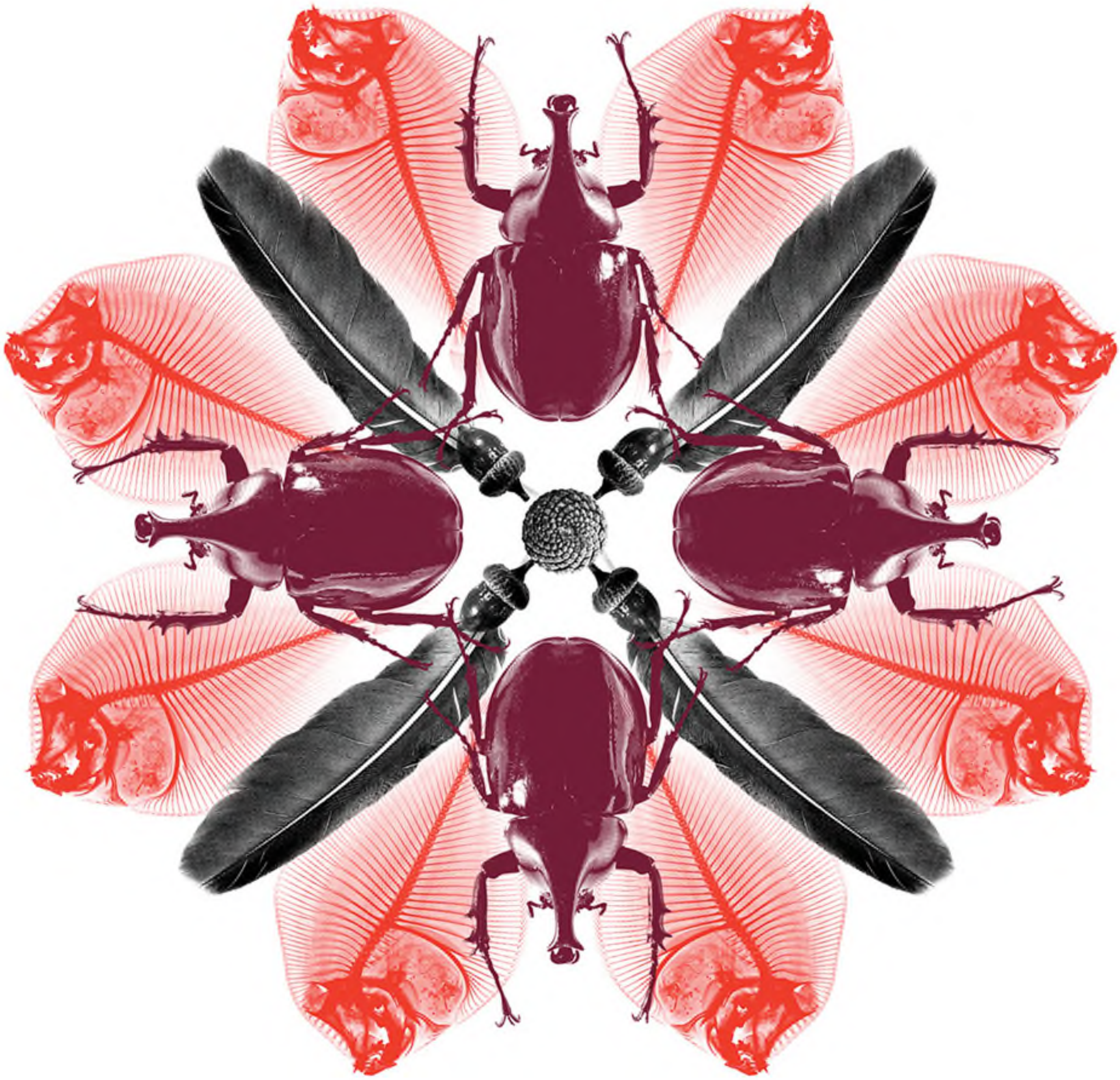
Australian Government
Department of Agriculture

# Final report for the review of biosecurity import requirements for fresh Chinese jujube fruit from China

January 2020



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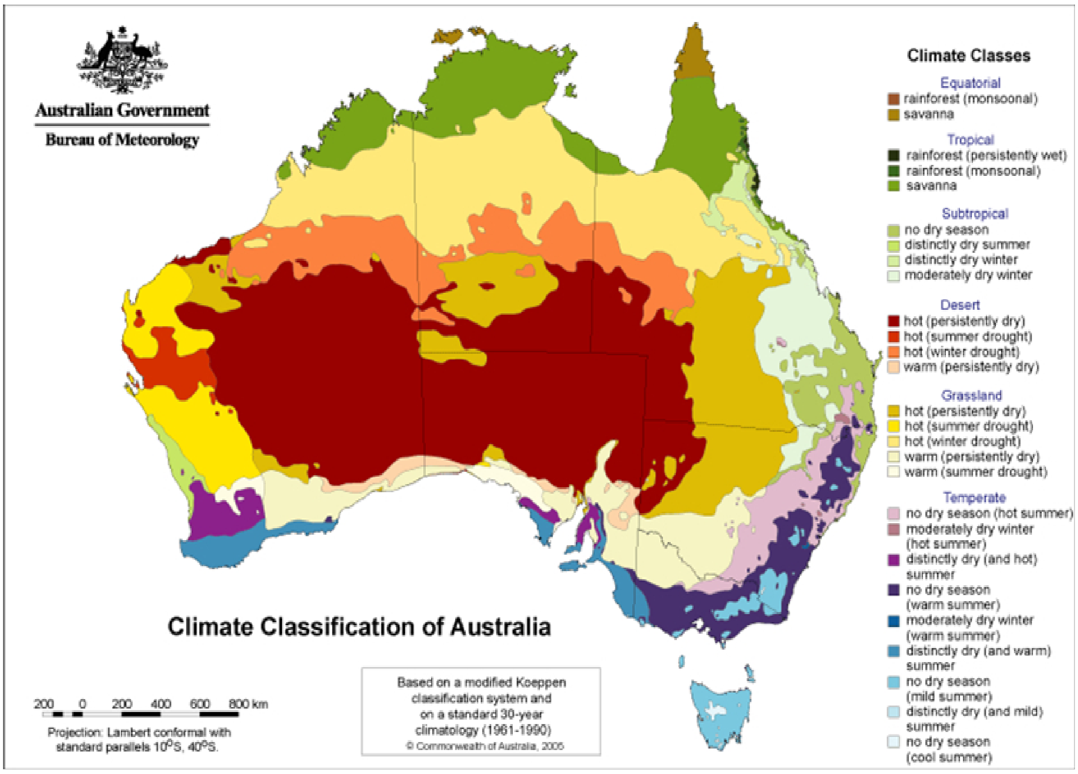
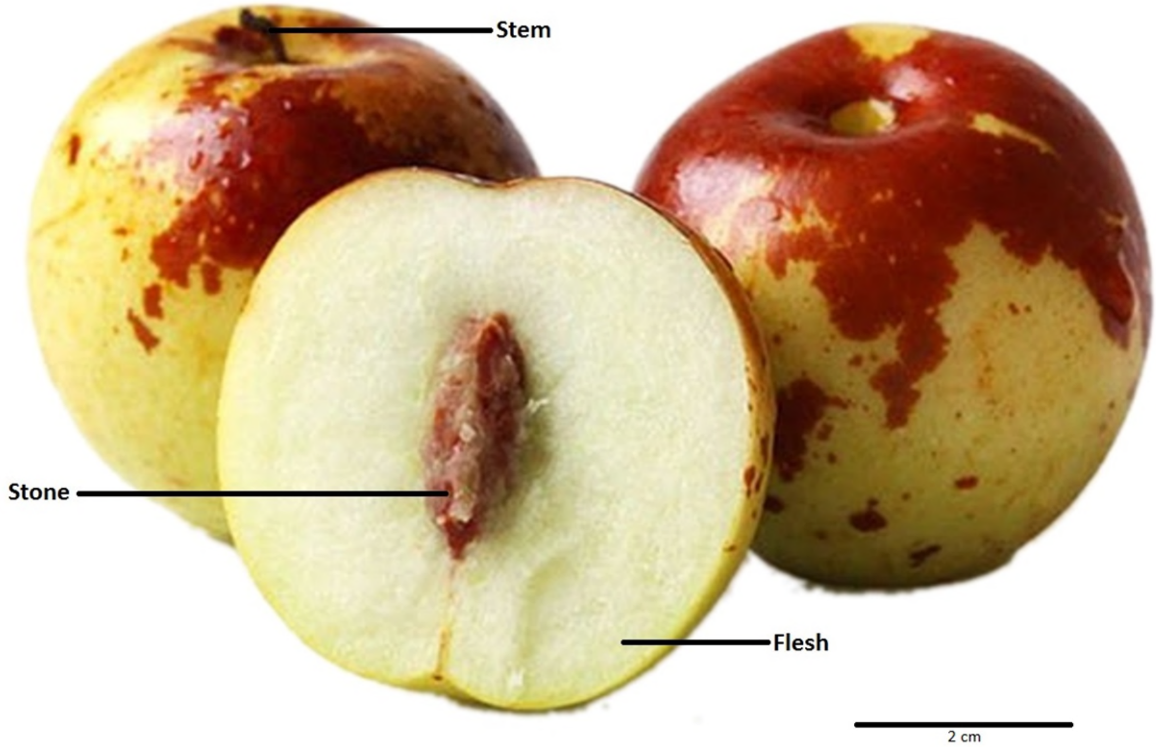


**Figure 1 Diagram of Chinese jujube fruit**




Source: Kisspng.com

# Acronyms and abbreviations

| Term or abbreviation | Definition |
|---|---|
| ACT | Australian Capital Territory |
| ALOP | Appropriate level of protection |
| AQSIQ | The General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China |
| 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 |
| GACC | The General Administration of Customs of the People's Republic of China |
| IPPC | International Plant Protection Convention |
| ISPM | International Standard for Phytosanitary Measures |
| NSW | New South Wales |
| NPPO | National Plant Protection Organisation |
| NT | Northern Territory |
| PRA | Pest risk analysis |
| Qld | Queensland |
| SA | South Australia |
| SPS Agreement | WTO agreement on the Application of Sanitary and Phytosanitary Measures |
| Tas. | Tasmania |
| the department | The Department of Agriculture |
| ULDs | Unit Loading Devices |
| Vic. | Victoria |
| WA | Western Australia |
| WTO | World Trade Organization |

# Summary

This risk analysis report considers the biosecurity risks for Australia associated with the importation of commercially produced fresh Chinese jujube fruit (Chinese jujubes) for human consumption from China.

This final report recommends that the importation of fresh Chinese jujubes to Australia from all commercial production areas of China be permitted, subject to it meeting a range of biosecurity requirements as summarised in this report.

This final report contains details of all known pests with the potential to be associated with the importation of fresh Chinese jujubes from China that may be of biosecurity concern to Australia. It also provides risk assessments for identified quarantine pests, and recommends risk management measures to reduce the biosecurity risk to an acceptable level.

Seven quarantine pests have been identified in this risk analysis as requiring risk management measures. These pests are:

- Fruit flies: Oriental fruit fly (*Bactrocera dorsalis*), guava fruit fly (*Bactrocera correcta*), melon fly (*Zeugodacus cucurbitae*) and jujube fruit fly (*Carpomyia vesuviana*).
- Fruit borer: peach fruit borer (*Carposina sasakii*).
- Spider mite: hawthorn spider mite (*Amphitetranychus viennensis*).
- Mealybug: heliococcus mealybug (*Heliococcus destructor*).

One thrips species, chilli thrips (*Scirtothrips dorsalis*), has been assessed as a regulated article as it is capable of harbouring and spreading emerging orthotospoviruses that are quarantine pests for Australia, and therefore require risk management measures.

These eight identified species are the same, or of the same pest groups, as those associated with other horticultural commodities that have been assessed previously by the department.

This final report recommends a range of risk management measures, combined with an operational system, to ensure biosecurity standards are met. The recommended risk management measures will reduce the risks posed by the eight identified species (seven quarantine pests and one regulated article), so as to achieve the appropriate level of protection for Australia. These measures are:

- area freedom or fruit treatment (such as cold treatment, methyl bromide fumigation followed by cold treatment, or irradiation) for fruit flies
- area freedom or fruit treatment (such as methyl bromide fumigation or irradiation) or a systems approach approved by the Department of Agriculture for peach fruit borer
- pre-export visual inspection and, if found, remedial action for spider mites, mealybugs and/or thrips.

Upon finalisation of this policy, China must be able to demonstrate to the Department of Agriculture that processes and procedures are in place to implement the recommended risk

management measures. This will ensure safe trade in fresh Chinese jujubes from China. 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 https://bicon.agriculture.gov.au/BiconWeb4.0.

Written submissions on the draft report were received from four stakeholders. In addition, a number of issues were raised by stakeholders (in writing and during meetings) through the risk analysis process. The department has made a number of changes to the report following consideration of all the technical comments raised by stakeholders, and subsequent review of the literature. These changes include:

- Amendments to 'Appendix A: Initiation and categorisation for pests of fresh Chinese jujube fruit from China' and elsewhere as appropriate, following consultation with plant pathologists and review of further scientific literature on the taxonomic status and assessment of three pathogens, *Neofusicoccum ribis, Dothiorella gregaria* and *Macrophoma kuwatsukai*. *Neofusicoccum ribis* has been removed from the pest categorisation as it is not present in China. Additionally, *N. ribis* only infects *Ribis* species and is not associated with Chinese jujubes. *Dothiorella gregaria* and *Macrophoma kuwatsukai* have been added to the pest categorisation and assessed as not on the pathway of fresh Chinese jujube fruit.
- Amendments to 'Appendix A: Initiation and categorisation for pests of fresh Chinese jujube fruit from China' and elsewhere as appropriate, following a review of the regional pest status of *Hop stunt viroid*, *Phytophthora palmivora* and *Armillaria tabescens*. Consistent with the department's plant quarantine pest and official control policy, and in accordance with the IPPC International Standards for Phytosanitary Measures, these pests are not considered to be under official control, and therefore not recognised as a pest of quarantine concern. The assessment for these pests have been amended to terminate at 'Present in Australia' step of the pest categorisation.
- Addition of 'Appendix B1: Issues raised in stakeholder comments' which summarises the key technical issues raised by stakeholders, and how they were considered by the department.
- Addition of 'Appendix B2: An overview of jujube witches' broom phytoplasma (JWB)' which provides further supporting evidence that JWB is not associated with the pathway of commercially grown and packed fresh Chinese jujube fruit, in particular clarification that JWB is not seed transmissible.
- Addition of 'Appendix C: Risk management measures recommended for quarantine pests and regulated thrips for fresh Chinese jujubes from China', which clarifies details of the phytosanitary risk management options, currently recognised by the department as effective for management of the biosecurity risk of each of the identified quarantine pests.
- Minor corrections, rewording and editorial changes for consistency, clarity and web-accessibility.

# 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 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 of Agriculture (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 a 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 other 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 website at http://www.agriculture.gov.au/biosecurity/risk-analysis/guidelines.

## 1.2 This risk analysis

### 1.2.1 Background

The Department of Animal and Plant Quarantine and Inspection, General Administration of Customs of the People’s Republic of China (GACC) (formerly known as General Administration of Quality Supervision, Inspection and Quarantine of the People’s Republic of China (AQSIQ)), in a submission received by Australia in May 2017, formally requested market access to Australia for fresh Chinese jujube fruit for human consumption. This submission included information on the pests associated with Chinese jujubes crops in China, including the plant part(s) affected, and the standard commercial production practices for fresh Chinese jujubes in China.

On 10 August 2018, the department announced the commencement of this risk analysis, advising that it would be progressed as a review of biosecurity import requirements. This analysis has been conducted in accordance with the *Biosecurity Act 2015*.

In September 2018, officers from the department visited major Chinese jujube production areas in China. The objectives of the visit were to observe commercial production, pest management and other export practices.

### 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 Chinese jujube fruit (henceforth Chinese jujubes) (*Ziziphus jujuba* Mill.), grown in China using standard commercial production practices and packing procedures, as described in Chapter 3: China's commercial production practices for Chinese jujubes, for import into Australia, for human consumption.

For the purpose of this risk analysis, Chinese jujubes are defined as single fruit that may possess a short fruit stem (Figure 1). This risk analysis assesses commercially produced fresh Chinese jujubes of all cultivars/varieties from all provinces or regions of China in which they are grown for export.

### 1.2.3 Existing policy

#### International policy

Fresh Chinese jujubes for human consumption have not previously been assessed for import into Australia. However import policy exists for dried Chinese jujubes from China. There are also existing biosecurity import conditions for Chinese jujube nursery stock from all countries (Department of Agriculture and Water Resources 2018).

Australia also has biosecurity import conditions for Chinese horticultural commodities including apples (Biosecurity Australia 2010a), pears (Biosecurity Australia 2005a), table grapes (Biosecurity Australia 2011a), stone fruits (nectarines, peaches, plums and apricots) (Department of Agriculture and Water Resources 2016, 2017a), and longan and lychees (DAFF 2004a). The import requirements for these commodity pathways can be found at the department's Biosecurity Import Conditions (BICON) system on the department's website at https://bicon.agriculture.gov.au/BiconWeb4.0.

A preliminary assessment identified that the potential pests of biosecurity concern for fresh Chinese jujubes from China are the same as, or similar to, pests that have been assessed previously by the department in risk analyses for these Chinese horticultural commodities and other horticultural commodities, and for which appropriate measures are already established.

The department has considered all the pests and pest groups previously identified in the existing policies and, where relevant, the information in those assessments has been taken into account in this risk analysis. The department has also reviewed the latest literature to ensure that information in previous assessments is still valid. 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* (thrips group PRA) (Australian Government Department of Agriculture and Water Resources 2017), which is applicable to Chinese jujubes from China. The department has determined that the information in those assessments can be adopted for the species under consideration in this risk analysis.

**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 jurisdictions. 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. Once plant 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 fresh Chinese jujubes from China that are assessed in this risk analysis, other organisms may arrive with the imported commodity. These organisms may include 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 and animal life or health) or phytosanitary risks (to plant life or health). These risks are identified and addressed using existing operational procedures that require a 600-unit inspection of all consignments on arrival, or equivalent procedures. The department will investigate if any pest identified through these processes may be of biosecurity concern to Australia, and thus may require remedial action.

### 1.2.5 Consultation

On 10 August 2018 the department notified stakeholders in Biosecurity Advice 2018-20 of the commencement of a review of biosecurity import requirements for fresh Chinese jujubes from China.

Prior to, and after the announcement of this risk analysis, the department engaged with the Australian jujube industry regarding the process and technical aspects of this risk analysis, including through direct meetings (face-to-face and teleconferences) and correspondences.

The department has also consulted with the government of the People's Republic of China, as well as with Australian state and territory governments during the preparation of this report.

The draft report was released on 18 March 2019 (Biosecurity Advice 2019-P04) for comment by stakeholders, for a period of 60 calendar days that concluded on 17 May 2019.

The department received four written submissions on the draft report. All submissions received, and issues raised by stakeholders throughout the risk analysis process were carefully considered, and, where relevant, changes were made in this final report. A summary of key technical stakeholder comments and how they were considered is provided in Appendix B1.

### 1.2.6 Next Steps

The final report will be published on the department's website together with a notice advising stakeholders of its release. The department will also notify the People's Republic of China, registered stakeholders and the WTO Secretariat of the release of the final report. Publication of the final report will represent the end of the risk analysis process.

Before any trade in fresh Chinese jujubes from China commences, the department will verify that China can implement the required pest risk management measures, and the system of operational procedures necessary to maintain and verify the phytosanitary status of fresh Chinese jujubes for export to Australia from China (as specified in Chapter 5: Pest risk management of this report). On verification of these requirements, the import conditions for fresh Chinese jujubes from China will be published in the department's Biosecurity Import Conditions (BICON) system. Applications of import permits can then be made online through BICON.

# 2 Method for pest risk analysis

This chapter sets out the method used for the pest risk analysis (PRA) in this report. The Department of Agriculture has conducted this PRA in accordance with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for pest risk analysis* (FAO 2019a) and ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2019c) 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 2019b). A pest is 'any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products' (FAO 2019b). This definition is also applied in the *Biosecurity Act 2015*.

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

Unrestricted risk is estimated taking into account the existing commercial production practices of the exporting country and that, on arrival in Australia, 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 and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests' (FAO 2019b).

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 three consecutive stages: initiation, pest risk assessment and pest risk management.

## 2.1 Stage 1 Initiation

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

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 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.

## 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 2019b).

The following three, 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 2019b).

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 2019c). 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 two 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 2019b). In order to estimate the likelihood of establishment of a pest, reliable biological information (for example, lifecycle, host range, epidemiology, 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 2019b). 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**

| Likelihood | Descriptive definition | Indicative range |
|---|---|---|
| High | The event would be very likely to occur | 0.7 < to ≤ 1 |
| Moderate | The event would occur with an even likelihood | 0.3 < to ≤ 0.7 |
| Low | The event would be unlikely to occur | 0.05 < to ≤ 0.3 |
| Very low | The event would be very unlikely to occur | 0.001 < to ≤ 0.05 |
| Extremely low | The event would be extremely unlikely to occur | 0.000001 < to ≤ 0.001 |
| Negligible | The event would almost certainly not occur | 0 < to ≤ 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 2019b) and ISPM 11 (FAO 2019c).

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 six criteria, the consequences were estimated over four geographic levels, defined as:

**Local**—an aggregate of households or enterprises (a rural community, a town or a local government area).

**District**—a geographically or geopolitically associated collection of aggregates (generally a recognised section of a state or territory, such as 'Far North Queensland').

**Regional**—a geographically or geopolitically associated collection of districts in a geographic area (generally a state or territory, although there may be exceptions with larger states such as Western Australia).

**National**—Australia wide (Australian mainland states and territories and Tasmania).

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

**Indiscernible**—pest impact unlikely to be noticeable.

**Minor significance**—expected to lead to a minor increase in mortality/morbidity of hosts or a minor decrease in production but not expected to threaten the economic viability of production. Expected to decrease the value of non-commercial criteria but not threaten the criterion's intrinsic value. Effects would generally be reversible.

**Significant**—expected to threaten the economic viability of production through a moderate increase in mortality/morbidity of hosts, or a moderate decrease in production. Expected to significantly diminish or threaten the intrinsic value of non-commercial criteria. Effects may not be reversible.

**Major significance**—expected to threaten the economic viability through a large increase in mortality/morbidity of hosts, or a large decrease in production. Expected to severely or irreversibly damage the intrinsic 'value' of non-commercial criteria.

The estimates of the magnitude of the potential consequences over the four geographic levels were translated into a qualitative impact score (A-G) 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 four 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 four 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 four 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<br>more than one criterion has an impact of 'F'; or<br>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<br>all criteria have an impact of 'E'. | High |
| 3 | One or more criteria have an impact of 'E'; or<br>all criteria have an impact of 'D'. | Moderate |
| 4 | One or more criteria have an impact of 'D'; or<br>all criteria have an impact of 'C'. | Low |
| 5 | One or more criteria have an impact of 'C'; or<br>all criteria have an impact of 'B'. | Very Low |
| 6 | One or more but not all criteria have an impact of 'B', and<br>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 likelihood 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 the Group PRA 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.

The Group PRA that was applied to this risk analysis is:

- The *Final group pest risk analysis for thrips and orthotospoviruses on fresh fruit, vegetable, cut-flower and foliage imports* (Australian Government Department of Agriculture and Water Resources 2017), which is referred to as the 'thrips 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 recommended 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 2019c) 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 for each quarantine pest where the level of biosecurity risk does not achieve the ALOP for Australia. These are presented in Chapter 5: Pest risk management, of this report.

# 3 China's commercial production practices for Chinese jujubes

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

## 3.1 Considerations used in estimating unrestricted risk

The People's Republic of China provided a technical market access submission to Australia on commercial fresh Chinese jujube production in China, including information on the standard commercial practices used in the production of Chinese jujubes in different regions, and for all commercially produced Chinese jujubes varieties. This information has been complemented with data from other sources such as published literature, and was taken into consideration when estimating the unrestricted risks of pests that may be associated with the import of this commodity.

Officers from the department visited the key Chinese jujube production areas of China in September 2018. The objective of the visit was to observe Chinese jujube production systems, packing procedures and pest management practices and other export practices for fresh Chinese jujubes. The department's observations and additional information provided during the visit confirmed the production and processing procedures described in this chapter as standard commercial production practices for fresh Chinese jujubes for export.

In estimating the likelihood of pest introduction, it was considered that the pre-harvest, harvest and post-harvest production practices for fresh Chinese jujubes, as described in this chapter, are implemented for all regions, and for all fresh Chinese jujubes within the scope of this analysis. Where a specific practice described in this chapter is not taken into account to estimate the unrestricted risk, it is clearly identified and explained in Chapter 4.

## 3.2 Chinese jujube production areas

Chinese jujube is one of the most important fruit crops in China and has been grown in China for more than 4,000 years (AQSIQ 2017; Johnstone 2017). Shandong, Shaanxi, Shanxi, Henan, Hebei and Xinjiang provinces account for about 90 per cent of total Chinese jujube production in China (Map3) (AQSIQ 2017). The main Chinese jujube production areas include the Heilongjiang basin and Taihang Mountain areas in Hebei, northwest Shandong plains and Taiyi Taihang Mountain areas, the central Henan plain, Fenhe River basin, Sushi basin, Zhanghe River basin, southern Shanxi Yellow River, areas along Hutuo River and the Wutai Maintain areas in Shanxi and Weihe plain in Shaanxi (AQSIQ 2017). Currently, "Dongzao" is the most popular fresh Chinese jujube cultivar with a total of 107,000 hectares under cultivation that produces more than 410,000 tonnes of fresh fruit annually (AQSIQ 2017).

## 3.3 Climate in production areas

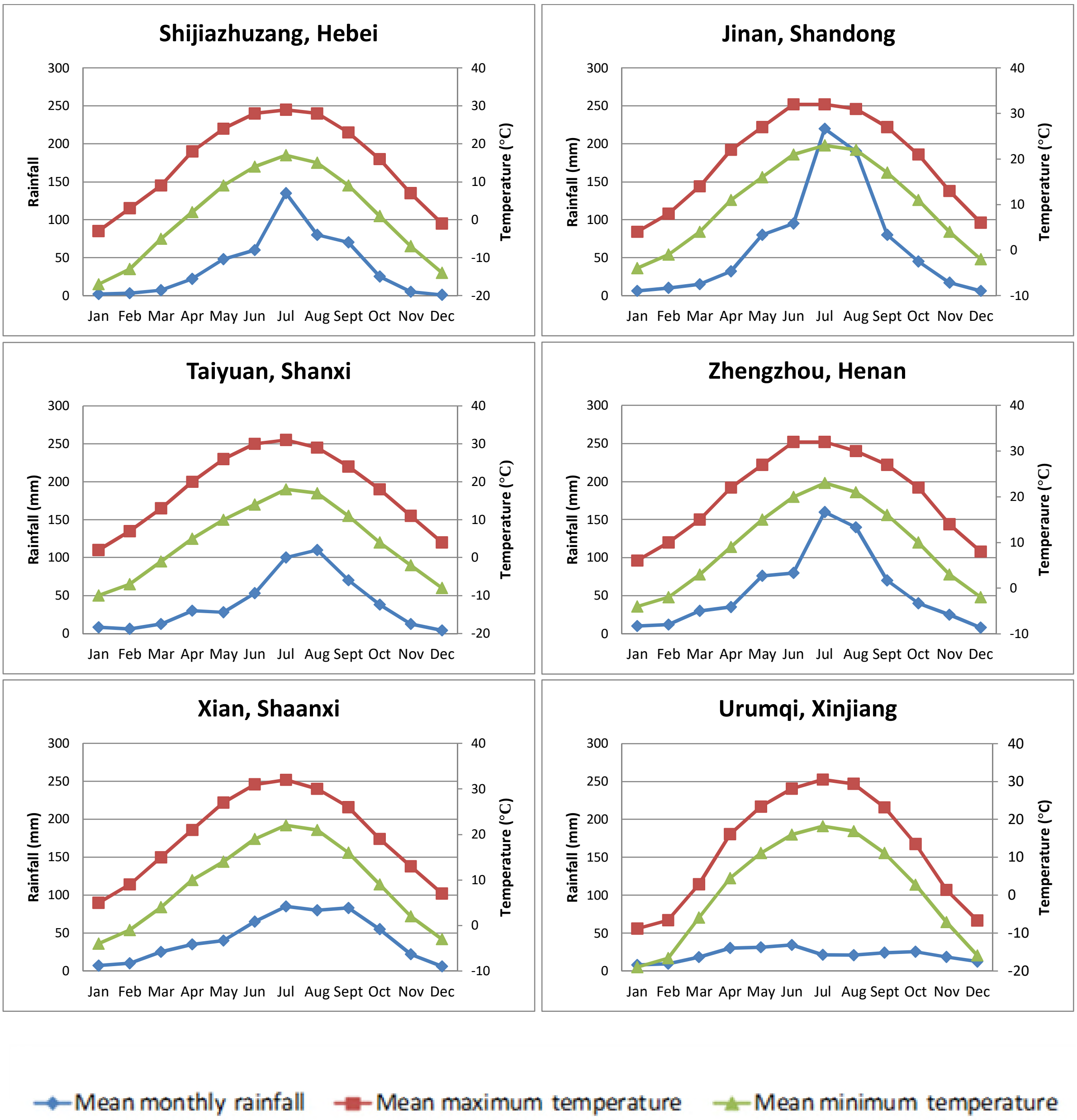
The Chinese jujube grows best in a warm sunny location. Trees thrive without any special care if they are given adequate heat and sun (CRFG 1996). The Chinese jujube grows best in climates with a long, hot, dry summer after adequate rain early in the season, with cool temperatures during its dormancy (AgriFutures 2017). It requires average daily temperatures above 20 degrees Celsius (°C) for fruit set. Fruit development requires average daily temperatures over 24–25 °C.

Climatic conditions in the main Chinese jujube production areas are mostly temperate with cold and dry winters, and wet and warm conditions in summer. In most of the production areas, temperatures range from as low as sub-zero (down to -20 °C) to 30 °C. Rainfall varies across the provinces, with the highest rainfall occurring in Shandong. May, June and July are the highest rainfall months in the main Chinese jujube production provinces (Figure 2).

**Map 3 Main Chinese jujube production areas in China**


Source: AQSIQ 2017

**Figure 2 Mean monthly maximum and minimum temperatures and monthly rainfall in the main Chinese jujube production areas**




Source: WorldClimate, www.worldclimate.com

## 3.4 Pre-harvest

### 3.4.1 Cultivars

Chinese jujube, also called Chinese date, red date, ber or tsao, is native to China and one of the oldest cultivated fruit trees in China (CRFG 1996; Yao 2013). Botanically it is derived from sour jujube or wild jujube (*Ziziphus spinosa* Hu), which was cultivated for its big fruit and good flavour (Yao 2013). Over 400 cultivars of Chinese jujube are grown across China (CRFG 1996).

The main commercially grown Chinese jujube cultivars include Dongzao (winter date), Lizao (pear date), Junzao, Zanhuang Dazao (Zanhuang Chinese date), Sushui Cuizao (Sushui crisp Chinese date), Jinsi Xiaozao (Jijithus) and Hupingzao (Huping date). All of these cultivars are used as fresh fruits in China. Dongzao is the main export cultivar.

### 3.4.2 Cultivation practices

#### Nursery stock production and propagation

Until the 1960s the most widely used method of Chinese jujube propagation was by root suckers. With the wider adoption of new cultivars, after 1960s, Chinese jujube grafting on sour jujube rootstock became increasingly popular. Although efforts have been made to use softwood cuttings and tissue culture propagation, grafting is still the most popular propagation technique (Yao 2013). In order to produce high quality disease-free nursery stocks, rootstocks for grafting are chosen from disease-free root suckers or seedlings germinated from disease-free seeds. Scions are chosen from disease-free Chinese jujube trees.

#### Orchard planning and plantation

In China, jujube trees are planted in orchards at spacings of 2–3 metre x 3–4 metre (intensive orchard), 1 metre x 2 metre (planned intensive planting), and 0.5–0.7 metre x 1 metre (super-intensive planting). Jujube trees are also grown in greenhouses (protected plantings) (Johnstone 2014). In some parts of China, for example in Shanxi province, Chinese jujubes are grown in tunnel polyhouses (Figure 3). The main purposes of the polyhouses are to increase the temperatures to bring the harvesting season earlier, to produce high quality fruit by minimising pests and diseases, and to protect fruits from damage caused by rain, especially during fruit maturing stage when late rains can cause fruit spilt.

#### Soil and irrigation

Chinese jujube trees grow well on a variety of soils, but prefer sandy loams or lighter well-drained soils. Chinese jujube trees are able to grow in soils with high salinity or alkalinity, but grow best in soils with pH 4.5–8.4 (AgriFutures 2017; CRFG 1996; Johnstone 2014). In Shanxi and Hebei provinces, the soil pH of Chinese jujube orchards is normally in the range of pH 7.0 to pH 8.5.

Chinese jujube trees are tolerant to drought conditions, and produce reasonable yields under severe water scarcity. However, regular watering is important to assure quality fruit production (CRFG 1996; Johnstone 2017).

#### Fertilisation

Chinese jujube trees grow well with little or no fertiliser. Light broadcast applications of balanced fertilisers to the established plants at two-month intervals during the growing season support tree growth. Foliar applications of fertilisers are also made during the growing season.

#### Canopy training and pruning

Training of canopy is carried out during the first few years of growth of Chinese jujube trees. In the first season after planting, both training and pruning are normally carried out during the dormant season (Figure 4). Topping may be carried out during summer.

**Figure 3 Tunnel polyhouse and an established open Chinese jujube orchard**

Figure 4 Pruning Chinese jujube trees during the dormant season

**Tree girdling**

In China, a number of special production practices are used to enhance yield and overall fruit quality. Trunk and branch girdling (ring barking) is a common practice with the aim of increasing fruit set and quality.

At the beginning of the flowering season, girdling is performed by removing a circular bark strip from around the trunk with a girdling knife. Short and deep wounds are usually made with an axe in the Chinese jujube tree bark and phloem around the trunk. The ring cut is done on the trunk above ground to the depth of the cambium layer without cutting the xylem (Figure 5).

**Figure 5 Tree girdling (ring barking) around a mature Chinese jujube tree**

### Orchards for export production

Orchards for export production purposes must be registered with GACC and comply with scheduled jujube tree growing methods. These include, applying organic fertiliser to improve organic matter content in soil, meeting the requirements of 'Standard for Quality of Irrigation Water -GB/5084-2005', and maintaining soil moisture content at 60 to 80 per cent of maximum water-holding capacity. Scheduled irrigation, soil and foliar fertilisers are also recommended.

A crop production calendar is used in the orchard to manage production practices. A generic schedule of production practices for Chinese jujube cultivation is provided (AQSIQ 2017), noting that the schedules may vary among different growing regions.

| Month – Phenophase | Management tasks |
| --- | --- |
| Early November to April – Dormancy period | • prune and collect scions<br>• repair terraces and fork over the soil |

| | |
|---|---|
| Early April to mid-May – Before and after sprouting | • remove unwanted buds and sprouts<br>• irrigate and apply soil and foliar fertiliser |
| June – Blossoming period | • pruning<br>• spray plant-growth regulators and microelement fertiliser<br>• irrigate and apply soil and foliar fertiliser<br>• weeding |
| July – Young fruit period<br>August – Fruit development period | • weeding and apply green manure<br>• apply fertilisers and irrigate<br>• weeding and apply green manure |
| September/October – mature period to leaf-falling period | • harvest mature fruits<br>• preserving, drying, baking and processing of fruits<br>• apply fertilisers and ploughing the orchard |

### 3.4.3 Pest management

During the Chinese jujube fruit growing season, provincial and regional customs officers under GACC are responsible for assisting registered orchards to design pest monitoring and control plans, and supervising the implementation of pest monitoring and management.

Generic pest management process scheduled by GACC is provided below, noting that the schedules may vary among different growing regions.

| Month – Phenophase | Monitoring and management tasks |
|---|---|
| Early November to April – Dormancy period | • clean the orchards<br>• tie straws to tree trunk and/or main branches to trap overwintering insects. The straws are removed and burned in spring to kill the insects trapped.<br>• scrape bark and paint tree trunks with limed water to kill overwintering insects and eggs<br>• remove jujube witch's broom (JWB) infected plants and branches<br>• cover tree trunk bases with plastic sheets and heap the soil to prevent *Sucra jujuba* adults from laying eggs on the trees |
| Early-April to mid-May – Before and after sprouting | • spray pesticides and fungicides to prevent and control *Scythropus yasumatsui*, JWB, *Ancylis sativa*, *Contarinia* sp. and other insects and diseases<br>• before budding, spray lime sulphur for disease prevention; spray diesel oil emulsion on trees infested by *Ceroplastes japonicus* and other similar pests<br>• set up sex pheromone and protein bait fruit fly traps for *Bactrocera dorsalis*, *Bactrocera correcta*, *Zeugodacus cucurbitae* and *Carpomyia vesuviana* |

| Month – Phenophase | Monitoring and management tasks |
|---|---|
| June – Blossoming period | • maintain and inspect fruit fly traps<br>• control and prevent *Ancylis sativa*, red spider mites and similar insects in the orchard without limiting bee pollination<br>• remove weeds |
| July – Young fruit period | • maintain and inspect fruit fly traps<br>• apply pesticides and fungicides to control and prevent *Phakopsora ziziphi-vulgaris*, *Ceroplastes japonicus*, red spider mites and other similar pests in the orchard<br>• set up sex pheromone traps for *Carposina sasakii* Chemical control measures are applied one week after adult male flight activity has peaked (e.g. 5–6 moths/ha) to kill adults, eggs and larvae |
| August – Fruit development period | • maintain and inspect fruit fly traps<br>• apply pesticides and fungicides to control and prevent *Phakopsora ziziphi-vulgaris*, *Ceroplastes japonicus*, red spider mites and other similar pests in the orchard<br>• apply chemical control measures one week after *Carposina sasakii* adult male flight activity has peaked (e.g. 5–6 moths/ha) to kill adults, eggs and larvae. |
| September/October – mature period to leaf falling period | • maintain and inspect fruit fly traps<br>• remove fallen fruits to minimise overwintering *Carposina sasakii* and other insects and pathogens<br>• tie straws to tree trunks and/or main branches to trap overwintering insects. The straws are removed and burned in spring to kill the insects trapped. |

**Monitoring and control for specific pests**

***Fruit flies***

In general, in addition to the national Fruit Fly Trapping Network in China, Chinese jujubes exporting orchards set additional fruit fly traps for Oriental fruit fly (*Bactrocera dorsalis*) and guava fruit fly (*Bactrocera correcta*) (methyl eugenol -ME traps) and melon fruit fly (*Zeugodacus cucurbitae*) (cuelure - CUE traps), and jujube fruit fly (*Carpomyia vesuviana*) (protein bait - PB traps) (Figure 6). The number of traps is dependent on the size of the orchards. Trap densities may vary in different growing regions, but traps are commonly used at rates of one trap per 5 to 10 ha. Traps are inspected every two weeks and serviced every month by technical officers from GACC regional offices from May to October each year.

***Peach fruit borer (Carposina sasakii)***

Peach fruit borer is closely monitored in jujube orchards, and peach fruit borer traps are set to trap and kill male moths. Trap densities may vary in different growing regions, but traps are commonly used at rates of two traps per ha. Traps are checked every three days. Pesticides are sprayed one week after the male moth flight activity reaches its peak to kill adults, eggs and larvae. Spray records are kept.

During the phytosanitary inspection by technical officers from GACC regional offices prior to export, fruit cutting is conducted to verify that the fruits are free from peach fruit borer.

**Figure 6 Trapping and monitoring of fruit flies and peach fruit borer**


## 3.5 Harvesting and handling procedures

Chinese jujube fruits are likely to be harvested from July to October with the peak harvest in September, depending on varieties, production practices and growing regions. Fruits are usually picked manually by workers using ladders or loading and unloading tools. To maintain the quality of the fruit, mature fruits are picked in batches. In the picking process, appropriate care is taken to minimise injuries or damage to the fruit. Care is taken to avoid inclusion of leaves or other plant debris. Rotten and damaged fruits are discarded (Figure 7).

For maintaining traceability of origin to the orchard and for hygiene purposes, a number of precautions are undertaken. For example:

- Pickers must wear gloves and put harvested fruits in a carry-on bag. Fruits must be handled with care to avoid physical damages. Damaged or abnormally shaped fruit are discarded.
- Pickers empty their carry-on bags into plastic collection bins with care. Each bin must carry a record card with the details of the registered orchard, picker's name and date of picking. The collection bins must not touch the ground to avoid contamination.
- Each bin must carry a certificate issued by the orchard manager, and be transported to packinghouses for processing.

**Figure 7 Harvesting of fresh Chinese jujubes**

## 3.6 Post-harvest

After harvest, Chinese jujube fruit being transported from orchards to packinghouses require protection to prevent damage. Fruits are ideally transported by motor van to the packing house in small plastic crates into which the fruits are collected.

### 3.6.1 Packinghouse processes

Fruit are processed immediately after harvest, or cold stored at -2 °C to 0 °C before packing. Packinghouse processes include a number of steps, as follows:

**Receival**

When jujube fruit arrive at the packinghouse, they are checked to confirm they are from a registered jujube orchard, then 10 per cent or more of the fruits are randomly sampled to check for fruit damage, pests and diseases, abnormal fruit shapes and colour.

**Cold storage in raw material cold rooms**

Chinese jujube fruit that pass inspection are stored in raw material cold rooms (at -2 °C to 0 °C) until packing. Fruit for export must be stored separately from those for domestic supply.

**Sorting**

Fruit from the cold room are loaded onto sorting tables to remove any trash (e.g. leaves and soil), and each fruit is inspected for physical damage, and damage from pests or diseases (Figure 8). The bins collecting the discarded fruit and trash are emptied daily or more frequently if required.

**Grading and packing**

After sorting, fruit are manually packed into three grades according to size (large, medium or small).

Fruit are packed into commercial packaging. Packaging materials must be clean, free from any toxic materials, non-polluting and breathable, and should not cause friction injury when in contact with fruit. The fruit packages are then packed into cardboard boxes for storage and transport.

**Quality inspection**

To check whether packed fruit meet export quality requirements, 10 per cent of boxes are randomly sampled and inspected (Figure 9). Fruit that meet commercial requirements are stored in separate cold rooms. Where fruit do not meet commercial requirements, the relevant orchards are warned, and the fruit must be re-packed and re-inspected or downgraded and withdrawn from the export program.

**Cold storage**

Packed fruit are stored in cold rooms (at -2 °C to 0 °C, 85 per cent relative humidity). Fruit for export are cold stored separately from those for domestic markets.

**Figure 8 Sorting of fresh Chinese jujube fruits for packing**

**Figure 9 Quality inspection of fresh Chinese jujubes after packing**

#### Phytosanitary inspection

Technical officers from GACC regional offices inspect the consignment for compliance with the importing country's phytosanitary requirements. A phytosanitary certificate is issued for consignments that pass inspection.

#### Shipping

Fresh Chinese jujubes are shipped in refrigerated containers or by air freight to the importing country.

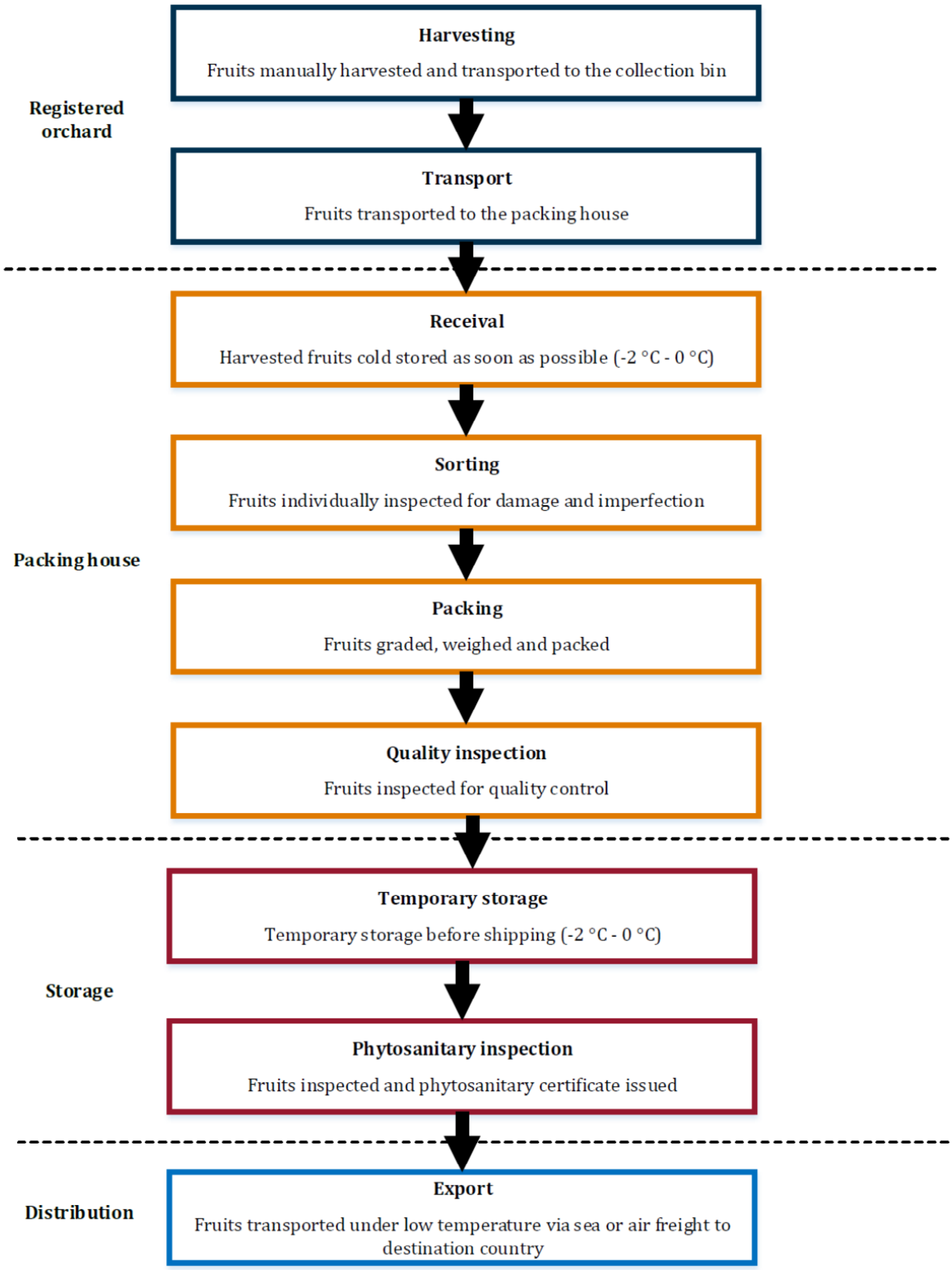
### 3.6.2 Transport

Loading, unloading and transport activities must be carried out in compliance with China’s export standards. Transport vehicles must be cleaned and securely closed after loading, and during transportation. Fresh Chinese jujubes for export from China must be loaded into refrigerated containers or air freight cans from the packinghouse's cool room.

Exporting enterprises must inspect their products, and consignments must also go through provincial and regional customs pre-export inspection and quarantine.

A schematic diagram summarising the harvesting, processing and storage system for fresh Chinese jujubes prior to export is provided in Figure 10.

Figure 10 Summary of operational steps for fresh Chinese jujubes grown in China for export

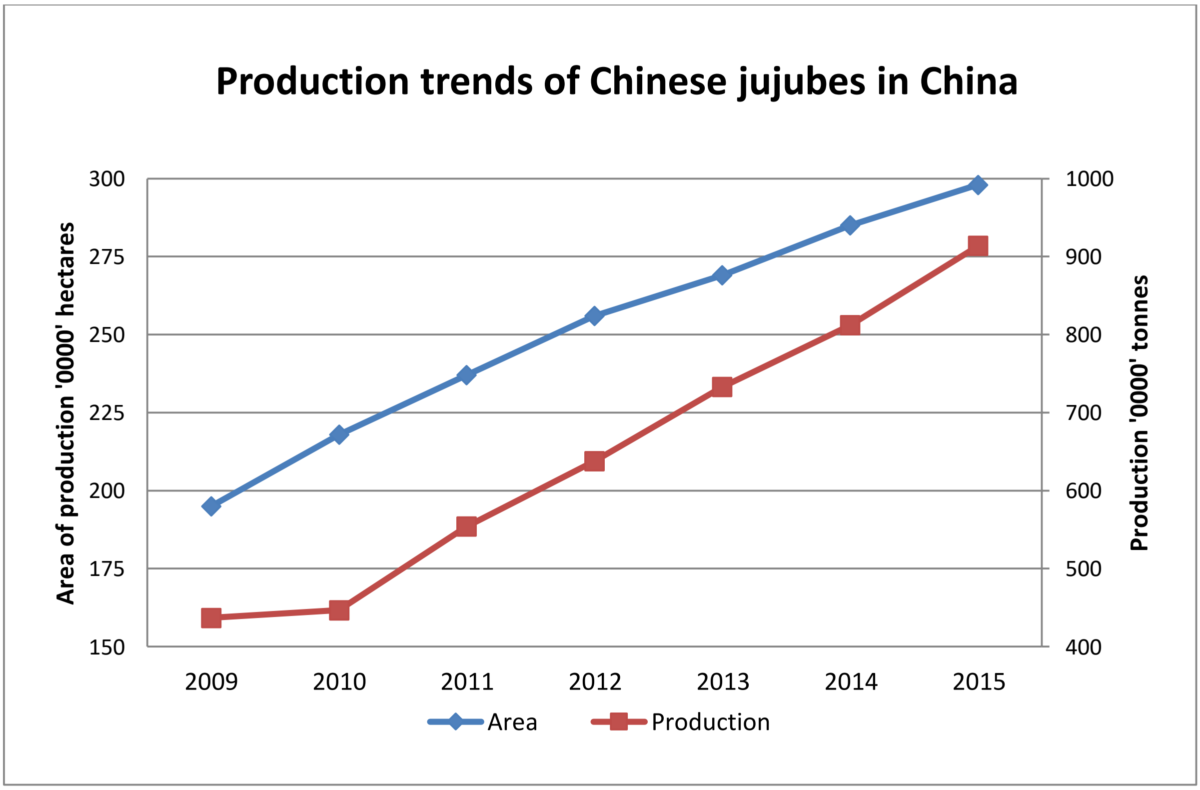


## 3.7 Export capability

### 3.7.1 Production statistics

China is the largest producer of Chinese jujubes in the world, producing approximately 9 million tonnes of fresh jujubes from around three million hectares in 2015. Figure 11 demonstrates the production trend of Chinese jujubes in China from 2009 to 2015. Although fresh Chinese jujubes are becoming increasingly popular, the majority of production is consumed as dried jujubes or other processed jujube products.

**Figure 11 Production trends of Chinese jujubes in China (2009-2015)**




Over 99 per cent of China's fresh Chinese jujube production is consumed domestically. China currently has market access for fresh Chinese jujubes to Canada, Chile, South Africa and Thailand. Total exports of only a few tonnes of fresh Chinese jujubes to these markets occurred in 2018 season.

China's fresh Chinese jujubes are expected to be exported between July and November, depending on varieties, production practices and growing regions. Transportation of fruit from China to Australia would be either by air or sea freight, with the total time from the orchard to arrival in Australia expected to be from a few days to as long as three to five weeks (China Shipping Australia 2014).

# 4 Pest risk assessments for quarantine pests

A total of eight quarantine pests for Australia (Table 4.1) and one regulated thrips species (Table 4.2), associated with export quality fresh Chinese jujubes commercially produced in China were identified in the pest categorisation process (Appendix A: Initiation and categorisation for pests of fresh Chinese jujube fruit from China). This chapter assesses the likelihoods of the entry (importation and distribution), establishment and spread of these species, and the economic (including environmental) consequences these species may cause if they were to enter, establish and spread in Australia.

Most of the identified quarantine pests or pest groups considered here, have been assessed previously by the department. Where appropriate, the outcomes of the 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.

The biosecurity risk posed by thrips and the orthotospoviruses they transmit, from all countries on fresh fruit, vegetable, cut-flower and foliage imports was previously assessed in the *Final group pest risk analysis for thrips and orthotospoviruses on fresh fruit, vegetable, cut-flower and foliage imports* (Australian Government Department of Agriculture and Water Resources 2017). This assessment is applicable to the same pests on Chinese jujubes from China. 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 thrips group PRA to this risk analysis is outlined in Section 2.2.7. A summary of pest information from the thrips group PRA is presented in this chapter for convenience.

Assessments of risks associated with these species are presented in this chapter unless otherwise indicated.

### Table 4.1 Quarantine pests associated with fresh Chinese jujubes from China

| Pest | Common name |
|---|---|
| **Spider mites [Prostigmata: Tetranychidae]** | |
| *Amphitetranychus viennensis* (EP) | hawthorn spider mite |
| **Fruit flies [Diptera: Tephritidae]** | |
| *Bactrocera correcta* (EP) | guava fruit fly |
| *Zeugodacus cucurbitae* (EP) | melon fly |
| *Bactrocera dorsalis* (EP) | Oriental fruit fly |
| *Carpomyia vesuviana* | jujube fruit fly |
| **Mealybugs [Hemiptera: Pseudococcidae]** | |
| *Heliococcus destructor* | heliococcus mealybug |
| **Armoured scales [Hemiptera: Diaspididae]** | |
| *Parlatoreopsis chinensis* | Chinese obscure scale |
| **Fruit borer [Lepidoptera: Carposinidae]** | |
| *Carposina sasakii* (EP) | peach fruit borer |

**EP:** Species has been assessed previously and import policy already exists.

### Table 4.2 Regulated thrips associated with fresh Chinese jujubes from China

| Pest | Common name |
|---|---|
| **Thrips [Thysanoptera: Thripidae]** | |
| *Scirtothrips dorsalis* (GP, RA) | chilli thrips |

**GP:** Species has been assessed previously in a group PRA and the group PRA has been applied (Australian Government Department of Agriculture and Water Resources 2017). **RA:** Regulated article, refer to Section 4.8 for definition of a Regulated article.

## 4.1 Hawthorn spider mite

### *Amphitetranychus viennensis* (EP)

*Amphitetranychus viennensis* (hawthorn spider mite), previously known as *Tetranychus viennensis*, belongs to the Tetranychidae family. Mites of this family are commonly referred to as spider mites due to their habit of spinning protective silken webbing on plants under which they feed (Zhang 2003). *Amphitetranychus viennensis* is present in major Chinese jujube production areas in China. *Amphitetranychus viennensis* produces three to 15 generations a year in China, depending on the climatic conditions in the area of occurrence (Wang et al. 2007). *Amphitetranychus viennensis* adult females lay eggs on the under surface of leaves. Nymphs and adults feed on stems, branches, leaves, buds, flowers, and fruits of Chinese jujubes (AQSIQ 2017). The mites damage plants with their stylets, penetrating into tissues.

The life cycle of spider mites consists of five stages—egg, larva, protonymph, deutonymph and adult. The largest of these life stages are adult females, which typically measure 0.3 to 0.5 millimetres in length and are commonly red, brown, green or yellow in colour. Immature stages resemble adults, but are smaller (Alford 2007; NAPPO 2014; Zhang 2008; Zhang 2003). Development from egg to adult takes one to two weeks depending on temperature, host, humidity and other environmental conditions (Zhang 2008; Zhang 2003). Due to their short development time, several generations can occur each year. In most species, females overwinter in protected sites. Spider mites can spread aerially, and through the movement of infested materials including plants and contaminated equipment and clothing. They can also disperse by crawling between plants, particularly under high infestation levels (NAPPO 2014; Zhang 2003).

*Amphitetranychus viennensis* has been assessed previously in the existing import policies for the nectarines, plums, peaches and apricots, apples, and table grapes from China pathways (Biosecurity Australia 2010a, 2011a; Department of Agriculture and Water Resources 2016, 2017a). In each of those existing policies, the unrestricted risk estimate for *A. viennensis* did not achieve the ALOP for Australia. Therefore, specific risk management measures are required for *A. viennensis* on these pathways.

The department has assessed the likelihood of importation of *A. viennensis* on the fresh Chinese jujubes from China pathway as being similar to the previous assessments of Moderate for nectarines, peaches, plums and apricots from China (Department of Agriculture and Water Resources 2016, 2017a). There is no information to suggest the presence of *A. viennensis* in China has changed since they were assessed for nectarines, peaches, plums and apricots from China. Chinese jujubes are morphologically similar to stone fruits (nectarines, peaches, plums and apricots), and the horticultural practices, major production areas and climatic conditions for these commodities in China are also similar. For these reasons, the likelihood of importation of *A. viennensis* on Chinese jujubes from China is considered similar to previously made assessments of Moderate.

Previous assessments of *A. viennensis* on other commodity pathways rated the likelihood of distribution as Moderate. Chinese jujubes from China are expected to be distributed in Australia in a similar way to other fruit commodities assessed previously. *Amphitetranychus viennensis* has a wide host range, and host materials are readily available in some parts of Australia. Additionally, adults of *A. viennensis* are capable of aerial dispersal, and would thus be able to find a suitable host if infested Chinese jujubes were discarded in the environment. There are climatic conditions suitable for the development of *A. viennensis* in some parts of Australia. Due to the year-round availability of host material, suitable climatic conditions, and the ability of *A. viennensis* to disperse to find hosts, the department has determined the likelihood of distribution for *A. viennensis* on the Chinese jujubes from China pathway to be similar to previously made assessments. Therefore, the same rating of Moderate for the likelihood of distribution of *A. viennensis* is adopted for the Chinese jujubes from China pathway.

The likelihoods of establishment and spread of *A. viennensis* in Australia are also similar to those of previous assessments of High and Moderate respectively. Those likelihoods relate specifically to events that occur in Australia and are essentially independent of the import pathway. The consequences of entry, establishment and spread for *A. viennensis* are also independent of the import pathway and are similar between pest risk assessments of Moderate. Therefore, the existing ratings for the likelihoods of entry, establishment and spread, and the rating for the overall consequences of *A. viennensis* have been adopted for the Chinese jujubes from China pathway.

In addition, the department has reviewed the latest literature—for example, (Choi et al. 2018; Li et al. 2017a), and no new information has been identified that would significantly change the risk ratings for importation, distribution, establishment, spread or consequences as set out for *A. viennensis* in the existing policies.

The likelihoods of importation, distribution and spread for *A. viennensis* on the Chinese jujubes from China pathway are all assessed as Moderate, and the likelihood of establishment is assessed as High. The consequences of entry, establishment, and spread are assessed as Moderate. 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 Low. All likelihood ratings are set out in Table 4.5.

### 4.1.1 Unrestricted risk estimate

The unrestricted risk estimate for *A. viennensis* on the Chinese jujubes from China pathway is assessed as Low, which is identical to the outcomes of previous assessments, and which does not achieve the ALOP for Australia. Therefore, specific risk management measures are required for *A. viennensis* on this pathway.

## 4.2 Oriental fruit fly and melon fly

### ***Bactrocera dorsalis*** **(EP) and** ***Zeugodacus cucurbitae*** **(EP)**

*Bactrocera dorsalis* (Oriental fruit fly) and *Zeugodacus cucurbitae* (melon fly) belong to the Tephritidae family, which is a group of pests considered to be among the most damaging pests of horticultural crops. They have been grouped together in this assessment on the basis of their related biologies, because of which they are predicted to pose similar risks and to require similar risk management measures. Both species have been listed as quarantine pests for China and are under official control (AQSIQ 2007) and their geographic distributions in China are similar; these include Fujian, Guangdong, Guangxi, Guizhou, Hainan, Hunan, Hubei, Jiangsu, Sichuan and Yunnan provinces in southern China (AQSIQ 2017).

On the basis of phylogenetic relationship analysis, the fruit fly *Bactrocera cucurbitae* has recently been proposed to be placed in the genus *Zeugodacus* (De Meyer et al. 2015; Virgilio et al. 2015a). Current and existing literature refers to melon fly under both the former (*Bactrocera cucurbitae*) and proposed (*Zeugodacus cucurbitae*) scientific names. This document refers to melon fly as *Zeugodacus cucurbitae*.

Tephritid fruit flies have four life stages: egg, larva, pupa and adult. Adults are predominantly black, or black and yellow. Eggs are laid into the skin of the host fruit, and hatched larvae feed within the fruit. Pupation occurs in the soil under the host plant (CABI 2019a). Tephritid fruit flies can produce several generations each year, depending primarily on temperature. Adults occur throughout the year and begin mating within a week and may live one to three months depending on temperatures and up to 12 months in cool conditions (Christenson & Foote 1960). Adults may live for many months and in laboratory studies the potential fecundity of females of *B. dorsalis* is well over 1000 eggs per individual (Fletcher 1989a). The major means of movement and dispersal of tephritid flies are transportation of infected fruit and adult flight (Fletcher 1989b). Some tephritid flies can migrate long distances and some species can fly more than 50 kilometres (Fletcher 1989b).

*Bactrocera dorsalis* has been assessed previously in a number of existing import policies, including for apples, table grapes, pears, nectarines, plums, peaches and apricots from China (AQIS 1998b; Biosecurity Australia 2010a, 2011a; Department of Agriculture and Water Resources 2016, 2017a). Both *B. dorsalis* and *Z. cucurbitae* have also been assessed previously in existing policies for longan and lychees from China and Thailand (DAFF 2004a), lychees from Taiwan and Vietnam (DAFF 2013), mangoes from India (Biosecurity Australia 2008) and dragon fruit from Vietnam (Department of Agriculture and Water Resources 2017b). In each of those existing policies, the unrestricted risk estimate for *B. dorsalis and Z. cucurbitae* did not achieve the ALOP for Australia. Therefore, specific risk management measures are required for *B. dorsalis* and *Z. cucurbitae* on those pathways.

The department has assessed the likelihood of importation of *B. dorsalis* and *Z. cucurbitae* on the fresh Chinese jujube fruit from China pathway as being most similar to the previous assessments for *B. dorsalis* on nectarines, peaches, plums and apricots from China (Biosecurity Australia 2010a, 2011a; Department of Agriculture and Water Resources 2016, 2017a). There is no information to suggest the presence of these fruit flies in China has changed since they were assessed for those pathways. *Bactrocera dorsalis* and *Z. cucurbitae* lay their eggs directly into host fruit, where the larvae then hatch and grow. While this feeding eventually leads to obvious damage to the fruit, signs of infestation are not obvious when the eggs are initially laid. Chinese jujubes is recorded as a host for *B. dorsalis* and *Z. cucurbitae*. Fresh Chinese jujubes are morphologically similar to stone fruits (nectarines, peaches, plums and apricots), and the horticultural practices, major production areas and climatic conditions for these commodities in China are also similar. For these reasons, the likelihoods of importation of *B. dorsalis* and *Z. cucurbitae* on fresh Chinese jujube fruit from China are considered similar to the previously made assessments of High.

Previous assessments of *B. dorsalis* and *Z. cucurbitae* on other commodity/country pathways rated the likelihoods of distribution as High. Fresh Chinese jujubes from China are expected to be distributed in Australia in a similar way to other fruit commodities assessed previously. *Bactrocera dorsalis* and *Z. cucurbitae* have wide host ranges, and host material is likely to be available at all times in parts of Australia. Additionally, adults of *B. dorsalis* and *Z. cucurbitae* are capable of flight, and would thus be able to find a suitable host if infested fresh Chinese jujubes were discarded in the environment. There are climatic conditions suitable for the development of *B. dorsalis* and *Z. cucurbitae* in most parts of Australia. Due to the year-round availability of host material, suitability of climatic conditions, and the ability of *B. dorsalis* and *Z. cucurbitae* to disperse to find hosts, the department has determined the likelihoods of distribution for *B. dorsalis* and *Z. cucurbitae* on the fresh Chinese jujubes from China pathway to be similar to previously made assessments. Therefore, the same rating of High for the likelihood of distribution of *B. dorsalis* and *Z. cucurbitae* are adopted for the fresh Chinese jujubes from China pathway.

The likelihoods of establishment and spread of *B. dorsalis* and *Z. cucurbitae* in Australia are similar to those of previous assessments of High. Those likelihoods relate specifically to events that occur in Australia and are essentially independent of the import pathway. The consequences of entry, establishment and spread for *B. dorsalis* and *Z. cucurbitae* are also independent of the import pathway and are similar between pest risk assessments of High. Therefore, the existing ratings for the likelihoods of entry, establishment and spread, and the ratings for the overall consequences of *B. dorsalis* and *Z. cucurbitae* have been adopted for the fresh Chinese jujubes from China pathway.

In addition, the department has reviewed the latest literature—for example, (Boontop 2016; Bugti et al. 2015; De Meyer et al. 2015; Follett, Manoukis & Mackey 2018; Huang & Chi 2014; Kim & Kim 2018; Pietersen, Terblanche & Addison 2017; Shelly et al. 2017; Theron, Manrakhan & Weldon 2017; Virgilio et al. 2015a; Weems et al. 2016), and no new information has been identified that would significantly change the risk ratings for importation, distribution, establishment, spread or consequences as set out for *B. dorsalis* and *Z. cucurbitae* in the existing policies.

The likelihoods of importation, distribution, establishment and spread for *B. dorsalis* and *Z. cucurbitae* on the fresh Chinese jujubes from China pathway are all assessed as High. The consequences of entry, establishment, and spread are also assessed as High. When these likelihood and consequence ratings are combined using the rules presented in Table 2.2 and Table 2.5, the unrestricted risk for each species is determined to be High. All likelihood ratings are set out in Table 4.5.

### Unrestricted risk estimate

The unrestricted risk estimates for *B. dorsalis* and *Z. cucurbitae* on the fresh Chinese jujubes from China pathway are assessed as High, which is identical to the outcomes of previous assessments, and which do not achieve the ALOP for Australia. Therefore, specific risk management measures are required for *B. dorsalis* and *Z. cucurbitae* on this pathway.

## 4.3 Guava fruit fly

### *Bactrocera correcta* (EP)

*Bactrocera correcta* (guava fruit fly) belongs to the Tephritidae family, which is a group of pests considered to be among the most damaging pests of horticultural crops (Allwood et al. 1999; AQSIQ 2017; Kunprom, Sopaladawan & Pramual 2015; Maynard, Hamilton & Grimshaw 2004). *Bactrocera correcta* has been listed as a quarantine pest for China and is under official control (AQSIQ 2007). Its distribution in China is limited to Yunnan and Sichuan provinces (Liu, Yan & Ye 2013).

Tephritid flies have four life stages: egg, larva, pupa and adult. Adults are predominantly black, or black and yellow. Eggs are laid into the skin of the host fruit, and hatched larvae feed within the fruit. Pupation occurs in the soil under the host plant (CABI 2019a). It can produce several generations each year, depending primarily on temperature. Adults occur throughout the year and begin mating about eight to 12 days and may live one to three months depending on temperatures and up to 12 months in cool conditions (Christenson & Foote 1960). The major means of movement and dispersal of tephritid flies are transportation of infected fruit and adult flight (Fletcher 1989b). Some tephritid flies can migrate long distances and some species can fly more than 50 kilometres (Fletcher 1989b).

*Bactrocera correcta* have been assessed previously in the existing import policies for nectarines, plums, peaches and apricots from China (Biosecurity Australia 2010a, 2011a; Department of Agriculture and Water Resources 2016, 2017a), dragon fruit from Vietnam (Department of Agriculture and Water Resources 2017b), and mangoes from India, Indonesia, Thailand, Vietnam and Pakistan (Biosecurity Australia 2008, 2011b; Department of Agriculture and Water Resources 2015). In those existing policies, the unrestricted risk estimates for *B. correcta* did not achieve the ALOP for Australia. Therefore, specific risk management measures are required for *B. correcta* on those pathways.

The department has assessed the likelihood of importation of *B. correcta* on the fresh Chinese jujube fruit from China pathway as being similar to the previous assessments of Low for nectarines, peaches, plums and apricots from China (Department of Agriculture and Water Resources 2016, 2017a) on the basis of its limited distribution in China. Tephritid fruit flies lay their eggs directly into host fruit, where the larvae then hatch and grow. While this feeding eventually leads to obvious damage to the fruit, signs of infestation are not obvious when the eggs are initially laid. Fresh Chinese jujubes is recorded as a host for *B. correcta*, and the presence of *B. correcta* in China has not changed since they were assessed for nectarines, peaches, plums and apricots from China. Fresh Chinese jujubes are morphologically similar to stone fruits (nectarines, peaches, plums and apricots), and the horticultural practices, major production areas and climatic conditions for these commodities in China are also similar. For these reasons, the likelihood of importation of *B. correcta* on fresh Chinese jujubes from China is considered similar to previously made assessments of Low.

Previous assessments of *B. correcta* on other commodity/country pathways rated the likelihood of distribution as High. Fresh Chinese jujubes from China are expected to be distributed in Australia in a similar way to other fruit commodities assessed previously. *Bactrocera correcta* has a wide host range, and host material is likely to be available at all times in parts of Australia. Additionally, adults of *B. correcta* are capable of flight, and would thus be likely to find a suitable host if infested fresh Chinese jujubes were discarded in the environment. There are climatic conditions suitable for the development of *B. correcta* in some parts of Australia. Due to the year-round availability of host material, suitability of climatic conditions, and the ability of *B. correcta* to disperse to find hosts, the department has determined the likelihood of distribution for *B. correcta* on the fresh Chinese jujubes from China pathway to be similar to previously made assessments. Therefore, the same rating of High for the likelihood of distribution of *B. correcta* is adopted for the fresh Chinese jujubes from China pathway.

The likelihoods of establishment and spread of *B. correcta* in Australia are similar to those of previous assessments of High. Those likelihoods relate specifically to events that occur in Australia and are essentially independent of the import pathway. The consequences of entry, establishment and spread for *B. correcta* are also independent of the import pathway and are similar between pest risk assessments of High. Therefore, the existing ratings for the likelihoods of entry, establishment and spread, and the rating for the overall consequences of *B. correcta* have been adopted for the fresh Chinese jujubes from China pathway.

In addition, the department has reviewed the latest literature—for example, (Guo et al. 2018b; Jiang et al. 2013; Kamiji, Arakawa & Kadoi 2014; Liu et al. 2015; Qin et al. 2016; Solangi et al. 2017) and no new information has been identified that would significantly change the risk ratings for importation, distribution, establishment, spread or consequences as set out for fruit flies in the existing policies.

The likelihoods of distribution, establishment and spread for *B. correcta* on the fresh Chinese jujubes from China pathway are all assessed as High, while the likelihood of importation is assessed as Low. The consequences of entry, establishment, and spread are assessed as High. When these likelihood and consequence ratings are combined using the rules presented in Table 2.2 and Table 2.5, the unrestricted risk is determined to be Moderate. All likelihood ratings are set out in Table 4.5.

**Unrestricted risk estimate**

The unrestricted risk estimate for *B. correcta* on the fresh Chinese jujubes from China pathway is assessed as Moderate, which is similar to the outcomes of previous assessments, and which does not achieve the ALOP for Australia. Therefore, specific risk management measures are required for *B. correcta* on this pathway.

## 4.4 Jujube fruit fly

### *Carpomyia vesuviana*

*Carpomyia vesuviana* (jujube fruit fly) belongs to the Tephritidae or fruit fly family. The adults are small brownish yellow flies, smaller than a housefly. They have characteristics brown longitudinal lines with numerous black spots on the dorsal, ventral and pleural surface of the thorax. The forewing and hindwings are hyaline and possess greyish-brown spots and a few yellowish cross-bands (Haldhar et al. 2016; Kavitharaghavan, Savithri & Vijayarghavan 2005). The adult male is slightly larger than female; and the mean length of adult male is about 4.7 millimetres, and of the adult female 4.4 millimetres. The mean wing-expanse of male and female adults is over 3.8 millimetres (Kavitharaghavan, Savithri & Vijayarghavan 2005). The female and male can mate multiple times, and adults can live up to 45 days (He et al. 2009a; Hu et al. 2013).

*Carpomyia vesuviana* has four life stages: egg, larva, pupa and adult (Balikai 2009; Haldhar et al. 2016; Kavitharaghavan, Savithri & Vijayarghavan 2005). The eggs are small, creamy-white in colour, elongated, spindle-shaped, measuring about 0.9 millimetres in length (Kavitharaghavan, Savithri & Vijayarghavan 2005). The female usually oviposits eggs into the fruit skin singly at the early stages of fruit development and may lay up to 20 eggs on a single fruit (Balikai 2009; Haldhar et al. 2016; Kavitharaghavan, Savithri & Vijayarghavan 2005; Pollini & Cravedi 2014). The female prefers to oviposit at the distal part of the fruit (Haldhar et al. 2016; Karuppaiah 2014; Kavitharaghavan, Savithri & Vijayarghavan 2005).

The incubation period of the eggs (hatching) is two to five days (Karuppaiah 2014). After hatching, the larva (maggot) starts to feed on the fruit pulp and makes galleries inside the fruit (He et al. 2009a). The larva has three instars before pupation (Balikai 2009; Kavitharaghavan, Savithri & Vijayarghavan 2005). The duration of the larval stage is about 8 to 12 days depending upon temperature (Balikai 2009; Karuppaiah 2014; Kavitharaghavan, Savithri & Vijayarghavan 2005). The larvae are creamy-white in colour, measuring about 7.7 millimetres in length at maturity. The anterior region of the larva is narrow, and the posterior region is blunt (Kavitharaghavan, Savithri & Vijayarghavan 2005).

At the end of the larval stage, mature larvae make a circular hole in the skin of the fruit. The larvae then exit the fruit from those holes and fall to the ground for pupation in soil (Haldhar et al. 2016; Karuppaiah 2014; Kavitharaghavan, Savithri & Vijayarghavan 2005) where they overwinter as pupae in soil (He et al. 2009a). Average pupal periods range from about 14 to 180 days, depending on season and temperatures (Reddy 1990).

Host plants of *C. vesuviana* are restricted to wild and cultivated species of *Ziziphus* (Farrara et al. 2009; Haldhar et al. 2016; Karuppaiah 2014; Stibick 2004).

*Carpomyia vesuviana* has been reported in Bangladesh, Georgia, India, Thailand, Indian Ocean Islands, Iran, Mauritius, Middle East (Oman), Pakistan, Afghanistan, Southern Europe, Italy, Bosnia, North Africa, Caucasus, Turkmenistan, Turkey, and Uzbekistan (Amini et al. 2014; Farrara et al. 2009; Hu et al. 2013; Karuppaiah 2014; Li et al. 2017b; Pollini & Cravedi 2014; Stibick 2004). It is the most important economic pest of *Ziziphus* species in these countries (Amini et al. 2014; Farrara et al. 2009; Hu et al. 2013; Karuppaiah 2014; Li et al. 2017b; Pollini & Cravedi 2014). Economic losses due to jujube fruit fly infestation vary in different countries and climatic conditions, but can range from 20 to 100 per cent, depending on the in-field management practices (Al-Masudey & Al-yousuf 2012; Balikai 2009; Bhagvan, Acharya & Meena

2017; Farrara et al. 2009; Haldhar et al. 2018; Haldhar et al. 2016; Karuppaiah 2014; Mari, Chachar & Chachar 2013).

*Carpomyia vesuviana* was first detected in the Turpan region of Xinjiang in China in 2007 (He et al. 2009a). It is listed as a quarantine pest for China, and has been under official control since 2009 (National Forestry Administration of China 2012, 2016). The distribution of *C. vesuviana* is limited to the Turpan region of Xinjiang in China, as verified by the National Fruit Fly Trapping Network, and additional trapping systems in other major jujube growing regions across China (GACC 2018). The department recognises *C. vesuviana* pest freedom status for Chinese jujubes growing regions outside the Turpan region of Xinjiang.

The risk assessment presented here has therefore been conducted for fresh Chinese jujubes sourced from the Turpan region of Xinjiang in China where *C. vesuviana* is present, but will also apply to other areas where pest freedom status has been suspended.

The risk scenario of concern is the presence of developing larvae and eggs of *C. vesuviana* within imported fresh Chinese jujubes.

### 4.4.1 Likelihood of entry

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

#### Likelihood of importation

The likelihood that *Carpomyia vesuviana* will arrive in Australia with the importation of fresh Chinese jujubes from China is assessed as: **High.**

The following information supports this assessment:

*Carpomyia vesuviana* is present in the Turpan region of Xinjiang in China, which is a Chinese jujubes growing region.

- *Carpomyia vesuviana* was first reported to damage *Ziziphus jujuba* in the Turpan region of Xinjiang in China in 2007 (He et al. 2009a; Hu et al. 2013; Pollini & Cravedi 2014). A survey conducted between 2007 and 2008 found that around 33.3 per cent of mature jujube trees were infested (He et al. 2009a).

- *Carpomyia vesuviana* is listed as a quarantine pest for China, and has been under official control since 2009 (National Forestry Administration of China 2012, 2016). A *Technical regulation for monitoring and control of C. vesuviana* was developed and implemented in 2009 (National Forestry Administration of China 2016). *Quarantine technical rules of C. vesuviana* were developed and implemented in 2012 (National Forestry Administration of China 2012). The distribution of *C. vesuviana* is limited to the Turpan region of Xinjiang in China, as verified by the National Fruit Fly Trapping network and additional trapping systems in other major jujube growing regions (GACC 2018).

- Using computer modelling, Lü et al. (2008) suggested that the potential geographic distribution of *C. vesuviana* could include Shandong, Henan, Shaanxi, Shanxi, Hebei and Beijing, which are the major Chinese jujube production areas in China. It also has the potential to establish in other regions, including Yunnan, west of Liaoning, and Guangxi, east of Sichuan, and Gansu, north of Jiangsu, Anhui and Hubei, west and north of Xinjiang.

Eggs and larvae of *C. vesuviana* could be present within the infested fruit during the harvesting period.

- *Carpomyia vesuviana* reproduces sexually and may have multiple overlapping generations each year. Depending on the climate and temperature, the number of generations of *C. vesuviana* can vary, for example, from one to two generations in Italy (Pollini & Cravedi 2014), to two to three generations in the Turpan region of Xinjiang in China (He et al. 2009a) and northern India (Haldhar et al. 2016), and up to six to nine overlapping generations in southern India (Karuppaiah 2014).
- In the Turpan region of Xinjiang, the emergence of *C. vesuviana* adults from the overwintering population starts in mid-May and ends in early July, coinciding with the flowering to early fruit-setting stages (He et al. 2009a). The emergence period lasts up to 48 days. Adult females start laying eggs into the young jujube fruit from mid-June.
- The infestation of *C. vesuviana* starts at the onset of fruiting (Karuppaiah 2014). Adult females lay eggs by inserting their ovipositor into the young developing fruit. Females usually lays eggs singly early in the season when the fruits are immature, but as the season progresses, up to 20 eggs per fruit have been recorded (Balikai 2009; Haldhar et al. 2016; Kavitharaghavan, Savithri & Vijayarghavan 2005; Pollini & Cravedi 2014).
- *Carpomyia vesuviana* can lay eggs into jujube fruit throughout the entire growing season. Normally, jujube fruit harvesting finishes by late September in the Turpan region of Xinjiang (He et al. 2009a). In some other regions, harvesting of Chinese jujubes continues into October.
- After two to five days, larvae hatch from eggs and feed on pulp inside the fruit (Azam-Ali et al. 2006; Balikai, Kotikal & Prasanna 2013; Bugti et al. 2015; Pollini & Cravedi 2014).
- Pupae are very unlikely to be associated with fruit because mature larvae exit the fruit and pupate in the soil (Haldhar et al. 2016; Karuppaiah 2014; Kavitharaghavan, Savithri & Vijayarghavan 2005).
- Infested fruit may remain attached to the tree and be harvested, especially those that have been recently infested (He et al. 2009a; Hu et al. 2013) .

Feeding damage in Chinese jujube fruit may not be readily seen.

- *Carpomyia vesuviana* lays eggs under the skin of fruit, with larvae feeding internally after hatching (Balikai 2009; Haldhar et al. 2016; Kavitharaghavan, Savithri & Vijayarghavan 2005; Pollini & Cravedi 2014).
- The oviposition hole is small (0.5 to 1.5 millimetres) (Hu et al. 2013) therefore, newly-infested fruit are likely to go unnoticed during harvesting and packinghouse procedures.
- Fruit infested by *C. vesuviana* may become deformed and their growth become retarded around the oviposition puncture. In severe cases, a large number of fruits may rot and drop off trees prematurely (Haldhar et al. 2016; Karuppaiah 2014; Kavitharaghavan, Savithri & Vijayarghavan 2005).
- Secondary damage to fruit by fruit flies can also occur. Fruit that have been punctured by oviposition or in where the flesh has been fed by larvae have been reported to often have internal rotting due to secondary infection by bacteria or fungi (Mau & Martin Kessing 2007). Any Chinese jujube fruit showing signs of rotting is very likely to be removed during routine harvesting and packing procedures, and is unlikely to be packed for export. However, the symptoms may not be visible externally at the early stage of infestation, and therefore these fruit may escape detection.

Eggs and larvae of *C. vesuviana* could survive cold storage in China and cold transport to Australia.

- Harvested jujube fruits are normally cold stored at -2 to 0 degrees Celsius, depending on the sugar content of the fruit.
- Fresh Chinese jujubes can undergo cold storage without damage. At -2 to 0 degrees Celsius, fresh Chinese jujubes can be stored for two to three months without affecting the colour, firmness or eating quality.
- However, some fruits are likely to be packed immediately after harvesting and air freighted to Australia, which significantly reduces the duration of cold storage and transport.
- The lower development thresholds for eggs and larvae of *C. vesuviana* are 13.6 and 6.4 degrees Celsius respectively (National Forestry Administration of China 2016). These are significantly higher than the cold conditions of cold storage and transport.
- The ability of *C. vesuviana* eggs and larvae to survive cold temperatures for extended periods is not well known. However, it is known that larvae of *C. vesuviana* can tolerate very low temperatures, at least for very short periods. Ding et al. (2014a) reported that the supercooling point of the 3$^{rd}$ star larvae was -9.75±0.64 degrees Celsius and the mean freezing point was – 5.53±0.46 degrees Celsius.

*Carpomyia vesuviana* is present in the Turpan region of Xinjiang, which is one of the major Chinese jujubes growing regions. It is the most important economic pest of *Ziziphus* species. If infested Chinese jujube fruit remains attached to the tree and is harvested, infestation of Chinese jujube fruit may not be immediately apparent until secondary infections have developed and produced obvious signs of attack or tissue decay. Newly-infested fruit may not be easily distinguished during sorting, packing and quality inspection procedures. Chinese jujube fruit are stored and transported at temperatures that are below the lower developmental thresholds for eggs and larvae, therefore, some mortality may occur. However, it is likely that some eggs and larvae would survive the cold storage and transport, depending on the temperatures and duration of these processes.

For the reasons outlined, for fresh Chinese jujube fruit sourced from the Turpan region, the estimated likelihood of importation of eggs and larvae of *C. vesuviana* is assessed as 'High'.

#### Likelihood of distribution

The likelihood that *C. vesuviana* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of fresh Chinese jujubes from China and subsequently transfer to a susceptible part of a host is assessed as: **Low.**

The following information provides supporting evidence for this assessment.

It is likely that imported fresh Chinese jujubes will be commercially sold in every state of Australia.

- It is expected that when fresh Chinese jujubes from China arrive in Australia, they will be distributed for retail sale in many areas of the country. The major population centres are likely to receive the majority of the imported fresh Chinese jujubes.
- Human consumption is the intended use for fresh Chinese jujubes in Australia. Fresh Chinese jujubes with no obvious signs of infestation could potentially be distributed via the wholesale and retail trade, and waste material is likely to be generated.

- If *C. vesuviana* eggs and larvae are in the Chinese jujubes, packed fruit infested with *C. vesuviana* are likely to be transported to their destination without being detected.

Cold storage and transport of fresh Chinese jujubes around Australia may not kill all eggs and larvae of *C. vesuviana* within the infested fruits.

- Upon arrival, fresh Chinese jujubes will be maintained in cool storage and transported by temperature controlled transport services to multiple retail points throughout Australia.
- As noted above, the lower developmental thresholds for eggs and larvae of *C. vesuviana* are significantly higher than the cold conditions of cold storage and transport. Therefore, eggs and early stage larvae are unlikely to develop during cold storage and transport in Australia.
- The ability of *C. vesuviana* eggs and larvae to survive cold temperatures for extended periods is not well known. However, it is known that larvae of *C. vesuviana* can tolerate very low temperatures.

It is likely that small quantities of infested fresh Chinese jujubes will be discarded into the environment.

- Most of the fruit will be consumed other than the seed. Individual consumers may discard seeds with or without small quantities of flesh to urban, rural or natural environments. Rotten fruits may be discarded in domestic compost.
- Fresh Chinese jujubes with obvious symptoms of infestation are unmarketable and will be discarded.
- Commercial waste of imported fresh Chinese jujubes may also be generated prior to or during retail sale. Most commercial waste will be discarded into managed waste systems.

Eggs and early stage larvae of *C. vesuviana* may not complete development within the discarded infested fruit.

- It is likely that many eggs and early stage larvae inside discarded infested fruit would be unable to complete development before the fruit desiccates under dry conditions, or the fruit rots under wet conditions.
- Some late stage larvae within the infested fruit could develop into mature larvae before the fruit dries or rots. Subsequently, pupation could occur.
- The lower development thresholds for pupae of *C. vesuviana* is 6.38 degrees Celsius (National Forestry Administration of China 2016), and the optimal temperature for pupal development and adult emergence is 30 degrees Celsius. The incidence of *C. vesuviana* has been noted to be high when relative humidities are 62-82 per cent and temperatures range between 17-25.5 degrees Celsius (Karuppaiah 2014). Therefore, temperatures and relative humidities at the anticipated time of import (July to November) are suitable in many parts of Australia for successful development of pupae and adult emergence.

*Emergent C. vesuviana* adults would need to find a suitable host.

- Host plants of *C. vesuviana* are limited to wild and cultivated species of *Ziziphus* (Farrara et al. 2009; Haldhar et al. 2016; Karuppaiah 2014; Stibick 2004).
- Australia has a small Chinese jujube industry. *Ziziphus jujuba* is grown in small areas of Western Australia, Victoria, New South Wales, Queensland and South Australia, with the majority of production in Western Australia.
- *Ziziphus mauritiana* (Indian jujube, considered as a weed in Australia) and a number of other *Ziziphus* species are also distributed sporadically in Western Australia, Northern

Territory, north-eastern Queensland and south-eastern Queensland (ALA 2018; ATRP 2010).

- In Australia, depending on the cultivars and maturing stages, Chinese jujube trees in Australia start fruit-setting in November and fruits are harvested from February to April. The timing of fruit setting and maturing of the wild *Ziziphus* species in Australia landscape is similar to that of cultivated Chinese jujube plants.
- The majority of imported fresh Chinese jujubes from China are likely to arrive in Australia from August to October (AQSIQ 2017).
- Adults *C. vesuviana* can mate multiple times and adults can live up to 45 days (He et al. 2009a). Therefore, some mated females may be able to find a suitable host and lay eggs in fruit. However, the seasonal asynchrony between imported infested fruit and availability of host fruit in Australia would limit the capacity of a mated female finding a suitable host fruit.
- Flight capability of *C. vesuviana* adults is highly dependent on temperature conditions and the age. They can fly about one to three kilometres (Ding et al. 2014b). The ability of adult *C. vesuviana* to fly several kilometres increases the likelihood of them finding a suitable host locally.

Eggs and larvae of *C. vesuviana* are likely to survive cold storage and transport. Late stage larvae within infested fruits are likely to complete development in discarded fruit. Temperatures and relative humidities at the anticipated time of import (July to November) are suitable in many parts of Australia for the development of pupae and adult emergence. Although infested fruit are less likely to be imported, or are likely to be detected on arrival in Australia, infested fruit with eggs and early stage larvae may go undetected until sold. Many eggs and early stage larvae are unlikely to complete development on discarded fruit before fruit either desiccate or rot. For larvae that develop into adult flies, some of the mated females may be able to find the limited number of suitable hosts and lay eggs in the fruit.

For the reasons outlined, the estimated likelihood of estimate for distribution is assessed as ‘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 Section 2.2.2 and Table 2.2.

The likelihood that *Carpomyia vesuviana* will enter Australia as a result of trade in fresh Chinese jujubes from China and be distributed in a viable state to a susceptible host is assessed as: **Low.**

### 4.4.2 Likelihood of establishment

The likelihood that *Carpomyia vesuviana* will establish in 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.

The availability of host plants of *Carpomyia vesuviana* is limited.

- Host plants of *C. vesuviana* are limited to wild and cultivated species of *Ziziphus* (Farrara et al. 2009; Haldhar et al. 2016; Karuppaiah 2014; Stibick 2004).

- Australia has a small Chinese jujube industry. *Ziziphus jujuba* is grown in Western Australia, Victoria, New South Wales, Queensland and South Australia, with the majority of production in Western Australia.
- *Ziziphus mauritiana* (Indian jujube*,* considered to be a weed in Australia) and a number of other *Ziziphus* species are also distributed sporadically in Western Australia, Northern Territory, and north-eastern Queensland and south-eastern Queensland (ALA 2018; ATRP 2010).

Australia possesses suitable climatic conditions for *C. vesuviana* reproduction.

- *Carpomyia vesuviana* is present in China (Turpan region), Bangladesh, Georgia, India, Thailand, Indian Ocean Islands, Iran, Mauritius, Middle East (Oman), Pakistan, Afghanistan, Southern Europe, Italy, Bosnia, North Africa, Caucasus, Turkmenistan, Turkey, and Uzbekistan (Amini et al. 2014; Farrara et al. 2009; Hu et al. 2013; Karuppaiah 2014; Li et al. 2017b; Pollini & Cravedi 2014; Stibick 2004), in regions from ranging from tropical to temperate climates (Stibick 2004).
- Climatic conditions of parts of Australia, and notable where Chinese jujubes are grown, are similar to the climatic conditions where *C. vesuviana* is record as present*.*

*Carpomyia vesuviana* has effective reproduction and adaptation systems.

- *Carpomyia vesuviana* may have multiple generations each year. Depending upon climate and temperature, the number of generations of *C. vesuviana* varies, for example, from one to two generations in Italy, to two to three generations in India and China, and eight to 10 generations in Iran (Balikai 2009; Haldhar et al. 2016; Karuppaiah 2014; Pollini & Cravedi 2014).
- Adult females usually lay eggs singly in the early developmental stages of fruit, and the total number of eggs per fruit can be up to 20 (Balikai 2009; Haldhar et al. 2016; Kavitharaghavan, Savithri & Vijayarghavan 2005; Pollini & Cravedi 2014). The incubation period (i.e. egg hatching) takes two to five days under optimal conditions (Karuppaiah 2014; Kavitharaghavan, Savithri & Vijayarghavan 2005).
- It is likely that *C. vesuviana* uses sex pheromones to assist mate-founding behaviours, as methyl eugenol-baited traps have been successfully used to trap *C. vesuviana* throughout the period from fruit-setting to harvesting of the jujube fruit (Bugti et al. 2015). Utilisation of pheromones is likely to increase the chances of a reproductive population being established from sparsely distributed individuals.

Biological control agents and insecticides have shown to be effective in the control of *C. vesuviana.*

- Several biological control agents have shown effectiveness for controlling *C. vesuviana*, for example, *Trybliographa daci*, *Dichasmimorpha longicaudata* and *Fopius arisanus* (Bugti et al. 2015; Carmichael 2008; Farrara et al. 2009; Papadopoulos & Katsoyannos 2002; Stibick 2008; Zamek et al. 2012). These natural enemies of *C. vesuviana* are present in some parts of Australia, and may have some impacts on the likelihood of establishment of a nascent population of *C. vesuviana* in Australia.

- Insecticides containing the active constituents malathion, fenthion, monocrotophos, phosphamidon, dichlovos, chlorpyriphos, carbaryl, dipterex, imidacloprid, triazophos, dimethoate, deltamethrin and azadirachtin (neem) are effective for controlling *C. vesuviana* (Ahmad et al. 2005; Balikai 2009; Karuppaiah 2014). Some of these active constituents are registered for use in Australia (Australian Pesticides and Veterinary Medicines Authority (APVMA 2018).

There are similarities of climate in many areas of Australia to that of *C. vesuviana*'s current distribution. The capacity of *C. vesuviana* to produce several overlapping generations would aid its establishment in Australia. Lack of insecticides registered for use on Chinese jujube plants would make it difficult to prevent the establishment of *C. vesuviana* in Australia. Therefore, although *C. vesuviana* can only complete its life cycle on *Ziziphus* species, which are generally sparsely dispersed across the Australian landscape, the likelihood of establishment would be high if it were to find appropriate host plants. In overview these observations support a likelihood estimate for establishment of 'High'.

### 4.4.3 Likelihood of spread

The likelihood that *Carpomyia vesuviana* will spread within Australia, based on a comparison of factors in the source and destination areas that affect the expansion of the geographic distribution of the pest is assessed as: **Moderate.**

The following information provides supporting evidence for this assessment.

Australia is likely to have suitable climatic conditions for spread of *C. vesuviana*.

- *Carpomyia vesuviana* is present in many countries with diverse environmental conditions including Bangladesh, China, Georgia, India, Thailand, Indian Ocean Islands, Iran, Mauritius, Middle East (Oman), Pakistan, Afghanistan, Southern Europe, Italy, Bosnia, North Africa, Caucasus, Turkmenistan, Turkey, and Uzbekistan (Amini et al. 2014; Farrara et al. 2009; Hu et al. 2013; Karuppaiah 2014; Li et al. 2017b; Pollini & Cravedi 2014; Stibick 2004).
- Given the ability of *C. vesuviana* to produce overlapping generations at temperatures above 20 °C (Farrara et al. 2009; Karuppaiah 2014; Kavitharaghavan, Savithri & Vijayarghavan 2005), and its overwintering habit in the pupal stage under cold temperatures (Karuppaiah 2014), climatic conditions in parts of Australia are likely to support the spread of *C. vesuviana.*

Distribution and abundance of host plants of *C. vesuviana* are limited in Australia.

- The host range of *C. vesuviana* is restricted to wild and cultivated species of *Ziziphus* (Farrara et al. 2009; Haldhar et al. 2016; Karuppaiah 2014; Stibick 2004).
- *Ziziphus jujuba* are grown in small areas in Western Australia, Victoria, New South Wales, Queensland and South Australia, with the majority of production in Western Australia. *Ziziphus mauritiana* (considered to be a weed in Australia) and many other wild *Ziziphus* species are also distributed sporadically in Western Australia, Northern Territory, north-eastern Queensland and south-eastern Queensland (ALA 2018; ATRP 2010).

*Carpomya vesuviana* could potentially spread by the movement of infested jujube fruit within Australia.

- Domestic trade of agricultural products could aid the spread of *C. vesuviana*. If infested jujube fruits from Australian orchards where *C. vesuviana* has become established were to be sold domestically, *C. vesuviana* might spread to other parts of Australia.
- The movement of infested fruits, imported or grown in Australia, by travellers might aid the spread of *C. vesuviana.* However, long-distance spread across the continent by travellers would be limited by current domestic regulations and procedures, such as those in force in Western Australia and South Australia.

*Carpomya vesuviana* has capacity for independent flight.

- Flight capability of *C. vesuviana* adults is highly dependent on temperature conditions and age. They can fly about one to three kilometres (Ding et al. 2014b).
- Large geographic distances and other natural barriers between Chinese jujubes growing areas in Australia are likely to limit the natural spread of *C. vesuviana*.

The suitable climatic conditions and natural environment across Australia where Chinese jujube plants are mainly grown, and the possible movement of infested fruits between production areas, support the potential of jujube fruit fly to spread. However, the limited host availability, and large geographic distances between jujube growing areas and between sporadically distributed wild weedy *Ziziphus* plants, would make it difficult for the adults to spread unaided over larger distances. In overview these observations support a likelihood estimate for spread of 'Moderate'.

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

The overall likelihood of entry, establishment and spread of *Carpomyia vesuviana* in Australia has been estimated according to the matrix of rules described in Table 2.2.

The overall likelihood that *Carpomyia vesuviana* will enter Australia as a result of trade in fresh Chinese jujube fruit from China, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is: **Low.**

### 4.4.5 Consequences

The potential consequences of the establishment of *Carpomyia vesuviana* in Australia have been estimated according to the matrix of rules described in Table 2.5.

Based on the decision rules described in Table 2.4, 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 |
|---|---|
| **Direct** | |
| Plant life or health | D – Major significance at the local level<br>*Carpomyia vesuviana* is the most important economic pest of *Ziziphus* spp. The yield loss of jujube fruit due to *C. vesuviana* infestation varies in different countries and climatic conditions, but ranges from 20 to 100 per cent, depending on orchard management practices (Al-Masudey & Al-yousuf 2012; Balikai 2009; Bhagvan, Acharya & Meena 2017; Farrara et al. 2009; Haldhar et al. 2018; Haldhar et al. 2016; Karuppaiah 2014; Mari, Chachar & Chachar 2013). In Turpan region of Xinjiang, a survey conducted between 2007 and 2008 found that one in every three jujube trees was infested by *C. vesuviana* (He et al. 2009b). Thus, *C. vesuviana* is most likely to cause significant economic loss to Australia's expanding Chinese jujube industry. |
| Other aspects of the environment | A – Indiscernible at the local level<br>There are currently no known direct consequences of *C. vesuviana* on other aspects of the natural environment, but its introduction into a new environment may lead to some competition for resources with native species. |
| **Indirect** | |
| Eradication, control | E – Significant at the regional level<br>Programs to control/eradicate *C. vesuviana* from areas in Australia would be costly if an outbreak were to occur.<br>Since the first report of *C. vesuviana* in the Turpan region of Xinjiang in 2007, significant efforts have been put in place to eradicate/control this significant pest. In addition to the National Fruit Fly Trapping Systems, a large number of traps have been added in jujube orchards and growing regions to monitor this pest. A technical regulation for monitoring and control of *C. vesuviana* was developed and implemented in China in 2009 (National Forestry Administration of China 2016). Quarantine technical rules of *C. vesuviana* was developed and implemented in 2012 (National Forestry Administration of China 2012). Although *C. vesuviana* has not been eradicated, the distribution of *C. vesuviana* has been successfully contained to the Turpan region of Xinjiang in China (GACC 2018).<br>Eradication of fruit flies is generally very costly. For example, the total costs to eradicate Queensland fruit fly from Tasmania during the outbreak in 2018, is estimated to be more than $20 million (Beavis 2018). Oriental fruit flies were first detected in the Redland area of Miami-Dade County, Florida, USA in 2015 and then also in 2016, the associated total economic impacts to the county were estimated to be between $10.2 million and $58.5 million (Alvarez, Evans & Hodges 2016). |
| Domestic trade | D – Major significance at the local level.<br>The presence of *C. vesuviana* in commercial jujube production areas in Australia would be likely to result in interstate trade restrictions on Chinese jujube fruits, potential loss of markets, and significant industry adjustment at the local level. |
| International trade | C – Significant at the local level.<br>*Carpomyia vesuviana* is present in Bangladesh, China (Turpan region), Georgia, India, Thailand, Indian Ocean Islands, Iran, Mauritius, Middle East (Oman), Pakistan, Afghanistan, |

| | |
|---|---|
| | Southern Europe, Italy, Bosnia, North Africa, Caucasus, Turkmenistan, Turkey, and Uzbekistan (Amini et al. 2014; Farrara et al. 2009; Hu et al. 2013; Karuppaiah 2014; Li et al. 2017b; Pollini & Cravedi 2014; Stibick 2004). It has been identified as an important pest of quarantine concern to a number of countries, including China and the USA. Export of Chinese jujube fruit from areas where *C. vesuviana* is present might be restricted or subjected to costly disinfestation treatments. Australia has a small Chinese jujube industry and does not currently export jujubes. |
| Environmental and non-commercial | B – Minor significance at the local level<br>Additional pesticide applications or other control measures would be required to control jujube fruit fly on susceptible hosts, and these may have minor impact on the environment. |

### 4.4.6 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.

| **Unrestricted risk estimate for *Carpomyia vesuviana*** | |
|---|---|
| Overall likelihood of entry, establishment and spread | Low |
| Consequences | Moderate |
| Unrestricted risk | Low |

As indicated, the unrestricted risk estimate for *C. vesuviana* has been assessed as ‘low’, which does not achieve ALOP for Australia. Therefore, specific risk management measures are required for *C. vesuviana* on this pathway.

## 4.5 Mealybug

### *Heliococcus destructor*

*Heliococcus destructor* (heliococcus mealybug) belongs to the Pseudococcidae or mealybug family (García Morales et al. 2018). In general, mealybugs injure plants by sucking sap. They also produce honeydew, which serves as food for ants or as a substrate for development of sooty moulds. Mealybugs generally prefer warm, humid and sheltered sites away from adverse environmental conditions and natural enemies (Biosecurity Australia 2008; García Morales et al. 2018). Many mealybug species pose serious problems for agriculture, particularly when introduced into new areas where their natural enemies are not present (García Morales et al. 2018).

*Heliococcus destructor* is present in Guangdong, Jiangxi, Tianjin, Xinjiang, Shanxi, Shaanxi, Henan, Shandong, Gansu, Ningxia, and Hebei provinces in China (AQSIQ 2017; Tang 1981; Wu & Wu 2016; Xinjiang Forestry Pest Information 2018). Adult females lay eggs in mid-May; after oviposition, eggs hatch within 10 days. Nymphs overwinter in the soil, on tree trunks, or in crevices and become active in April. Adult emergence occurs in May (Xinjiang Forestry Pest Information 2018). It is reported that in Xinjiang *H. destructor* produces three overlapping generations each year. The first generation occurs in late May to mid-July, the second generation in early July to early September, and the third generation from late August, coinciding with the jujube harvesting period. *Heliococcus destructor* feeds on roots, stems, branches, buds, leaves, flowers, seeds and fruits (including stalks) of *Ziziphus jujuba* (AQSIQ 2017; Tang 1981; USDA-APHIS 2016). Nymphs mainly attack the leaves, fruits, secondary branches and trunk joints. *Heliococcus destructor* infestation can result in the mesophyll of leaves becoming thinner, and in severe cases, damaged leaves fall off trees. Infestation on branches can cause retarded growth, producing fewer or no fruit, and even death of the whole tree (Xinjiang Forestry Pest Information 2018).

*Heliococcus destructor* has not previously been specifically assessed by the department, however all mealybugs, including the genus *Heliococcus*, have been assessed in the *Final group pest risk analysis for mealybugs and the viruses they transmit on fresh fruit, vegetable, cut-flower and foliage imports* (Department of Agriculture and Water Resources 2019). In addition, a number of Pseudococcidae mealybug species have been assessed previously in existing import policies, for example, in the import policies for apples, table grapes, pears, nectarines, plums, peaches and apricots from China (AQIS 1998b; Biosecurity Australia 2010a, 2011a; Department of Agriculture and Water Resources 2016, 2017a), persimmon from Japan, Korea and Israel (DAFF 2004c), mango from Taiwan (Biosecurity Australia 2006), India (Biosecurity Australia 2008), Indonesia, Thailand and Vietnam (Department of Agriculture and Water Resources 2015), mangosteen from Thailand (DAFF 2004b) and Indonesia (DAFF 2012), Unshu mandarin from Japan (Biosecurity Australia 2009), lychee from Taiwan and Vietnam (DAFF 2013), longan and lychee from China and Thailand (DAFF 2004a). In each of these existing policies, the unrestricted risk estimate for mealybugs was assessed as Low, which does not achieve the ALOP for Australia. Therefore, specific risk management measures are required for these pests on those pathways.

The biology of *H. destructor* and the damage caused to host plants is very similar to those recorded for other Pseudococcidae species (CABI & EPPO 1981; Danzig 2007; Department of Agriculture and Water Resources 2019; Holat, Kaydan & Mustu 2014; Reggiani et al. 2003). On this basis, *H. destructor* is considered to pose similar risks and to require similar risk management measures. Therefore, previous assessments for similar *Heliococcus* mealybugs and other Pseudococcidae species are adopted for *H. destructor* on the fresh Chinese jujubes pathway.

The department has assessed the likelihood of importation of *H. destructor* on the fresh Chinese jujubes from China pathway as being similar to the previous assessments of High for pseudococcid mealybug species on other commodity/country pathways. Mealybugs usually feed in protected areas on the undersides and/or on the axils of leaves of their hosts, but in population outbreaks they can also be associated with fruit. When a mealybug finds a suitable feeding site it anchors itself to the host plant with its mouthparts. A feeding mealybug is difficult to dislodge, as it produces a waxy protective coating that can make it difficult to remove through packing house processes. Since most life stages of these assessed mealybugs are quite small (Williams & Granara de Willink 1992), it is possible that they will remain undetected during routine packing house procedures, especially at low population densities. For these reasons, the likelihood of importation of *H. destructor* on fresh Chinese jujubes from China is considered similar to previously made assessments of High.

Previous assessments of Pseudococcidae mealybugs on other commodity/country pathways rated the likelihood of distribution as Moderate. Fresh Chinese jujubes from China are expected to be distributed in Australia in a similar way to other fruit commodities assessed previously. In general, mealybugs have a wide host range, and suitable host material is likely to be available all year round in Australia. The most active life stage of mealybugs is the 'crawler' or first instar, which is considered to be the most likely stage at which a Heliococcus mealybug will reach a host plant through its own activity. Mealybug nymphs and adults are not capable of flight, but can potentially be carried by wind or on farm workers' clothes. There are climatic conditions suitable for the development of *H. destructor* in most parts of Australia. *Heliococcus destructor* infests plant species in several families, including a number of economically important plants and herbaceous plants growing in ground cover that could be found in areas where fresh Chinese jujubes may be discarded. However, it is likely that disposed fresh Chinese jujubes would deteriorate quickly in the environment, so that the mealybug crawlers would only have a limited time to find a new host. For these reasons, the department has determined the likelihood of distribution for Heliococcus mealybugs on the fresh Chinese jujubes from China pathway to be similar to previously made assessments. Therefore, the same rating of Moderate for the likelihood of distribution of mealybugs is adopted for the fresh Chinese jujubes from China pathway.

The likelihoods of establishment and spread of *H. destructor* in Australia are similar to those of previous assessments of High. These likelihoods relate specifically to post-border events that occur in Australia and are essentially independent of the importation pathway. The consequences of entry, establishment and spread of Heliococcus mealybug are also independent of the importation pathway, and are considered comparable to those concluded from previous assessments of Low. Therefore, the existing ratings for the likelihood of entry, establishment and spread and the rating for the overall consequences for Heliococcus mealybugs have been adopted for fresh Chinese jujubes from China.

In addition, the department has reviewed the latest available literature— for example, (Bertin et al. 2010; Bertin et al. 2016; García Morales et al. 2018, 2019; Wu & Wu 2016; Xinjiang Forestry

Pest Information 2018). No new information has been identified that would significantly change the risk ratings for importation, distribution, establishment, spread or consequences, as set out for mealybugs in existing policies.

The likelihoods of importation, establishment and spread for Heliococcus mealybug on the fresh Chinese jujubes pathway from China are assessed as High, while the likelihood of distribution is assessed as Moderate. The consequences of entry, establishment, and spread are assessed as Low. When these likelihood and consequence ratings are combined using the rules presented in Table 2.2 and Table 2.5, the unrestricted risk is determined to be Low. All likelihood ratings are set out in Table 4.5.

**Unrestricted risk estimate**

The unrestricted risk estimate for *H. destructor* on the fresh Chinese jujubes from China pathway is assessed as Low, which is identical to the outcomes of previous assessments, and which does not achieve the ALOP for Australia. Therefore, specific risk management measures are required for *H. destructor* on this pathway.

## 4.6 Armoured scale

### *Parlatoreopsis chinensis*

*Parlatoreopsis chinensis* (synonym: *Parlatoria chinensis*) belongs to the Diaspididae family. Scales of this family are commonly referred to as armoured scales because they produce a hard, fibrous, wax-like covering that attaches the scale to the host plant (Carver, Gross & Woodward 1991). Armoured scales are highly polyphagous, with some species feeding on hosts from 100 families of plants (Anderson et al. 2010). *Parlatoreopsis chinensis* is wide spread in China including in major Chinese jujubes growing areas such as Beijing, Hebei, Shandong, Shanxi and Xinjiang; it causes economic damage to Chinese jujubes by attacking stems, branches, buds, leaves and fruits (AQSIQ 2017; García Morales et al. 2019).

*Parlatoreopsis chinensis* has up to three generations each year in China (García Morales et al. 2019). It has been reported to have two complete generations and a partial third generation in the USA (Miller & Davidson 2005). Armoured scales affect their hosts by removing sap, as well as by injecting toxic saliva during feeding (Kosztarab 1990). The feeding process results in cell death, deformation of plant parts and the formation of galls and pits, as well as increased susceptibility to other destructive agents such as frost, disease and other pests (Kosztarab 1990). High populations of scales can cause the death of trees (Beardsley & Gonzalez 1975; Smith, Beattie & Broadley 1997). In general, scale nymphs settle and feed on branches and fruit of the host plant, becoming immobile as they develop into late instar nymphs (Beardsley & Gonzalez 1975; Koteja 1990). The female reaches sexual maturity without undergoing true metamorphosis, remaining legless and immobile on the host plant (Koteja 1990). This contrasts with the male scale which has a pupal stage from which it emerges as a winged adult form. The female life stages include adult, egg and nymph while the male has adult, egg, nymph, pre-pupal and pupa stages. The mature adult female is approximately 1.0 to 1.5 millimetres in length (Takagi 1990). The mature male is seldom seen and is rarely more than one millimetre in length (Giliomee 1990); the adult male is winged, does not feed and lives for only one to three days (Beardsley & Gonzalez 1975; Koteja 1990).

*Parlatoreopsis chinensis* has been assessed as not present on the fresh nectarine fruit from China pathway, as no report of an association with nectarine fruit was found (Department of Agriculture and Water Resources 2016). *Parlatoreopsis chinensis* is the currently accepted taxonomic identity for which *Parlatoria chinensis* is a synonym (AQSIQ 2017; García Morales et al. 2019). Several *Parlatoria* armoured scale species have been assessed previously in existing import policies, for example, fresh apples, pears and table grapes from China (Biosecurity Australia 2005a, 2010a, 2011a), stone fruit from USA (Biosecurity Australia 2010b), fresh mango from Taiwan (Biosecurity Australia 2006), India (Biosecurity Australia 2008), Pakistan (Biosecurity Australia 2011b), Indonesia, Thailand and Vietnam (Department of Agriculture and Water Resources 2015), Unshu mandarin from Japan (Biosecurity Australia 2009), sweet orange from Italy (Biosecurity Australia 2005b) and citrus from Egypt (Biosecurity Australia 2002). In these existing policies, the unrestricted risk estimate for armoured scales was assessed as Very Low or Negligible, depending on the commodity identity, which in all cases achieve the ALOP for Australia. Therefore no specific risk management measures are required for these pests on these pathways.

The biology of *P. chinensis*, and the damage caused to host plants by *P. chinensis,* are very similar to those associated with other *Parlatoria* armoured scales (AQSIQ 2017; Beardsley & Gonzalez

1975; García Morales et al. 2019; Kosztarab 1990; Koteja 1990). *Parlatoreopsis chinensis* is considered to pose similar risks and to require similar risk management measures. Therefore, previous assessments for other *Parlatoria* armoured scales are adopted for *P. chinensis* on the fresh Chinese jujube fruit pathway.

The department has assessed the likelihood of importation of *P. chinensis* on the fresh jujube fruit from China pathway as being similar to previous assessments of Low for armoured scale species on fruit commodities morphologically similar to fresh Chinese jujubes, such as stone fruits (nectarines, peaches, plums and apricots) from the USA. Armoured scale infestations cause visible symptoms on the fruit, and are likely to cause the infested fruit to be rejected from export. Crawlers are the only mobile stage that could contaminate clean fruit. All stages except crawlers and adult males are firmly attached to fruit and are unable to move. Fresh Chinese jujube fruit has smooth skin and a shallow depression at the stem end (Figure 1), and each fruit would be individually screened at the packinghouse during packing processes. For these reasons, the likelihood of importation of *Parlatoreopsis chinensis* on fresh jujubes from China is considered similar to previous assessments for armoured scales on stone fruits from the USA, as Low.

Previous assessments for armoured scales on other commodity/country pathways rated the likelihood of distribution as Low. Fresh jujube fruit from China is expected to be distributed in Australia in the same way as other host fruit currently being imported. Armoured scales have a limited ability to disperse independently from the fresh jujubes pathway, as adult females are sessile and firmly attached to their host and are incapable of independent movement (Carver, Gross & Woodward 1991; Watson 2018). The ability of *P. chinensis* to disperse is limited to the first instar stage or crawler and crawlers (Miller 2005; Morse et al. 2009; Watson 2018) and they would be unlikely to survive for an extended period off their hosts (Watson 2018). Abiotic factors such as unsuitable temperatures strongly influence the survival rate for crawlers during the dispersal stage (Watson 2018) potentially resulting in high mortality. For these reasons, the department has determined the likelihood of distribution for *P. chinensis* on the fresh jujube fruit from China pathway to be similar to previous assessments. Therefore the same rating of Low for the likelihood of distribution of *P. chinensis* is adopted for the fresh jujube fruit from China pathway. Due to the low mobility of this species and the vulnerability of the mobile stages, the department has determined the likelihood of distribution for *P. chinensis* on the fresh jujube fruit from China pathway to be similar to previous assessments. Therefore, the previously determined rating of Low for the likelihood of distribution for armoured scales is adopted for the fresh jujube fruit from China pathway.

The likelihoods of establishment and spread of armoured scales in Australia are also similar to those of previous assessments High and Moderate respectively. Those likelihoods relate specifically to events that occur in Australia and are essentially independent of the importation pathway. The consequences of entry, establishment and spread for *P. chinensis* are independent of the importation pathway and are similar to those of previous pest risk assessments of Low. Therefore, the existing ratings for the likelihoods of entry, establishment and spread, and the rating for the overall consequences for other armoured scales have been adopted for *P. chinensis* on the fresh jujube fruit from China pathway.

In addition, the department has reviewed the latest literature — for example, (Evans & Dooley 2013; García Morales et al. 2018, 2019; Magsig-Castillo et al. 2010; Suh, Yu & Hong 2013;

Watson 2018), and no new information has been identified that would significantly change the risk ratings for importation, distribution, establishment, spread or consequences, as set out for armoured scales in existing policies.

The likelihoods of importation and distribution, and the consequences of entry, establishment, and spread for *P. chinensis* on the fresh jujubes from China pathway are all assessed as Low. The likelihood of establishment is assessed as High, while the likelihood of spread is assessed as Moderate. When these likelihood and consequences ratings are combined using the rules presented in Table 2.2 and Table 2.5, the unrestricted risk is determined to be Negligible. All these likelihood ratings are set out in Table 4.5.

**Unrestricted risk estimate**

The unrestricted risk estimate for *P. chinensis* on the fresh jujubes from China pathway is assessed as Negligible, which is identical to the outcomes of previous assessments, and which achieves the ALOP for Australia. Therefore, specific risk management measures are not required for *P. chinensis* on this pathway.

## 4.7 Peach fruit borer

### *Carposina sasakii* (EP)

*Carposina sasakii* (peach fruit borer) belongs to the Carposinidae family and is an important pest of nectarines, peaches, apricots, plums, pome fruits (apple, pear), jujubes, hawthorn and pomegranate (CABI 2019a; Lei et al. 2012; Wang et al. 2015a; Wang et al. 2016). *Carposina sasakii* can destroy 15 to 20 per cent of Chinese jujubes in poorly managed jujube orchards (Ciceoi et al. 2017).

*Carposina sasakii* has four life stages: egg, larva, pupa and adult (Ma 2006). Adults are white-grey to brown-grey in colour. Females are seven to eight millimetres in length with a wingspan of 15-19 millimetres, and males are five to six millimetres in length with a wingspan of 13-15 millimetres (CABI 2019a; Ma 2006). Eggs are laid on the fruit near the calyx and stalk ends. After hatching, young larvae bore into the fruit and feed on pulp within the fruit then moves deep into the fruit core (Lei et al. 2012; Shutova 1978). Larvae are peach to red in colour and 13-16 millimetres in length. Pupae are 6.5-8.6 millimetres in length and pupation occurs in the soil. This species has one to three generations each year (Ma 2006).

*Carposina sasakii* has been assessed previously in the existing import policies for apples, nectarines, plums, peaches and apricots from China (Biosecurity Australia 2010a; Department of Agriculture and Water Resources 2016, 2017a), pears from China and Korea (AQIS 1998b, 1999) and Fuji apples from Japan (AQIS 1998a). In those existing policies, the unrestricted risk estimate for *C. sasakii* did not achieve the ALOP for Australia. Therefore, specific risk management measures are required for *C. sasakii* on these pathways.

The department has assessed the likelihood of importation of *C. sasakii* on the fresh Chinese jujubes from China pathway as being similar to the previous assessments of High for nectarines, peaches, plums and apricots from China (Department of Agriculture and Water Resources 2016, 2017a). Chinese jujubes is recorded as a host for *C. sasakii*, and there is no information to suggest the presence of *C. sasakii* in China has changed since it was assessed for nectarines, peaches, plums and apricots. Fresh Chinese jujubes are morphologically similar to stone fruits (nectarines, peaches, plums and apricots), and the horticultural practices, major production areas and climatic conditions for these commodities in China are also similar. For these reasons, the likelihood of importation of *C. sasakii* on fresh Chinese jujubes from China is considered similar to previously made assessments of High.

Previous assessments of *C. sasakii* on other commodity/country pathways rated the likelihood of distribution as High. Fresh Chinese jujubes from China are expected to be distributed in Australia in a similar way to other fruit commodities assessed previously. *Carposina sasakii* has a wide host range, and host material is likely to be available at all times in parts of Australia. Additionally, adults of *C. sasakii* are capable of flight, and would thus be able to find a suitable host if infested fresh Chinese jujubes were discarded in the environment. There are climatic conditions suitable for the development of *C. sasakii* in some parts of Australia. Due to the year-round availability of host material, suitable climatic conditions, and the ability of *C. sasakii* to disperse to find hosts, the department has determined the likelihood of distribution for *C. sasakii* on the fresh Chinese jujubes from China pathway to be similar to previously made assessments. Therefore, the same rating of High for the likelihood of distribution of *C. sasakii* is adopted for the fresh Chinese jujubes from China pathway.

The likelihoods of establishment and spread of *C. sasakii* in Australia are similar to those of previous assessments of High. Those likelihoods relate specifically to events that occur in Australia and are essentially independent of the import pathway. The consequences of entry, establishment and spread for *C. sasakii* are also independent of the import pathway and are similar to those previous pest risk assessments of Moderate. Therefore, the existing ratings for the likelihoods of entry, establishment and spread, and the rating for the overall consequences for *C. sasakii* have been adopted for the fresh Chinese jujubes from China pathway.

In addition, the department has reviewed the latest literature — for example, (APHIS-USDA 2016; CABI 2019a; Lei et al. 2012; Wang et al. 2016), and no new information has been identified that would significantly change the risk ratings for importation, distribution, establishment, spread or consequences, as set out for *C. sasakii* in the existing policies.

The likelihoods of importation, distribution, establishment and spread for *C. sasakii* on the fresh Chinese jujubes from China pathway are all assessed as High, and the consequences of entry, establishment, and spread are assessed as Moderate. When these likelihood and consequences ratings are combined using the rules presented in Table 2.2 and Table 2.5, the unrestricted risk is determined to be Moderate. All likelihood ratings are set out in Table 4.5.

**Unrestricted risk estimate**

The unrestricted risk estimate for *C. sasakii* on the fresh Chinese jujubes from China pathway is assessed as Moderate, which is identical to the outcomes of previous assessments, and which does not achieve the ALOP for Australia. Therefore, specific risk management measures are required for *C. sasakii* on this pathway.

## 4.8 Chilli thrips

### *Scirtothrips dorsalis* (EP, RA)

No thrips species that are quarantine pests for Australia were identified on the fresh Chinese jujubes from China pathway.

*Scirtothrips dorsalis* (chilli thrips) is present in China and has been reported to be associated with *Ziziphus* spp. (Azam-Ali et al. 2006; Balikai, Kotikal & Prasanna 2013; Nizamani et al. 2015; Venette & Davis 2004). This thrips is present in New South Wales, Northern Territory, Queensland (Plant Health Australia 2018) and Western Australia (Poole 2010). It is not a regulated pest in Tasmania (DPIPWE Tasmania 2016). Therefore, it has not been identified as a quarantine pest for Australia. However, *S. dorsalis* has been identified as a r~~R~~egulated a~~A~~rticle because it is capable of harbouring and spreading (vectoring) emerging orthotospoviruses such as *Groundnut bud necrosis orthotospoviruses* (GBNV) and *Groundnut yellow spot orthotospoviruses* (GYSV) that are present in China (Mackesy & Sullivan 2016; Yin et al. 2014) and are quarantine pests for Australia, as detailed in the thrips group PRA (Australian Government Department of Agriculture and Water Resources 2017).

A regulated article is defined by the IPPC as '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 2018). For readability and simplicity, *S. dorsalis* is referred to as 'regulated thrips' in this document, where appropriate.

The indicative likelihood of entry for all thrips is assessed in the thrips group PRA as Moderate. This indicative likelihood is also relevant to regulated thrips that transmit quarantine orthotospoviruses. After assessment of relevant pathway-specific factors (see Section 2.2.7) for fresh Chinese jujubes from China, likelihoods of entry of Moderate were verified as appropriate for this regulated thrips (Table 4.3).

**Table 4.3 Regulated thrips species for fresh Chinese jujube fruit from China**

| Pest | In thrips group PRA | Quarantine thrips | Regulated thrips | On Chinese jujubes pathway | Moderate likelihood of entry for thrips verified |
|---|---|---|---|---|---|
| *Scirtothrips dorsalis* (RA) | Yes | No | Yes | Yes | Yes |

**RA:** Regulated article, see text above for definition of a regulated article.

A summary of the risk assessment for quarantine orthotospoviruses transmitted by thrips is presented in Table 4.4 for convenience.

**Table 4.4 Risk estimates for emerging quarantine orthospoviruses vectored by regulated thrips**

| Risk component | Rating for emerging quarantine orthotospovirus (a) |
|---|---|
| Likelihood of entry (importation x distribution) | Low (Moderate x Moderate) |
| Likelihood of establishment | Moderate |
| Likelihood of spread | High |
| Overall likelihood of entry, establishment and spread | Low |
| Consequences | Moderate |
| **Unrestricted risk** | **Low** |

**(a)**: The identified regulated thrips vectors emerging quarantine orthotospoviruses. This table presents the risk estimates for these viruses from the thrips group PRA.

The unrestricted risk estimate for emerging quarantine orthotospoviruses transmitted by regulated thrips is Low (Table 4.4), which does not achieve the ALOP for Australia, as assessed in the Thrips group PRA.

This unrestricted risk estimate is considered to be applicable for the emerging orthotospoviruses known to be vectored by the thrips species present on the pathway for fresh Chinese jujubes from China. Therefore, specific risk management measures are required for regulated thrips to mitigate the risks posed by emerging quarantine orthotospoviruses to achieve the ALOP for Australia.

The conclusion of this risk assessment, which is based on the thrips group PRA, applies to all phytophagous quarantine thrips and regulated thrips on the fresh Chinese jujubes from China pathway, irrespective of their specific identification in this document.

## 4.9 Pest risk assessment conclusions

**Table 4.5 Summary of unrestricted risk estimates for quarantine pests associated with fresh Chinese jujube fruit from China**

| Pest name | Likelihood of | | | | | | Consequences | URE |
|---|---|---|---|---|---|---|---|---|
| | Entry | | | Establishment | Spread | EES | | |
| | Importation | Distribution | **Overall** | | | | | |
| **Spider mite [Prostigmata: Tetranychidae]** | | | | | | | | |
| *Amphitetranychus viennensis* (EP) | Moderate | Moderate | **Low** | High | Moderate | Low | Moderate | **Low** |
| **Fruit flies [Diptera: Tephritidae]** | | | | | | | | |
| *Bactrocera dorsalis* (EP) | High | High | **High** | High | High | High | High | **High** |
| *Zeugodacus cucurbitae* (EP) | High | High | **High** | High | High | High | High | **High** |
| *Bactrocera correcta* (EP) | Low | High | **Low** | High | High | Low | High | **Moderate** |
| *Carpomyia vesuviana* | High | Low | **Low** | High | Moderate | Low | Moderate | **Low** |
| **Mealybugs [Hemiptera: Pseudococcidae]** | | | | | | | | |
| *Heliococcus destructor* | High | Moderate | **Moderate** | High | High | Moderate | Low | **Low** |
| **Armoured scales [Hemiptera: Diaspididae]** | | | | | | | | |
| *Parlatoreopsis chinensis* | Low | Low | **Very Low** | High | Moderate | Very Low | Low | **Negligible** |
| **Borer [Lepidoptera: Carposinidae]** | | | | | | | | |
| *Carposina sasakii* (EP) | High | High | **High** | High | High | High | Moderate | **Moderate** |
| **Thrips [Thysanoptera: Thripidae]** | | | | | | | | |
| *Scirtothrips dorsalis* (GP, RA) | Moderate | Moderate | **Low** | Moderate | High | Low | Moderate | **Low** |

**EP:** Species has been assessed previously and import policy already exists. **ESS:** Overall likelihood of entry, establishment and spread. **GP:** Species has been assessed previously in a Group PRA and the Group PRA has been applied (Australian Government Department of Agriculture and Water Resources 2017). **RA:** Regulated article, refer to Section 4.8 for definition of a regulated article**. URE:** Unrestricted risk estimate. This is expressed in an ascending scale from negligible to extreme.

## 4.10 Summary of assessment of quarantine pests of concern

This section provides a summary of the assessment of quarantine pests of concern (shown in Figure 12).

The pest categorisation process (Appendix A: Initiation and categorisation for pests of fresh Chinese jujube fruit from China) identified 181 pests. Of these 181 pests:

- 76 pests are already present in Australia and not under official control, and therefore were not considered further;
- 96 of the remaining 105 pests were assessed as not having potential to be on the fresh Chinese jujubes pathway, and therefore did not undergo further assessment;
- one of the remaining nine pests was assessed as not being of potential economic consequence, and therefore did not undergo further assessment.

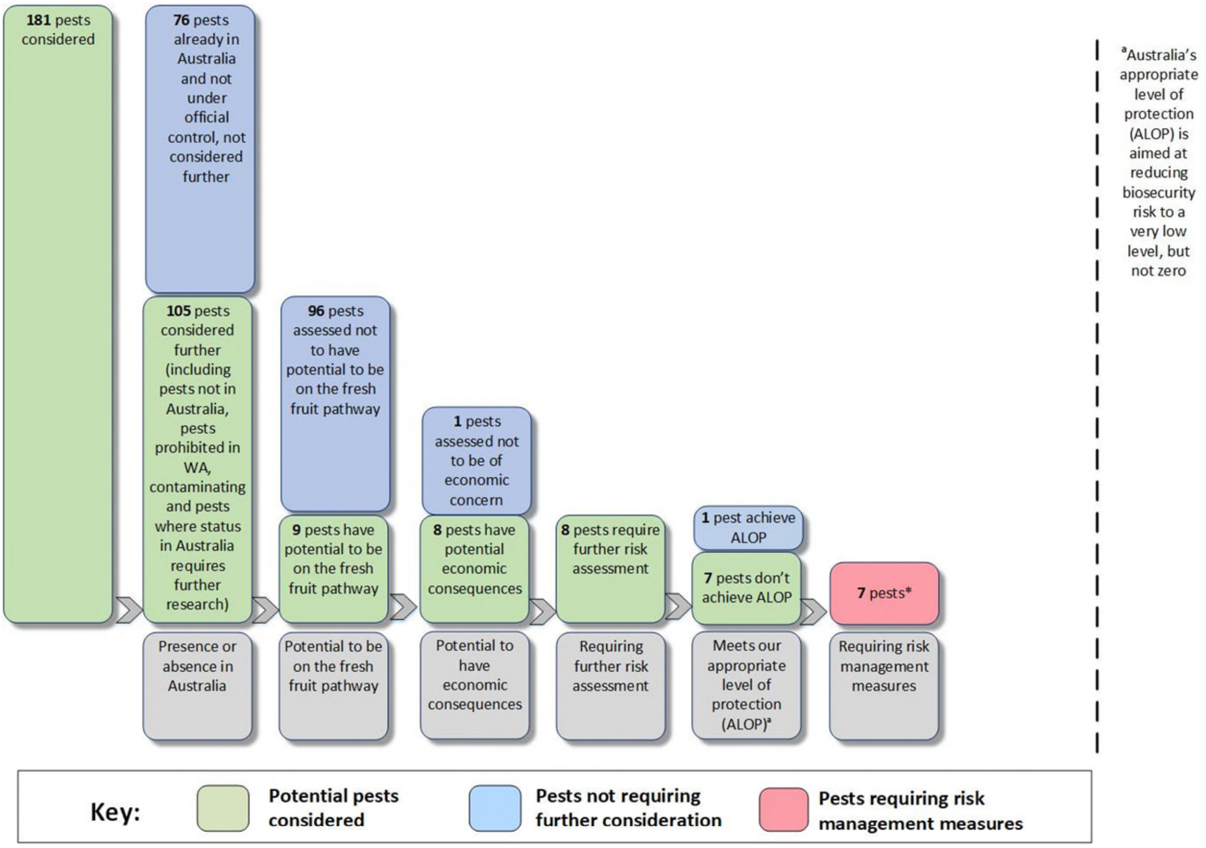
The outcome of the above process left eight pests that required further consideration, that is, a pest risk assessment. Pest risk assessments for these eight species were subsequently completed.

- The estimated risk for one of the pests was assessed as achieving the ALOP for Australia, and thus no specific risk management measures are required for this pest on this pathway. This pest is:
  - Chinese obscure scale (*Parlatoreopsis chinensis*)
- The estimated risks for seven quarantine pests were assessed as not achieving the ALOP for Australia, and thus specific management measures are required. These pests are:
  - Hawthorn spider mite (*Amphitetranychus viennensis*)
  - Oriental fruit fly (*Bactrocera dorsalis*)
  - Melon fly (*Zeugodacus cucurbitae*)
  - Guava fruit fly (*Bactrocera correcta*)
  - Jujube fruit fly (*Carpomyia vesuviana*)
  - Heliococcus mealybug (*Heliococcus destructor*)
  - Peach fruit borer (*Carposina sasakii*)

One thrips species present in China, chilli thrips (*Scirtothrips dorsalis*), was identified in the thrips group PRA as a regulated thrips due to its ability to vector emerging quarantine orthotospoviruses. Its potential to introduce emerging quarantine orthotopsoviruses into Australia via the fresh Chinese jujubes pathway was confirmed (Table 4.3 and Table 4.4) and the thrips group PRA was applied for this thrips species. This regulated thrips requires specific risk management measures to mitigate the risk from emerging quarantine orthotopsoviruses.

The regulated thrips species has not been included in Figure 12: Summary of assessment of quarantine pests of concern.

### Figure 12 Summary of assessment of quarantine pests of concern




*Note that Figure 12 does not include the regulated thrips species, and the emerging quarantine orthotospoviruses they vector, as identified in this chapter and summarised in Section 4.10.

# 5 Pest risk management

This chapter provides information on the management of quarantine pests and regulated thrips identified as having an unrestricted risk that does not achieve the appropriate level of protection (ALOP) for Australia. The recommended risk management measures for these pests are described in this chapter. This chapter also describes the operational system that is required for the maintenance and verification of the phytosanitary status of fresh Chinese jujubes from China for export to Australia.

## 5.1 Pest risk management measures and phytosanitary procedures

Pest risk management evaluates and selects options for measures to reduce the risk of entry, establishment or spread of quarantine pests and regulated thrips for Australia where they have been assessed to have an unrestricted risk level that does not achieve the ALOP for Australia. In calculating the unrestricted risk estimates, the standard commercial production practices in China have been considered, including the post-harvest procedures and the packing of fruit (as described in Chapter 3: China's commercial production practices for Chinese jujubes).

In addition to China's standard commercial production systems and packing house operations for fresh Chinese jujube fruit (as described in Chapter 3: China's commercial production practices for Chinese jujubes), specific pest risk management measures are recommended in order to achieve the ALOP for Australia.

In this chapter, the Department of Agriculture has recommended risk management measures that may be applied to consignments of fresh Chinese jujube fruit sourced from China. Finalisation of the import conditions may be undertaken with input from the Australian states and territories as appropriate.

### 5.1.1 Analysis of pest interception data to date

Australia does not currently permit imports of fresh Chinese jujubes from any country. There has been trade in other horticultural commodities from China, including apples since 2010, pears since 1999, longan and lychees since 2005, nectarines since 2016, and table grapes since 2018.

Examination of interception data collected from imports of apples, pears, nectarines and table grapes imported from China, all of which are produced in fruit fly pest free areas, found occasional interceptions of species of ladybirds, mites, mealybugs, moths, and scales. All of the organisms intercepted were actioned under existing policy. Remedial actions were implemented and all consignments subsequently released.

There have been interceptions of fruit fly (*Bactrocera dorsalis*) in consignments of imported lychees. The lychees were produced in southern China, which is outside the recognised fruit fly pest free area, therefore as per the import requirements, were required to undergo mandatory phytosanitary treatment. All non-compliant consignments were actioned under existing policy, such as subject to suitable remedial treatment, exported or destroyed.

Interceptions of quarantine pests for Australia, such as fruit flies, can occur and the risk is managed through established import processes which include refusing entry of affected consignments and conducting investigations and implementing measures to prevent any reoccurrence. These can include auditing treatment facilities, processes and procedures through the export pathway and potentially suspending imports (either all imports, or imports from specific sources).

China's major Chinese jujube growing regions are located within the recognised fruit fly pest free areas and it is expected that the majority of fresh Chinese jujube fruit for export will be sourced from the fruit fly pest free areas. For fresh Chinese jujube fruit sourced from outside the fruit fly pest areas or where area of freedom status has been suspended, fruit treatments approved by the department must be implemented.

Fresh Chinese jujube fruit are morphologically similar to stone fruits (nectarines, peaches, plums and apricots), and to a lesser extent, apples and pears. The horticultural practices, major production areas and climatic conditions for these commodities in China are also similar. Therefore, in the event that pests from these pest groups are associated with fresh Chinese jujube pathway, it is expected that they may also be detected by the on-arrival phytosanitary inspection and remedial actions will be implemented.

If any organisms are intercepted on fresh Chinese jujubes from China that have not been assessed in this policy, the Department of Agriculture is required to undertake an assessment to determine the quarantine status of the intercepted organism and whether phytosanitary action is required.

### 5.1.2 Pest risk management for quarantine pests

The pest risk assessment identified the quarantine pests listed in Table 5.1 as having unrestricted risks that do not achieve the ALOP for Australia. Therefore, risk management measures are required to manage the risks posed by these pests. The recommended measures are also listed in Table 5.1. Further clarification of the phytosanitary risk management options currently recognised by the department as effective to manage the biosecurity risk of each of the identified quarantine pests is provided in Appendix C.

**Table 5.1 Risk management measures recommended for quarantine pests of fresh Chinese jujubes from China**

| Quarantine pests | Common name | Measures |
|---|---|---|
| **Spider mites [Prostigmata:Tetranychidae]** | | |
| *Amphitetranychus viennensis* (EP) | hawthorn spider mite | pre-export visual inspection and, if found, remedial action (such as methyl bromide fumigation) **a** |
| **Mealybugs [Hemiptera: Pseudococcidae]** | | |
| *Heliococcus destructor* (EP) | heliococcus mealybug | |
| **Fruit flies [Diptera: Tephritidae]** | | |
| *Bactrocera dorsalis* (EP) | Oriental fruit fly | Area freedom **b**<br>OR<br>Fruit treatment considered to be effective against all life stages of these pest species (such as cold treatment, methyl bromide fumigation followed by cold treatment, or irradiation) |
| *Zeugodacus cucurbitae* (EP) | melon fly | |
| *Bactrocera correcta* (EP) | guava fruit fly | |
| *Carpomyia vesuviana* | jujube fruit fly | Area freedom **b**<br>OR |

| | | |
|---|---|---|
| | | Fruit treatment considered to be effective against all life stages of this pest (such as irradiation) **c** |
| **Fruit borer [Lepidoptera: Carposinidae]** | | |
| *Carposina sasakii* (EP) | peach fruit borer | Area freedom **b**<br>OR<br>Fruit treatment considered to be effective against all life stages of this pest (such as methyl bromide fumigation or irradiation)<br>OR<br>A systems approach approved by the department |

**a** Remedial action by GACC may include applying approved treatment to the consignment to ensure that the pest is no longer viable or withdrawing the consignment from export to Australia. **b** Area freedom may include pest free areas, pest free places of production or pest free production sites. **c** Currently there is no approved fruit disinfestation treatment available for jujube fruit fly. Irradiation is the only treatment option recognised by the department to manage jujube fruit fly, however, irradiated fresh Chinese jujubes are not currently permitted to be sold in Australia under regulations managed by Food Standards Australia New Zealand (FSANZ). **EP** Species has been assessed previously and import policy already exists.

### 5.1.3 Pest risk management for regulated thrips

The thrips group PRA has identified thrips and emerging orthotospoviruses of biosecurity importance to Australia (Australian Government Department of Agriculture and Water Resources 2017). *Scirtothrips dorsalis* is associated with fresh Chinese jujubes from China. Measures are required to reduce the risk posed by the emerging quarantine orthotospoviruses it vectors, to achieve the ALOP for Australia (Table 5.2).a

**Table 5.2 Risk management measures recommended for regulated thrips associated with fresh Chinese jujubes from China**

| Regulated thrips | Common name | Measure |
|---|---|---|
| *Scirtothrips dorsalis* (GP, RA) | chilli thrips | pre-export visual inspection and, if found, remedial action **a** (such as methyl bromide fumigation) |

**a** Remedial action by GACC may include applying approved treatment to the consignment to ensure that the pest is no longer viable or withdrawing the consignment from export to Australia. **GP** Species has been assessed previously in a group PRA and the group PRA has been applied. **RA** Regulated article, refer to Section 4.8 for definition of a Regulated article.

### 5.1.4 Risk management measures for quarantine pests and regulated thrips

This final report for fresh Chinese jujubes recommends that when the following risk management measures are followed, the restricted risk for all identified quarantine and regulated pests assessed will achieve the appropriate level of protection (ALOP) for Australia. The management measures include:

- pre-export visual inspection, and remedial action for thrips, spider mites, and mealybugs if live pests are found
- area freedom or fruit treatment (such as cold treatment, methyl bromide fumigation followed by cold treatment, or irradiation) for fruit flies

- area freedom or fruit treatment (such as methyl bromide fumigation or irradiation) or a systems approach approved by the Australian Government Department of Agriculture for peach fruit borer.

#### Management for *Amphitetranychus viennensis*, *Heliococcus destructor* and *Scirtothrips dorsalis*

The Department of Agriculture recommends the option of pre-export visual inspection and, if found, remedial action, as measures for the spider mite, mealybug and thrips. The objective of the recommended measures is to reduce the risk associated with these pests to achieve the ALOP for Australia.

*Recommended measure: Pre-export visual inspection and, if found, remedial action*

All consignments of fresh Chinese jujubes exported to Australia from China must be inspected by technical officers from GACC regional offices and found free of *Amphitetranychus viennensis*, *Heliococcus destructor* and *Scirtothrips dorsalis*. Pre-export visual inspection must be undertaken by technical officers from GACC regional offices in accordance with ISPM 23*: Guidelines for inspection* (FAO 2019e) and consistent with the principles of ISPM 31*: Methodologies for sampling of consignments* (FAO 2016b). Export consignments found to contain these pests must be subjected to remedial action. Remedial action may include withdrawing the consignment from export to Australia or, if available, applying an approved treatment to ensure that the pest is no longer viable.

#### Management for *Bactrocera correcta*, *Zeugodacus cucurbitae*, *Bactrocera dorsalis* and *Carpomyia vesuviana*

To manage the risk of *Bactrocera correcta*, *Bactrocera dorsalis, Carpomyia vesuviana* and *Zeugodacus cucurbitae*, the Department of Agriculture recommends the options of area freedom or fruit treatments (such as cold treatment, methyl bromide fumigation followed by cold treatment, or irradiation) as measures for these fruit flies. The objective of the recommended measures is to reduce the risk associated with these pests to achieve the ALOP for Australia.

*Recommended measure 1: Area freedom*

The requirements for establishing pest free areas or pest free places of production are set out in ISPM 4: Requirements for the establishment of pest free areas (FAO 2017a) and ISPM 10: *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 2016a) and more specifically in ISPM 26: *Establishment of pest free areas for fruit flies (Tephritidae)* (FAO 2019f).

The Department of Agriculture recognises that the tephritid fruit flies *B. correcta, B. dorsalis* and *Z. cucurbitae* are absent to the north of latitude 33 degrees in China, consistent with the principles of pest free areas, which have been established based on trapping and regulation (Key Quarantine Fruit Fly Laboratory 2000). The Department of Agriculture also recognises that *C. vesuviana* is absent from China except in the Turpan region of Xinjiang (National Forestry Administration of China 2012, 2016).

For maintaining area freedom status for these fruit flies and other economically significant fruit flies for northern China, China's existing National Fruit Flies Trapping Network would be required to be maintained in all areas, including production areas where fresh Chinese jujube fruits are to be sourced for export to Australia.

If an outbreak of a tephritid fruit fly species of economic concern was to occur, China is required to notify the department within 48 hours. National emergency action plans for outbreaks are then required to be activated, which include establishing a delimiting survey by setting up additional traps to identify the site and extent of the fruit fly outbreak, and determine, the surrounding area and buffer zone. Fruit sampling is also conducted.

Exports of fresh Chinese jujubes from the fruit fly outbreak areas must be suspended or undergo disinfestation treatment recognised and approved by the Australian Government Department of Agriculture.

For fresh Chinese jujube fruit sourced from outside the recognised *B. correcta*, *B. dorsalis* and *Z. cucurbitae* pest free areas, or where area freedom status has been suspended, treatments recognised and approved by the department for management of *B. correcta, B. dorsalis* and *Z. cucurbitae* such as cold treatment (recommended measure 2), methyl bromide fumigation followed by cold treatment (recommended measure 3), or irradiation (recommended measure 4) must be undertaken.

*Recommended measure 2: Cold treatment*

The Australian Government Department of Agriculture recommends that the following cold treatments will effectively manage *B. correcta* and *B. dorsalis* on fresh Chinese jujube fruit from China. These cold treatment schedules are based on the USDA treatment manual (USDA T107f) and the generic cold treatment at 3 °C or below for 18 days for *Bactrocera* fruit flies agreed between GACC and the department, based on the findings of Myers et al. (2016).

- pulp temperature of 0.56 °C or below for 11 days, or
- pulp temperature of 1.11 °C or below for 12 days, or
- pulp temperature of 1.67 °C or below for 14 days, or
- pulp temperature of 3 °C or below for 18 days.

*Zeugodacus cucurbitae* has been reported to be more cold tolerant than *Bactrocera* species (Myers et al. 2016). The Australian Government Department of Agriculture recommends that the following cold treatments (based on USDA treatment manual USDA T107a) will effectively manage *Z. cucurbitae* on fresh Chinese jujube fruit from China:

- pulp temperature of 1.11 °C or below for 14 days, or
- pulp temperature of 1.67 °C or below for 16 days, or
- pulp temperature of 2.22 °C or below for 18 days.

Cold treatments can be conducted pre-export in China or in transit.

To manage the risks of *C. vesuviana*, the Australian Government Department of Agriculture is willing to consider cold treatments supported by efficacy data provided by China.

*Recommended measure 3: Methyl bromide fumigation followed by cold treatment*

The Australian Government Department of Agriculture recommends the following methyl bromide fumigation (based on USDA treatment manual T108a) to manage *B. correcta*, *Z. cucurbitae* and *B. dorsalis* on fresh Chinese jujube fruit:

- 32 grams per cubic metre for two hours at a pulp temperature of 21 °C or greater at not more than 50 per cent chamber load, followed by cold treatment at a pulp temperature of 2.77 °C or lower for 4 days, or
- 32 grams per cubic metre for two and half hours at a pulp temperature of 21 °C or greater at not more than 50 per cent chamber load, followed by cold treatment at a pulp temperature of 4.44 °C or lower for 4 days, or
- 32 grams per cubic metre for three hours at a pulp temperature of 21 °C or greater at not more than 50 per cent chamber load, followed by cold treatment at a pulp temperature of 8.33 °C or lower for 3 days.

*Recommended measure 4: Irradiation*

Irradiation treatment is considered a suitable measure for *B. correcta*, *Z. cucurbitae*, *B. dorsalis* and *C. vesuviana*. The treatment schedule of 150 gray minimum absorbed dose is specified in ISPM 28 Annex 7: *Irradiation treatment for fruit flies of the family Tephritidae (generic)* (FAO 2017c). A dose of 150 gray would make adult emergence from irradiated fruit an unlikely event.

The use of irradiation as a phytosanitary measure is subject to the Australian Government Department of Agriculture's approval of the irradiation facilities identified by GACC. Should China wish to use irradiation as a phytosanitary measure, GACC would need to provide a submission to the Australian Government Department of Agriculture. The submission must fulfil requirements as set out in ISPM 18 (FAO 2019d).

Currently, irradiated fresh Chinese jujubes are not permitted to be sold in Australia under regulations managed by the Food Standards Australia New Zealand (FSANZ). However, application may be made to FSANZ by any interested stakeholder to change the Australia New Zealand Food Standards Code to allow fresh Chinese jujubes (or any other fruits) treated with irradiation for phytosanitary purposes to be sold in Australia. Information on the irradiation of food and examples of previous FSANZ assessments can be found on the FSANZ website (foodstandards.gov.au).

**Management for *Carposina sasakii***

The Australian Government Department of Agriculture recommends the options of area freedom, or fruit treatment (methyl bromide fumigation or irradiation), or a systems approach approved by the Australian Government Department of Agriculture as management measure for *C. sasakii*. The objective of the recommended measures is to reduce the risk associated with *C. sasakii* to achieve the ALOP for Australia.

*Recommended measure 1: Area freedom*

The requirements for establishing pest free areas or pest free places of production or pest free production sites are set out in ISPM 4: *Requirements for the establishment of pest free areas* (FAO

2017a) and ISPM 10: *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 2016a).

Should China wish to use area freedom as a measure to manage the risk posed by *C. sasakii*, GACC would need to demonstrate the establishment of area freedom for *C. sasakii* in accordance with the requirements as set out in ISPMs 4 or 10.

*Recommended measure 2: Methyl bromide fumigation*

The fumigation treatment schedules set out below are those currently applied to reduce the risk of importation of *C. sasakii* on stone fruit (nectarine, plum, peach and apricot) from China and USA. These fumigation treatment schedules are also considered effective to manage *C. sasakii* in Chinese jujubes.

It is recommended that where fumigation with methyl bromide is utilised, it must be carried out according to the specifications below:

- 32 grams per cubic metre for two hours at a fruit pulp temperature of 21 °C or greater at not more than 50% chamber load, or
- 40 grams per cubic metre for two hours at a fruit pulp temperature of 16 °C or greater not more than 50% chamber load, or
- 48 grams per cubic metre for two hours at a fruit pulp temperature of 11 °C or greater not more than 50% chamber load.

*Recommended measure 3: Irradiation*

Irradiation treatment is considered a suitable measure option for *C. sasakii*. The Australian Government Department of Agriculture recommends 400 gray as minimum generic dose rate for the Class Insecta (except pupae and adults of the order Lepidoptera) (USDA 2015).

The use of irradiation as a phytosanitary measure is subject to the Australian Government Department of Agriculture's approval of the irradiation facilities identified by GACC. Should China wish to use irradiation as a phytosanitary measure, GACC would need to provide a submission to the Australian Government Department of Agriculture. The submission must fulfil requirements as set out in ISPM 18: *Guidelines for the use of irradiation as a phytosanitary measure* (FAO 2019d).

*Recommended measure 4: Systems approach*

The Australian Government Department of Agriculture recommends the following systems approach based on orchard control and surveillance, trapping, fruit cutting and inspection to reduce the risk associated with *C. sasakii* to meet Australia's ALOP.

- Orchard control and surveillance

Registered growers must implement an orchard control program (for example integrated pest management (IPM) programs for fresh Chinese jujubes for export). Programs would be approved by GACC and incorporate field sanitation and appropriate pesticide applications for *C. sasakii*.

GACC regional offices are responsible for ensuring that growers of Chinese jujubes for export are aware of pests of quarantine concern to Australia, and that the export orchards are subject to field sanitation and control measures. Registered growers must keep records of control measures for auditing. Details of control programs must be provided to the Australian Government Department of Agriculture by GACC before trade commences if requested.

Monitoring/detection surveys for pests that require orchard management measures must be conducted regularly by growers under the supervision of technical officers from GACC regional offices in orchards registered for export, to verify the effectiveness of the measures. GACC will maintain annual survey results using a standard reporting format. These results will be made available to the Australian Government Department of Agriculture if requested.

Specific traps effective for *C. sasakii* must be used to monitor this pest in orchards. If detected, control measures must be undertaken.

- Fruit cutting and inspection

A total of 600 fruit per phytosanitary certificate must be visually inspected for phytosanitary inspection, 60 fruits from the 600 fruits must be cut and examined to verify fruits are free from *C. sasakii* larvae. The fruit for fruit cutting may be taken from the 'cull' fruit.

If any *C. sasakii* larvae are found during the fruit cut, the consignment must be withdrawn from export to Australia or remedial action must be taken.

#### Consideration of alternative measures

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

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

A system of operational procedures is necessary to maintain and verify the phytosanitary status of fresh Chinese jujubes from China. This is to ensure that the recommended risk management measures have been met and are maintained.

### 5.2.1 A system of traceability to production sites

The objectives of this recommended requirement are to ensure that:

- fresh Chinese jujubes are sourced only from orchards producing commercial export-quality fruit
- orchards from which fresh Chinese jujubes are sourced can be identified so that investigation and corrective action can be targeted, rather than applied it to all contributing export orchards, in the event that live/viable pests are intercepted and
- orchards are capable of applying in-field measures (for example, a systems approach or pest free place of production or production site).

Export orchards are registered with GACC at the beginning of each growing season and registered orchards must pass an audits by GACC, which is conducted prior to the commencement of harvest. The list of registered orchards must be kept by GACC. GACC must ensure that fresh Chinese jujubes for export to Australia can be traced back to the registered orchard in China. GACC is required to ensure the registered orchards are suitably equipped and have a system in place to carry out the specified phytosanitary activities. GACC would be responsible for ensuring that export fresh Chinese jujubes growers are aware of pests of biosecurity concern to Australia and of the required risk management measures. Records of GACC's audits must be made available to the Department of Agriculture upon request. Records of orchard monitoring/management would be made available upon request.

### 5.2.2 Registration of packinghouses and auditing of procedures

The objectives of this recommended procedure are to ensure that:

- fresh Chinese jujubes are sourced only from packinghouses processing commercial-quality fresh Chinese jujubes that have been approved by GACC

Export packinghouses are registered with GACC before the commencement of harvest each season. The list of registered packinghouses must be kept by GACC. GACC are required to ensure that the registered packinghouses are suitably equipped and have a system in place to carry out the specified phytosanitary activities. Records of GACC audits must be made available to the Department of Agriculture upon request.

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

The objectives of this recommended procedure are to ensure that:

- fresh Chinese jujubes are treated by treatment providers that have been approved by GACC.

In circumstances where fresh Chinese jujubes undergo treatment, this process must be undertaken by the treatment providers that have been registered with and audited by GACC for that purpose. Records of GACC registration requirements and audits must be made available to the Department of Agriculture upon request.

Approval for treatment providers by GACC must include verification that suitable systems are in place to ensure compliance with the treatment requirements. These may include:

- documented procedures to ensure fresh Chinese jujubes are appropriately treated, and safeguarded post-treatment
- staff training to ensure compliance with procedures
- record-keeping procedures
- suitability of facilities and equipment
- compliance with GACC's system of oversight of treatment application or system of authorisation of treatment oversight.

The Australian NPPO provides final approval of facilities, following review of the regulatory oversight provided by the exporting NPPO and the capability demonstrated by the facility. Site visits may be required for the Australian NPPO to have assurance that the treatment can be applied accurately and consistently.

The use of irradiation requires a shared work plan that documents roles and responsibilities of all relevant stakeholders.

### 5.2.4 Packaging and labelling and containers

The objectives of this recommended procedure are to ensure that:

- fresh Chinese jujubes 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 2019b)
- unprocessed packing material - which is not permitted, as it may vector other pests not associated with Chinese jujubes - is not imported with Chinese jujubes
- all wood material associated with the consignment used in packaging and transport of fresh Chinese jujubes must comply with the department's import conditions, as published on BICON
- secure packaging is used for export of fresh Chinese jujubes to Australia to prevent re-infestation during storage and transport and prevent escape of pests during clearance procedures on arrival in Australia. To make consignments insect proof and secure, at least one of the following packaging options must be used:
  - **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.
  - **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 loaded and sealed at the packinghouse.
- the packaged fresh Chinese jujubes are labelled with sufficient identification information for the purposes of traceability. This may include:
  - for treated product: the treatment facility name/number and treatment identification number
  - for fresh Chinese jujubes where the measures include plantation freedom/area freedom/systems approach: plantation's reference/number
  - for fresh Chinese jujubes where phytosanitary measures are applied at the packinghouse: packing house registration reference/number.

Export packinghouses and treatment providers (where applicable) must ensure clean, new packaging and labelling are appropriate 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 during storage and movement is maintained.

Treated and/ or inspected fresh Chinese jujubes 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.

### 5.2.6 Freedom from trash

The objective of this recommended procedure is to ensure that fresh Chinese jujubes 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 must 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 GACC

The objectives of this recommended procedure are to ensure that Australia's import conditions have been met.

- All consignments must be inspected in accordance with official procedures for all visually-detectable quarantine pests and other regulated articles (including soil, animal matter, and plant debris) using random samples of 600 units per phytosanitary certificate, or equivalent, as per ISPM 31: *Methodologies for sampling consignments* (FAO 2016b). One unit is considered to be a single Chinese jujube fruit.
- A phytosanitary certificate must be issued for each consignment upon completion of pre-export inspection and treatment to verify that the required risk management measures 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)
  - details of disinfestation treatments (for example, methyl bromide fumigation)
  - any other statements that may be required such as identification of the consignment as being sourced from a recognised pest free areas

### 5.2.8 Phytosanitary inspection by the Department of Agriculture

The objectives of this recommended procedure are to ensure that:

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

On arrival in Australia, the Department of Agriculture 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 biosecurity status of consignments of fresh Chinese jujubes from China meet Australia's import conditions. When inspecting consignments, the department will use random samples of 600-units or equivalent, per phytosanitary certificate (or as goods are lodged) 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 conditions will be subject to a suitable remedial treatment where an effective treatment is available and biosecurity risks associated with applying the treatment can be effectively managed, or 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, fruit flies of economic importance.

In the event that fresh Chinese jujubes consignments are repeatedly non-compliant, the Department of Agriculture reserves the right to suspend imports (either all imports, or imports from specific pathways), and to conduct an audit of the risk management systems. Imports will recommence only when the Department of Agriculture is satisfied that appropriate corrective action has been undertaken.

## 5.3 Uncategorised pests

If an organism that has not been categorised in this review, including contaminant pests, is found on fresh Chinese jujubes in China or detected on arrival in Australia, it will require assessment by the Department of Agriculture to determine its quarantine status and whether phytosanitary action is required.

Assessment will also be made if the detected species was categorised as not likely to be on the import pathway. If the detected species was categorised as being on the pathway, but assessed as having an unrestricted risk that achieves the ALOP for Australia, then it may require reassessment. 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 existing measures continue to provide the appropriate level of protection for Australia.

## 5.4 Review of processes

### 5.4.1 Verification of protocol

Prior to or during the first season of trade, the Department of Agriculture will verify the implementation of the required import conditions and phytosanitary measures including registration, operational procedures and treatment providers, where applicable. For example, for measures conducted off shore, the department may require information about standard operating procedures (SOPs). This may involve representatives from the Department of Agriculture visiting areas in China that produce fresh Chinese jujubes for export to Australia.

### 5.4.2 Review of policy

GACC must inform the Department of Agriculture immediately on detection of any newly identified pests of Chinese jujubes 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 2017b).

The Department of Agriculture will review the import policy after a suitable volume of trade has been achieved. In addition, the department reserves the right to review the import policy as deemed necessary, including if there is reason to believe that pest or phytosanitary status in China has changed.

## 5.5 Meeting Australia's food 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).

The Department of Agriculture administers the *Imported Food Control Act 1992*. This legislation provides for the inspection and control of imported food using a risk-based border inspection program, the Imported Food Inspection Scheme. More information on this inspection scheme, including the testing of imported food, is available from the department's website at http://agriculture.gov.au/import/goods/food/inspection-compliance/inspection-scheme.

Food Standards Australia New Zealand (FSANZ) is responsible for developing and maintaining the Code, including Standard 1.4.2 - Agvet chemicals. This standard is available on the Federal Register of Legislation at https://www.legislation.gov.au/or through the FSANZ website at http://www.foodstandards.gov.au/code/Pages/default.aspx.

Standard 1.4.2 and Schedules 20 and 21 of the Code set out the maximum residue limits (MRLs) and extraneous residue limits (ERLs) for agricultural or veterinary chemicals that are permitted in food, 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.

Standard 1.5.3 of the code stipulates the mandatory requirements where irradiation is applied as a phytosanitary measure, including the permitted fruit and vegetables, sources of irradiation, minimum and a maximum absorbed dose, and the record keeping and labelling requirements for irradiated produce.

# 6 Conclusion

The findings of this final risk analysis for fresh Chinese jujubes from China are based on a comprehensive scientific analysis of relevant literature, and other avenues of enquiry.

The Department of Agriculture considers that the risk management measures recommended in this report will provide an appropriate level of protection against the quarantine pests and regulated thrips identified as associated with the trade of fresh Chinese jujubes from China.

# Appendix A: Initiation and categorisation for pests of fresh Chinese jujube fruit from China

The following pest categorisation table identifies pests that have the potential to be present on fresh Chinese jujube fruit grown in China using typical commercial production and packing procedures, and to be imported into Australia.

The *Final group pest risk analysis for thrips and orthotospoviruses on fresh fruit, vegetable, cut-flower and foliage imports* (Australian Government Department of Agriculture and Water Resources 2017) has been applied in this risk analysis.

The purpose of pest categorisation is to ascertain which of these pests require detailed assessment in order to determine whether phytosanitary measures are required. The steps in the pest categorisation process are considered sequentially. The assessment terminates at 'Yes' for the third column (presence within Australia), except for pests that are present, but under official control and/or pests of regional concern. In cases where this does not apply, assessment terminates at the first 'No' in any of the following columns.

In the final column of the table (column 7) the acronym 'EP' is used. The acronym EP (existing policy) is used for pests that have previously been assessed by Australia and for which policy existed before the collation of this pest list.

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

This is not a comprehensive list of all pests associated with the entire Chinese jujube plant, and it does not include soil-borne pests and pathogens, wood-borers, root pests and secondary pests, as these are not directly related to the export pathway of fresh fruit. Other pests that may occasionally be detected in trade, which are not specifically associated with Chinese jujube, are not considered here. Any such contaminant pests detected at the border are managed under existing standard operational procedures. It is important to note that any quarantine pests detected on-arrival by quarantine inspections will be actioned appropriately, even if they have not been assessed in this report.

The department is aware of the recent changes in fungal nomenclature concerning 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 China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| **ARTHROPODS** | | | | | | |
| **Acarina (Prostigmata)** | | | | | | |
| *Amphitetranychus viennensis* (Zacher, 1920)<br>Synonym: *Tetranychus viennensis* Zacher, 1920<br>[Tetranychidae]<br>Hawthorn spider mite | Yes (AQSIQ 2017) | No records found | Yes. *Amphitetranychus viennensis* was listed as present in major jujube production areas in China. It feeds on stems, branches, leaves, buds, flowers, and fruits of jujube (AQSIQ 2017). It may escape from detection during the harvesting and packing house procedures due to its small size (<1mm) (NAPPO 2014). | Yes. This species is polyphagous. Hosts also include peanut, quince, fig, strawberry, cotton, apple, cherry, plum, peach, pear and raspberry (CABI 2019a; Migeon & Dorkeld 2013). These hosts are widely available throughout Australia. This species is found in many parts of temperate Asia and Europe (Migeon & Dorkeld 2013). Many parts of temperate Australia have similar climatic conditions to regions where the pest is currently established. | Yes. This species is an important pest of apple, peach, pear, apricot, plum, hawthorn, cherry, sweet cherry and raspberry in Asia and Europe (Jeppson, Keifer & Baker 1975). | Yes (EP) |
| *Eutetranychus orientalis* (Klein, 1936)<br>[Tetranychidae]<br>Oriental red mite; citrus brown mite | Yes (Shun et al. 1996; Zhou et al. 2006a). | Yes. NSW, NT, Qld, WA (Halliday 2000, 2013; Plant Health Australia 2017) | Assessment not required | Assessment not required | Assessment not required | No |
| *Panonychus citri* (McGregor, 1916)<br>[Tetranychidae]<br>Citrus red mite | Yes (Li, Wang & Waterhouse 1997; Manson 1987; Wang 1981). | Yes. NSW, SA (CSIRO 2005; Halliday 2013). Listed as a Declared Organism (Prohibited – section 12 (C1 Prohibited)) for WA (Government | No. It is a common pest of citrus (Li, Wang & Waterhouse 1997; Zhang 2003). On citrus, adults and nymphs feed on the host tissue, producing tiny grey or silvery spots on leaves and citrus fruit | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | of Western Australia 2017) | (stippling). Infestations on leaves are frequently greater than on fruits. Severe infestations can lead to premature leaf fall, dieback and decreased vigour (EFSA 2008; Zanardi et al. 2015). *Ziziphus jujuba* was listed as a minor host (Wang 1981). No report of an association with fresh Chinese jujube fruit was found. | | | |
| *Panonychus ulmi* (Koch, 1836)<br>[Acari: Tetranychidae]<br>European red mite | Yes (AQSIQ 2006c) | Yes. NSW, SA, Tas., Vic., WA (Halliday 1998; Plant Health Australia 2017) | Assessment not required | Assessment not required | Assessment not required | No |
| *Tegolophus zizyphagus* (Keifer, 1939)<br>Synonym: *Epitrimerus zizyphagus* Kiefer, 1939<br>[Eriophyidae] | Yes (AQSIQ 2017) | No records found | No. It usually induces galls on stems, branches buds and roots of *Z. jujuba*. It also causes leaf edge curls (AQSIQ 2017; Li et al. 2015). No report of an association with fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Tetranychus cinnabarinus* (Boisduval, 1867)<br>[Tetranychidae] | Yes (AQSIQ 2017; Li, Wang & Waterhouse 1997) | No records found | No. It feeds on stems, branches, leaves, buds and flowers of *Z. jujuba* (AQSIQ 2017). Heavy feeding can resemble symptoms of magnesium deficiency on the host | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| Carmine spider mite; common spider mite | | | plant (CABI 2019a). No report of an association with fresh Chinese jujube fruit was found. | | | |
| *Tetranychus truncatus* Ehara 1956<br>[Tetranychidae]<br>Cassava mite | Yes (AQSIQ 2017) | No records found | No. It feeds on leaves of *Z. jujuba* (AQSIQ 2017). No report of an association with fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Tyrophagus putrescentiae* (Schrank, 1781)<br>[Acaridae]<br>Cereal mite; stored products mite; mould mite | Yes (AQSIQ 2017) | Yes. NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2017; Poole 2010) | Assessment not required | Assessment not required | Assessment not required | No |
| **Coleoptera** | | | | | | |
| *Adoretus sinicus* Burmeister, 1855<br>Synonym: *Adoretus tenuimaculatus* Waterhouse, 1875<br>[Scarabaeidae]Chinese rose beetle | Yes (Li, Wang & Waterhouse 1997) | No records found | No. Adults of this genus feed on leaves of *Ziziphus* spp. and larvae feed on roots (Hill 2008). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Callosobruchus chinensis* L.<br>[Bruchidae]<br>Chinese bruchid | Yes (Liu & Luo 2006) | Yes. ACT, NSW, NT, Qld, SA, Vic., WA (ALA 2018; Lambrides & Imrie 2000) | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| *Chlorophanus grandis* Roelofs, 1873<br>[Curculionidae] | Yes (Hua 2002) | No records found | No. *Chlorophanus grandis* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Adults feed on leaves of host plants (Han et al. 2014). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Cryptocephalus japonica* Baly<br>[Chrysomelidae] | Yes (Liu & Luo 2006) | No records found | No. *Cryptocephalus japonica* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). It feeds on buds, leaves and flowers of host plants (Liu & Luo 2006). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Cryptocephalus pilosellus* Suffrian<br>[Chrysomelidae] | Yes (Liu & Luo 2006) | No records found | No. *Cryptocephalus pilosellus* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). It feeds on buds, leaves and flowers of host plants (Liu & Luo 2006). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Labidostomis bipunctata* (Mannerheim, 1825)<br>[Chrysomelidae]<br>Leaf beetle | Yes (Guskova 2016) | No records found | No. *Labidostomis bipunctata* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). It is a leaf feeder (Guskova | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | 2016). No report of an association with mature fresh Chinese jujube fruit was found. | | | |
| *Laria pisorum* L.<br>Synonym: *Bruchus pisorum* Linnaeus, 1758<br>[Bruchidae]<br>Pea weevil | Yes (Liu & Luo 2006) | Yes. NSW, Qld, Vic., SA, WA (CSIRO 2017; Poole 2010) | Assessment not required | Assessment not required | Assessment not required | No |
| *Lytta* sp.<br>[Meloidae]<br>Blister beetle | Yes (Liu & Luo 2006) | No records found | No. Adults usually feed on mainly floral parts and leaves of *Ziziphus* spp. (Liu & Luo 2006) and larvae are predatory (Selander & Fasulo 2010). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Maladera orientalis* (Motschulsky, 1857)<br>[Scarabaeidae]<br>Smaller velvet chafer | Yes (AQSIQ 2017) | No records found | No. Adults feed on leaves, stems, branches and buds of *Z. jujuba* (AQSIQ 2017). Larvae are root feeders (Wang & Meng 2004). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Mylabris phalerata*<br>[Meloidae] | Yes (Liu & Luo 2006) | No records found | No. Adults feed mainly on floral parts and leaves of *Ziziphus* species. Larvae are predatory (Selander & | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| Blister beetle | | | Fasulo 2010). No report of an association with mature fresh Chinese jujube fruit was found. | | | |
| *Scythropus yasumatsui* Kono et Morimoto (1993)<br>Synonym: *Pachyrhinus yasumatsui* (Kono & Morimoto, 1960)<br>[Curculionidae]<br>Curculionid | Yes (AQSIQ 2017) | No records found | No. Adults usually feed on leaves, stems, branches and buds of *Z. jujuba* (AQSIQ 2017). Larvae feed on roots (Li & Zhang 1985). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Sympiezomias citri* Chao, 1977<br>[Curculionidae]<br>Grey citrus weevil | Yes (AQSIQ 2017) | No records found | No. Adults feed on leaves of *Ziziphus* spp. (AQSIQ 2017). Larvae feed on roots (Ma, Huang & Lin 2014). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Sympiezomias velatus* (Chevrolat, 1845)<br>[Curculionidae]<br>Big gourd-shaped weevil | Yes (AQSIQ 2017) | No records found | No. Adults feed on leaves of *Ziziphus* spp. (AQSIQ 2017). Larvae feed on roots (Baidu 2018). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| **Diptera** | | | | | | |
| *Bactrocera correcta* (Bezzi, 1916)<br>[Tephritidae]<br>Guava fruit fly | Yes (AQSIQ 2017; Li, Wang & Waterhouse 1997; Lu et al. 2010a)<br>Limited distribution in south and southwest China (Li, Wang & Waterhouse 1997). *Bactrocera correcta* is a quarantine pest of China (AQSIQ 2007; Zhang et al. 2011b). | No records found | Yes. Associated with the fruit of *Z. jujuba* (AQSIQ 2017; Balikai 2009; CABI 2019a). Lays eggs under the skin of the fruit and the larvae feed on the pulp (CABI 2019a; CDFA 2016; Steck 2002). | Yes. *Bactrocera correcta* infests 62 species of plants belonging to 30 families (Allwood et al. 1999; Kunprom, Sopaladawan & Pramual 2015; Maynard, Hamilton & Grimshaw 2004). Some of the hosts of this pest include pawpaw, guava, mango, cherry, citrus and peach. It is found across Asia (Allwood et al. 1999; CABI 2019a; Maynard, Hamilton & Grimshaw 2004). Its hosts and current geographic distribution suggest that it could establish and spread in Australia. | Yes. This pest has caused up to 80 per cent damage in guava crops (CABI 2019a). | Yes (EP) |
| *Bactrocera diversa* (Coquillett, 1904)<br>Synonym: *Dacus diversus*<br>[Tephritidae]<br>Three striped fruit fly | Yes (Drew, Romig & Dorji 2007; Wang & Zhao 1989; Yang, Carey & Dowell 1994) | No records found | No. Primarily a flower feeder (Drew, Romig & Dorji 2007; USDA-APHIS 2016). *Ziziphus jujuba* was listed as a host. No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Bactrocera dorsalis* (Hendel, 1912)<br>Synonym: *Dacus dorsalis* Hendel, 1912 | Yes (AQSIQ 2017; CABI 2019a; Huang 2006; Li, Wang & Waterhouse 1997) | No records found | Yes, Associated with *Z. jujuba* (Allwood et al. 1999; AQSIQ 2015, 2017; Azam-Ali et al. 2006; CABI 2019a). Oviposits eggs into fruits and the larvae | Yes. This species is found throughout Asia, with restricted distribution elsewhere (Stibick 2004). It is highly polyphagous, with 239 recorded hosts, including | Yes. This species is a very serious pest of a wide variety of fruit and vegetables, and damage levels can be up to 100 per | Yes (EP) |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| [Tephritidae]<br>Oriental fruit fly | | | feed on pulp within the fruit (AQSIQ 2017; Azam-Ali et al. 2006; Bugti et al. 2015; CABI 2019a). | apple, pear, table grapes, cherry, peach, plum, nectarines, mangoes, jujube, capsicum, citrus and melon (Allwood et al. 1999; CABI 2019a; Stibick 2004). Its hosts, and geographic distribution suggest that it could establish and spread in Australia. | cent of unprotected fruits (CABI 2019a). | |
| *Carpomyia vesuviana* Costa, 1854<br>Synonym: *Carpomya vesuviana*<br>[Tephritidae]<br>Jujube fruit fly; Ber fruit fly | Yes. Locally distributed in parts of Xinjiang (Hu et al. 2013; Karuppaiah 2014; Pollini & Cravedi 2014). It is a quarantine pest for China (AQSIQ 2007). | No records found | Yes. Associated with *Z. jujuba* (Azam-Ali et al. 2006; Balikai, Kotikal & Prasanna 2013; Hu et al. 2013; Karuppaiah 2014; Pollini & Cravedi 2014). Eggs laid beneath the skin of the fruit and the larvae feed on the fruit pulp (Azam-Ali et al. 2006; Balikai, Kotikal & Prasanna 2013; Bugti et al. 2015; Pollini & Cravedi 2014). | Yes. It only affects *Zizyphus* spp. but is highly destructive (Haldhar et al. 2016). It has a wide distribution, including Bangladesh, China, Georgia, India, Indian Ocean Islands, Iran, Mauritius, Oman, Pakistan, Southern Europe (Italy, Bosnia), Turkmenistan, Turkey, North Africa, Thailand, and Uzbekistan (Amini et al. 2014; Haldhar et al. 2016; Karuppaiah 2014; Pollini & Cravedi 2014). Its hosts and geographic distribution suggest that it could establish and spread in parts of Australia. | Yes. *Carpomyia vesuviana* is the most destructive pest of *Zizyphus* spp.which often affects the quality and commodity price of jujube products (Amini et al. 2014; Haldhar et al. 2016; Hu et al. 2013; Karuppaiah 2014; Li et al. 2017b). It has caused 80 to 100 per cent fruit damage under severe infestations (Balikai, Kotikal & Prasanna 2013; Karuppaiah 2014). | Yes |
| *Contarinia* sp.<br>[Cecidomyiidae]<br>Gall midges | Yes (Bi et al. 2005; Worldbank 2009) | No records found | No. *Contarinia* spp. forms galls on leaves and flower buds of *Z. jujuba* (Barnes 1948; Bi et al. 2005). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| *Dasineura datifolia* Jiang<br>[Cecidomyiidae]<br>Gall midges | Yes (AQSIQ 2017) | No records found | No. It forms galls on leaves of *Z. jujuba* (Jiao et al. 2017). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Dasineura jujubifolia* Jiao & Bu, sp. Nov., 2017<br>[Cecidomyiidae]<br>Gall midges | Yes (Jiao et al. 2017) | No records found | No. It forms galls on leaves of *Z. jujuba* (Jiao et al. 2017). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Zeugodacus cucurbitae* (Coquillett, 1899)<br>Synonym: *Bactrocera cucurbitae* (Coquillett, 1899)<br>*Bactrocera cucurbitae* has been reclassified as *Zeugodacus cucurbitae* (Virgilio et al. 2015a; Virgilio et al. 2015b)<br>[Tephritidae]<br>Melon fly | Yes (AQSIQ 2017) | No records found for mainland Australia (Hardy & Foote 2011). | Yes. Associated with *Z. jujuba* (Allwood et al. 1999; AQSIQ 2017; CABI 2019b). Lays eggs under the skin of the fruit and the larvae feed on the pulp (Bugti et al. 2015; CABI 2019b; Dhillon et al. 2005). | Yes. *Zeugodacus cucurbitae* is a serious pest of cucurbitaceous crops and it has been reported to damage 81 host plant species (Allwood et al. 1999; CABI 2019b; Dhillon et al. 2005; FDACS 2017). Its hosts include pawpaw, guava, jujube, sapota, mango, pear, strawberry, fig, avocado, apple, lychee and citrus. It is found across Asia (Allwood et al. 1999; CABI 2019b; Dhillon et al. 2005; Stonehouse et al. 2002). Its hosts, and geographic distribution suggest that it could establish and spread in Australia. | Yes. This pest has caused up to 100 per cent damage depending upon cucurbit species and the season (CABI 2019b; Dhillon et al. 2005) and it is a serious pest of jujube production in Pakistan (Stonehouse et al. 2002). | Yes (EP) |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| **Hemiptera** | | | | | | |
| *Amrasca biguttula* Ishida<br>[Cicadellidae]<br>cotton leafhopper | Yes (Cui & Xia 1998) | No records found | No. Adults and nymphs feed on leaves of *Ziziphus* spp. (Nizamani et al. 2015). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Antecerococcus ornatus* (Green 1909)<br>Synonym: *Cerococcus ornatus* Green, 1909<br>[Cerococcidae]<br>Star scale; False pit scale | Yes (Hua 2000) | No records found | No. It forms pits on stems and branches. *Z. jujuba* was listed as a host (Hua 2000). However, no report of an association with fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Aonidiella orientalis* (Newstead, 1894)<br>[Diaspididae]<br>Oriental scale; Oriental yellow scale | Yes (AQSIQ 2017) | Yes. NT, Qld, WA (García Morales et al. 2018; Plant Health Australia 2017; Poole 2010). | Assessment not required | Assessment not required | Assessment not required | No |
| *Aphis gossypii* Glover, 1877<br>[Aphididae]<br>Cotton aphid, Melon aphid | Yes (Li, Wang & Waterhouse 1997) | Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2017; Poole 2010). Because *A. gossypii* is a known vector of plum pox virus (which is absent from Australia but is present in Hunan province in | No. It prefers to feed on the underside of young leaves causing infested leaves to curl downwards and appear wrinkled or reddened (CABI 2019a). *Ziziphus jujuba* was listed as a host (Nizamani et al. 2015). No report of an association with fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | China)(CABI 2019a; Gildow et al. 2004; Kaya et al. 2014), the potential to be on the pathway needs to be assessed. | | | | |
| *Apolygus lucorum* (Meyer-Dur, 1843)<br>Synonym: *Lygus lucorum* (Meyer-Dur, 1843)<br>[Miridae]<br>Mirid bug | Yes (Pan et al. 2015) | No records found | No. It feeds on foliage of *Z. jujuba* in China (Pan et al. 2015). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Aspidiotus destructor* Signoret, 1869<br>[Diaspididae]<br>Coconut scale | Yes (AQSIQ 2017) | Yes. NSW, NT, Qld, Vic., WA (García Morales et al. 2018; Plant Health Australia 2017; Poole 2010). | Assessment not required | Assessment not required | Assessment not required | No |
| *Bemisia tabaci* (Gennadius, 1889)<br>[Aleyrodidae]<br>Tobacco whitefly; Silverleaf whitefly, Sweet potato whitefly, Cassava whitefly | Yes (Hua 2000). | Yes. All states and territories (CSIRO 2005). However it is a known vector of a number of plant viruses including quarantine pests for Australia, for example, Tomato yellow leaf curl virus (TYLCV) and Tomato yellow leaf curl China virus (TYLCCV) (Li et al. 2014a; Pan et al. 2012). | No. It is a phloem feeder and females lay eggs on the underside of leaves. Adults superficially feed on fruits (CABI 2019b; Guo et al. 2018a; Li et al. 2011). Adult whiteflies are very active and are unlikely to remain on the fruit when disturbed during harvesting and packing processes. However, if detected at the border, risk assessment will be | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | required, consistent with Section 5.3 of this report. | | | |
| *Ceroplastes floridensis* Comstock, 1881<br>[Coccidae]<br>Florida wax scale | Yes (AQSIQ 2017; CAAS 1992) | Yes. NSW, Qld (Plant Health Australia 2017). Listed as a Declared Organism (Prohibited – section 12 (C1 Prohibited)) for WA (Government of Western Australia 2017) | No. Primarily occurs on stems, leaves and branches of *Z. jujuba* (AQSIQ 2017; Miller et al. 2007). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Ceroplastes japonicus* (Green, 1921)<br>Synonym: *Paracerostegia japonica* (Green, 1921)<br>[Coccidae]<br>Tortoise wax scale; Japanese wax scale | Yes (AQSIQ 2006b, a, 2017) | No records found | No. Adults and nymphs feed on stems, branches, leaves and buds of Chinese jujubes in China (AQSIQ 2017). On citrus, feeding damages include chlorosis of leaves, discolouration of fruit, wilting and dieback of branches. It also causes premature drop of leaves, flowers and fruits (Davis, French & Venette 2005). However, Liu et al. (2003) also reported that *C. japonicus* feeds on leaves and flower buds of jujube in China. No report of an association with mature fresh Chinese jujube fruit was found. In addition, if it does go on fruit, the infested fruits are likely to be discarded during picking and packinghouse | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | processes as jujube fruit has smooth skin and shallow stem ends, and each fruit individually screened at the packinghouse. Therefore, it is unlikely to be on the commercially grown and packed jujube fruit pathway. | | | |
| *Charagochilus angusticollis* Linnavuori, 1961<br>[Miridae]<br>Plant bug | Yes (Hua 2000) | No records found | No. Usually plant bugs feed on plant tissue, fruit sap and some species predate psyllids (DOR 2002). *Ziziphus jujuba* was listed as a host (Hua 2000). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Chrysomphalus aonidum*<br>[Diaspididae]<br>Oriental scale | Yes (AQSIQ 2017; Li, Wang & Waterhouse 1997) | Yes. NSW, NT, Qld, Tas., WA (CSIRO 2017; Plant Health Australia 2017). | Assessment not required | Assessment not required | Assessment not required | No |
| *Cicadella viridis* (Linnaeus, 1758)<br>Synonym: *Tettigella viridis* Linnaeus, 1758<br>[Cicadellidae]<br>Green leafhopper | Yes (AQSIQ 2006b, a, 2017) | No records found | No. It is associated with leaves of *Z. jujuba* (AQSIQ 2017). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| *Coccus hesperidum* Linnaeus, Linnaeus, 1758<br>[Coccidae]<br>Brown soft scale | Yes (CABI 2019b; Li, Wang & Waterhouse 1997) | Yes. All states and territories (Plant Health Australia 2018) | Assessment not required | Assessment not required | Assessment not required | No |
| *Comstockaspis perniciosa* (Comstock, 1881)<br>Synonym: *Diaspidiotus perniciosus* (Comstock, 1881); *Quadraspidiotus perniciosus* (Comstock, 1881)<br>[Diaspididae]<br>California scale; San Jose scale | Yes (AQSIQ 2017; CABI 2019a; Yang, Tulake & Li 2005) | Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2017) | Assessment not required | Assessment not required | Assessment not required | No |
| *Cryptotympana atrata* (Fabricius, 1775)<br>[Cicadidae]<br>Blackish cicada | Yes (AQSIQ 2017) | No records found | No. It is associated with *Z. jujuba* (AQSIQ 2017). Adults suck sap from branches and lay eggs in xylem of young shoots, causing dieback of shoots to near the site of oviposition. Nymphs live in soil and feed on sap of roots (CHNZX-Farming 2008). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Didesmococcus koreanus* Borchsenius, 1955 | Yes (Hua 2000) | No records found | No. *Didesmococcus koreanus* is usually found on twigs, branches and | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
| --- | --- | --- | --- | --- | --- | --- |
| Synonym: *Didesmococcus coreanus*<br>[Coccidae]<br>Korean hardy scale | | | leaves of its hosts (Ben-Dov & Hodgson 1997). *Ziziphus jujuba* is listed as a host (Hua 2000). No report of an association with mature fresh Chinese jujube fruit was found. | | | |
| *Drepanococcus chiton* (Green, 1909)<br>[Coccidae] | Yes (García Morales et al. 2018) | No records found | No. *Drepanococcus chiton* is usually found on twigs, branches and leaves of its hosts (Ben-Dov & Hodgson 1997). It has been reported on Chinese jujube trees (Azam-Ali et al. 2006). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Erthesina fullo* (Thunberg, 1783)<br>[Pentatomidae]<br>Yellow spotted stink bug; yellow marmorated stink bug | Yes (AQSIQ 2017; Lu, Wu & Wang 1992) | No records found | No. It was recorded as a pest on *Z. jujuba*, adults and nymphs damage branches and fruit of their hosts (AQSIQ 2017; Feng & Wang 2004). However, they are highly mobile and are likely to fall from the fruit during harvesting (Department of Agriculture and Water Resources 2016). Fruits damaged by nymphs and adults become 'cat faced' (CABI 2019b; Mizell 2008) and are unlikely to be picked during harvest, | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | or are likely to be removed during the sorting and packing processes (CABI 2019b; Mizell 2008). | | | |
| *Eulecanium excrescens* Ferris, 1927<br>[Coccidae]<br>Excrescent scale | Yes (Hua 2000) | No records found | No. It is usually found on leaves and bark of its hosts feeding on sap, which weakens the plant, causing leaf loss and dieback (Malumphy 2005). *Ziziphus jujuba* was listed as a host (Hua 2000). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Eulecanium giganteum* (Shinji, 1935)<br>[Coccidae]<br>scale | Yes (AQSIQ 2017) | No records found | No. It occurs on the stems, branches, bark, buds or underside of leaves of *Ziziphus jujuba* (AQSIQ 2017; Malumphy 2005). Females of this genus overwinter on stems, and deposit their eggs underneath their protective scales (Malumphy 2005). No report of an association with mature Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Eurystylus costalis* Stål, 1870<br>[Miridae] | Yes (Hua 2000) | No records found | No. It usually feeds on plant tissues and fruit sap of its hosts (Lu et al. 2010b). Some species | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| Mirid bug | | | predate psyllids (DOR 2002). *Ziziphus jujuba* was listed as a host (Hua 2000). No report of an association with mature fresh Chinese jujube fruit was found. | | | |
| *Gampsocoris pulchellus* (Dallas, 1852)<br>[Berytidae]<br>Stilt bug | Yes (Hua 2000) | Yes. NT (Gross 1950) | No. It feeds on young buds, leaves and stems of its hosts (Yang 1982). *Ziziphus jujuba* was listed as a host (Hua 2000). No report of an association with mature Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Halyomorpha picus* (Fabricius, 1794)<br>[Pentatomidae] | Yes (Hua 2000; Jin & Gao ; Lee et al. 2013) | No records found | No. *Halyomorpha picus* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). No report of an association with mature fresh Chinese jujube fruit was found. This species feeds on leaves, shoots and fruits of its host plants (Lee et al. 2013). Nymphs and adults are unlikely to remain on the fruit when disturbed during harvesting and packing house processes. Fruit damaged by nymphs and adults are likely to be removed during harvesting and packing processes. | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| *Heliococcus destructor* Borchsenius, 1941<br>Synonym: *Heliococcus zizyphi* Borchsenius, 1958<br>[Pseudococcidae]<br>Mealybug | Yes (AQSIQ 2017) | No records found | Yes. It feeds on roots, stems, branches, buds, leaves, flowers and fruits of *Ziziphus jujuba* (AQSIQ 2017). | Yes. Hosts of *H. destructor* include mulberry, wild prunus, pear, pomegranate, white clover and bow-wood as well as *Z. jujuba* (García Morales et al. 2018). Some of these hosts are available in Australia (AVH 2014). Its current distribution includes Armenia, Bulgaria, China, Georgia, Kazakhstan, Kyrgyzstan, Morocco, Poland, Russia, Switzerland, Tajikistan, Turkmenistan, Ukraine and Uzbekistan (García Morales et al. 2018). These regions have similar environmental conditions to those found in some parts of Australia. | Yes. Species of the genus *Heliococcus* are significant pests of grapevine and can also transmit *Grapevine virus A* and *Grapevine leafroll-associated virus 1* and *3* (Zorloni et al. 2006). *Helicoccus destructor* affects roots, stems, branches, buds, leaves, flowers and fruits of jujube in China (AQSIQ 2017). Therefore, it has the potential to cause economic damage on host plants. | Yes |
| *Hemiberlesia lataniae* (Signoret, 1869)<br>[Diaspididae]<br>Latania scale | Yes (AQSIQ 2017; CABI 2019a; García Morales et al. 2018) | Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2017; Poole 2010; Watson 2018) | Assessment not required | Assessment not required | Assessment not required | No |
| *Hishimonoides aurifascialis* Kuoh (Chen et al., 1984)<br>[Hemiptera: Cicadellidae]<br>Leafhopper | Yes (Dai, Viraktamath & Zhang 2010) | No records found | No. It usually attacks the shoots and females oviposit eggs into the epidermis of shoots and veins (Dai, Viraktamath & Zhang 2010; Kim & Kim 1993). No report of an association with mature Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| *Hishimonoides laterosporeus* Li and Zhang, 2005<br>Synonym: *Hishimonoides chinensis* Anufriev, 1970<br>[Cicadellidae]<br>Leafhopper | Yes (Dai, Viraktamath & Zhang 2010; Jin & Gao 1984) | No records found | No. *Hishimonoides laterosporeus* is a phloem-feeding insect (Dai, Viraktamath & Zhang 2010; Jin & Gao 1984). *Ziziphus jujuba* was listed as a host (Dai, Viraktamath & Zhang 2010; Kim & Kim 1993). No report of an association with mature Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Hishimonus lamellatus* Cai et Kuoh, 1995<br>[Hemiptera: Cicadellidae] | Yes (Hao et al. 2015a) | No records found | No**.** *Hishimonus lamellatus* is a phloem-feeding insect (Hao et al. 2015a). It is associated with *Ziziphus jujuba* (Hao et al. 2015a; Kim & Kim 1993). No report of an association with mature Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Hishimonus sellatus* (Uhler, 1896)<br>[Cicadellidae]<br>Rhombic marked leafhopper | Yes (Sun, Zhang & Tian 1988) | No records found | No**.** *Hishimonus sellatus* is a phloem-feeding insect (Hao et al. 2015a). This species feeds on shoots, and females oviposit eggs into the epidermis of shoots and veins (Kim & Kim 1993). *Ziziphus jujuba* was listed as a host (Sun, Zhang & Tian 1988). No report of an association with mature | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | Chinese jujube fruit was found. | | | |
| *Homoeocerus dilatatus* Horvath, 1879<br>[Coreidae]<br>Coreid bug | Yes (Ding et al. 2004; Hua 2000) | No records found | No. Adults and nymphs of coreid bugs damage branches and fruit of their hosts (Ding et al. 2004; Haldhar 2012; Kaur & Bansal 2012). *Ziziphus jujuba* was listed as a host (Hua 2000). Fruit damaged by nymphs and adults become 'cat faced' (Mizell 2008) and are unlikely to be picked during harvest, or are likely to be removed during the sorting and packing processes. | Assessment not required | Assessment not required | No |
| *Kerria lacca* (Kerr, 1782)<br>[Kerriidae]<br>Lac insect | Yes (Hua 2000) | No records found | No. These Lac insects usually feed on the branches of trees (preferring young branches) and they also produce a resin which is known as 'lac resin' or 'gum lacca' (Raman 2014). *Ziziphus jujuba* was listed as a host (Raman 2014). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Kerria yunnanensis* (Ou & Hong 1990) | Yes (Chen et al. 2011; Hua 2000) | No records found | No. These Lac insects usually feed on the young shoots of their hosts and | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
| --- | --- | --- | --- | --- | --- | --- |
| Synonym: *Kerria chinensis* (Chen et al. 1992, 1998) [Kerriidae] Lac insect | | | produce a resin which is known as 'lac resin' or 'gum lacca' (Balikai, Kotikal & Prasanna 2013; Raman 2014). *Ziziphus jujuba* was listed as a host (Balikai, Kotikal & Prasanna 2013). No report of an association with mature fresh Chinese jujube fruit was found. | | | |
| *Ledra auditura* Walker, 1858 [Cicadellidae] Auricled leafhopper | Yes (Yang 1965) | No records found | No. *Ledra auditura* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Leafhoppers usually feed on leaves of host plants (Yang 1965) and are unlikely to remain on the fruit when disturbed during harvesting and packing processes. | Assessment not required | Assessment not required | No |
| *Lepidosaphes ulmi* (Linneaus, 1758) [Diaspididae] Oystershell scale | Yes (AQSIQ 2017; CABI 2019a; García Morales et al. 2019) | Yes. NSW, Qld, SA, Tas., Vic., WA (CSIRO 2005; Plant Health Australia 2017). | Assessment not required | Assessment not required | Assessment not required | No |
| *Leptocorisa varicornis* (Fabricius, 1803) [Alydidae] Rice bug; Stink bug | Yes (Hua 2000) | No records found | No. Rice bugs feed on plant tissue, grains and fruit sap of their hosts (Serrano, Mizell & Byron 2017). Adults and nymphs are highly mobile and would be likely to fall | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | from the fruit during harvesting. Fruit damaged by nymphs and adults become distorted (Mizell 2008) and are likely to be removed during the harvesting and packing process. *Ziziphus jujuba* was listed as a host (Hua 2000). No report of an association with mature fresh Chinese jujube fruit was found. | | | |
| *Lygus pratensis*<br>[Miridae]<br>Mirid bug | Yes (Lu & Wu 2011; Lu et al. 2010b; Wan et al. 2006) | No records found | No. Nymphs and adults feed on buds, young leaves and flower buds of *Z. jujuba* (Shen et al. 1992). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Maconellicoccus hirsutus* (Green, 1908)<br>Synonym: *Phenacoccus hirsutus* Green, 1908<br>[Pseudococcidae]<br>Pink mealybug; Hibiscus mealybug | Yes (CABI 2019b) | Yes. NT, Qld, SA, WA (CABI 2019b) | Assessment not required | Assessment not required | Assessment not required | No |
| *Megacopta cribraria* (Fabricius 1798) | Yes (AQSIQ 2017) | No records found | No. It usually attacks stems, branches, buds, and leaves of *Ziziphus jujuba* (AQSIQ 2017). No | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| [Plataspidae]<br>Kudzu bug | | | report of an association with mature fresh Chinese jujube fruit was found. | | | |
| *Megalocryptes buteae* (Takahashi, 1942)<br>[Coccidae]<br>Soft scale | Yes (Hua 2000) | No records found | No. It has been reported to attack stems and branches of mango and bamboo plants (Kondo, Williams & Gullan 2005; Sugonyaev 2006). *Ziziphus jujuba* was listed as a host (Hua 2000). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Nipaecoccus viridis* (Newstead, 1894)<br>[Pseudococcidae]<br>Spherical mealybug; Lebbeck mealybug | Yes (Azam-Ali et al. 2006; García Morales et al. 2019) | Yes. NT, Qld and WA (CABI 2019b; Government of Western Australia 2017) | Assessment not required | Assessment not required | Assessment not required | No |
| *Parlatoreopsis chinensis* (Marlatt, 1908)<br>Synonym: *Parlatoria chinensis* Sasscer, 1919<br>[Diaspididae]<br>Chinese obscure scale | Yes (AQSIQ 2017; García Morales et al. 2019; Miller & Davidson 2005) | No records found | Yes. It attacks stems, branches, buds, leaves and fruits (including stalks) of Chinese jujubes (AQSIQ 2017). | Yes. It is highly polyphagous and has been recorded on at least 42 genera from 21 families including *Pistacia*, *Nerium*, *Acacia oshanesii*, *Albizia*, *Juglans*, *Ziziphus*, *Hibiscus*, *Ficus*, *Malus*, *Prunus*, *Pyrus*, *Rosa*, *Olea*, *Populus*, and *Salix* (García Morales et al. 2019; Miller & Davidson 2005). Some of these hosts are available in Australia (AVH 2014). Its current distribution | Yes. It is a significant pest of apple and is a pest of quarantine concern for Russia (Konstantinova 1976). It is a serious pest in China (Miller & Davidson 2005). It causes economic damage to Chinese jujubes by attacking stems, branches, buds, leaves and fruits (AQSIQ 2017). | Yes |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
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| | | | | includes China, Japan, Iran, Egypt, India, Philippines, Taiwan and USA (California, Florida and Missouri)(García Morales et al. 2019). These regions have environments and climates similar to those found in some parts of Australia. | | |
| *Parlatoria oleae* (Clovée, 1880)<br>[Diaspididae]<br>Olive parlatoria scale; Olive scale | Yes (AQSIQ 2017; Chen 2003; Li, Wang & Waterhouse 1997; Yang et al. 2008) | Yes. NSW, Qld, WA (CSIRO 2005; Taylor & Burt 2007) | Assessment not required | Assessment not required | Assessment not required | No |
| *Parlatoria ziziphi* (Lucas, 1853)<br>[Diaspididae]<br>Parlatoria scale | Yes (Hua 2000) | No records found | No. It is a primary pest of citrus, where it attacks on leaf, twig, branch and fruit (Jendoubi 2011). *Parlatoria ziziphi* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Blackburn and Miller (1984) stated that many of the records reported in the literature on hosts other than in the family Rutaceae are most likely erroneous. No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Parthenolecanium corni* (Bouche, 1844) | Yes (Hua 2000) | Yes. NSW, Vic., Tas. (CSIRO 2005). | No. *Ziziphus jujuba* was listed as a host of *P. corni* (Hua 2000). However, no | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| [Coccidae]<br>European fruit lecanium; Plum scale | | Listed as a Declared Organism (Prohibited – section 12 (C1 Prohibited)) for WA (Government of Western Australia 2017). | sufficient evidence found to support the association of this pest with Chinese jujube production in China. In addition, if this pest did feed on fruit, the infested fruits are likely to be discarded during picking and packinghouse processes as jujube fruit has smooth skin and shallow stem end, and each fruit is individually screened at the packinghouse. Therefore, it is unlikely to be associated with commercially grown and packed jujube fruit pathway. | | | |
| *Pinnaspis strachani* (Cooley, 1899)<br>[Diaspididae]<br>Hibiscus snow scale | Yes (AQSIQ 2017; CABI 2019a; García Morales et al. 2019) | Yes. NSW, NT, Qld, WA (Plant Health Australia 2017). | Assessment not required | Assessment not required | Assessment not required | No |
| *Planococcus citri* (Risso, 1813)<br>[Pseudococcidae]<br>Citrus mealybug | Yes (AQSIQ 2017; Li, Wang & Waterhouse 1997) | Yes. All states and territories (Plant Health Australia 2017). | Assessment not required | Assessment not required | Assessment not required | No |
| *Pseudococcus comstocki* (Kuwana, 1902)<br>[Pseudococccidae] | Yes (AQSIQ 2005; CIQSA 2001a, b) | No records found | No. *Pseudococcus comstocki* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). This | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | mealybug species can damage fruit of host plants by spotting and producing a change in the fruit skin texture (Kim et al. 1988; Wan et al. 2006). No report of an association with Chinese jujube production in China was found. | | | |
| *Pseudococcus cryptus* Hempel, 1918<br>*Pseudococcus citriculus* Green, 1922<br>[Pseudococcidae]<br>Citriculus mealybug; Cryptic mealybug | Yes (Hua 2000) | Yes. Qld (QDAF 2012).<br>Listed as a Declared Organism (Prohibited – section 12 (C1 Prohibited)) for WA (Government of Western Australia 2017). | No. It may feed on all parts of the tree (roots, stems, branches, buds, leaves, and fruits) of citrus (Blumberg, Ben-Dov & Mendel 1999; QDAF 2012). However, it is usually associated with leaves and twigs (Blumberg, Ben-Dov & Mendel 1999). *Ziziphus jujuba* was listed as a host (Hua 2000). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Rubiconia intermedia* (Wolff, 1811)<br>[Pentatomidae]<br>True bug; Stink bug | Yes (Hua 2000) | No records found | No. Usually stink bugs feed on plant tissue, grain and fruit sap (Tochigi 2000). *Ziziphus jujuba* was listed as a host (Hua 2000). No report of an association with mature | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | fresh Chinese jujube fruit was found. | | | |
| *Stephanitis nashi* Easki & Takeya, 1931<br>[Tingidae]<br>Pear lace bug | Yes (AQSIQ 2017; Hua 2000) | No records found | No. It usually feeds on leaves of *Z. jujuba* (AQSIQ 2017). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Typhlocyba* spp.<br>[Cicadellidae]<br>Leaf hopper | Yes (Chen et al. 1984a; NHB 2009; Yao 2013; Zhifure 2017) | Uncertain as not identified to species level.<br>Some *Typhlocyba* species are vectors of *Candidatus Phytoplasma ziziphi* (Chen et al. 1984a; Yao 2013; Zhifure 2017) which is a quarantine pest for Australia. | No. The nymphs and adults suck sap from the underside of leaves (NHB 2009). This pest is unlikely to remain on fruit when disturbed during harvesting. Therefore, it is unlikely to be on the fruit pathway. | Assessment not required | Assessment not required | No |
| *Yemma signatus* (Hsiao, 1974)<br>[Berytidae]<br>Berytid bug | Yes (Hua 2000) | No records found | No. Berytid bugs usually feed on young buds, leaves and stems (Yang 1982). *Ziziphus jujuba* was listed as a host (Hua 2000). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
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| **Lepidoptera** | | | | | | |
| *Achaea janata* (Linnaeus, 1758)<br>Synonym: *Achaea melicertella* Gaede, 1938; *Phalaena melicerta* Drury, 1773<br>[Noctuidae]<br>Jujube looper/castor oil looper | Yes (Hua 1981; USDA-APHIS 2016) | Yes. All states and territories (CSIRO 2005) | Assessment not required | Assessment not required | Assessment not required | No |
| *Ancylis sativa* Liu, 1979<br>[Tortricidae]<br>Jujube leaf roller | Yes (AQSIQ 2017) | No records found | No. It feeds on stems, branches, buds, leaves, and fruits of *Z. jujuba* (AQSIQ 2017). Foliage is often rolled or webbed against the fruit and fruitlets, which may then also be attacked (Nizamani et al. 2016). Leaf roller larvae feed on the surface of maturing fruit, which causes considerable visible damage, rendering fruit blemished and unmarketable. Therefore, during picking, grading and packing damaged fruits are likely to be removed. | Assessment not required | Assessment not required | No |
| *Carposina sasakii* Matsumura, 1900 | Yes (AQSIQ 2006c, 2017) | No records found | Yes. Eggs are laid on the fruit near the calyx and stalk end. After hatching, the young larvae bore | Yes. This species feeds on a wide range of cultivated fruit trees, such as apple, pear, jujube and stone fruit. This | Yes. *Carposina sasakii* is a very serious pest of fruit crops, causing up to 100 per cent crop loss in apple | Yes (EP) |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| Synonym: *Carposina niponensis* Walsingham, 1900<br>[Carposinidae]<br>Peach fruit borer | | | into the fruit and feed on pulp within the fruit of its host plants including *Ziziphus* spp. (AQSIQ 2017; Dhileepan 2017). | pest is capable of spreading independently as the adult moths can fly long distances (CABI 2019a). *Carposina sasakii* is known to have established and spread outside its native range in areas where it has been introduced. In Russia, internal quarantine measures are employed in an attempt to control the spread of *C. sasakii* (CABI 2019a). *C. sasakii* is found throughout many areas of China as well as Japan, Korea and Russia (CABI 2019a). The pest's host range, current distribution and demonstrated ability to spread in new areas suggest that it could establish and spread in Australia. | and pear orchards (CABI 2019a; Gibanov & Sanin 1971; Sytenko 1960). It causes significant economic consequences in its current range and would potentially do so in Australia. Consequences would include crop losses as well as quarantine restrictions on trade, both within Australia and internationally to areas where *C. sasakii* is not present. | |
| *Chalioides kondonis* Kondo, 1922<br>[Psychidae] | Yes (Hua 2005) | No records found | No. *Chalioides kondonis* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Larvae of *C. kondonis* usually feed on leaves (Deng et al. 2012). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Chihuo sunzao* Yang, 1978<br>[Geometridae] | Yes (Hua 2005) | No records found | No. Larvae of *C. sunzao* feed on leaves and flower buds of *Ziziphus* spp. | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | (Shen et al. 1992). No report of an association with mature fresh Chinese jujube fruit was found. | | | |
| *Chihuo zao* Yang, 1978<br>[Geometridae] | Yes (Hua 2005) | No records found | No. Larvae of *C. zao* feed on leaves and flower buds of *Z. jujuba* (Shen et al. 1992). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Clania minuscula* Butler, 1912<br>Synonym: *Eumeta minuscula* (Butler 1881)<br>[Psychidae]<br>Bagworm | Yes (Hua 2005) | No records found | No. *Clania minuscula* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Larvae of *C. minuscula* are leaf feeders (Xie et al. 1994). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Cnidocampa flavescens* (Walker, 1855)<br>[Limacodidae]<br>Oriental pear moth | Yes (AQSIQ 2017) | No records found | No. Larvae feed on leaves of *Z. jujuba* (AQSIQ 2017). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Cricula trifenestrata* (Helfer) 1837<br>[Saturniidae]<br>Cricula silk moth | Yes (AQSIQ 2017) | No records found | No. Larvae feed on leaves of *Z. jujuba* (AQSIQ 2017; USDA-APHIS 2016). No report of an association with mature fresh | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | Chinese jujube fruit was found. | | | |
| *Dasychira mendosa* (Hübner, 1934)<br>[Lymantriidae]<br>Hairy caterpillar; Brown tussock moth | Yes (Li, Wang & Waterhouse 1997) | Yes. NT, Qld (Plant Health Australia 2017). Listed as a Declared Organism (Prohibited – section 12 (C1 Prohibited)) for WA (Government of Western Australia 2017) | No. Larvae feed on leaves and fruits of *Ziziphus* spp. (Azam-Ali et al. 2006; Balikai 2009). Larvae feed on fruits superficially and are very colourful. During picking, grading and processing, the damaged fruits and larvae are likely to be removed. | Assessment not required | Assessment not required | No |
| *Euproctis xanthocampa* (Dyar, 1905)<br>[Lymantriidae] | Yes (Hua 2005) | No records found | No. Lymantrid larvae usually feed on leaves and fruits of *Ziziphus* spp. (Azam-Ali et al. 2006; Balikai 2009). Larvae feed on fruits superficially and are very colourful. During picking, grading and processing, the damaged fruits and larvae are likely to be removed. | Assessment not required | Assessment not required | No |
| *Europhera batanyensis* Caradja, 1993<br>Synonym: *Euzophera batangensis* Caradja, 1993<br>[Pyralidae]<br>Persimmon bark borer moth | Yes (Kim et al. 2016; Wang et al. 1993) | No records found | No. Larvae feed on bark of jujube trees (Wang et al. 1993). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| *Grapholita molesta* (Busck, 1916)<br>[Tortricidae]<br>Oriental fruit moth; Oriental peach moth | Yes (AQSIQ 2005; Ciceoi et al. 2017; CIQSA 2001a; Yang et al. 2016) | Yes. ACT, NSW, Qld, SA, Tas., Vic. (CABI 2019a; Plant Health Australia 2017). This species is listed as a Declared Organism (Prohibited (section 12)) under the Western Australian Biosecurity and Agriculture Management Act 2007 (Government of Western Australia 2017). | No. An important pest of stone fruit and pome fruits (CABI 2019a; Ciceoi et al. 2017; Gilligan, Baixeras & Brown 2018; Rothschild & Vickers 1991; Yang et al. 2016). *Ziziphus jujuba* was cited as a host (Yang et al. 2016). However, no primary reference reporting an association with *Z. jujuba* was found. | Assessment not required | Assessment not required | No |
| *Latoia hilarata* (Staudinger, 1887)<br>Synonym: *Parasa hilarata*<br>[Limacodidae]<br>Stinging caterpillar | Yes (Hua 2005; Ma 2006) | No records found | No. *Latoia hilarata* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Larvae feed on leaves (Ma 2006). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Marumba goschkewitschii* (Bremer & Grey, 1852)<br>Includes three sub-species: *Marumba goschkewitschii carstanjeni* Staudinger, 1887; *Marumba goschkewitschii complacens* Walker, 1864; *Marumba goschkewitschii* | Yes (Hua 2005) | No records found | No. Listed as pests of *Ziziphus* spp. (Shen et al. 1992). Eggs of sphingids are laid singly on the underside of leaves of the larval food plant. The early instar larvae are also found on the undersurface of leaves, while the older larvae camouflage themselves on stems. When larvae are ready to pupate, they | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
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| *gaschkewitshi* (Bremer & Grey, 1852<br>[Sphingidae]<br>Peach horn worm | | | move down into the leaf litter, where they make a rough open cocoon or cell on the soil surface (Hill 2008). No report of an association with mature fresh Chinese jujube fruit was found. | | | |
| *Narosa edoensis* Kawada, 1930<br>[Limacodidae] | Yes (Hua 2005) | No records found | No. *Narosa edoensis* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Larvae feed on leaves (Ma 2006). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Orgyia postica* (Walker, 1855<br>[Lymantriidae]<br>Cocoa tussock moth; tussock moth | Yes (AQSIQ 2017) | No records found | No. Larvae of this species usually feed on leaves and the young shoots of *Z. jujuba* (AQSIQ 2017; Plantwise 2018). Mature larvae can chew on young fruit, making small holes and causing early fall of fruit (CAAS 1992; Hoare 2001; PHA 2015; Plantwise 2018). Larvae are very hairy and colourful (CAAS 1992; PHA 2015). Therefore, larvae and externally damaged fruit (Plantwise 2018) are likely to be removed during harvesting and the packinghouse procedures. | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| *Phlossa conjuncta* (Walker, 1855)<br>[Limacodidae] | Yes (Hua 2005) | No records found | No. *Phlossa conjuncta* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Larvae feed on leaves (Ma 2006). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Parasa consocia* Walker, 1865<br>[Limacodidae]<br>Green urticating caterpillar; green cochlid | Yes (CIQSA 2001b; Hua 2005) | No records found | No. *Parasa consocia* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). *Parasa consocia* is a leaf feeder (Wang et al. 2008). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Parasa hilarata* (Staudinger, 1887)<br>[Limacodidae]<br>Stinging caterpillar | Yes (Hua 2005; Ma 2006) | No records found | No. *Parasa hilarata* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Larvae feed on leaves (Ma 2006). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Parasa sinica* Moore, 1877<br>[Limacodidae] | Yes (AQSIQ 2005; CIQSA 2001a; Hua 2005) | No records found | No. *Parasa sinica* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Larvae feed on leaves (Ma 2006). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| *Scopelodes venosa* Walker, 1855<br>[Limacodidae] | Yes (Hua 2005) | No records found | No. *Scopelodes venosa* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Larvae feed on leaves (Ma 2006). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Scopelodes venosa kwangtungensis* Hering 1933<br>[Limacodidae] | Yes (Hua 2005) | No records found | No. *Scopelodes venosa* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Larvae feed on leaves (Ma 2006). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Sucra jujuba* Chu, 1979<br>[Geometridae] | Yes (AQSIQ 2017) | No records found | No. Larvae of *S. jujuba* usually feed on leaves and flowers of *Z. jujuba* (AQSIQ 2017; Balikai, Kotikal & Prasanna 2013; USDA-APHIS 2016). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Thosea sinensis* (Walker, 1855)<br>[Limacodidae]<br>Coconut cup moth; nettle grub | Yes (CIQSA 2001b) | No records found | No. *Thosea sinensis* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). This species feeds on leaves of host plants (Yu et al. 2010). No report of an association with | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | mature fresh Chinese jujube fruit was found. | | | |
| *Yinchie zaohui* Yang, 1978<br>[Geometridae] | Yes (Hua 2005) | No records found | No. *Yinchie zaohui* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Larvae of geometrid usually feed on leaves and flowers of host plants (USDA-APHIS 2016). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | No | No |
| *Zamacra excavata* Dyra, 1905<br>[Geometridae] | Yes (Dong 1994) | No records found | No. *Zamacra excavata* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Larvae of geometrid usually feed on leaves and flowers of host plant (USDA-APHIS 2016). No report of an association with mature fresh Chinese jujube fruit was found. | Assessment not required | No | No |
| **Orthoptera** | | | | | | |
| *Calyptotrypus hibinonis* (Matsumura, 1928)<br>Synonym: *Madasumma hibinonis* Matsumura<br>Larger green bush cricket | Yes (Hua 2000) | No records found | No. *Calyptotrypus hibinonis* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Crickets usually feed on leaves but sometimes may chew on the surface | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | of fruit (Wan et al. 2006). Crickets are highly active and is unlikely to remain on fruit when disturbed during harvesting. Any damaged fruits are likely to be removed during picking and packing processes. | | | |
| *Atractomorpha ambigua* Bolivar, 1905<br>[Pyrgomorphidae]<br>Grasshoppers | Yes (Hua 2000) | No records found | No. *Atractomorpha ambigua* was listed as a pest of *Ziziphus* spp. (Shen et al. 1992). Grasshoppers usually feed on leaf but sometimes may chew on the surface of fruit (Wan et al. 2006). Grasshoppers are highly active and are unlikely to remain on fruit when disturbed during harvesting. | Assessment not required | Assessment not required | No |
| **Thysanoptera** | | | | | | |
| *Scirtothrips dorsalis* Hood, 1919<br>[Thripidae]<br>Chilli thrips, flower thrips, Yellow tea thrips | Yes (CABI & EPPO 2010) | Yes. NSW, NT, Qld (Plant Health Australia 2018) and WA (Poole 2010). It is not a regulated pest in Tasmania (DPIPWE Tasmania 2016). | Yes. It was reported on *Ziziphus* spp. (Azam-Ali et al. 2006; Balikai, Kotikal & Prasanna 2013; Nizamani et al. 2015; Venette & Davis 2004). It usually feeds on flowers and leaves of host plants. *Scirtothrips* spp. thrips are routinely intercepted on horticultural products at the Australian border | Yes. Assessed in the thrips group PRA (Australian Government Department of Agriculture and Water Resources 2017) | Yes. Assessed in the thrips group PRA (Australian Government Department of Agriculture and Water Resources 2017) | Thrips group PRA applied (Australian Government Department of Agriculture and Water Resources 2017) |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | (Australian Government Department of Agriculture and Water Resources 2017). | | | |
| **BACTERIA** | | | | | | |
| *Burkholderia cepacia* (ex Burkholder) Yabuuchi et al. 1993<br>Synonym: *Pseudomonas cepacia* (ex Burkholder 1950) Palleroni & Holmes, 1981)<br>[Burkholderiaceae Burkholderiales]<br>Sour skin of onion | Yes (AQSIQ 2017) | Yes. NSW (Cother & Dowling 1985). | Assessment not required | Assessment not required | Assessment not required | No |
| *Erwinia jujubovora* Wang Cai Feng et Gao<br>[Enterobacteriaceae: Enterobacteriales]<br>Fruit shrink disease | Yes (Wei & Wei 2006; Zhang et al. 2008) | No record found | No. *Erwinia jujubovora* associates with jujube fruits (Liu 1989; Ren & Zhang 2001; Wei & Wei 2006). Infection occurs via wounds on the fruit or via lenticels. The symptoms start to develop in 3 days after infection and the infected fruits shrink and drop prematurely when infection occurs at early fruit developing stages (Liu 1989; Ren & Zhang 2001; Wei & Wei 2006; Zhang et al. 2008). Infection may occur at the maturing stage, the skin | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | of the infected fruits turn red early and then develop into purple-red. The pulp of the infected fruit turns black and soft rot. The infected fruits normally drop off before reaching maturity (Zhang et al. 2008). If the infected fruits remain on the tress at harvest, they are likely to be discarded during harvesting, sorting and packing processes due to visible symptoms (Liu 1989; Ren & Zhang 2001; Wei & Wei 2006) as each fruit is individually screened at the packinghouse. Therefore, it is unlikely to be associated with the commercially grown and packed jujube fruit pathway. | | | |
| *Rhizobium radiobacter* (Beijerinck & van Delden 1902) Young et al. 2001<br>Synonym: *Agrobacterium tumefaciens* (E.F. Smith & Townsend) Conn (1907); *Agrobacterium radiobacter* (Beijerinck & van Delden (1902) Conn (1942)) | Yes (AQSIQ 2017) | Yes. All states and territories (Cook & Dubé 1989; Plant Health Australia 2018; Shivas 1989) | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| [Rhizobiales: Rhizobiaceae]<br>Crown gall | | | | | | |
| *Xanthomonas arboricola* Vauterin et al. 1995<br>[Xanthomonadales: Xanthomonadaceae]<br>Bacterial leaf spot | Yes (Qi et al. 2012) | Yes. All states and territories (Plant Health Australia 2018) | Assessment not required | Assessment not required | Assessment not required | No |
| *Xanthomonas campestris pv. campestris* (Pammel 1895) Dowson 1939<br>Synonym: *Xanthomonas campestris* (Pammel 1895) Dowson 1939<br>[Xanthomonadales: Xanthomonadaceae]<br>Bacterial leaf spot | Yes (Liu et al. 2006) | Yes. All states and territories (Plant Health Australia 2018). Listed as a permitted species for WA (Government of Western Australia 2017) | Assessment not required | Assessment not required | Assessment not required | No |
| **PHYTOPLASMA** | | | | | | |
| *Candidatus* Phytoplasma ziziphi (Jung et al. 2003)<br>[Acholeplasmatales: Acholeplasmataceae]<br>Jujube witches'- broom<br>JWB | Yes (AQSIQ 2017; Wang et al. 2015b) | No records found | No. *Ca.* Phytoplasma ziziphi (JWB) infected *Z. jujuba* plants exhibit a variety of symptoms, such as small leaves, yellowing, witches'-broom, phyllody, stunting, abnormal and sterile flowering (Gengzhongbang 2018; Khan, Raj & Snehi 2008; Shao et al. 2016). In China, normal orchard management measure for | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | JWB is removal of infected branches or trees. Healthy branches of infected trees can still set fruit. However, the fruits are of abnormal, with bumpy and discoloured skin (Zhifure 2017). These infected fruits are likely to be removed during harvesting and packing procedures as each fruit is individually screened at the packinghouse. JWB is not seed transmissible in Chinese jujubes (Chen et al. 1984a; Liu, Zhao & Zhou 2010) and seed transmission of phytoplasma strains related to JWB has not been reported on any plant species (Bertelli et al. 2002; Li et al. 2014a). Therefore, JWB is unlikely to be associated with the commercially grown and packed jujube fruit pathway. | | | |
| **CHROMALVEOLATA** | | | | | | |
| *Phytophthora citricola* Sawada [Peronosporales: Peronosporaceae] | Yes (Tai 1979) | Yes. NSW, SA, Vic., WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| Fruit Rot | | | | | | |
| *Phytophthora nicotianae* Breda de Haan<br>[Peronosporales: Peronosporaceae]<br>Fruit Rot | Yes (Tai 1979) | Yes. NSW, NT, Qld, SA, Vic., WA (Barber et al. 2013; Plant Health Australia 2018) | Assessment not required. | Assessment not required | Assessment not required | No |
| *Phytophthora palmivora* (E. J. Butler) E. J. Butler<br>[Peronosporales: Peronosporaceae]<br>Fruit rot; Phytophthora leaf blight | Yes (AQSIQ 2017; Tai 1979) | Yes. NSW, Qld, SA, Vic., WA (Barber et al. 2013; Plant Health Australia 2018). Listed as a Declared Organism (Prohibited – section 12 (C1 Prohibited)) for WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2017). Although *Phytophthora palmivora* is a Declared Organism in WA, specific measures are not required for this pathogen for the movement of fresh jujube fruit or other fruit commodities into WA from other Australian states/territories where *P. palmivora* is | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
| --- | --- | --- | --- | --- | --- | --- |
| | | present. Routine visual inspection is not adequate measure to detect *P. palmivora* in fresh jujube fruit pathway. | | | | |
| *Pythium aphanidermatum* (Edson) Fitzp.<br>[Peronosporales: Peronosporaceae] | Yes (Tai 1979; Zhuang 2005) | Yes. NSW, NT, Qld, WA (Plant Health Australia 2018; Shivas 1989; Simmonds 1966) | Assessment not required | Assessment not required | Assessment not required | No |
| **FUNGI** | | | | | | |
| *Albonectria rigidiuscula* (Berk. & Broome) Rossman & Samuels<br>Anamorph: *Fusarium decemcellulare* Brick; *Fusarium rigidiusculum* W.C. Snyder & H.N. Hansen<br>Teleomorph: *Nectria rigidiuscula* Berk. & Broome; *Fusarium decemcellulare* C. Brick; *Calonectria rigidiuscula* (Berk. & Broome) Sacc.; *Calonectria lichenigena* Speg.; *Calonectria eburnea* Rehm; *Calonectria sulcata* Starbäck; *Calonectria tetraspora* (Seaver) Sacc. & Trotter | Yes (Wang et al. 2015c) | Yes. NSW, Qld (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| [Hypocreales: Nectriaceae]<br><br>Nectria canker, Dry rot | | | | | | |
| *Alternaria alternata* (Fr.) Keissl.<br><br>[Pleosporales: Pleosporaceae]<br><br>Alternaria leaf blight, 'Tiepi' fruit disease, Fruit shrink disease | Yes (AQSIQ 2017; Zhuang 2005) | Yes. All states and territories (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Alternaria tenuissima* (Kunze) Wiltshire [Pleosporales: Pleosporaceae] | Yes (Zhuang 2001, 2005) | Yes. All states and territories (Plant Health Australia 2018) | Assessment not required | Assessment not requierd | Assessment not requiered | No |
| *Armillaria tabescens* (Scop.) Emel<br><br>[Agaricales: Physalacriaceae]<br><br>Ringless Honey Fungus | Yes (AQSIQ 2017) | Yes. Qld (Plant Health Australia 2018). Listed as a Declared Organism (Prohibited – section 12 (C1 Prohibited)) for WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2017). Although *Armillaria tabescens* is a Declared Organism in WA, specific measures are not required for this pathogen for the movement of fresh | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | jujube fruit or other fruit commodities into WA from other Australian states/territories where the *A. tabescens* is present. Routine visual inspection is not adequate measure to detect this pathogen if it is associated with fresh jujube fruit pathway. | | | | |
| *Ascochyta ziziphi* Pat.<br>[Pleosporales: Didymellaceae] | Yes (Tai 1979) | No records found | No. *Ascochyta* spp. usually cause leaf spot on their hosts (Mirzaee 2014). *Ziziphus jujuba* was listed as a host (Tai 1979). No report of an association with fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Aspergillus flavus* Link<br>[Eurotiales: Aspergillaceae] | Yes (Zhang et al. 2017a) | Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Aspergillus niger* V. Tiegh<br>[Eurotiales: Aspergillaceae] | Yes (AQSIQ 2017; Tai 1979) | Yes. ACT, NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| *Aspergillus parasiticus* Speare<br><br>[Eurotiales: Aspergillaceae] | Yes (Zhang et al. 2017a) | Yes. Qld (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Aspergillus versicolor* (Vuill.) Tirab.<br><br>[Eurotiales: Aspergillaceae] | Yes (Tai 1979) | Yes. NSW (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Athelia rolfsii* (Curzi) C.C.Tu & Kimbr.<br><br>Basionym: *Corticium rolfsii* Curzi<br><br>Synonym: *Pellicularia rolfsii* (Sacc.) Wast.<br><br>[Atheliales: Atheliaceae]<br><br>Sclerotium rot | Yes (Tai 1979) | Yes. NSW, NT, Qld, SA, Vic., WA, (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Botryosphaeria dothidea* (Moug.) Ces. & De Not.<br><br>Synonym: *Fusicoccum aesculi* Corda Grossenb & Dugger<br><br>[Botryosphaeriales: Botryosphaeriaceae] | Yes (AQSIQ 2006a, 2017) | Yes. NSW, Qld, Vic., WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| Ring spot of jujube; Thick rotten disease of jinsixiazao | | | | | | |
| *Botryosphaeria kuwatsukai* (Hara) G.Y. Sun & E. Tanaka 2015<br><br>Synonym: *Macrophoma kuwatsukai* Hara; *Botryosphaeria berengeriana* f. sp. *pyricola* (Nose) Kogan. & Sakuma; *Physalospora pyricola* Nose; *Guignardia pyricola* (Nose) W. Yamam.<br><br>[Botryosphaeriales: Botryosphaeriaceae]<br><br>Ring grain disease | Yes (Zhao & Kang 2013) | No records found | No. *Botryosphaeria kuwatsukai* has previously been classified as a synonym/anamorph of *Botryosphaeria dothidea*. Recently, *B. kuwatsukai* has been assigned to a new taxon (Wang et al. 2018a; Xu et al. 2014). It is well known that *Botryosphaeria kuwatsukai* has a very narrow host range, currently limited to apples and pears (CABI 2019a; Jeger et al. 2017; Wang et al. 2018a; Xu et al. 2014; Zhuang 2005) . Some Chinese literature reported *B. kuwatsukai* causing ring grain disease on *Ziziphus jujuba* (Ji et al. 2005; Yao, Zhang & Wu 2013). However these reports are not supported by recent taxonomic identification (Wang et al. 2018a; Xu et al. 2014) and it is anticipated that *B. kuwatsukai* (and *M. kuwatsukai*) on Chinese jujubes reported in the Chinese literature is a misidentification of | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | taxonomy or identified as *B. dothidea.* | | | |
| *Botrytis cinerea* Pers.<br>[Helotiales: Sclerotiniaceae]<br>Grey mould, Bud rot | Yes (Tai 1979) | Yes. NSW, Qld, SA, Vic., WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Ceratocystis adiposa* (E.J. Butler) C. Moreau<br>Synonym: *Sphaeronaema adiposum* E.J. Butler; *Ceratostomella adiposa* (E.J. Butler) Sartoris; *Endoconidiophora adiposa* (E.J. Butler) R.W. Davidson 1935; *Ophiostoma adiposum* (E.J. Butler) Nannf. 1934; *Ceratostomella major* J.F.H. Beyma 1935<br>[Microascales: Ceratocystidaceae]<br>Black rot | Yes (Tai 1979) | No records found | No. Associated with roots causing black rot (Farr & Rossman 2018). No report of an association with fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Ceratocystis fimbriata* Ellis & Halst.<br>[Microascales: Ceratocystidaceae]<br>Ceratocystis canker; jujube fruit rot | Yes (Han et al. 2015) | No. *Ceratocystis fimbriata* has several apparently host-specialised strains known as 'types', 'races', or forms (Baker et al. 2003; Harrington 2000; Vogelzang & Scott | No. There is a single report of *Ceratocystis fimbriata* causing *Z. jujuba* fruit rot (Han et al. 2015). *Ceratocystis fimbriata* has been isolated from rotten *Z. jujuba* fruit collected from a stall in a farmers' | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | 1990). *Ceratocystis fimbriata* isolates reported in Australia are all from *Syngonium* and are not known to be pathogenic to *Ziziphus* spp. (Plant Health Australia 2018; Vogelzang & Scott 1990). | market in Yunnan province in China, which is more than 1,500 kilometres away from the major Chinese jujube production areas. In a laboratory pathogenicity test, a fungal spore suspension injected into fresh jujube fruit produced typical symptoms in 10-12 days under room temperature. The obvious symptoms included rotten and partly sunken reddish brown fruit flesh (Han et al. 2015). Therefore, diseased fruits are unlikely to be harvested, or are likely to be removed during the sorting and packing processes. | | | |
| *Ceratocystis paradoxa* (Dade) C. Moreau<br>Synonym: *Thielaviopsis paradoxa* (De Seynes) Höhn.<br>[Microascales: Ceratocystidaceae] | Yes (Tai 1979) | Yes. NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Cercospora ziziphigena* Li Xu & Y.L. Guo | Yes (Phengsintham et al. 2012; Xu & Guo 2003) | No records found | No. Infects leaves of *Ziziphus* spp. (Phengsintham et al. 2012). No report of an | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| [Capnodiales: Mycosphaerellaceae] | | | association with fresh Chinese jujube fruit was found. | | | |
| *Cladosporium herbarum* (Pers.) Link<br>[Capnodiales: Cladosporiaceae] | Yes (Tai 1979) | Yes. NSW, Qld, SA, Tas., Vic., WA (Barkat et al. 2016; Plant Health Australia 2018) | Assessment not required | Assessment not required | Assessment not required | No |
| *Cladosporium oxysporum* Berk. & M.A. Curtis<br>[Capnodiales: Cladosporiaceae] | Yes (Zhuang 2001) | Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Cladosporium sphaerospermum* Penz.<br>[Capnodiales: Cladosporiaceae] | Yes (Zhuang 2001, 2005) | Yes. NSW, SA, WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Cladosporium tenuissimum* Cooke<br>[Capnodiales: Cladosporiaceae] | Yes (AQSIQ 2017) | Yes. NSW, Qld, WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Cladosporium ziziphi* P. Karst. & Roum.<br>[Capnodiales: Cladosporiaceae] | Yes (Zhang 2000) | No records found | No. Associated with leaves, causing leaf spot (Farr & Rossman 2018; Misra et al. 2013). *Ziziphus jujuba* was listed as a host (Zhang 2000). No report of an association with fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc. 1884<br>Synonym: *Glomerella cingulata* (Stoneman) Spauldi. & H. Schrenk<br>[Glomerellales: Glomerellaceae] | Yes (Zhuang 2005) | Yes. Present in all states and territories (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Coniothyrium olivaceum* Bonord.<br>[Pleosporales: Coniothyriaceae]<br>Fruit shrink disease | Yes (Tai 1979) | Yes. NSW, Qld, SA, Vic., WA (Plant Health Australia 2018). Listed as a permitted species for WA (Government of Western Australia 2017). | Assessment not required | Assessment not required | Assessment not required | No |
| *Curvularia lunata* (Wakker) Boedijn 1933<br>[Pleosporales: Pleosporaceae] | Yes (Zhang et al. 2017c) | Yes. NSW, Qld, Vic., WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Diplodia seriata* DeNot<br>[Botryosphaeriales: Botryosphaeriaceae] | Yes (Zhang et al. 2017b) | Yes. NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2018) | Assessment not required | Assessment not required | Assessment not required | No |
| *Dothiorella gregaria* Sacc. 1881<br>[Botryosphaeriales Botryosphaeriaceae]<br>*Dothiorella* canker, fruit shrink disease | Yes (Zhuang 2005) | No. The record of *D. gregaria* in Queensland (Simmonds 1966) is unreliable. | No. *Dothiorella gregaria* has been reported as one of the pathogens in the group associated with jujube fruit shrink disease in China (Li et al. 2005; Wu, Li & Gao 2012; Zhang et al. 2008). *Alaternaria* | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | *alternata* and *Erwinia jujubovora* are the major pathogens causing jujube fruit shrink disease (Wei & Wei 2006; Zhang et al. 2011a; Zhang et al. 2008). *Dothiorella gregaria* is considered a minor pathogen for Chinese jujube. It is an important pest of *Populus* spp. causing poplar *Dothiorella* canker in China (Jiang et al. 2011; Song, Wang & Zhao 2009; Zhang et al. 2008; Zhuang 2005). The symptoms of jujube fruit shrink disease start to develop in 3 days after infection and the infected fruits shrink and drop prematurely when infection occurs at the early fruit developing stages (Liu 1989; Ren & Zhang 2001; Wei & Wei 2006; Zhang et al. 2008). Infection may occur at the maturing stage, the skin of the infected fruits turn red early and then develop into purple-red. The pulp of the infected fruit turns black and soft rot. The infected fruits normally drop off before reaching maturity (Zhang et al. 2008). If the infected fruits remain on the tress | | | |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
| --- | --- | --- | --- | --- | --- | --- |
| | | | at harvest, they are likely to be discarded during harvesting, sorting and packing processes due to visible symptoms (Liu 1989; Ren & Zhang 2001; Wei & Wei 2006) as each fruit is individually screened at the packinghouse. Therefore, pathogens associated with jujube fruit shrink disease, such as *D. gregaria* and *E. jujubovora* are unlikely to be associated with the commercially grown and packed fresh jujube fruit pathway. | | | |
| *Entypella zizyphi* Syd. & E.J. Butler<br>[Xylariales: Diatrypaceae] | Yes (Wang 2013) | No records found | No. *Entypella ziziphi* affects twigs and branches of *Z. jujuba* (Ahlawat & Nagarajan 2007; Hoque et al. 2016; Wang 2013). No report of an association with fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Epicoccum nigrum* Link<br>[Pleosporales: Didymellaceae] | Yes (Tai 1979) | Yes. NSW, Qld, Tas., Vic., WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Fusarium equiseti* **(**Corda) Sacc. | Yes (Lu et al. 2014; Tai 1979) | Yes. All states and territories (Plant | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| [Hypocreales: Nectriaceae] | | Health Australia 2018). | | | | |
| *Fusarium haematococcum* Nalim, Samuels & Geiser<br>Anamorph: *Fusarium eumartii* C.W.Carp.<br>Teleomorph: *Fusarium solani* (Mart.) Sacc.; *Haematonectria haematococca* (Berk. & Broome) Samuels & Rossman; *Nectria haematococca* Berk. & Broome<br>[Hypocreales: Nectriaceae] | Yes (Gai et al. 2012; Li et al. 2018) | Yes. Qld, NSW, Vic. (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Fusarium incarnatum* (Desm.) Sacc.<br>Synonym: *Fusarium semitectum* Berk. & Ravenel; *Fusarium pallidoroseum* Cooke<br>[Hypocreales: Nectriaceae] | Yes (Guo et al. 2016) | Yes. All states and territories (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Fusarium oxysporum* Schltdl.<br>[Hypocreales: Nectriaceae] | Yes (Tai 1979; Zhang et al. 2013) | Yes. All states and territories in Australia (Summerell et al. 2011). | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| *Fusarium proliferatum* (Matsush.) Nirenberg,<br>[Hypocreales: Nectriaceae] | Yes (Zhang et al. 2012) | Yes. All states and territories (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Hypoxylon hypomiltum* Mont.<br>[Xylariales: Xylariaceae] | Yes (Tang, Jeewon & Hyde 2009) | Yes. NSW (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Lasiodiplodia theobromae* (Pat.) Griffon & Maubl.<br>Synonym: *Botryosphaeria rhodina* (Berk. & M.A. Curtis) Arx; *Botryodiplodia theobromae* Pat.<br>[Botryosphaeriales: Botryosphaeriaceae]<br>Blister canker | Yes (Yan et al. 2011) | Yes. NSW, NT, Qld, SA, WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Macrophomina phaseolina* (Tassi) Goid.<br>Synonym: *Macrophoma phaseolina* Tassi ; *Tiarosporella phaseolina* (Tassi) Aa; *Sclerotium bataticola* Taubenh.; *Rhizoctonia bataticola* (Taubenh.) E.J. Butler<br>[Botryosphaeriales: Botryosphaeriaceae]<br>Charcoal rot | Yes (Tai 1979) | Yes. NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2018) | No. Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| *Neocapnodium tanakae* (Shirai & Hara) W. Yamam<br>Synonym: *Capnodium tanakae* Shirai & Hara, in Hara<br>[Chaetothyriales: Trichomeriaceae]<br>Sooty mould | Yes (Tai 1979) | No records found | Yes. Sooty mould fungi are found superficially on plant parts including fruit, growing on honey dew secretions of insects (Laemmlen, Flint & Clark 2011). There is lack of information on sooty mould caused by *N. tanakae*. *Ziziphus jujuba* was listed as a host (Tai 1979). | Yes. Fungus may present superficially on the fruit rind which may be discarded as waste, and spores and mycelial fragments are windborne (Vann 2018) | No. Sooty mould fungi are not parasitic and grow only superficially on plant surfaces (Laemmlen, Flint & Clark 2011; Nelson 2008). They only lessen the aesthetic value of plant parts occasionally, or when on leaves slightly lower the vigour of plants by blocking sunlight essential for photosynthesis (Laemmlen, Flint & Clark 2011; Nelson 2008). The impact of sooty mould species is likely be of little importance economically as the fungi do not obtain food from the crop plant, and mycelial growth is easily removed, leaving the plant surface undamaged (Nelson 2008; Plantwise 2017). | No |
| *Nigrospora oryzae* (Berk. & Broome) Petch<br>[Incertae sedis: Incertae sedis] | Yes (Tai 1979) | Yes. NSW, NT, SA, Vic., WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Nothophoma quercina* (Syd. & P. Syd.) Q. Chen & L. Cai<br>Synonym: *Cicinobolus quercinus* Syd. & P. Syd.; *Phoma fungicola* | Yes (Bai et al. 2016) | Yes. SA, Vic., WA (CCEPP 2018; Wright 2017). | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| Aveskamp, Gruyter & Verkley; *Ampelomyces quercinus* (Syd. & P. Syd.) Rudakov<br>[Pleosporales: Didymellaceae]<br>Shoot canker; brown spot of jujube | | | | | | |
| *Paraconiothyrium fuckelii* (Sacc.) Verkley & Gruyter<br>Synonym: *Coniothyrium fuckelii* Sacc.<br>[Pleosporales: Montagnulaceae] | Yes (Tai 1979) | Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Patellaria atrata* (Hedw.) Fr.<br>[Patellariales: Patellariaceae] | Yes (Tai 1979) | Yes. NSW (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Penicillium expansum* (Link) Thom<br>[Eurotiales: Trichocomaceae] | Yes (Wang et al. 2014b) | Yes. NSW, Qld, Vic., WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Pestalotiopsis palmarum* (Cooke) Steyaert<br>Synonym: *Pestalotia palmarum* Cooke | Yes (Tai 1979) | Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| [Amphisphaeriales: Pestalotiopsidaceae]<br>Grey palm leaf spot | | | | | | |
| *Peyronellaea pomorum* (Thüm.) Aveskamp, Gruyter & Verkley<br>Synonym: *Phoma pomorum* Thüm.; *Didymella pomorum* (Thüm.) Qian Chen & L. Cai; *Phyllosticta prunicola* Opiz ex Sacc.<br>[Pleosporales: Didymellaceae] | Yes (Tai 1979; Zhuang 2005) | Yes. NSW, Qld, SA, Vic., WA (Cook & Dubé 1989; Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Phakopsora zizyphi-vulgaris* Dietel<br>Anamorph: *Malupa zizyphi-vulgaris* (P. Hennings) Buriticá & Hennen 1999<br>[Puccinales: Phakopsoraceae]<br>Rust | Yes (Dhileepan 2017; Quan 2000; Tai 1979) | No records found | No. The rust causes small irregular reddish brown pustules covering entire leaves, resulting in drying and defoliation (Jamadar, Balikai & Sataraddi 2009). *Ziziphus jujuba* was listed as a host (Tai 1979). No report of an association with fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Phoma destructiva* Plowr.<br>Synonym: *Boeremia exigua* (Desm.) Aveskamp, Gruyter & Verkley | Yes (Tai 1979) | Yes. NSW, Qld, WA (Plant Health Australia 2018; Shivas 1989; Simmonds 1966). | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
| --- | --- | --- | --- | --- | --- | --- |
| [Pleosporales: Didymellaceae]<br>'Tiepi' fruit disease | | | | | | |
| *Phoma glomerata* (Corda) Wollenw. & Hochapfel 1936<br>Synonym: *Didymella glomerata* (Corda) Q. Chen & L. Cai, in Chen, Jiang, Zhang, Cai & Crous 2015<br>[Pleosporales: Didymellaceae] | Yes (Zhao & Kang 2013) | Yes. All states and territories (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Phomopsis mauritiana* G.Q. Yuan & J.G. Wei<br>[Diaporthales: Diaporthaceae] | Yes (Yuan et al. 2008) | No records found | No. Affects leaves or stems of *Ziziphus* spp. (Yuan et al. 2008). No report of an association with fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Phomopsis ziziphicola* C.Q. Chang, Z.D. Jiang & P.K. Chi<br>[Diaporthales: Diaporthaceae] | Yes (Chang et al. 2005; Yuan et al. 2008) | No records found | No. Causes rots on the stem of *Ziziphus* spp. (Yuan et al. 2008). No report of an association with fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Phomopsis ziziphina* Ponnappa<br>[Diaporthales: Diaporthaceae]<br>Twig blight | Yes (Yuan et al. 2008) | No records found | No. Associated with twig blight of *Ziziphus* spp. (Mirzaee 2014; Sharma et al. 2003; Yuan et al. 2008). No report of an association with fresh | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | | Chinese jujube fruit was found. | | | |
| *Pleospora infectoria* Fuckel<br>Synonym: *Lewia infectoria* (Fuckel) M.E. Barr & E.G. Simmons; *Alternaria infectoria* E.G. Simmons<br>[Pleosporales: Pleosporaceae] | Yes (Zhuang 2005) | Yes. NSW, Qld, Tas., WA (Moslemi et al. 2017; Plant Health Australia 2018) | Assessment not required | Assessment not required | Assessment not required | No |
| *Pseudocercospora jujuba*e (S. Chowdhury) A.Z.M. Khan & Shamsi,<br>Synonym: *Cercospora jujubae* S. Chowdhury<br>[Capnodiales: Mycosphaerellaceae] | Yes (Liu & Guo 1998) | No records found | No. *Pseudocercospora jujubae* causes leaf spot in *Z. jujuba* (Mirzaee 2014). No report of an association with fresh Chinese jujube fruit was found. | Assessment not required. | Assessment not required | No |
| *Pseudocercospora vitis* (Lév.) Speg.<br>Synonym: *Cercospora vitis* (Lév.) Sacc.; *Cercosporiopsis vitis* (Lév.) M. Miura; *Cladosporium vitis* (Lév.) Sacc.<br>[Mycosphaerellales: Mycosphaerellaceae] | Yes (Tai 1979; Teng 1996) | Yes. Qld, SA (Cook & Dubé 1989; Simmonds 1966) | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| *Pseudocercospora ziziphi* (Petch) Crous & U. Braun [as '*zizyphi*']<br>Synonym: *Cercospora ziziphi* Petch<br>As *Cercospora ziziphae* in Azam-Ali (2006)<br>[Capnodiales: Mycosphaerellaceae]<br>Cercospora leaf spot | Yes (Tai 1979) | No records found | No. Causes leaf yellowing on Chinese jujubes (Azam-Ali et al. 2006). No report of an association with fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Pseudocercospora ziziphicola* (J.M. Yen) J.M. Yen<br>Synonym: *Cercospora ziziphicola* J.M. Yen<br>[Capnodiales: Mycosphaerellaceae] | Yes (Farr & Rossman 2018; Liu, Guo & Hsieh 1998) | No records found | No. Associated with leaves, causing leaf spot (Farr & Rossman 2018; Srivastava, Narayan & Srivastava 1995). *Ziziphus jujuba* was listed as a host (Liu, Guo & Hsieh 1998). No report of an association with fresh Chinese jujube fruit was found. | Assessment not required | Assessment not required | No |
| *Pseudoidium ziziphi* (J.M. Yen & Chin C. Wang) U. Braun & R.T.A. Cook<br>Synonym: *Oidium erysiphoides f. sp. ziziphi* J.M. Yen & Chin C. Wang; *Oidium zizyphi* (J.M. Yen & Chin C. Wang) U. Braun<br>[Erysiphales: Erysiphaceae] | Yes (Mirzaee 2014; Yuan et al. 2009) | No records found | No. *Pseudoidium ziziphi* infected plants show a whitish powdery mass on leaves, which leads them to shrink causing defoliation. The disease also causes white powdery spots on the fruit surface. The diseased fruit either prematurely drop or become corky, cracked and remain under- | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| Powdery mildew | | | developed (Mirzaee 2014). The pathogen has been reported in *Z. mauritiana* and *Z. nummularia* (Dhileepan 2017). It has been reported on *Z. mauritiana* in China (Yuan et al. 2009). No report of this pathogen on Chinese jujubes (*Z. jujuba*) was found. | | | |
| *Rhizoctonia solani* J.G. Kühn<br>Teleomorph: *Thanatephorus cucumeris* (A.B. Frank) Donk<br>[Cantharellales: Ceratobasidiaceae] | Yes (Tai 1979; Zhuang 2005) | Yes. All states and territories (Plant Health Australia 2018) | Assessment not required | Assessment not required | Assessment not required | No |
| *Rhizopus stolonifer* (Ehrenb.) Vuill. 1902<br>Synonym: *Rhizopus nigricans* Ehrb.<br>[Mucorales: Rhizopodaceae]<br>Black bread mold | Yes (Tai 1979) | Yes. Present in NSW, WA, NT (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Rhytidhysteron rufulum* (Spreng. : Fr.) Speg. | Yes (Farr & Rossman 2018; Teng 1996) | Yes. NSW, NT (Plant Health Australia 2018; Yuan 1996) | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| Synonym: *Tryblidiella rufula* (Spreng. : Fr.) Sacc.<br>[Patellariales: Patellariaceae] | | | | | | |
| *Rosellinia necatrix* Berl. ex Prill. l.<br>[Xylariales: Xylariaceae] | Yes (Tai 1979) | Yes. NSW, Qld, WA (Plant Health Australia 2018) | Assessment not required | Assessment not required | Assessment not required | No |
| *Streptotinia streptothrix* (Cooke & Ellis) Seifert & L.M. Kohn<br>Anamorph*: Botrytis streptothrix* (Cooke & Ellis) Sacc.<br>Synonym: *Polyactis streptothrix* Cooke & Ellis; *Streptobotrys streptothrix* (Cooke & Ellis) Hennebert<br>[Helotiales: Sclerotiniaceae]<br>Blight | Yes (Yuan et al. 2009) | No records found | No. Causes leaf blight and fruit brown rot on Indian jujube (*Z. mauritiana*) (Horst 2013; Yuan et al. 2009). No report of an association with Chinese jujubes (*Z. jujuba*) was found. | Assessment not required | Assessment not required | No |
| *Trichoderma viride* Pers.<br>[Hypocreales: Hypocreaceae] | Yes (Tai 1979) | Yes. NSW, SA, Qld, Vic., WA (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| *Trichothecium roseum* (Pers.) Link 1809 | Yes (Tai 1979) | Yes. NSW, Qld, SA, Vic., WA (Plant Health Australia 2018; Shivas 1989). | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
| --- | --- | --- | --- | --- | --- | --- |
| Synonym: *Trichoderma roseum* Pers.<br>[Hypocreales: Incertae sedis] | | | | | | |
| *Xanthochrous hispidus* (Bull.) Pat.<br>Synonym*: Inonotus hispidus* (Bull.) P. Karst.<br>[Hymenochaetales: Hymenochaetaceae]<br>Shaggy Bracket | Yes (Tai 1979) | Yes. Qld (Plant Health Australia 2018). | Assessment not required | Assessment not required | Assessment not required | No |
| **VIROIDS** | | | | | | |
| *Hop stunt viroid* Sasaki and Shikata 1977<br>Synonym: *Citrus cachexia viroid* (CcaV)<br>[Pospiviroidae: Hostuviroid]<br>HSVd | Yes (Yang et al. 2006a; Yang et al. 2006b; Zhang et al. 2009; Zhou et al. 2006b). | Yes. SA, Vic. (Koltunow, Krake & Rezaian 1988). Listed as a Declared Organism (Prohibited – section 12 (C1 Prohibited)) for WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2017). Although *Hop stunt viroid* is a Declared Organism in WA, specific measures are not required for this viroid for the movement of fresh | Assessment not required | Assessment not required | Assessment not required | No |

| Pest | Present in China | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences | Pest risk assessment required |
|---|---|---|---|---|---|---|
| | | jujube fruit or other fruit commodities into WA from other Australian states/territories where the viroid is present. Routine visual inspection is not adequate measure to detect this viroid in fresh jujube fruit pathway. | | | | |
| **VIRUSES** | | | | | | |
| *Jujube mosaic-associated virus* Du et al. 2017<br>[Caulimoviridae: Badnavirus]<br>Jujube mosaic disease; JuMaV | Yes (Du et al. 2017). | No records found | Yes. This virus was isolated from Chinese jujube trees with obvious mosaic and malformation symptoms in the leaves (Du et al. 2017). JuMaV is most closely related to the Badnavirus genus that are known to be systemic and could be asymptomatic (Bhat, Hohn & Selvarajan 2016), and therefore this virus could be associated with the fruit pathway. | No. There is no known vector of JuMaV. No reports of JuMaV seed transmission found. As described in Appendix B1, JuMaV is considered very unlikely to establish and spread in Australia through this pathway and therefore is not considered further in this risk analysis. | Assessment not required | No |

# Appendix B1: Issues raised in stakeholder comments

This section includes 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: Jujube witches' broom phytoplasma and assessment of potential transmission via vector and/or seed.**

Response: The department has conducted a further review of the available scientific literature, focusing on transmission of phytoplasmas. A detailed overview of *Candidatus* Phytoplasma ziziphi (jujube witches' broom (JWB) phytoplasma (16SrV-B)) is provided as Appendix B2. The following evidence summarises the overview, and supports the department's assessment in the pest categorisation (Appendix A) of the risk analysis report that JWB phytoplasma (16SrV-B) does not have the potential to be associated with the pathway of fresh Chinese jujube fruit that has been commercially grown and packed in China.

- Jujube fruits infected with JWB phytoplasma (16SrV-B) show visible symptoms, and are of abnormal shape with bumpy and discoloured skin. Symptomatic infected fruits are expected to be removed during harvesting and packing procedures, as each fruit is individually screened at the packinghouse in accordance with packinghouse procedures.
- In the event that any JWB phytoplasma (16SrV-B) infected fruits was to escape pre-export and on-arrival phytosanitary inspections, JWB phytoplasma (16SrV-B) within that infected fruit is very unlikely to be transmitted to a suitable host in Australia.
    - The known insect vectors of JWB phytoplasma (16SrV-B) are leafhoppers; *Hishimonus sellatus, Hishimonoides chinensis* and *H. aurifavialea*, and an unidentified *Typhlocyba* species. *Hishimonus sellatus, Hishimonoides chinensis* and *H. aurifavialea* are not present in Australia. Australian known *Hishimonus* spp. are not known to be vectors of plant disease. Some *Typhlocyba* species are present in Australia but transmission of phytoplasma by these species has not been reported.
    - Similar to other leafhoppers, the vectors of phytoplasmas are phloem-feeders and sap-sucking insects. They acquire disease agents from the vascular tissue of an infected host. It is very unlikely that phloem feeding insects would feed on discarded rotting or desiccating jujube fruit, as such species strongly prefer actively growing parts of a host plant.
    - JWB phytoplasma (16SrV-B) is not seed transmissible in jujubes. In addition, seed transmission of phytoplasma strains related to JWB phytoplasma (16SrV-B) has not been reported in any woody dicotyledonous plant species.

Based on this information, the department considers that the JWB phytoplasma (16SrV-B) is very unlikely to be associated with the import pathway of commercially grown and packed Chinese jujube fruit. JWB phytoplasma (16SrV-B) is not seed transmissible and known vectors are not present in Australia. Vectors are phloem-feeders and sap-sucking insects and it is very unlikely that these phloem feeding insects would feed on discarded rotting or desiccating Chinese jujube fruit. For these reasons, the JWB phytoplasma (16SrV-B) was assessed as not being on the pathway and the assessment was terminated in the pest categorisation table.

Additional technical information on the biology, classification, geographic distribution, host plants, symptoms, spread and transmission of JWB phytoplasma (16SrV-B) that further supports this conclusion has been included in **Appendix B2**.

**Issue 2: Jujube mosaic disease and Jujube mosaic-associated virus (JuMaV), and assessment of potential transmission via vector and/or seed.**

Response: Fruit from Jujube mosaic disease-affected trees can be deformed and discoloured, and are unlikely to enter the pathway of the commercially produced and packed commodity.

In China, jujube mosaic disease is considered to be transmitted by grafting and mechanical means, as well as by cicadellid and aphid vectors (Gengzhongbang 2019). It is not reported to be transmitted through seeds. Preventative control measures for jujube mosaic disease undertaken in China include use of clean nursery materials and clean equipment, and management of insect vectors in orchards.

As a consequence, the department considers it very unlikely that jujube mosaic disease could be transmitted from an infected Chinese jujube fruit to a suitable host plant in Australia. In supporting this assessment the department notes that seed is not a known pathway for transmission of jujube mosaic disease. Furthermore, fruit from Jujube mosaic disease-affected trees can be deformed and discoloured, and are unlikely to enter the pathway of the commercially produced and packed commodity. In the unlikely event that a diseased fruit was to enter Australia, and that suitable insect vectors exist in Australia, the latter are highly unlikely to access and/or feed on ageing picked jujube fruit, and then subsequently feed on a susceptible host to which the disease could be transmitted.

A virus identified as *Jujube mosaic-associated virus* (JuMaV) was recently isolated from leaf material of a Chinese jujube tree showing obvious mosaic and malformation symptoms (Du et al. 2017). However, the nature of its association with jujube mosaic disease, and its pathogenicity for plants, remain to be investigated. JuMaV is most closely related to members of the *Badnavirus* genus, some of which are known to establish systemic infections, and also to be able to cause asymptomatic infections (Bhat, Hohn & Selvarajan 2016). Therefore this virus may have the potential to be associated with the fruit pathway.

However there is as yet no specific information about characteristics of JuMaV such as host range, physical stability, or capacity for seed transmission (these being of relevance if JuMaV is not the causative agent of jujube mosaic disease). As for the causative agent of jujube mosaic disease, badnaviruses are commonly transmitted by insect vectors and mechanical means; most have a limited host range (Bhat, Hohn & Selvarajan 2016). Seed transmission has been reported for some badnaviruses of herbaceous plants, such as *Piper yellow mottle virus* on pepper weed (*Piper* spp.), *Taro bacilliform virus* on *Colocasia esculenta*, and *Kalanchoe top-spotting virus* on *Kalanchoe blossfeldiana*; seed transmission of *Cacao swollen shoot virus* has been reported in cacao trees. Nevertheless, the likelihood of germination of a JuMaV-infected seedling in Australia, access by a competent vector, and subsequent transmission from that vector to a susceptible host is also considered to be very unlikely.

**Issue 3: Possible presence of fruit flies in the recognised fruit fly pest free area.**

Response: The department officially recognises that tephritid fruit flies are absent in the export area north of latitude 33rd degrees of China, based on trapping data and protocols that are consistent with international standards used to establish pest free areas. This recognition is also supported by the outcomes of on-arrival phytosanitary inspection and pest interception data in and for Australia. A range of horticultural commodities that are hosts of tephritid fruit flies are imported into Australia from the recognised pest free area of China. These include pears (imported since 1999), apples (imported since 2010), nectarines (imported since 2017) and table grapes (imported since 2018). To date, there has been no detection of tephritid fruit flies on these horticultural commodities. A number of China's other trading partners including the USA, Chile, New Zealand and South Africa also recognise the area north of latitude 33rd degrees of China as tephritid fruit fly pest free area.

In China, the fruit fly pest free area is verified by the National Fruit Fly Trapping Network (NFFTN). This was established in 2000 to monitor fruit flies throughout China in accordance with the National Guideline for Fruit Fly Monitoring and Trapping, and the Requirement of Establishment of Pest Free Areas for Fruit Flies (Tephritidae) (GB/T 23631-2009). Over 13,000 fruit fly traps are operated under the NFFTN. In addition to the NFFTN, traps are also set up in export horticultural orchards and/or packinghouses.

Domestic fruit movement in China is governed by national standards and regulations such as 'Quarantine protocol for the movement of agricultural plants and plant products' (GB/T 15569-2009) and the 'Requirement of Establishment of Pest Free Areas for Fruit Flies (Tephritidae)' (GB/T 23631-2009). These are administered by the Ministry of Agriculture of the People's Republic of China, which oversees nationwide domestic plant quarantine affairs. Agricultural administrative departments in the provinces, autonomous regions and municipalities manage regional agricultural plant quarantine affairs and supervise local plant quarantine departments to county level. The regulations set out the procedures for the transportation of plant seeds, nursery stock and reproductive materials as well as quarantine plants and plant products. Consignments must be certified as free of quarantine pests of concern to the designated areas. For fruit flies, the regulated plant materials include fruit fly host species, for example grapes, apples, pears, stone fruit and citrus, and other crop seeds and saplings. The regulations also cover scions, rootstocks, tissue cultures, propagative material of other plants, vegetable seeds, seedlings and vegetable products of the above-mentioned commodities coming from county-level administrative regions with epidemics/outbreaks.

The risk of fruit movement with travellers to the fruit fly pest free area is primarily managed through improving public awareness by means such as publishing brochures, and presence of signs and bins at ports, airports, train and bus stations, and on main roads.

If an outbreak of a tephritid fruit fly species of economic concern was to occur, China is required to notify the department within 48 hours. National emergency action plans for outbreaks are then required to be activated, which include establishing a delimiting survey by setting up additional traps to identify the site and extent of the fruit fly outbreak, and determine the surrounding area and buffer zone. Fruit sampling is also conducted. No fruit fly detection has been reported to the department, or an outbreak declared in the recognised pest free area since horticultural trade commenced in 1999.

In the event of an outbreak in the fruit fly pest free area, an approved fruit fly treatment will be required to be applied and consignments be inspected after treatment prior to export to Australia.

**Issue 4: Pest free places of production or pest free production sites as a measure for the management of fruit flies.**

Response: In addition to pest free areas, the options of pest free places of production and pest free production sites have been recommended for the management of fruit flies. Pest free places of production and pest free production sites are internationally recognised phytosanitary measures to manage risks associated with quarantine pests. Pest free places of production and pest free production sites must meet the requirements as set out in ISPM 4: *Requirements for the establishment of pest free areas* and ISPM 10: *Requirements for the establishment of pest free places of production and pest free production* sites.

Should China wish use to use the option of pest free places of production or pest free production sites as a measure to manage the risk posed by fruit flies, GACC would need to demonstrate the establishment and maintenance of pest free places of production or pest free production sites in accordance with ISPM 4 and 10, and provide a submission to the department for consideration.

At this time, China has not provided a technical submission to demonstrate how it would meet the requirements of pest free places of production or pest free production sites for any fruit commodity currently permitted import into Australia. To date Australia has not accepted any pest free place of production or pest free production site as a means for management of biosecurity risks associated with a tephritid fruit fly for any commodity from any country.

**Issue 5: Non-disinfestation treatments for managing the biosecurity risk of peach fruit borer.**

Response: Four risk management options have been proposed for peach fruit borer (*Carposina sasakii*): (1) area freedom, (2) methyl bromide fumigation, (3) irradiation and (4) a systems approach based on orchard control and surveillance, trapping, fruit cutting and inspection. Concerns were raised by stakeholders that measures other than disinfestation treatments, such as a systems approach, may not be adequate to manage the risk associated with peach fruit borer.

Use of a systems approach is internationally recognised as a suitable phytosanitary measure to manage biosecurity risks associated with quarantine pests (ISPM 14: *The use of integrated measures in a systems approach for pest risk management*). The key components of the systems approach recommended to manage *C. sasakii* peach fruit borer include in-field management (such as orchard monitoring, surveillance and control), and pre-export fruit cutting and inspection. Fruit cutting and inspection are considered to be effective in detecting *C. sasakii* peach fruit borer larvae within infested fruit. On arrival, fruit are also subject to fruit cutting and inspection for *C. sasakii*.

Very similar systems-based approaches that also include in-field management (such as orchard monitoring, surveillance and control) and fruit cutting and inspection, have been successfully implemented to manage *C. sasakii* with imports of Chinese apples, pears and stone fruits.

*Carposina sasakii* has not been detected during Australian on-arrival phytosanitary inspection of these commodities that have been imported from China using a systems approach for *C. sasakii*.

The department considers a systems approach comprising in-field monitoring and control, and fruit cutting and inspection, to be appropriate for managing the biosecurity risk associated with *C. sasakii* in order to achieve the appropriate level of protection for Australia.

**Issue 6: Visual inspection as a phytosanitary measure for small arthropods such as thrips, mites and mealybugs.**

Response: Pre-export visual inspection, and application of remedial actions for thrips, mealybugs and/or spider mites, if live pests are found, is recommended to manage the biosecurity risks associated with these pests to achieve the appropriate level of protection for Australia. The department considers pre-export visual inspection an effective measure to manage these pests on a wide range of fresh horticultural commodities imported into Australia. Trading partners also recognise pre-export visual inspection as an appropriate measure for these pest groups. Australia exports a range of fresh horticultural commodities under the phytosanitary measure of pre-export visual inspection.

A wide range of fresh horticultural commodities have been imported from China where pre-export visual inspection is required to manage thrips, mealybugs and mites of quarantine concern to Australia. There has been trade from China in apples since 2010, pears since 1999, nectarines since 2016 and table grapes since 2018. These consignments have a high compliance rate, with inspected consignments generally found free of pests of quarantine concern to Australia, including quarantine pests such as thrips, mealybugs and mites.

Fresh Chinese jujube fruit are morphologically similar to nectarines and to a lesser extent, to apples and pears. Fresh Chinese jujube fruit has smooth skin and a shallow depression at the stem end, which means any surface pests present on the fruit can be expected to be visible. Pre-export visual inspection methods must be suitable for the commodity and the inspection method must be designed to detect pests that may be present on fresh Chinese jujube. There are international standards that provide guidance when conducting inspections, these being ISPM 23: *Guidelines for inspection* and ISPM 31: *Methodologies for sampling of consignments*. China is required to conduct pre-export visual inspection in accordance with these international standards.

In addition to pre-export visual inspection, consignments of fresh Chinese jujubes will be inspected on arrival in Australia to ensure they comply with Australia's import requirements. The department will inspect consignments of fresh Chinese jujubes, using an inspection method suitable for detecting any thrips, mealybugs and mites that may be present.

The detection of any thrips, mealybugs and mites of biosecurity concern on imported Chinese jujube 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, or the consignment will be exported or destroyed.

Pre-export visual inspection is considered appropriate to manage small arthropods such as thrips, mites and mealybugs on commodities where it is expected that these pests will be visible because of the morphology of the fruit. However, pre-export visual inspection may not be appropriate to manage these pest groups on commodities where the structure or morphology of the commodity provides many places for these small insects to hide. For example, the many crevices and spines of a pineapple, the calyx of a mangosteen or the flower head and leaves of cut flowers make small insects difficult to detect. For commodities such as these, visual inspection may not be appropriate to manage these pests.

**Issue 7: On-arrival inspection procedures.**

Response: 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 standards, ISPM 23: *Guidelines for phytosanitary inspection* and ISPM 31: *Methodologies for sampling consignments*. 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 Chinese jujubes, one unit is considered to be a single Chinese jujube fruit).

It should be noted that the 600 unit on-arrival phytosanitary inspection is in addition to a 600 unit pre-export phytosanitary inspection. The phytosanitary inspections must include the cutting of 60 fruit for *C. sasakii*, and can also be expected to identify the presence of other pests of biosecurity concern.

Australia uses a 600-unit inspection regime for all imported horticultural produce (fresh, unprocessed fruit and vegetables) requiring inspection. Samples are selected by the 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.

**Issue 8: Taxonomic status and assessment of *Neofusicoccum ribis*, *Dothiorella gregaria* and *Macrophoma kuwatsukai*.**

Response: The pathogen, *Neofusicoccum ribis* (and its understood synonyms, *Dothiorella gregaria* and *Botryosphaeria ribis*), which causes fruit shrink disease of Chinese jujubes, was included in the pest categorisation of the draft report. *Neofusicoccum ribis*, as its synonym *Botryosphaeria ribis* was assessed in the draft report as being present in Australia. Therefore, the agent was not considered further in the pest categorisation process. The department has subsequently reviewed the taxonomic status of *N. ribis* and now considers *B. ribis* not to be a synonym of *N. ribis*.

The department has further reviewed the scientific literature for *N. ribis* to determine if it is known to be associated with Chinese jujube fruit. *Neofusicoccum ribis* is only recorded from North America (Sakalidis et al. 2013) and is not known to be present in either China or Australia.

Additionally, *N. ribis* only infects *Ribis* species and is not associated with Chinese jujubes. The department has made changes to the report as a result of this re-assessment. The pest categorisation has been amended accordingly, such that *N. ribis* has been removed from the table.

*Dothiorella gregaria* has now been added to the pest categorisation for assessment. *Dothiorella gregaria* is a minor pathogen causing jujube fruit shrink disease. Infected fruits normally drop off the tree before reaching maturity (Zhang et al. 2008); infected fruit remaining on the tree are not likely to be harvested, and should this occur, are likely to be discarded during the sorting and packing processes. As such, *D. gregaria* is assessed as not having the potential to be on the pathway of commercially grown and packed Chinese jujube fruit, and has not been considered further in the pest categorisation process.

Following a review of the taxonomic status of *Macrophoma kuwatsukai*, this pathogen has been added to the pest categorisation for assessment under the currently accepted name of *Botryosphaeria kuwatsukai*. Some Chinese literature reported *B. kuwatsukai* as causing ring grain disease of Chinese jujube. However, *B. kuwatsukai* has recently been assigned to a new taxon and it is the department's view that the reports in Chinese literature relating to *B. kuwatsukai* or *M. kuwatsukai* on Chinese jujubes are likely to have been misidentifications, or an incorrect identification as a synonym of *B. dothidea*. *Botryosphaeria kuwatsukai* has a very narrow host range, currently considered to be limited to apples and pears. Therefore, *B. kuwatsukai* has been assessed as not having the potential to be on the pathway of commercially grown and packed Chinese jujube fruit, and has not been considered further in the pest categorisation process.

**Other issues**

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

- amendments to 'Appendix A: Initiation and categorisation for pests of fresh Chinese jujube fruit from China' following a review of the regional pest status of *Hop stunt viroid*, *Phytophthora palmivora* and *Armillaria tabescens*. Consistent with the department's plant quarantine pest and official control policy, and in accordance with the IPPC International Standards for Phytosanitary Measures, these pests are not considered to be under official control and therefore not recognised as pests of quarantine concern. The assessments for these pests have been amended to terminate at the 'Present in Australia' step of the pest categorisation.
- minor corrections, rewording and editorial changes for consistency, clarity and web-accessibility.

# Appendix B2: An overview of jujube witches' broom phytoplasma

## Introduction

The name 'phytoplasma' (genus '*Candidatus* Phytoplasma') (*Ca.* Phytoplasma) has been applied to call wall-less, non-helical prokaryotes that colonise plant phloem and insects (Firrao et al. 2004). Phytoplasmas are dependent on their host to multiply, and lack many metabolic genes such as those coding for ATP synthases and sugar uptake and use (Bertaccini et al. 2014; Christensen et al. 2005; Osima, K. & Namba 2013). Phytoplasmas survive in the isotonic environments in the host plant phloem sap and/or vector insect hemolymph (Bertaccini et al. 2014).

Over the last decade, phytoplasmas have been discovered at an increasingly rapid pace as agents of emerging diseases worldwide, and 16S rDNA studies by Restriction Fragment Length Polymorphism (RFLP) analyses and sequencing has produced a detailed picture of phytoplasma diversity and of their phylogenetic relationships with other prokaryotes (Bertaccini et al. 2014). A new species of '*Ca.* Phytoplasma' is assigned if the available sequence of the 16S rRNA gene is greater than 1200 nucleotides and its homology is less than 97.5 per cent with other defined '*Ca.* Phytoplasma' species. To date, about 40 '*Ca.* Phytoplasma' species, 33 ribosomal groups and 130 ribosomal sub-groups have been described (Satta 2017).

Infections of phytoplasmas can cause significant economic impacts and have been identified in a wide range of plant species (Liu, Zhao & Liu 2016; Streten & Gibb 2006). Jujube Witches'-broom phytoplasma is an obligate pathogen that causes jujube witches'-broom (JWB) disease. It is an important disease affecting jujube production in China (Liu, Zhao & Zhou 2010).

## Classification of JWB phytoplasma

Based on 16S rRNA sequences analyses, the phytoplasma causing jujube witches' broom disease has been classified as *Candidatus* Phytoplasma ziziphi (*Ca.* P. ziziphi, JWB phytoplasma, 16SrV-B) and assigned to the elm yellows group (16SrV) subgroup B (Table 1) (Jung et al. 2003; Wang et al. 2018b). The complete genome sequence of JWB phytoplasma consists of one circular chromosome of 750, 803 bp with a GC content of 23 per cent and 694 protein-encoding genes. A large number of JWB phytoplasma genes are genome specific, and 13 per cent of the annotated genes are predicted to be associated with virulence. Although a number of transporter genes have been identified in JWB phytoplasma, KEGG pathway analyses reveal potentially reduced metabolic capabilities in JWB phytoplasma (Wang et al. 2018b).

The following evidence supports the department's assessment that JWB phytoplasma (16SrV-B) is not associated with the pathway of fresh Chinese jujube fruit commercially grown and packed in China; and further, that any infected fruit is very unlikely to be a source for transmission to a suitable host in Australia.

## Geographic distribution of JWB phytoplasma

*Candidatus* Phytoplasma ziziphi (16SrV-B) is present in major jujube growing areas in China (Chen et al. 1984b; Liu, Zhao & Zhou 2010). It has also been reported in jujube production areas in India, Italy, Korea and Japan (Bertaccini & Duduk 2011; Han 2005; Jung et al. 2003; Liu, Zhao & Zhou 2010).

**Table 1: Phytoplasmas in the 16SrV: 'elm yellows' group**

| 16SrV: 'elm yellows' group (Europe, America, Asia, Africa) | |
|---|---|
| V-A | Elm yellows (EY) '*Ca*. P. ulmi' |
| V-B | Jujube witches' broom (JWB-G1) '*Ca*. P. ziziphi' |
| V-C | "Flavescence dorée" (FD-C) |
| V-D | "Flavescence dorée" (FD-D) |
| V-E | Rubus stunt (RuS) '*Ca*. P. rubi' |
| V-F | Balanite Witches' broom (BltWB) '*Ca*. P. balanitae' |
| V-G | Korean jujube witches' broom |
| V-H | Bischofia polycarpa wictches' broom |

## Host plants of JWB phytoplasma

*Candidatus* Phytoplasma ziziphi (JWB phytoplasma, *Ca.* P. ziziphi, 16SrV-B) is known to naturally occur in Chinese jujubes (*Ziziphus jujuba*) in China (Bu et al. 2016; Jung et al. 2003; Liu, Zhao & Liu 2016; Wang et al. 2018b). Natural occurrence of *Ca.* P. ziziphi has also been reported on Indian dates (*Z. nummularia*) in India (Khan, Raj & Snehi 2008).

Phytoplasma strains related to *Ca.* P. ziziphi (16SrV-B) have been reported from a number of dicot woody plants, including Chinese scholar tree (*Sophora japonica*) (Yu, Cao & Zhang 2012), *Spiraea salicifolia* (Li et al. 2010), sweet cherry (Wang et al. 2018c; Wang et al. 2014a), peach and damask rose (Lee et al. 2004; Marcone, Guerra & Uyemoto 2014; Saeed et al. 2016). Phytoplasma strains related to group 16SrV, subgroup V-B have also been reported to infect herbaceous plants such as alfalfa (Li et al. 2012) and rose balsam (*Impatiens balsamina*) (Li et al. 2014b).

## Symptoms of JWB phytoplasma on Chinese jujube

Symptoms of JWB phytoplasma typically develop first on the lower branches of the main stem and then spread throughout the plant. The infected jujube plants exhibit a variety of symptoms, such as small leaves, yellowing, witches'-broom, phyllody, stunting, abnormal and sterile flowering, resulting in little or no fruit production (Gengzhongbang 2018; Khan, Raj & Snehi 2008; Liu, Zhao & Zhou 2010; Shao et al. 2016; Tsai et al. 1988). Healthy looking branches of the infected trees can still set some fruit. However, the fruits show visible symptoms and are of abnormal shape, with bumpy and discoloured skin (Liu, Zhao & Zhou 2010; Zhifure 2017). Tip dieback also occurs on infected branches (Tsai et al. 1988). Infected Chinese jujube trees die within one to two years for young trees and three to six years for older trees. In severe cases, infected trees can die in the year of infection if not managed (Tsai et al. 1988).

### Spread and transmission of JWB phytoplasma

Similar to other phytoplasmas, *Ca.* P. ziziphi is well known to be transmitted by propagation materials such as rootstocks, root tillering cuttings and other types of grafting materials used as scions (Caglayan, Gazel & Škorić 2019; Chen et al. 1984b; Jung et al. 2003; Liu, Zhao & Zhou 2010). *Ca.* P. ziziphi is also known to be transmitted by micro-propagated jujube shoots (Tian et al. 2000). It is established that JWB phytoplasma cannot be transmitted by soil, seed, pollen, sap inoculation or natural contact between the roots of diseased and healthy trees underground (Chen et al. 1984b; Liu, Zhao & Zhou 2010).

In jujube, *Ca*. P. ziziphi can be transmitted by the insect vectors *Hishimonus sellatus, Hishimonoides chinensis, H. aurifavialea* and an unidentified *Typhlocyba* species (Chen et al. 1984b; Hao et al. 2015b; Liu, Zhao & Zhou 2010; Weintraub & Beanland 2006). *Hishimonus sellatus, Hishimonoides chinensis* and *H. aurifavialea* are not present in Australia. Some *Typhlocyba* species are present in Australia but transmission by these species has not been reported. Similar to other leafhoppers, *Typhlocyba* spp. are phloem-feeders and sap-sucking insects, and it is unlikely that these phloem feeding insects would feed on discarded rotting or desiccating Chinese jujube fruit.

JWB *Ca*. P. ziziphi (16SrV-B) seed transmission has not been reported in any plant species. Chen et al. (1984b) raised more than 700 jujube seedlings from a large number of seeds collected from JWB infected jujube trees; no JWB symptoms were observed on any of these seedlings over three years observation after germination. This supports the department's assessment that JWB phytoplasma (16SrV-B) is not seed transmissible in jujubes.

Phytoplasma strains related to *Ca.* P. ziziphi (16SrV-B) have been reported in a number of dicotyledonous woody plants, including *Sophora japonica* (Yu, Cao & Zhang 2012), (Yu el al. 2012), sweet cherry (Wang et al. 2018c; Wang et al. 2014a), peach and damask rose (Lee et al. 2004; Marcone, Guerra & Uyemoto 2014; Saeed et al. 2016). However, seed transmission of these phytoplasma strains has not been reported.

A phytoplasma strain related to subgroup 16SrV-B also reported to infect the herbaceous plant rose balsam (*Impatiens balsamina*) (Li et al. 2014b). Infected plants, in that study, failed to produce any seeds. In elm trees, Bertelli et al. (2002) found that elm yellows phytoplasma (16SrV-A), a phytoplasma belonging to another subgroup (V-A) of the elm yellows group (16SrV) was not seed transmittable based on observation that as 16SrV-A was not detected in the 24 plantlets germinated and grown from 350 seeds.

Seed transmission of other groups of phytoplasmas has not been reported in any woody plant species. In apricot, presence of ESFY phytoplasma (*Ca*. P. prunorum, 16SrX-B) has been detected in flowers, fruits and seed (tegument and kernels) but not in pollen. Tests indicated that ESFY 16SrX-B cannot be transmitted by seeds to seedlings (Necas, Masková & Krska 2008). In lime, Faghihi et al. (2011) reported that Witches'-broom disease caused by *Ca.* P. aurantifolia (16SrII-B) was not seed transmissible. Leaf, stem and root samples from seedling germinated and grown from Witches'-broom disease-infected lime seeds were tested for two years; they did not show presence of phytoplasma DNA in laboratory analyses, and disease symptoms were not observed (Faghihi et al. 2011). Phytoplasma DNA was detected in seed coats of some seeds from infected trees but no excised embryos were positive for the phytoplasma in lime (Faghihi et al. 2011) or mulberry (Jiang et al. 2004).

Seed transmission of some phytoplasma groups outside the elm yellows group (16SrV) has been reported in a number of herbaceous plants and monocot plants. These include for example, subgroup 16SrI and 16SrXII-A on tomato and corn (Contaldo et al. 2012; Contaldo et al. 2016; Satta 2017), subgroup 16SrIV on coconut palm (Oropeza et al. 2017), subgroups 16SrI, 16SrII and 16SrXII-A on sesame (Satta 2017), and subgroups 16SrXII-A and 16SrI-B on winter oilseed rape (Satta 2017).

### Conclusions

Based on the information provided above, the department concludes that JWB phytoplasma is very unlikely to be associated with the pathway of commercially grown and packed Chinese jujube fruit. Symptomatic infected fruits are very likely to be removed during harvesting and packing procedures, as fruit shows visible symptoms and each fruit is individually screened at the packinghouse. In the event that a JWB phytoplasma infected fruit was to escapes pre-export and on-arrival visual inspections, JWB phytoplasma is very unlikely to be transmitted to a suitable host in Australia as JWB phytoplasma is not seed transmissible, and known vector species of JWB phytoplasma are not present in Australia. Additionally, vectors of phytoplasmas are phloem-feeders and sap-sucking insects and it is very unlikely that these phloem feeding insects would feed on discarded rotting or desiccating jujube fruit.

# Appendix C: Risk management measures recommended for quarantine pests and regulated thrips for fresh Chinese jujubes from China

This table clarifies the pest risk management measures, as described in Chapter five: Pest risk management, for each of the identified quarantine pests.

| Pests | Risk management measure |
|---|---|
| Hawthorn spider mite (*Amphitetranychus viennensis*), heliococcus mealybugs (*Heliococcus destructor*) and/or chilli thrips (*Scirtothrips dorsalis*) | Pre-export visual inspection and, if found, remedial action (such as methyl bromide fumigation) |
| Melon fly (*Zeugodacus cucurbitae*) only, OR melon fly (*Zeugodacus cucurbitae*) with one or both of Oriental fruit fly (*Bactrocera dorsalis*) and guava fruit fly (*Bactrocera correcta*) | **1. Area freedom**<br>The Department of Agriculture recognises that *B. correcta, B. dorsalis* and *Z. cucurbitae* are absent to the north of latitude 33 degrees in China.<br>OR<br>**2. Fruit treatments**<br>For fruit sourced from where only *Z. cucurbitae* is present or *Z. cucurbitae* and one or both of *B. correcta* and *B. dorsalis* are present or where pest freedom status has been suspended, the following fruit treatment should be implemented.<br>***Cold treatment:***<br>• pulp temperature of 1.11 °C or below for 14 days, or<br>• pulp temperature of 1.67 °C or below for 16 days, or<br>• pulp temperature of 2.22 °C or below for 18 days.<br>OR<br>**Methyl bromide fumigation followed by cold treatment:**<br>• 32 grams per cubic metre for two hours at a pulp temperature of 21 °C or greater at not more than 50 per cent chamber load, followed by cold treatment at a pulp temperature of 2.77 °C or lower for 4 days, or<br>• 32 grams per cubic metre for two and half hours at a pulp temperature of 21 °C or greater at not more than 50 per cent chamber load, followed by cold treatment at a pulp temperature of 4.44 °C or lower for 4 days, or<br>• 32 grams per cubic metre for three hours at a pulp temperature of 21 °C or greater at not more than 50 per cent chamber load, followed by cold treatment at a pulp temperature of 8.33 °C or lower for 3 days.<br>OR<br>**Irradiation***<br>150 gray minimum absorbed dose as specified in ISPM 28 Annex 7: Irradiation treatment for fruit flies of the family Tephritidae (generic). |
| Oriental fruit fly (*Bactrocera dorsalis*) and/or guava fruit fly (*Bactrocera correcta*) | **1. Area freedom**<br>The Department of Agriculture recognises that *B. correcta* and *B. dorsalis* are absent to the north of latitude 33 degrees in China.<br>OR |

| Pests | Risk management measure |
|---|---|
| | **2. Fruit treatments**<br>For fruit sourced from where *B. correcta* and/or *B. dorsalis* are present or where pest freedom status has been suspended, the following fruit treatment should be implemented.<br>***Cold treatment:***<br>• pulp temperature of 0.56 °C or below for 11 days, or<br>• pulp temperature of 1.11 °C or below for 12 days, or<br>• pulp temperature of 1.67 °C or below for 14 days, or<br>• pulp temperature of 3 °C or below for 18 days.<br>OR<br>***Methyl bromide fumigation followed by cold treatment:***<br>• 32 grams per cubic metre for two hours at a pulp temperature of 21 °C or greater at not more than 50 per cent chamber load, followed by cold treatment at a pulp temperature of 2.77 °C or lower for 4 days, or<br>• 32 grams per cubic metre for two and half hours at a pulp temperature of 21 °C or greater at not more than 50 per cent chamber load, followed by cold treatment at a pulp temperature of 4.44 °C or lower for 4 days, or<br>• 32 grams per cubic metre for three hours at a pulp temperature of 21 °C or greater at not more than 50 per cent chamber load, followed by cold treatment at a pulp temperature of 8.33 °C or lower for 3 days.<br>OR<br>***Irradiation****<br>150 gray minimum absorbed dose as specified in ISPM 28 Annex 7: Irradiation treatment for fruit flies of the family Tephritidae (generic). |
| Jujube fruit fly (*Carpomyia vesuviana*) | **1. Area freedom**<br>The Department of Agriculture recognises that C. *vesuviana* is absent from China except in the Turpan region of Xinjiang.<br>OR<br>**2. Fruit treatment**<br>For fruit sourced from where C. *vesuviana* is present or where pest freedom status has been suspended, the following fruit treatment should be implemented.<br>***Irradiation****<br>150 gray minimum absorbed dose as specified in ISPM 28 Annex 7: Irradiation treatment for fruit flies of the family Tephritidae (generic). |
| Peach fruit borer (*Carposina sasakii*) | **1. Area freedom**<br>The Department of Agriculture has not recognised any *C. sasakii* pest free area in China to date. Should China wish to use area freedom as a measure to manage the risk posed by *C. sasakii*, GACC would need to demonstrate the establishment of area freedom for *C. sasakii* in accordance with the requirements as set out in ISPMs 4 or 10.<br>OR<br>**2. Fruit treatment**<br>The Department of Agriculture recommends the following fruit treatments for management of *Carposina sasakii* |

<table>
<tr><th>Pests</th><th>Risk management measure</th></tr>
<tr><td></td><td>Methyl bromide fumigation<ul><li>32 grams per cubic metre for two hours at a fruit pulp temperature of 21 °C or greater at not more than 50 per cent chamber load, or</li><li>40 grams per cubic metre for two hours at a fruit pulp temperature of 16 °C or greater at not more than 50 per cent chamber load, or</li><li>48 grams per cubic metre for two hours at a fruit pulp temperature of 11 °C or greater at not more than 50 per cent chamber load.</li></ul>OR<br>Irradiation*<br>400 gray minimum absorbed dose for the Class Insecta.<br>OR<br>Systems approach<br>The Department of Agriculture recommends the following systems approach for management of the risk associated with C. sasakii.<ul><li>orchard control and surveillance, trapping</li><li>fruit cutting and inspection.</li></ul></td></tr>
</table>

* Irradiated fresh Chinese jujubes are not currently permitted to be sold in Australia under regulations managed by Food Standards Australia New Zealand (FSANZ). The use of irradiation as a phytosanitary measure is subject to the approval by FSANZ, and the Department of Agriculture's approval of the irradiation facilities identified by GACC. Should China wish to use irradiation as a phytosanitary measure, GACC would need to provide a submission to the Department of Agriculture for consideration. The submission must fulfil requirements as set out in ISPM 18: *Guidelines for the use of irradiation as a phytosanitary measure*.

# Glossary

| Term or abbreviation | Definition |
| --- | --- |
| Additional declaration | A statement that is required by an importing country to be entered on a phytosanitary certificate and which provides specific additional information on a consignment in relation to regulated pests (FAO 2019b). |
| 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 *Biosecurity Act 2015* 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 2019b). |
| Area of low pest prevalence | An area, whether all of a country, part of a country, or all parts of several countries, as identified by the competent authorities, in which a specific pest occurs at low levels and which is subject to effective surveillance, control or eradication measures (FAO 2019b). |
| 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 *Biosecurity Act 2015* 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 | The *Biosecurity Act 2015* defines biosecurity measures as measures to manage any of the following: biosecurity risk, the risk of contagion of a listed human disease, the risk of listed human diseases entering, emerging, establishing themselves or spreading in Australian territory, and biosecurity emergencies and human biosecurity emergencies. |
| Biosecurity import risk analysis (BIRA) | The *Biosecurity Act 2015* 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 *Biosecurity Act 2015* 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 2019b). |
| Control (of a pest) | Suppression, containment or eradication of a pest population (FAO 2019b). |
| 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. |

| Term or abbreviation | Definition |
|---|---|
| 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 2019b). |
| 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 2019b). |
| Establishment (of a pest) | Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2019b). |
| Fresh | Living; not dried, deep-frozen or otherwise conserved (FAO 2019b). |
| Fumigation | A method of pest control that completely fills an area with gaseous pesticides to suffocate or poison the pests within. |
| 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. |
| Goods | The *Biosecurity Act 2015* 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 2019b). |
| Import permit | Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2019b). |
| 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 2019b). |
| 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 2019b). |
| Intended use | Declared purpose for which plants, plant products, or other regulated articles are imported, produced or used (FAO 2019b). |
| Interception (of a pest) | The detection of a pest during inspection or testing of an imported consignment (FAO 2019b). |
| 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 2019b). |
| Introduction (of a pest) | The entry of a pest resulting in its establishment (FAO 2019b). |
| 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 2019b). 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 2019b). |
| Non-regulated risk analysis | Refers to the process for conducting a risk analysis that is not regulated under legislation (Biosecurity import risk analysis guidelines 2016). |
| 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 2019b). |
| Orchard | A contiguous area of Chinese jujube 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 2019b). |
| Pest | Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2019b). |
| 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 2019b). |
| Pest free area (PFA) | An area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained (FAO 2019b). |
| Pest free place of production | Place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period (FAO 2019b). |
| Pest free production site | A defined portion of a place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period and that is managed as a separate unit in the same way as a pest free place of production (FAO 2019b). |
| 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 2019b). |
| 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 2019b). |
| Pest risk assessment (for regulated non-quarantine pests) | Evaluation of the probability that a pest in plants for planting affects the intended use of those plants with an economically unacceptable impact (FAO 2019b). |
| Pest risk management (for quarantine pests) | Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2019b). |
| Pest risk management (for regulated non-quarantine pests) | Evaluation and selection of options to reduce the risk that a pest in plants for planting causes an economically unacceptable impact on the intended use of those plants (FAO 2019b). |
| 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 |

| Term or abbreviation | Definition |
|---|---|
| | the basis of current and historical pest records and other information (FAO 2019b). |
| Phytosanitary certificate | An official paper document or its official electronic equivalent, consistent with the model of certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (FAO 2019b). |
| Phytosanitary certification | Use of phytosanitary procedures leading to the issue of a phytosanitary certificate (FAO 2019b). |
| Phytosanitary measure | Phytosanitary relates to the health of plants. Any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO 2019b). 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 2019b). |
| Phytosanitary regulation | Official rule to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests, including establishment of procedures for phytosanitary certification (FAO 2019b). |
| 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 2019b). |
| Practically free | Of a consignment, field or place of production, without pests (or a specific pests) in numbers or quantities in excess of those that can be expected to result from, and be consistent with good cultural and handling practices employed in the production and marketing of the commodity (FAO 2019b). |
| Production site | In this report, a production site is a continuous planting of Chinese jujube 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. |
| Pupa | An inactive life stage that only occurs in insects that undergo complete metamorphosis, for example butterflies and moths (Lepidoptera), beetles (Coleoptera) and bees, wasps and ants (Hymenoptera). |
| Quarantine | Official confinement of regulated articles for observation and research or for further inspection, testing or treatment (FAO 2019b). |
| 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 2019b). |
| 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 2019b). |
| 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 2019b). |
| Regulated pest | A quarantine pest or a regulated non-quarantine pest (FAO 2019b). |
| 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. |

| Term or abbreviation | Definition |
|---|---|
| Risk management measure | Are 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 2019b). |
| SPS Agreement | WTO Agreement on the Application of Sanitary and Phytosanitary Measures. |
| Stakeholders | Government agencies, individuals, community or industry groups or organizations, whether in Australia or overseas, including the proponent/applicant for a specific proposal, who have an interest in the policy issues. |
| Surveillance | An official process which collects and records data on pest occurrence or absence by surveying, monitoring or other procedures (FAO 2019b). |
| Systems approach(es) | The integration of different risk management measures, at least two of which act independently, and which cumulatively achieve the appropriate level of protection against regulated pests. |
| Trash | Soil, splinters, twigs, leaves and other plant material, other than fruit as defined in the scope of this risk analysis.<br>For example, stem and leaf material, seeds, soil, animal matter/parts or other extraneous material |
| Treatment | Official procedure for the killing, inactivation or removal of pests, or for rendering pests infertile or for devitalisation (FAO 2019b). |
| 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. |

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