., Vic., WA (APPD 2022; Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Lasiodiplodia theobromae</i> (Pat.) Griffon & Maubl. Synonym: <i>Botryosphaeria rhodina</i> (Berk. & M.A. Curtis) Arx; <i>Physalospora rhodina</i> (Berk. & Curtis) [Botryosphaeriales: Botryosphaeriaceae]	Yes (Tovar-Pedraza et al. 2013; Úrbez-Torres et al. 2008)	Yes. NSW, NT, Qld, WA, (APPD 2022; Maslen, Collis & Stuart 1996; Qiu et al. 2011; Shivas 1989).	Assessment not required	Assessment not required	Assessment not required	No
<i>Macrophomina phaseolina</i> (Tassi) Goid [Botryosphaeriales: Botryosphaeriaceae]	Yes (Beas-Fernández et al. 2006)	Yes. NSW, NT, Qld, SA, Vic., WA, (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No
<i>Neoscytalidium dimidiatum</i> (Penz.) Crous and Slippers [Botryosphaeriales: Botryosphaeriaceae]	Yes (Fernández-Herrera et al. 2017)	Yes. NT, Qld, WA (APPD 2022; Ray, Burgess & Lanoiselet 2010)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium digitatum</i> Sacc. Synonym: <i>Monilia digiata</i> [Eurotiales: Trichocomaceae]	Yes (CABI 2022a)	Yes. NSW, Qld, SA, Vic, WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium italicum</i> Wehmer [Eurotiales: Trichocomaceae] Blue mould	Yes (Hernández-Montiel et al. 2010)	Yes. NSW, Qld, SA, Vic., WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No



Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Phyllosticta capitalensis</i> Henn. [Botryosphaerales: Botryosphaeriaceae]	Yes (Baayen et al. 2002).	Yes (Miles et al. 2013).	Assessment not required	Assessment not required	Assessment not required	No
<i>Phyllosticta citricarpa</i> (McAlpine) Aa Synonym: <i>Guignardia citricarpa</i> Kiely [Botryosphaerales: Botryosphaeriaceae] Citrus black spot (CBS)	No. Previous reports from Mexico are unreliable and it is now considered absent (EPPO 2022). EU Commission Decision 98/83 of 8 January 1998 recognizes Mexico as free from all strains of <i>Guignardia citricarpa</i> pathogenic to citrus (European Commission 1998).	Yes. NSW, NT, Qld, (APPD 2022; Glienke et al. 2011) Regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022). However, routine visual inspection is not an adequate measure detect this pest in host material, as <i>P. citricarpa</i> has been isolated from asymptomatic lime fruits (Baldassari, Wickert & de Goes 2008), and specific measures are not required for this pest for the movement of fruit or planting material into WA for similar or higher risk hosts or pathways from NSW and Queensland where the pest is present (DPIRD 2022).	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium aphanidermatum</i> (Edson) Fitzp [Pythiales: Pythiaceae]	Yes (Rodriguez-Alvarado et al. 2001)	Yes. NSW, Qld, Vic., WA (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No

<b>Pest</b>	<b>Present in Mexico</b>	<b>Present within Australia</b>	<b>Potential to enter on pathway</b>	<b>Potential for establishment and spread</b>	<b>Potential for economic consequences</b>	<b>Pest risk assessment required</b>
<i>Rhizoctonia solani</i> JG. Kühn Synonym: <i>Thanatephorous cucumeris</i> [Cantharellales: Ceratobasidiaceae]	Yes. (Orozco-Avitia et al. 2013)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (APPD 2022; Carling et al. 2002)	Assessment not required	Assessment not required	Assessment not required	No
<i>Schizophyllum commune</i> (L.) Fr. [Agaricales: Schizophyllaceae] Wood rot	Yes. (Santiago et al. 2016)	Yes. NSW, NT, Qld, SA, Vic., WA, (APPD 2022)	Assessment not required	Assessment not required	Assessment not required	No
<i>Sclerotinia sclerotiorum</i> (Lib.) de Bary [Helotiales: Sclerotiniaceae] Scleronitina stem rot	Yes. (Otto-Hanson et al. 2011)	Yes. NSW, Qld, SA, Tas., Vic., WA (APPD 2022; Kohn et al. 1988)	Assessment not required	Assessment not required	Assessment not required	No
<i>Thielaviopsis basicola</i> (Berk. & Broome) Ferraris [Microascales: Ceratocystidaceae]	Yes (Wheeler & Gannaway 2007)	Yes. NSW, Qld, SA, Tas, Vic., WA (APPD 2022; Mondal, Nehl & Allen 2004)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Zasmidium citri-griseum</i> (F.E. Fisher) U. Braun & Crous Synonyms <i>Mycosphaerella citri</i> Whiteside; <i>Zasmidium citri</i> (Crous) [Capnodiales: Mycosphaerellaceae] Greasy spot	Yes (Mondal et al. 2004)	Yes. Qld (APPD 2022). Regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).	Yes. The pathogen is known to enter citrus fruit via the stomata, causing a blotchy appearance (Mondal & Timmer 2006).	No. The main method of infection of this pathogen is via ascospores produced from pseudothecia – conidia are not considered relevant to infection (Whiteside 1976). The literature points to pseudothecia of this species as being exclusively grown from rotting leaves (Abdelfattah et al. 2017; Kucharek & Whiteside 2000; Mondal et al. 2004; Mondal & Timmer 2002, 2006; Whiteside 1970, 1972). The department is not aware of any information which would suggest that this species can develop pseudothecia from infections of citrus fruit. Therefore, there appears not to be a mechanism for this species to establish in Australia from imported fruit.	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b>PHYTOPLASMAS</b>						
<p><i>Brazilian Huanglongbing disease-associated phytoplasma</i> (BHDA-phytoplasma) (16Sr IX)</p> <p>Pigeon pea witches' broom phytoplasma group – not yet assigned</p> <p>[Acholeplasmatales: Acholeplasmataceae]</p>	Yes (Martínez-Bustamante et al. 2019)	No records found	<p>Yes. BHDA-phytoplasma (16Sr IX) was isolated from <i>C. latifolia</i> trees, showing foliar symptoms similar but contrasting to those caused by <i>Candidatus Liberibacter asiaticus</i> (CLas), responsible for Huanglongbing (HLB) disease. No CLas co-infection was detected and no association of this phytoplasma with fruit or symptomatic fruits were reported (Martínez-Bustamante et al. 2019). However, phytoplasmas inhabit the phloem sieve-tube and can establish systemic infections (Christensen et al. 2005). Asymptomatic lime fruit sourced from BHDA-phytoplasma (16Sr IX) infected plants may carry the phytoplasma. However, the presence of infected symptomatic plants in lime orchard producing export quality fruit is most unlikely due to orchard management practices in place in Mexico (SENASICA 2018).</p>	<p>No. The movement of phytoplasmas from imported fruit to a suitable host would require a vector (Weintraub &amp; Beanland 2006), identified as phloem-sucking leaf hoppers, plant hoppers and psyllids (Bosco et al. 2007). The vector in Mexico has not yet been identified, but the insects collected from orchards where this phytoplasma was isolated (Martínez-Bustamante et al. 2019) are not present in Australia.</p> <p>Additionally, if potential phytoplasma vectors were present in Australia, they would preferentially feed on new flushes of growth (Halbert &amp; Manjunath 2004) rather than on discarded fruit.</p> <p>There is no evidence that phytoplasmas can be seed transmitted in citrus (Jeger et al. 2017c) and <i>Citrus latifolia</i> fruit is typically seedless (Morton 1987).</p>	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
' <i>Candidatus</i> Phytoplasma asteris' (16SrI-B) (HLB symptom associated phytoplasma) [Acholeplasmatales: Acholeplasmataceae]	Yes (Arratia-Castro et al. 2014; Poghosyan, Hernandez-Gonzalez & Lebsky 2015)	No records found. The 16SrI-B phytoplasma is not present in Australia (Gopurenko et al. 2016; Liu et al. 2017). Buckland Valley grapevine yellows phytoplasma from Australia is closely related to the Aster Yellows (AY) phytoplasma group (16SrI), but it is phylogenetically distinguishable from 16SrI-B phytoplasma, and may represent a new phytoplasma group, rather than an AY subgroup (Constable et al. 2002).	Yes. ' <i>Candidatus</i> Phytoplasma asteris' (16SrI-B) was isolated from symptomatic leaf tissues of <i>Citrus latifolia</i> grown in Mexico (Arratia-Castro et al. 2014). It produces Huanglongbing (HLB)-like symptoms on leaves, but not on fruit (Arratia-Castro et al. 2014). There are no reports of its association with the fruit. However, phytoplasmas inhabit the phloem sieve-tube and can establish systemic infections (Christensen et al. 2005). Asymptomatic lime fruit sourced from ' <i>Ca. P. asteris</i> ' (16SrI - B) infected plants may carry the phytoplasma. However, the presence of infected symptomatic plants in lime orchard producing export quality fruit is most unlikely due to orchard management practices in place in Mexico (SENASICA 2018).	No. The movement of phytoplasmas from imported fruit to a suitable host would require a vector (Weintraub & Beanland 2006), such as phloem-sucking leaf hoppers, plant hoppers or psyllids (Bosco et al. 2007). The vector for this phytoplasma has not yet been identified (Arratia-Castro et al. 2014).  Potential vector insects present in Australia would preferentially feed on new flushes of growth (Halbert & Manjunath 2004) rather than on harvested or discarded fruit. Potential vectors are not known to feed on rotting or desiccating fruit.  There is no evidence that phytoplasmas can be seed transmitted in citrus (Jeger et al. 2017c) and <i>Citrus latifolia</i> fruit is typically seedless (Morton 1987).	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b>VIROIDS</b>						
<i>Hop stunt viroid</i> (HSVd) Synonym: <i>Citrus cachexia viroid</i> (CcaVd), <i>Citrus viroid II</i> [Pospiviroidae: <i>Hostuviroid</i> ] Cachexia (formerly Xyloporosis)	Yes (Almeyda-León et al. 2002; Alvarado Gómez et al. 2000)	Yes. Endemic in Australia (Donovan 2022; Gillings, Broadbent & Gollnow 1991).  Regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Citrus exocortis viroid</i> Synonym: <i>Citrus viroid</i> <i>Ila</i> (CVd-IIa) [Pospiviroidae: Pospiviroid] Exocortis	Yes (Almeyda-León et al. 2002; Alvarado Gómez et al. 2000)	Yes. Limited distribution in NSW and Qld (Hardy, Donovan & Barkley 2008; van Brunschot et al. 2014). Regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).	Yes. <i>Citrus exocortis viroid</i> infects <i>Citrus latifolia</i> in Mexico causing severe bark cracking on main branches and trunk, tree deterioration and poor growth (Almeyda-León et al. 2002; Alvarado Gómez et al. 2000). Symptoms on lime fruit have not been recorded. It is also known to establish symptomless infections (Semancik et al. 1988). As the infection is systemic, this viroid could be present in lime fruit.	No. This viroid is primarily spread in infected budwood (Almeyda-León et al. 2002). It is also transmitted mechanically by pruning and harvesting operations (Barbosa et al. 2005) and by grafting (Melgarejo Nárdiz et al. 2010). Although this viroid is seed-borne in some hosts (e.g., grapes, <i>Impatiens</i> , <i>Verbena</i> ), there is no evidence to suggest that <i>Citrus exocortis viroid</i> is seed-borne in citrus (Bar-Joseph 2003, 2015; Duran-Vila & Semancik 2003), and evidence for mechanical transmission from an infected fruit to a susceptible host has not been found. Therefore, the viroid is unlikely to further establish in Australia via the fruit pathway.	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b>VIRUSES</b>						
<i>Citrus leprosis virus C</i> (CiLV-C) [Kitaviridae: <i>Cilevirus</i> ] Citrus leprosis	Yes (García-Escamilla et al. 2018; Hartung et al. 2015; Izquierdo Castillo et al. 2011; Roy et al. 2015a)	No records found	Yes. CiLV-C is reported to infect a number of citrus hosts, including <i>Citrus latifolia</i> (Jeger et al. 2017b; Lovisolo, Colariccio & Masenga 2000). Reports of CiLV-C infecting <i>Citrus latifolia</i> naturally in the field in Mexico have not been identified. However, this virus has been shown to infect <i>C. latifolia</i> by viruliferous mites ( <i>Brevipalpus yothersi</i> ), under specific experimental conditions within a greenhouse. (Rodríguez-Ramírez et al. 2019). As a result of this experiment, it was stated by Rodriguez Ramirez (2019) that CiLV-C has the potential to occur under field conditions but probably under specific yet unknown circumstances.	Yes. CiLV-C is vectored by the mites <i>Brevipalpus yothersi</i> , <i>B. californicus</i> and <i>B. papayensis</i> , which are present in Australia (Beard et al. 2015b; Halliday 2019; Plant Health Australia 2018). The presence of suitable citrus hosts, including sweet orange and mandarin, in many parts of Australia may facilitate establishment of this virus.	Yes. Citrus leprosis is an economically important disease in Brazil (Bastianel et al. 2010), Colombia and Mexico (Roy et al. 2014) and would likely have significant impacts if introduced to Australia. It directly reduces the production and life span of citrus plants (Rodrigues et al. 2003). Significant costs can be incurred controlling citrus leprosis. In Brazil up to \$100 million is invested annually for chemical control of the mite vectors (NAPPO 2015).	Yes



Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<p><i>Citrus tristeza virus</i> (CTV) (Strains absent from Australia/under official control)</p> <p>[Closteroviridae: <i>Closterovirus</i>]</p> <p>Tristeza of citrus</p>	Yes (Herrera-Isidró et al. 2009)	<p>Yes. Sweet orange stem-pitting strain is found in Queensland, and grapefruit stem-pitting strain is widely distributed in Australia (Broadbent, Brlansky &amp; Lindsto 1996).</p> <p>The mandarin stem-pitting strains are absent from Australia.</p> <p>CTV sweet orange stem-pitting strain is regulated as a Declared Pest, Prohibited - s12 by WA under the <i>Biosecurity and Agriculture Management Act 2007</i> (Government of Western Australia 2022).</p>	Yes. <i>Citrus latifolia</i> is a natural host of CTV (Harper 2013; Yokomi 2009). The virus is phloem limited and can be detected in leaves, stems, fruits, and roots (Yokomi 2009).	No. Although the virus can be found on the fruit, CTV is not seed-borne (Dawson et al. 2015; Yokomi 2009), and <i>Citrus latifolia</i> is generally seedless. As mechanical transmission from an infected fruit to a susceptible host has never been demonstrated, this virus is unlikely to establish in Australia through the fruit pathway.	Assessment not required	No

Pest	Present in Mexico	Present within Australia	Potential to enter on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<p><i>Orchid fleck</i>  <i>dichorhavirus – Citrus strain</i> (OFV-citrus/ OFV-Cit1)  Synonyms: <i>Citrus leprosis virus N</i> (CiLV-N), <i>Citrus necrotic spot virus</i> (CiNSV)  [Rhabdoviridae: <i>Dichorhavirus</i>]  Citrus leprosis</p>	<p>Yes (García-Escamilla et al. 2018; Hartung et al. 2015; Roy et al. 2015a; Roy et al. 2014; Roy et al. 2020)  Previous records of <i>Citrus leprosis virus N</i> in Mexico were misidentifications of <i>Orchid fleck dichorhavirus – Citrus strain</i>. These records are now considered to be records of OFV-citrus (Chabi-Jesus et al. 2018; Kondo et al. 2017).</p>	No records found	<p>Yes. <i>Orchid fleck dichorhavirus – Citrus strain</i> infects <i>Citrus latifolia</i> naturally and causes leprosis disease in Mexico (Roy et al. 2015a; Roy et al. 2020). Leprosis is a localised infection which develops on leaves, twigs and fruits of citrus (Alanís-Martínez et al. 2013). The virus has been isolated from localised lesions of citrus fruit (Roy et al. 2015a). This virus is vectored by <i>Brevipalpus</i> mites (adults or nymphs) (Dietzgen et al. 2018; Ramos-González et al. 2017; Rodrigues &amp; Childers 2013; Roy et al. 2013), which could be present on fruit.</p>	<p>Yes. The virus can be transmitted by mites of the genus <i>Brevipalpus</i> in a persistent, circulative manner (Dietzgen et al. 2018). Its natural vectors, <i>B. californicus</i> and <i>B. yothersi</i> (Beltran-Beltran et al. 2020; Dietzgen et al. 2018; García-Escamilla et al. 2018), are widely distributed in Australia (APPD 2022; Beard et al. 2015b). Suitable susceptible host plants, including sweet orange and mandarin (Jeger et al. 2017b), are also widely distributed in Australia.</p>	<p>Yes. Citrus leprosis is an economically important disease in Colombia and Mexico (Roy et al. 2014). It directly reduces the production of citrus plants (Beltran-Beltran et al. 2020). As this virus is considered a quarantine pest for several countries, if established there would be restrictions for international market access (León 2012).</p>	Yes

## Appendix B: Issues raised in stakeholder comments

This section summarises key technical issues raised by stakeholders during consultation on the draft report, and the department's responses. Additional information on other issues commonly raised by stakeholders, which may be outside the scope of this technical report, is available on the department's website.

### **Issue 1: Concerns with the pest categorisation method, which considers production practices and export packing house procedures, resulting in many pests not being fully assessed.**

This risk analysis has been conducted in accordance with Australia's method for pest risk analysis, as outlined in Chapter 2. This method is consistent with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for pest risk analysis* and ISPM 11: *Pest risk analysis for quarantine pests*, and the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (WTO-SPS Agreement). A key step in pest risk analysis is pest categorisation, which can be found at Appendix A in the report.

ISPM 11 states that *'The opportunity to eliminate an organism or organisms from consideration before in-depth examination is undertaken is a valuable characteristic of the categorisation process. An advantage of pest categorisation is that it can be done with relatively little information; however, information should be sufficient to adequately carry out the categorisation'*. In line with ISPM 11, the department utilises the pest categorisation step to screen out some pests from further consideration where appropriate for the Persian lime fruit from Mexico pathway.

It is acknowledged that the wording used in the table, specifically the heading for the 'Potential to be on pathway' column, may have caused confusion. The department is transitioning to a new table format in its risk analyses, which uses more specific phrasing to describe the pathway assessment step. While the new table format has not been fully adopted for this final report, the 'Potential to be on pathway' heading has been changed to 'Potential to enter on pathway' to clarify that we are assessing the potential of a pest being present on Persian lime fruit at the point of importation. While pests have the potential to be on the fruit, the pathway assessment considers whether the pest will be associated at time of importation.

For each pest that is not present in Australia, or is present and under official control, the department assesses its potential to enter on the Persian lime fruit from Mexico pathway. The pathway being assessed reflects the standard of goods reasonably expected to be imported, and this includes the consideration of the standard commercial production practices followed to produce export quality fruit. This means the assessment considers whether pests will be removed in the orchard or on arrival at the packinghouse, whether pests survive export process and transport, or are likely to be able to move off the fruit to a host.

Mexico proposed a well-defined export pathway, including the production system and packing house procedures, which formed the basis for the draft assessment. The draft assessment considered that pests were unlikely to have the potential to be on imported fruit when the commercial production practices were taken into consideration, resulting in a number of pests not being assessed further in a pest risk assessment. However, stakeholders raised concerns the draft report did not provide sufficient transparency to demonstrate how conclusions were reached for pests not having the potential to be on the pathway and that some pests, such as

cryptic pests that could shelter or attach to the calyx, may be able to remain on the pathway even when the in-field pest controls and packing house processes are applied.

Department officers conducted a second visit to Persian lime orchards and packing houses in Veracruz state in August 2022 to confirm the export pathway. The combined risk reduction achieved via initial low pest prevalence in the crop, with packing house procedures including washing, brushing, disinfection, drying, waxing, quality control and phytosanitary inspection prior to export, was confirmed to significantly reduce the likelihood that these pests will be present in exported limes.

However, the department acknowledges stakeholders' concerns that the approach taken for the draft report may not have provided sufficient transparency to demonstrate how these conclusions were reached. Accordingly, the department has reviewed and revised all pest entries in the pest categorisation table to clarify the evidence and arguments supporting the assessment for potential for entry on the pathway. As a result of this review, it was considered that a number of pests should be considered further in a pest risk assessment to provide transparency and demonstrate how the commercial production and packing house processes sufficiently reduce the risk of these pests to an appropriate level. The pests considered further in a pest risk assessment are thrips (*Caliothrips fasciatus*, *Frankliniella bispinosa* and *Scirtothrips citri*), mealybugs (*Dysmicoccus neobrevipes*, *Paracoccus marginatus* and *Pseudococcus maritimus*), scales (*Chrysomphalus dictyospermi*, *Parlatoria cinerea*, *P. pergandii*, *Pinnaspis aspidistrae*, *Pseudaonidia trilobitiformis* and *Unaspis citri*), and a spider mite (*Panonychus citri*).

It is important to note that a number of pests remain pests of biosecurity concern for Australia although they were assessed at the pest categorisation stage as not having the potential to be on the pathway, establish, spread or have economic consequences, or were assessed in the pest risk assessment as achieving the ALOP for Australia. Remedial action will be undertaken if these quarantine pests or regulated articles are detected on arrival. As outlined in Section 5.3 'Uncategorised pests', if a pest species categorised as not having the potential to be on the import pathway, or categorised as on the pathway but assessed as achieving the ALOP for Australia, is detected at on-arrival inspection, it will require re-assessment. The effectiveness of the import conditions at managing pests on the pathway will be reviewed to ensure the specific commercial production practices continue to provide the ALOP for Australia or if additional measures are required.

## **Issue 2: The term 'contaminating pest' is not used consistently in the report.**

The department acknowledges the use of the term 'contaminating pest' in the pest categorisation table may have caused confusion. The definition provided in Section 1.2.4 of the draft report defines contaminating pests as 'pests considered not to be associated with the fruit pathway, pests of other crops, or predators and parasitoids of other crops' (page 6). However, the term 'contaminating pest' was used in the pest categorisation table of the draft report to refer to pests that may be associated with Persian lime fruit but are likely to be removed by in-field pest controls and packinghouse procedures.

Entries have been amended in the final report to remove references to contaminating pests in the pest categorisation table and the assessment for potential association with fruit when in-field pest controls and packing house procedures were taken into consideration has been clarified. Changes have been made to the entries for *Aleurocanthus woglumi*, *Aleurothrixus*

*floccosus*, *Chrysomphalus dictyospermi*, *Diaphorina citri*, *Dysmicoccus neobrevipes*, *Hemiberlesia cyanophylli*, *Homalodisca vitripennis*, *Morganella longispina*, *Paracoccus marginatus*, *Parlatoria cinerea*, *Parlatoria pergandii*, *Pinnaspis aspidistrae*, *Pseudaonidia trilobitiformis*, *Pseudococcus maritimus*, *Unaspis citri*, *Amorbia cuneana*, *Caliothrips fasciatus*, *Frankliniella bispinosa*, *Scirtothrips citri*, *Eotetranychus lewisi*, *Eutetranychus banksi*, *Lorryia formosa*, *Panonychus citri* and *Tetranychus pacificus*.

**Issue 3: Information on the expected volume of trade is not provided, therefore it is not clear how the indicative probabilities were determined.**

The department's risk analyses determine likelihoods that pests will enter Australia in a viable state, be distributed and subsequently transfer to a host, under the implicit assumption that those likelihoods refer to the volume of the commodity likely to be imported in a year of trade. This is described in section 2.2.2 of the report.

Volume of trade is subject to many factors. Ultimately the volumes imported are determined by commercial decisions, which may be influenced by the availability of goods to export, costs of transport and distribution, market competition, regulatory constraints and consumer demand. These factors all affect the unit price and desirability of importing goods. For these reasons, specific data on volumes of trade is not included in the analysis.

As outlined in section 2.2.2, in assessing the volume of trade in this risk analysis, the department assumed that a substantial volume of trade will occur. In the absence of any comparable existing trade it is difficult to estimate the volume of Persian lime fruit that might be imported in any given year from Mexico. For the purposes of estimating risk in the risk analysis, an annual import volume of around 1,000 tonnes was used. This figure was selected because it is a round number, equating to approximately 20 tonnes (or one container) per week. This is a conservative estimate, which is significantly higher than the 550 tonnes per year that Mexico advised they could potentially export.

**Issue 4: Review and clarify why *Alternaria limicola* and *Colletotrichum abscissum* were not considered to be on the pathway and therefore not assessed further in the pest categorisation when they can be associated with citrus fruit.**

After consideration of stakeholder comments, the department has reviewed the assessments for 'potential for entry on pathway' for *Alternaria limicola* and *Colletotrichum abscissum*. For the reasons outlined below, the department considers that *A. limicola* and *C. abscissum* do not have the potential to enter on the Persian lime fruit pathway, and are therefore not considered further in the pest categorisation. Amendments have been made to the 'potential to enter on pathway' entries to explain the rationales for this assessment. Further clarification and explanation to the rationale are detailed below.

***Alternaria limicola***

*Alternaria limicola* primarily causes citrus leaf spot disease (also known as Mancha foliar disease) in Mexican lime (*Citrus aurantiifolia*) but has also been isolated from leaves and twigs of other citrus species. It is a minor pathogen of *Citrus latifolia*, seldom causing significant damage on that host (Timmer et al. 2003). While lesions on immature *Citrus aurantiifolia* fruit have been reported, evidence of infection of fruit in other hosts, including *Citrus latifolia*, is not available.

The department is not aware of evidence indicating latent infection in apparently symptomless fruit. Infection is associated with lesions, particularly the necrotic parts of older lesions (Palm & Civerolo 1994). Production of conidia and sporulation is typically associated with high humidity or light moisture on the surface, which are not conditions usually experienced in transit or storage. *Alternaria* spp. produce relatively few, if any, conidia on mature lesions on fruit (Timmer et al. 2003). If harvested Persian lime fruit are symptomless at the time of export, it is considered unlikely that a latent infection would result in the development of new lesions and produce conidia in transit or along the distribution chain. Infectious spores are unlikely to be present either at the time of harvest, or subsequently after arrival in Australia.

Some fruit may senesce after arrival in Australia if not consumed within a few weeks. However, conditions in retail outlets and the homes and businesses of consumers would not be conducive to initiating spore production. Some *Alternaria* spp. are associated with postharvest rots, but the department is not aware of any reports of fruit rot associated with *Alternaria limicola*. Unconsumed fruit would typically be discarded, with most waste entering municipal waste disposal or home composting systems, which are unlikely to provide conditions suitable for pathogen survival and successful dispersal to new hosts.

### ***Colletotrichum abscisum***

*Colletotrichum abscisum*, responsible for postbloom fruit drop (PFD) disease, is reported from parts of Mexico, and affects all citrus, including *Citrus latifolia* (Peres et al. 2008). The draft report pest categorisation table stated that 'there is no scientific evidence demonstrating that *Colletotrichum abscisum* affects citrus fruit, including *Citrus latifolia*' (page 123). The department acknowledges that, while *Colletotrichum abscisum* does not initiate infection of the fruit tissues, spores of the pathogen could nevertheless potentially be present on the surface of lime fruit harvested from affected orchards.

*Colletotrichum abscisum* infects citrus flower petals, where lesions are formed with acervuli (asexual fruiting bodies) that produce conidia (asexual, non-motile spores of a fungus). Conidia are splashed from these acervuli from petals onto leaves, twigs, fruit and calyxes, where they germinate to form appressoria (flattened and thickened tips of hyphal branches that facilitate penetration of the host plant, only a few cells deep) (Peres et al. 2005; Timmer, Brown & Zitko 1998).

Orchards may contain trees that simultaneously have both flowers and mature fruit ready for harvest. *Colletotrichum abscisum* conidia splashed from infected flower petals could settle on mature lime fruit prior to harvest. However, the likelihood of viable propagules being imported on fresh Persian lime fruit exported from Mexico is considered to be extremely low.

Control measures during production, including the use of fungicides during peak flowering, pruning and irrigation management, reduce the incidence of the pathogen within orchards. After harvest the packing house procedures, which include washing, brushing, disinfection (fungicide treatment), drying and waxing, will significantly reduce the likelihood that viable *C. abscisum* propagules will be present on fruit packed for export. Additionally, in the unlikely event spores were present on imported fruit, there is no obvious transmission pathway for dispersal of spores to a new host.

**Issue 5: Clarity is needed as to why *Citrus leprosis virus C* (CiLV-C), a causal agent of citrus leprosis disease, was not assessed.**

*Citrus leprosis virus C* (CiLV-C) was not assessed further in the initiation stage of the draft report (page 136), as it was considered that there was no reliable host records demonstrating that Persian lime fruit is susceptible to natural infection with CiLV-C. The department has reviewed all relevant literature and acknowledges that despite the limited reports of natural infection in the field, research suggests that *C. latifolia* could have the potential to be infected by CiLV-C by viruliferous mites under specific conditions. Therefore, CiLV-C could potentially be associated with the Persian lime fruit from Mexico pathway.

CiLV-C has been found in at least 25 states in Mexico during routine surveillance, including at least one report from *Citrus latifolia* in Quintana Roo state (Ramírez y Ramírez, SENASICA, pers. comm. 17 December 2020). However, these reports are sporadic, so it should not be assumed CiLV-C is prevalent in production areas. Rodríguez-Ramírez et al. (2019) reported that *C. latifolia* could be infected with CiLV-C by viruliferous *Brevipalpus yothersi* mites in greenhouse experiments and suggested CiLV-C has the potential for infection in the field. Beltran-Beltran et al. (2020) subsequently reported the presence of CiLV-C in mites (*Brevipalpus californicus* and *B. yothersi*) collected from the leaves of 'lime' trees at 7 locations in Mexico. While the study sampled mites from both Persian lime and key lime, the paper did not clearly identify which lime species the viruliferous mites were collected from, so the association of CiLV-C with *C. latifolia* in that study was not certain. However, CiLV-C is known to affect several other citrus species causing citrus leprosis disease.

Based on the weight of evidence, the department has taken a conservative approach as *C. latifolia* does appear to be susceptible to infection by CiLV-C. Therefore, the pest risk assessment for citrus leprosis disease has been revised to include CiLV-C. The inclusion of CiLV-C in a combined assessment for citrus leprosis disease has not resulted in a change to the likelihood risk ratings.

**Issue 6: *Marmara gulosa* (citrus peel miner) should be assessed in the pest categorisation.**

The department acknowledges that *Marmara gulosa* should have been included in the pest categorisation of the draft report. *Marmara gulosa* has been added to the pest categorisation of the final report and was considered as requiring further assessment in a pest risk assessment. The unrestricted risk estimate for *M. gulosa* on the Persian lime fruit from Mexico pathway is assessed as Very low, which achieves the ALOP for Australia. Key factors influencing the assessment rating are the fact that the pest has a limited distribution in Mexico, it is not present in most Persian lime production areas, and feeding by the larvae causes obvious damage to the fruit rind and infested fruit will not be suitable for export and removed during packing house processes. Therefore specific risk management measures are not required for *M. gulosa* on this pathway.

**Issue 7: *Caliothrips fasciatus* (Californian bean thrips) has been detected on oranges and mandarins imported into Australia, therefore the risk associated with imported limes should be re-assessed.**

The department has reviewed the assessment for *Caliothrips fasciatus* (California bean thrips), including the history of this pest in international trade on fresh citrus fruit, biological factors

impacting potential survival, morphology of the fruit and standard production practices followed to reduce pests on the pathway.

A pest risk assessment was undertaken to evaluate the likelihood of the introduction (entry and establishment) and spread of *C. fasciatus* on the Persian lime fruit from Mexico pathway, and the magnitude of the associated potential consequence. The combination of the likelihoods and consequences gives an overall estimate of the biosecurity risk for *C. fasciatus*, known as the unrestricted risk estimate (URE). The URE of *C. fasciatus* was assessed as Very low, which achieves the ALOP for Australia. Therefore, specific risk management measures are not required for *C. fasciatus*.

*Caliothrips fasciatus* has been a problem in exports of navel orange fruit from the United States of America in the past (Hoddle, Stosic & Mound 2006). The pest has also occasionally been found on mandarins, lemons, tangelo and other citrus, but such incidents are relatively rare. *Caliothrips fasciatus* has been intercepted once on limes imported into Australia over the last 20 years. An additional detection on lime fruit identified only as *Caliothrips* sp. is considered likely to also have been *C. fasciatus*.

*Caliothrips fasciatus* does not feed on citrus but the thrips can incidentally be present in citrus orchards, feeding and reproducing on weed hosts. *Caliothrips fasciatus* adults are active at temperatures above 10°C (Khan, Seal & Adhikari 2022). In regions with cool winters, adult bean thrips can aggregate in the navels of mature orange fruit, seeking a protected site in which to overwinter (Hoddle, Stosic & Mound 2006). *Caliothrips fasciatus* populations in Mexico's lime production areas may be less inclined to exhibit overwintering behaviour compared with thrips in cooler regions further north (including the citrus growing areas of central California) due to the warmer mean minimum temperatures.

The morphology of lime fruit does not provide *C. fasciatus* with the same opportunities for shelter as navel oranges. The thrips are therefore less likely to be present on lime fruit at the time of harvest, and more likely to be removed from the fruit during packinghouse procedures prior to export.

Given the lack of direct association of *Caliothrips fasciatus* with lime fruit, the limited sites for overwintering on lime fruit, and likely removal of the pests by washing, brushing and waxing of the fruit in the packing house prior to export, the likelihood of entry is estimated to be Low.

The department considers there to be sufficient differences between the Persian lime fruit from Mexico pathway compared to other citrus species and considers the unrestricted risk estimate of Very low for *C. fasciatus* on the Persian lime fruit from Mexico pathway is technically justified.

#### **Issue 8: Why is Australia regulating pathotypes of *Elsinoë fawcettii* (citrus scab)?**

According to *ISPM 11: Pest risk analysis for quarantine pests*, when assessing pest risk the taxonomic unit for the pest is generally species. The use of a higher or lower taxonomic level should be supported by scientifically sound rationale. In the case of levels below the species, this should include evidence demonstrating that factors such as differences in virulence, host range or vector relationships are significant enough to affect pest risk.

Australia has regulated exotic pathotypes of *Elsinoë fawcettii* as quarantine pests for many years. Different pathotypes affect different hosts, so some pathotypes could feasibly have more



significant economic impacts than others (for example, a broader host range, or affecting more economically important hosts). As indicated in the pest risk assessment, the only pathotypes identified in Australia to date are the Tryon's and Lemon pathotypes, which predominantly affect lemons and mandarins. The introduction of additional pathotypes that could also potentially affect limes, pomelo, grapefruit, oranges or other citrus would likely result in additional economic impacts.

As noted in *ISPM 2: Framework for pest risk analysis* and *ISPM 11: Pest risk analysis for quarantine pests*, uncertainty is an inherent part of pest risk analysis and expert judgement may be required to account for information gaps. While the identity of the pathotypes present in Mexico has not been determined, the department considers it likely that they would be different to those present in Australia. Host records from Mexico including grapefruit, pomelo and tangor suggest a different pathotype may be involved. It is on this basis that the department made the decision to assess exotic *E. fawcettii* pathotypes as potential quarantine pests.

However, the unrestricted risk estimate for *E. fawcettii* associated with commercially produced Persian lime fruit from Mexico was assessed as Negligible, which achieves the ALOP for Australia. Therefore, no additional specific risk management measures are required for *E. fawcettii* on this pathway.

**Issue 9: The likelihood of economic consequence of *Elsinoë fawcettii* (citrus scab) was assessed as Low, but there is insufficient information provided to reach that conclusion without understanding the pathotype and host range of the Mexican strain.**

While the identity of the citrus scab pathotype that may be present in Mexico has not been discerned, host records in Mexico are indicative of the potential plants that could be affected if that pathotype was introduced into Australia. The potential consequences resulting from the introduction and establishment of additional pathotypes was previously assessed as Low in the *Final report for the review of biosecurity import requirements for Tahitian limes from the Cook Islands, Niue, Samoa, Tonga and Vanuatu* (DAWR 2018), with the critical factors being direct impacts on plant health and the costs of eradication/control.

The previous assessment considered likely impacts from all exotic *Elsinoë fawcettii* pathotypes on plant health, as no information on pathotypes present in Pacific Island countries, and limited information on known hosts, was available at the time.

While introduction of new pathotypes could potentially result in broader impacts than currently caused by pathotypes already present in Australia, those impacts would be localised and limited to specific susceptible crops where local conditions were conducive to survival and dispersal of the pathogen. Critically, no additional impacts on major citrus crops like sweet oranges, lemons and mandarins would be expected. Sweet oranges are not susceptible to any known pathotype of *E. fawcettii*, while the pathotypes present in Australia already affect lemon and mandarin.

Accordingly, direct impacts on plant health were estimated to be of major significance at the local level, which could potentially result in a large decrease in production. Across Far North Queensland (an area consistent with the 'district level' geographic scale) impacts could still be significant, resulting in a moderate decrease in production. Similarly, if new pathotypes established then the potential costs of control or eradication were also estimated to be of major significance at the local level, and significant at the district level.

It is acknowledged that citrus types that are apparently resistant to the *E. fawcettii* pathotypes already in Australia, such as grapefruit and limes, could be affected if new pathotypes capable of infecting those hosts established in parts of Australia where they are grown. However, fresh fruit is an improbable pathway for establishment of citrus scab due to the unlikely transmission from infected fruit to new hosts. Given the very low likelihood of entry, establishment and spread of additional *E. fawcettii* pathotypes, and the low economic consequences, the overall unrestricted risk estimate achieves ALOP and no phytosanitary measures are required.

#### **Issue 10: Why were fruit flies not considered to be pests of Persian lime fruit?**

The risks associated with fruit flies were investigated as part of the risk analysis. No specific fruit fly species that are present in Mexico and likely to be associated with lime fruit exports were identified.

Three fruit fly species were assessed in the pest categorisation and were considered not to be pests of Persian limes (*Anastrepha fraterculus* and *A. ludens*) or to have been eradicated (*Ceratitis capitata*), and therefore were not considered further in the analysis.

The assessment that *Anastrepha fraterculus* would not be on the import pathway due to the lack of identified host association with *Citrus latifolia* was questioned, given the limited research undertaken. Further clarification and explanation to the rationale are detailed below.

The Persian lime (*Citrus latifolia*) is not a natural host for any fruit fly species present in Mexico. Under the international standards presented in ISPM 37: *Determination of host status of fruit to fruit flies (Tephritidae)* (FAO 2019d) there is no basis for considering the import of Persian limes from Mexico to be a fruit fly risk.

The available information does not suggest *C. latifolia* is a likely host for *A. fraterculus*. As indicated in the pest categorisation, there are no known reports of infestation in commercially produced limes, no reports of oviposition in the field, and no reports of infested fruit in field sampling. *Anastrepha fraterculus* is not known as a pest of citrus in Mexico. However other citrus species such as Valencia oranges and ruby red grapefruit have been demonstrated as non-hosts for *A. fraterculus* in Mexico. Additionally, Mexico is a major exporter of fresh lime fruit, and export destinations include countries with strict import requirements for fruit flies. It is noted that these markets do not require measures (for example, phytosanitary treatment or area freedom) for *A. fraterculus* on fresh Persian lime imports.

As per ISPM 37 (FAO 2019d), when existing biological or historical information provides sufficient evidence that the fruit does not support infestation and development to viable adults, no further surveys or field trials should be required and the plant should be categorized as a non-host. The department considers the available information to be sufficiently conclusive to support recognition of *C. latifolia* as a non-host for *A. fraterculus*.

The department acknowledges the concerns of stakeholders around fruit flies, given the economic importance of such pests. In the event Mexico's pest status changes (for example, there is an incursion of an exotic fruit fly), or if a live fruit fly was to be detected in a consignment of lime fruit imported from Mexico, then trade will be suspended while the incident is investigated and/or a review of policy is undertaken to determine if additional measures may be required. In addition, the department continually monitors the literature and if there is any

new evidence to suggest a change in host status of *A. fraterculus* then the department will review the policy.

**Issue 11: Concerns raised with the assessment of *Xanthomonas citri* subsp. *citri* (citrus canker) and further information on pest status, eradication program and risk on imported limes required.**

The department acknowledges the stakeholder concerns about the threat posed by citrus canker given that it is a serious and devastating disease, and previous incursions in Australia have been very costly for growers.

The department considered *Xanthomonas citri* subsp. *citri*, the bacterium responsible for citrus canker disease, in the pest categorisation. In 2020, *X. citri* subsp. *citri* was detected in non-commercial *Citrus aurantiifolia* trees growing in an urban area in the Mexican state of Tamaulipas, near the border with Texas, USA. In response, the department sought information from Mexico regarding the extent of the outbreak, as well as the measures to prevent spread to export lime orchards and eradicate the disease.

To date citrus canker has not been detected in any other states in Mexico, or outside the intensive surveillance zone within northern Tamaulipas. Extensive surveys to delimit the extent of the outbreak have been undertaken in the region. Eradication efforts include destruction of positive or suspect trees, insecticide control of leaf miner pests that feed on citrus foliage and cause damage, which increases the susceptibility of trees to citrus canker infection, and dissemination of education material to households, including plant exchanges to encourage households to replace susceptible citrus plants with non-host alternatives.

Commercial producers of citrus are educated about disease symptoms, and there is ongoing monitoring of orchard health throughout the year. Mexico has an ongoing citrus canker surveillance program across 22 of the main citrus-producing states, which follows the international standard *ISPM 6: Surveillance* (FAO 2018) and SENASICA regulations. General surveillance is also undertaken in other parts of the country as part of the national phytosanitary surveillance program for the 36 high priority pests, which includes citrus canker. *Xanthomonas citri* subsp. *citri* has not been recorded in any commercial Persian lime growing areas of Mexico.

As a result of these eradication and surveillance measures, the current official status of *X. citri* subsp. *citri* in Mexico is 'Transient, actionable and under eradication' (NAPPO 2022). The department recognises citrus canker as being under eradication in Mexico and therefore *X. citri* subsp. *citri* was not assessed further in the pest categorisation. This is consistent with the methodology where only pests present in Mexico and not under eradication are assessed further in the analysis.

In the event the disease was to spread to a commercial export orchard and evaded detection prior to harvest, affected fruit with lesions are likely to be detected and rejected during grading and packing prior to export. Packing facilities may have quality grading systems, which use electronic scanning to detect defects on the rind such as cankers and other disease symptoms. Consignments also undergo phytosanitary inspection prior to export, so if symptomatic fruit are present in the inspection sample they would be detected and the consignment rejected for export. For these reasons, importation on commercially grown and exported Persian lime fruit from Mexico is unlikely.

While infected fresh fruit does provide a potential pathway for *X. citri* subsp. *citri* to enter Australia, the bacterium is extremely unlikely to establish via this pathway and cause citrus canker disease. Asymptomatic commercially packed fruit is not an epidemiologically significant pathway for the introduction and establishment of citrus canker into new areas. The disease naturally spreads during severe meteorological events such as typhoons, hurricanes and tornadoes (Irey et al. 2006; Shiotani et al. 2009), while longer distance spread typically occurs with the movement of diseased propagative materials such as budwood, rootstock seedlings or budded trees (Shiotani et al. 2009). There is no authenticated record of citrus canker disease being introduced on commercially grown fresh fruit (Das 2003; Gottwald & Graham 2000).

Mature fruit lesions may be a poor and insignificant source of *X. citri* subsp. *citri* inoculum, as they are reported to produce fewer bacteria than foliar lesions (Shiotani et al. 2009). It is very unlikely that bacteria could be dispersed from discarded fruit waste to successfully infect a new host plant. Even if fruit are discarded near a susceptible host, conditions conducive for dispersal of bacteria from the ground into the canopy are unlikely (Gottwald et al. 2009).

While the unrestricted risk estimate for *X. citri* subsp. *citri* has not been formally assessed in a pest risk assessment to determine whether it achieves ALOP on the fresh Persian lime fruit from Mexico pathway, an outbreak of citrus canker disease resulting from the importation of infected fresh fruit is unlikely. *Xanthomonas citri* subsp. *citri* remains a high priority quarantine pest for Australia, and it will be actioned accordingly if detected on arrival. Such a detection would result in an immediate suspension of imports while the incident is investigated, and depending on the outcomes of that investigation, further pest risk assessment may be undertaken, or additional measures may be implemented to prevent further non-compliance.

#### **Issue 12: Why wasn't Huanglongbing considered? Diseased fruit could be imported, and psyllid vectors carrying the disease could also be imported with fresh limes.**

'*Candidatus Liberibacter asiaticus*', the bacterium responsible for Huanglongbing or citrus greening disease, was considered in the pest categorisation table. Although feasibly present in the tissues of infected fruit, such fruit do not provide a pathway for establishment of the disease in Australia, so do not pose a biosecurity risk. The pathogen requires an insect vector, typically a psyllid such as *Diaphorina citri* (Asian citrus psyllid) or *Trioza erytreae* (African citrus psyllid), to feed on the infected fruit and transmit it to other host plants. These vectors are not present in Australia.

The psyllid vector *D. citri* was included in the draft report pest categorisation and while it was assessed as being present in Mexico it was not considered to have the potential to enter on the pathway. None of the life stages of the psyllid are directly associated with mature fruit, and if psyllids are present on fruit when it is harvested they will typically fall off when disturbed. Any remaining psyllids would be removed by standard packing house procedures, which includes washing, brushing and waxing of fruit. *D. citri* therefore was not assessed further.

A pest risk assessment for '*Candidatus Liberibacter asiaticus*' was previously undertaken by the department in the *Pest Risk Analysis report for 'Candidatus Liberibacter species' and their vectors associated with Rutaceae* (DAFF 2011) for multiple import pathways, including fresh fruit. The unrestricted risk estimate for '*C. Liberibacter asiaticus*' in fresh citrus fruit was assessed as Extremely low, which achieves the ALOP for Australia (DAFF 2011). Key factors informing the unrestricted risk estimate for fresh citrus fruit pathways were that infected fruit typically falls

from the tree prematurely or is highly symptomatic with significant defects, which would render it unsuitable for export, and that the bacterium requires a psyllid vector for transmission from the fruit to another host, and known vectors are not present in Australia. There is no information to suggest the previous assessment is not applicable to Mexico's export pathway for Persian limes. Although unlikely, '*Candidatus Liberibacter asiaticus*' could feasibly be present in imported lime fruit, but consistent with the previous assessment, in the absence of a vector and transmission pathway it has no potential to establish and spread, and therefore was not assessed further.

The *Pest Risk Analysis report for 'Candidatus Liberibacter species' and their vectors associated with Rutaceae* (DAFF 2011) also considered risks associated with entry of *D. citri* on fresh fruit. While none of the psyllid life stages are typically associated with mature fruit, they could be present as hitchhikers if the fruit are not subject to washing or brushing, and psyllid eggs and nymphs may be present in leaf trash. Reported associations of psyllids with fruit in trade (for example Halbert and Nunez (2004)) typically refer to field-packed fruit for processing that does not undergo any cleaning or trash removal before export.

The *Candidatus Liberibacter* assessment considered typical commercial packing house procedures for export of fresh citrus fruit as appropriate to manage the risks of *D. citri*. These packing house procedures are applied for Persian lime fruit from Mexico and are therefore considered appropriate to manage the risk of *D. citri* on the Persian lime fruit pathway.

While *D. citri* is occasionally intercepted at the border (Inspector-General of Biosecurity 2019), such detections are not in commercial consignments of citrus fruit. It is almost exclusively intercepted at airports in passenger baggage, typically on curry leaves (*Murraya koenigii*), but has also been found at least once on kaffir lime leaves.

Australia has imported considerable volumes of citrus fruit from the USA, where *Diaphorina citri* is present, and there has been no detection of *D. citri* on imported citrus fruit. Mexico's export pathway is very similar to that in the USA, (for example the fruit undergo washing, brushing and waxing), therefore the risks associated with *D. citri* on the Persian lime fruit pathway are not expected to be different to that of citrus from USA. If *D. citri* is detected during inspection the existing policy (DAFF 2011) will apply.

### **Issue 13: Clarify why secure packaging is required as concerns were raised that packaging would prevent ventilation and affect fruit quality.**

The secure packaging requirements are described in Section 5.2.4 of the report and apply to most fresh horticultural goods imported into Australia. The objective of the packaging requirements is to prevent goods that have been processed, packed, and inspected and found free of pests of biosecurity concern being re-infested with pests during storage or transport. In addition, secure packaging is required to prevent the escape of potential quarantine pests during the clearance procedures on arrival in Australia.

The secure packaging requirements as described in Section 5.2.4 of the report, allow for produce to be packed in cartons (packages) that have ventilation holes, provided the holes are covered with mesh or screen with a pore size of no more than 1.6 mm and strand thickness of not less than 0.16 mm. Such packaging can be used for the export of Persian limes from Mexico, which will allow for ventilation while ensuring the security of the goods is maintained.

**Issue 14: Who is verifying production practices and export procedures that were considered when assessing the potential risks?**

The department visited lime production areas and export packinghouse facilities in 2018 and 2022 to confirm typical production practices and export procedures. These production practices were taken into consideration in assessment of the unrestricted risk estimates for the identified quarantine pests and regulated articles, which achieved the ALOP for Australia. Specified commercial production practices are therefore recommended to be mandatory for these pests.

Before trade commences, Mexico must be able to demonstrate to the department that procedures and processes are in place to implement the specified existing commercial production practices of in-field pest management and packing house requirements, and operational system. The processes and procedures are to be approved and verified by the department prior to commencement of export activities to ensure safe trade in fresh Persian lime fruit from Mexico.

The department will verify that each consignment meets Australia's import conditions, that consignments are as described on the phytosanitary certificate, and that quarantine integrity has been maintained (Section 5.2.7). Procedures will include verification of documentation, reconciliation of the consignment against documentation, and phytosanitary inspection of the goods. Consignments are inspected to ensure they are free from visually detectable quarantine pests and other regulated articles such as soil, animal and plant debris (biosecurity risk material).

Australia requires a high level of confidence that biosecurity risk material is not present in the consignment. This level of confidence equates to a 95% level of confidence that infestations of 0.5% or more will be detected, and is achieved by a 600-unit inspection (for fresh Persian lime, one unit is considered to be a single Persian lime fruit). Section 5.2.8 outlines remedial actions for non-compliance, which can include remedial treatment, export or destruction of non-compliant consignments, or suspension of imports should repeated non-compliance occur.

The department reserves the right to suspend imports, either across the entire import pathway or a specific subset of the import pathway that causes non-compliance, such as specific export orchards and/or packing houses. SENASICA must conduct an investigation and implement corrective actions. Imports will be allowed to recommence only when the department is satisfied that appropriate corrective action has been undertaken, and may involve the department conducting an audit and/or site visit, where required.

**Issue 15: It is stated in the draft report that Persian lime fruit for export are to be harvested when fully green, however, photos on pages 27 to 32 of the draft report show a high amount of yellowing.**

Lime fruit are sorted according to market requirements and standards at the grading stage of the process, which occurs after the washing, brushing and waxing stages. The photos in the draft report showed fruit prior to grading. While some substandard fruit may be manually removed by workers prior to washing, most will still be subject to washing, brushing and waxing (although undersized fruit is typically screened out prior to washing). Therefore, some fruit showing yellowing colour can be seen in the photos of these steps in the process. After grading,

any yellowing fruit not meeting the grade requirements necessary for export would typically be diverted for processing markets or domestic consumption.

The department acknowledges the statement in the draft report (page 23) that harvesting starts when the peel is fully green. This was based on information provided by Mexico (SENASICA 2017). However, peel colour is not a good indicator of fruit maturity, and the colour of mature fruit is variable, so some fruit may have yellowish-green peel when harvested. There is little quality difference between light green and yellow limes, although consumer preference in many countries is for green lime fruit (Pranamornkith 2009).

Fruit colour is one of the factors determining suitability for export. Observations of lime fruit arriving at packing houses during the 2022 visit confirmed that while the fruit generally were fully green, some fruit did display variability in colour. Lime fruit are subsequently graded and sorted in the packing house, so yellowing fruit may be removed from the export pathway, depending on the specific requirements of the importing country.

The main market for Mexico's lime fruit exports is the United States of America, so Mexico's export quality standards are largely based on standards established by the USDA. For fruit classified as grade 1 a minimum of 75% of the fruit surface must be green. Other markets have different requirements, with Europe requiring a minimum 80% of the fruit surface to be green, and Asian markets requiring 90% to be green (SENASICA 2017). Australia does not mandate specific fruit colour requirements for lime fruit imported from any country.

To avoid confusion, the reference to fruit being harvested when fully green has been deleted.

**Issue 16: Clarification and review of the likelihood of entry, establishment and spread and consequences risk estimate ratings for Citrus leprosis vectored by *Brevipalpus* mites and proposed measures.**

The department has reviewed the ratings for citrus leprosis, and based on the available evidence considers the ratings and overall unrestricted risk estimate to be appropriate. Fruit infected with citrus leprosis viruses are assessed as not being a pathway for establishment of citrus leprosis disease in Australia. Viruliferous mites carried on imported fresh fruit are an unlikely pathway for establishment of citrus leprosis disease in Australia.

The department made very conservative estimates of the likelihoods of importation and distribution, as there is considerable uncertainty about the prevalence of the viruses and the vector mites in Mexico, the efficacy of control measures in the field, and the efficacy of cleaning processes in the packing house.

The likelihood of entry for citrus leprosis viruses in *Brevipalpus* spp. mites on imported Persian lime fruit from Mexico was assessed as Very low. Critical factors moderating the risk were that:

- the vector *Brevipalpus* spp. mites do not appear to be prevalent in production areas, with very few *Brevipalpus* mites being found during orchard surveillance surveys and other studies. Both CiLV-C and OFV-citrus are regulated pests that are under official control in Mexico, so if detected any diseased plants will be removed and the vector mites controlled.

- As indicated in the pest risk assessment, mites in the orchard are controlled through application of miticides, planting of windbreaks to reduce aerial dispersal of mites, pruning, removal of weeds and limiting movement of people and equipment between orchards.
- Citrus leprosis viruses are not systemic in the host plant, so mites can only acquire a virus if they feed on infected tissue. In export orchards with no evident leprosis infection, even if mites are present there is a very low probability of those mites acquiring or being infected with CiLV-C or OFV-citrus.
- In the event lime fruit infested with *Brevipalpus* spp. mites are harvested and sent to the packing house, most mites will be removed by washing, brushing and waxing processes in the packing house, while quality control inspection and the pre-export phytosanitary inspection provide additional opportunities for infested fruit to be identified and removed.
- While *Brevipalpus* spp. mites can survive typical transport and storage conditions, there may be considerable mortality, particularly among juvenile life stages. Therefore, few fruit infested with viable viruliferous mites would be expected to be imported.
- After importation, lime fruit will be distributed via commercial supply chains to retail or wholesale markets. Fruit may be purchased by the public, commercial food processors or hospitality businesses for consumption. Typically, from the time the lime fruit are released from quarantine until they are consumed and waste discarded, the fruit will be held within a premises (or perhaps within a bag or other receptacle while in transit between premises), so opportunities for mites to leave the fruit and find a new host are extremely limited.
- The vast majority of fruit waste is discarded via municipal or commercial waste disposal systems, including green waste processing, which do not provide opportunities for mite dispersal. Some fruit waste will be discarded into backyard composting systems, which have varying levels of containment, but would not typically be conducive to mite survival and dispersal.
- While infested fruit waste could be discarded outdoors (in a garden for example), very few fruit are likely to be disposed of in this manner. The probability that mites would be able to leave the lime fruit and successfully move to another suitable host is even more remote.

The cumulative risk reduction through all these factors means there is only a very low likelihood that viruliferous mites would be imported and successfully transfer to a suitable host.

The department also considers the estimate of the potential economic consequences is appropriate, and consistent with the risk assessment methodology described in section 2.2.3. The potential economic consequences were assessed as Moderate, largely due to the direct impacts on plant health, which were rated as significant at the regional level. As indicated in section 2.2.3, such impacts would threaten the economic viability of production through a moderate increase in mortality of hosts, or a moderate decrease in production, which may not be reversible. It recognises that there could be significant costs in controlling citrus leprosis, and potential impacts on domestic or international trade. Such impacts are not likely to be expected at a broader geographic scale (that is, across all mainland states and territories and Tasmania). Citrus leprosis viruses are only likely to have an impact in regions where the vector mites are prevalent. A higher rating at the regional level was also not considered appropriate as a large



decrease in production would not be expected at that scale. Losses would be moderated by implementation of control measures, some of which may already be applied for other pests.

Stakeholders suggested that phytosanitary treatments should be considered to prevent entry of *Brevipalpus* spp. mites, including hot water treatment. However, as citrus leprosis viruses achieve ALOP on the fresh Persian lime fruit from Mexico pathway no phytosanitary measures are required to mitigate the biosecurity risks to an acceptable level. Therefore, the application of a hot water treatment of lime fruit prior to export is not warranted.

**Issue 17: Clarification how the pre-export phytosanitary inspection method will ensure pests are detected.**

Pre-export phytosanitary inspection, and application of remedial actions in the event live pests are found, is recommended to ensure consignments of Persian lime fruit are free of quarantine pests and meet the import conditions for Australia. Phytosanitary inspection and certification are undertaken by the exporting country's NPPO. The department considers pre-export phytosanitary inspection an effective procedure to ensure import conditions are met and consignments are free of quarantine pests on a wide range of fresh horticultural commodities imported into Australia. Australia also exports a range of fresh horticultural commodities that are subject to pre-export phytosanitary inspection.

Inspection methods must be suitable to detect pests that may be present on fresh Persian lime fruit. There are international standards that provide guidance when conducting inspections, these being ISPM 23: *Guidelines for inspection* (FAO 2023) and ISPM 31: *Methodologies for sampling of consignments* (FAO 2016). Mexico is required to conduct pre-export visual inspection in accordance with these international standards.

For fresh horticultural commodities, where pests are typically visible, or symptoms of infestation or infection are evident, pre-export visual inspection is a standard phytosanitary procedure to confirm freedom from quarantine pests. It is important to note that freedom from quarantine pests refers to freedom from pests in numbers or quantities that can be detected by the application of relevant phytosanitary procedures (for example, visual inspection). It should not be interpreted to mean absolute freedom in all cases but rather that quarantine pests are believed not to be present, based on the procedures used for their detection or elimination, acknowledging that there is some possibility that pests will not be detected (FAO 2022b). This is consistent with the objectives of Australia's biosecurity policy framework (Section 1.1).

In addition to pre-export phytosanitary inspection, consignments of fresh Persian lime fruit will be inspected on arrival in Australia to ensure the goods comply with Australia's import requirements. The detection of any quarantine pests (including thrips, mealybugs and mites) or disease symptoms on imported Persian lime fruit will result in remedial action. This may include the consignment being subject to an appropriate treatment where an effective treatment is available and biosecurity risks associated with applying the treatment can be effectively managed, otherwise the consignment will be re-exported or destroyed.

### **Issue 18: The appropriateness of the 600-unit inspection sampling rate to verify the phytosanitary status of the goods on arrival was questioned.**

Prior to release from biosecurity control in Australia, the department will verify that the consignment meets Australia's import conditions. Procedures will include verification of documentation, reconciliation of the consignment against documentation, and phytosanitary inspection of the goods. Consignments are inspected to ensure they are free from visually detectable quarantine pests and other regulated articles such as soil, animal and plant debris (biosecurity risk material). In conducting a phytosanitary inspection, the department samples and inspects goods in a manner that is consistent with the international standard, ISPM 23: *Guidelines for phytosanitary inspection* (FAO 2019c). The statistical basis for the sampling of consignments is described in ISPM 31: *Methodologies for sampling consignments* (FAO 2016).

Australia requires a high level of confidence that biosecurity risk material is not present in the consignment. This level of confidence equates to a 95% level of confidence that an infestation of 0.5% or more will be detected, which is achieved by a 600-unit inspection (for fresh Persian lime, one unit is considered to be a single Persian lime fruit). It should be noted that the 600-unit on-arrival phytosanitary inspection undertaken by the department is in addition to the 600-unit pre-export phytosanitary inspection undertaken by SENASICA in Mexico.

Australia uses a 600-unit inspection regime for all imported horticultural produce (fresh, unprocessed fruit and vegetables) requiring inspection. Samples are selected by departmental biosecurity officers and are taken randomly across a homogenous lot. This 600-unit inspection rate is internationally accepted, and is an established method used by Australia for decades in inspecting imported horticultural produce. The department ensures that inspection methods are capable of detecting target pests and inspectors are trained to implement these methods.

### **Other issues**

The department has made a number of changes to the risk analysis following consideration of stakeholder comments on the draft report and subsequent review of scientific literature. These include:

- Reassessed the potential to enter on the pathway for a number of pests in Appendix A: Initiation and categorisation.
- Strengthened the arguments for *Hemiberlesia cyanophylli*, *Morganella longispina*, *Eotetranychus yumensis*, *Eotetranychus banksi*, and *Tetranychus pacificus* to clarify the assessment of 'No' for potential to enter on pathway.
- Corrected a pest entry error in the pest categorisation, removing *Guignardia mangiferae* and replacing it with the correct species, *Phyllosticta capitalensis*. Historic references to endophytic *Guignardia mangiferae* on citrus were referring to *Phyllosticta capitalensis*. No information implicating *Guignardia mangiferae* with disease in Persian lime in Mexico has been found.
- Updated the pest categorisation entry for *Hop stunt viroid* (strains responsible for cachexia disease were previously known as *Citrus cachexia viroid*) to clarify that the viroid is endemic in Australia. The statement that it is under official control in Australia has been deleted.
- In the citrus leprosis PRA, the consequences impact score for 'Other aspects of the environment' was changed from 'B – Minor impact at the local level' to 'A – indiscernible

at the local level'. The impacts previously described in the draft report related to impacts on native plants, which were already addressed under the 'Plant life or health' category. No other direct impacts on the environment caused by citrus leprosis viruses have been identified. This change does not change the overall consequences rating.

## 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 or regulated articles (FAO 2022a).
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).
Appropriate level of protection (ALOP) for Australia	The <i>Biosecurity Act 2015</i> defines the appropriate level of protection (or ALOP) for Australia as a high level of sanitary and phytosanitary protection aimed at reducing biosecurity risks to very low, but not to zero.
Area	An officially defined country, part of a country or all or parts of several countries (FAO 2022a).
Arthropod	The largest phylum of animals, including the insects, arachnids and crustaceans.
Asexual reproduction	The development of new individual from a single cell or group of cells in the absence of meiosis.
Australian territory	Australian territory as referenced in the <i>Biosecurity Act 2015</i> refers to Australia, Christmas Island and Cocos (Keeling) Islands.
Biosecurity	The prevention of the entry, establishment or spread of unwanted pests and infectious disease agents to protect human, animal or plant health or life, and the environment.
Biosecurity measures	Measures applied to protect human, animal or plant life or health from risks arising from the introduction, establishment and spread of pests and diseases and from risks arising from additives, toxins and contaminants in food and feed
Biosecurity import risk analysis (BIRA)	The <i>Biosecurity Act 2015</i> defines a BIRA as an evaluation of the level of biosecurity risk associated with particular goods, or a particular class of goods, that may be imported, or proposed to be imported, into Australian territory, including, if necessary, the identification of conditions that must be met to manage the level of biosecurity risk associated with the goods, or the class of goods, to a level that achieves the ALOP for Australia. The risk analysis process is regulated under legislation.
Biosecurity risk	The <i>Biosecurity Act 2015</i> refers to biosecurity risk as the likelihood of a disease or pest entering, establishing or spreading in Australian territory, and the potential for the disease or pest causing harm to human, animal or plant health, the environment, economic or community activities.
Calyx	A collective term referring to all of the sepals in a flower.
Consignment	A quantity of plants, plant products or other articles being moved from one country to another and covered, when required, by a single phytosanitary certificate (a consignment may be composed of one or more commodities or lots) (FAO 2022a).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO 2022a).
Crawler	Intermediate mobile nymph stage of certain Arthropods.
Diapause	Period of suspended development/growth occurring in some insects, in which metabolism is decreased.
The department	The Department of Agriculture, Fisheries and Forestry.
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 2022a).
Endemic	Belonging to, native to, or prevalent in a particular geography, area or environment.
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO 2022a).

Term or abbreviation	Definition
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2022a).
Existing policy (EP)	This denotes that a pest species has previously been assessed in another policy published by the department.
Fresh	Living; not dried, deep-frozen or otherwise conserved (FAO 2022a).
Genus	A taxonomic category ranking below a family and above a species and generally consisting of a group of species exhibiting similar characteristics. In taxonomic nomenclature the genus name is used, either alone or followed by a Latin adjective or epithet, to form the name of a species.
Group policy (GP)	This refers to the <i>Final group pest risk analysis for thrips and orthotospoviruses on fresh fruit, vegetable, cut-flower and foliage imports</i> (thrips Group PRA) (DAWR 2017a), the <i>Final group pest risk analysis for mealybugs and the viruses they transmit on fresh fruit, vegetable, cut-flower and foliage imports</i> (mealybugs Group PRA) (DAWR 2019) and the <i>Final group pest risk analysis for soft and hard scale insects on fresh fruit, vegetable, cut-flower and foliage imports</i> (scales Group PRA) (DAWE 2021).
Goods	The <i>Biosecurity Act 2015</i> defines goods as an animal, a plant (whether moveable or not), a sample or specimen of a disease agent, a pest, mail or any other article, substance or thing (including, but not limited to, any kind of moveable property).
Host	An organism that harbours a parasite, mutual partner, or commensal partner, typically providing nourishment and shelter.
Host range	Species capable, under natural conditions, of sustaining a specific pest or other organism (FAO 2022a).
Import permit	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2022a).
Infection	The internal 'endophytic' colonisation of a plant, or plant organ, and is generally associated with the development of disease symptoms as the integrity of cells and/or biological processes are disrupted.
Infestation (of a commodity)	Presence in a commodity of a living pest of the plant or plant product concerned. Infestation includes infection (FAO 2022a).
Inspection	Official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (FAO 2022a).
Intended use	Declared purpose for which plants, plant products, or other articles are imported, produced or used (FAO 2022a).
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment (FAO 2022a).
International Plant Protection Convention (IPPC)	The IPPC is an international plant health agreement, established in 1952, that aims to protect cultivated and wild plants by preventing the introduction and spread of pests. The IPPC provides an international framework for plant protection that includes developing International Standards for Phytosanitary Measures (ISPMs) for safeguarding plant resources.
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 IPPC (FAO 2022a).
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO 2022a).
Larva	A juvenile form of animal with indirect development, undergoing metamorphosis (for example, insects or amphibians).
Lot	A number of units of a single commodity, identifiable by its homogeneity of composition, origin et cetera, forming part of a consignment (FAO 2022a). Within this report a 'lot' refers to a quantity of fruit of a single variety,

Term or abbreviation	Definition
	harvested from a single production site during a single pick and packed at one time.
Mature fruit	Commercial maturity is the start of the ripening process. The ripening process will then continue and provide a product that is consumer-acceptable. Maturity assessments include colour, starch, index, soluble solids content, flesh firmness, acidity, and ethylene production rate.
National Plant Protection Organization (NPPO)	Official service established by a government to discharge the functions specified by the IPPC (FAO 2022a).
Nymph	The immature form of some insect species that undergoes incomplete metamorphosis. It is not to be confused with larva, as its overall form is already that of the adult.
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 2022a).
Orchard	A contiguous area of lime trees operated as a single entity. Within this report a single orchard is covered under one registration and is issued a unique identifying number.
Pathogen	A biological agent that can cause disease to its host.
Pathway	Any means that allows the entry or spread of a pest (FAO 2022a).
Peduncle	A flower stalk bearing either a cluster or a solitary flower, which develops into fruit.
Pest	Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2022a).
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 2022a).
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 2022a).
Pest risk assessment (for quarantine pests)	Evaluation of the probability of the introduction and spread of a pest and of the magnitude of the associated potential economic consequences (FAO 2022a).
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2022a).
Pest status (in an area)	Presence or absence, at the present time, of a pest in an area, including where appropriate its distribution, as officially determined using expert judgement on the basis of current and historical pest records and other information (FAO 2022a).
Phytosanitary certificate	An official paper document or its official electronic equivalent, consistent with the model certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (FAO 2022a).
Phytosanitary certification	Use of phytosanitary procedures leading to the issue of a phytosanitary certificate (FAO 2022a).
Phytosanitary measure	Phytosanitary relates to the health of plants. Any legislation, regulation or official procedure having the purpose to prevent the introduction or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO 2022a). In this risk analysis the term 'phytosanitary measure' and 'risk management measure' may be used interchangeably.
Phytosanitary procedure	Any official method for implementing phytosanitary measures including the performance of inspections, tests, surveillance or treatments in connection with regulated pests (FAO 2022a).

<b>Term or abbreviation</b>	<b>Definition</b>
Phytosanitary regulation	Official rule to prevent the introduction or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests, including establishment of procedures for phytosanitary certification (FAO 2022a).
Polyphagous	Feeding on a relatively large number of hosts from different plant family and/or genera.
PRA area	Area in relation to which a pest risk analysis is conducted (FAO 2022a).
Production site	In this report, a production site is a continuous planting of lime trees treated as a single unit for pest management purposes. If an orchard is subdivided into one or more units for pest management purposes, then each unit is a production site. If the orchard is not subdivided, then the orchard is also the production site.
Quarantine	Official confinement of regulated articles, pests or beneficial organisms for inspection, testing, treatment, observation or research (FAO 2022a).
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 2022a).
Regulated article	Any plant, plant product, storage place, packaging, conveyance, container, soil and any other organism, object or material capable of harbouring or spreading pests, deemed to require phytosanitary measures, particularly where international transportation is involved (FAO 2022a).
Regulated non-quarantine pest	A non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party (FAO 2022a).
Regulated pest	A quarantine pest or a regulated non-quarantine pest (FAO 2022a).
Restricted risk	Restricted risk is the risk estimate when risk management measures are applied.
Risk analysis	Refers to the technical or scientific process for assessing the level of biosecurity risk associated with the goods, or the class of goods, and if necessary, the identification of conditions that must be met to manage the level of biosecurity risk associated with the goods, or class of goods to a level that achieves the ALOP for Australia.
Risk management measure	Conditions that must be met to manage the level of biosecurity risk associated with the goods or the class of goods, to a level that achieves the ALOP for Australia. In this risk analysis, the term 'risk management measure' and 'phytosanitary measure' may be used interchangeably.
Saprophyte	An organism deriving its nourishment from dead organic matter.
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO 2022a).
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures.
Stakeholders	Government agencies, individuals, community or industry groups or organizations, whether in Australia or overseas, including the proponent/applicant for a specific proposal, who have an interest in the policy issues.
Surveillance	An official process which collects and records data on pest presence or absence by survey, monitoring or other procedures (FAO 2022a).
Systems approach(es)	The integration of different risk management measures, at least 2 of which act independently, and which cumulatively achieve the appropriate level of protection against regulated pests.
Trash	Soil, splinters, twigs, leaves and other plant material, other than fruit as defined in the scope of this risk analysis. For example, stem and leaf material, seeds, soil, animal matter/parts or other extraneous material

<b>Term or abbreviation</b>	<b>Definition</b>
Treatment (as a phytosanitary measure)	Official procedure for killing, inactivating, removing, rendering infertile or devitalizing regulated pests (FAO 2022a).
Unrestricted risk	Unrestricted risk estimates apply in the absence of risk management measures.
Vector	An organism that does not cause disease itself, but which causes infection by conveying pathogens from one host to another.
Viable	Alive, able to germinate or capable of growth.
Viruliferous	Containing, producing or conveying an agent of infection, usually a virus (Merriam-Webster 2020). For example: aphids that carry viruses are viruliferous aphids



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