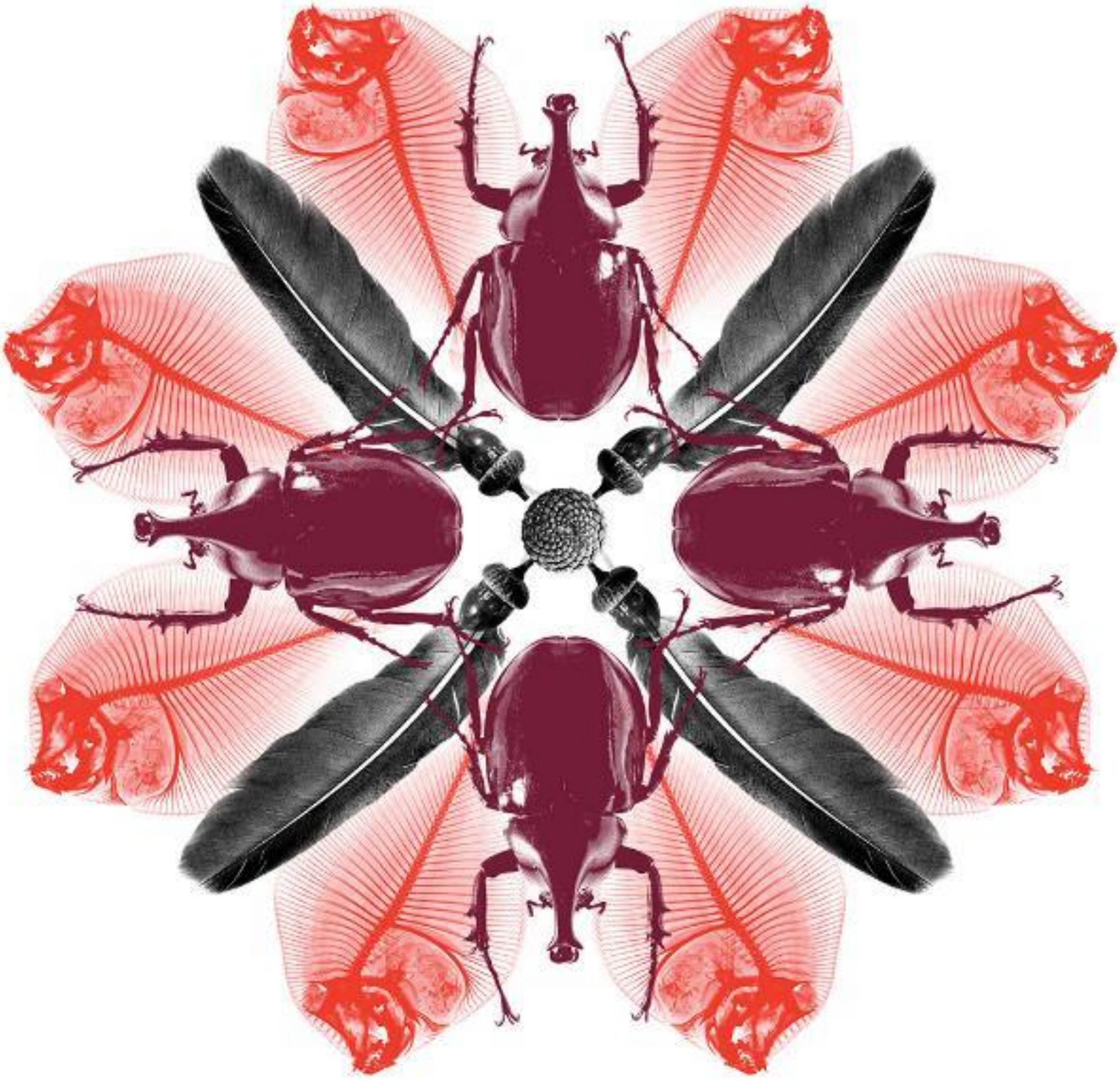
Australian Government

Department of Agriculture and Water Resources

Final report for the review of biosecurity import requirements for fresh dates from the Middle East and North Africa region

February 2019



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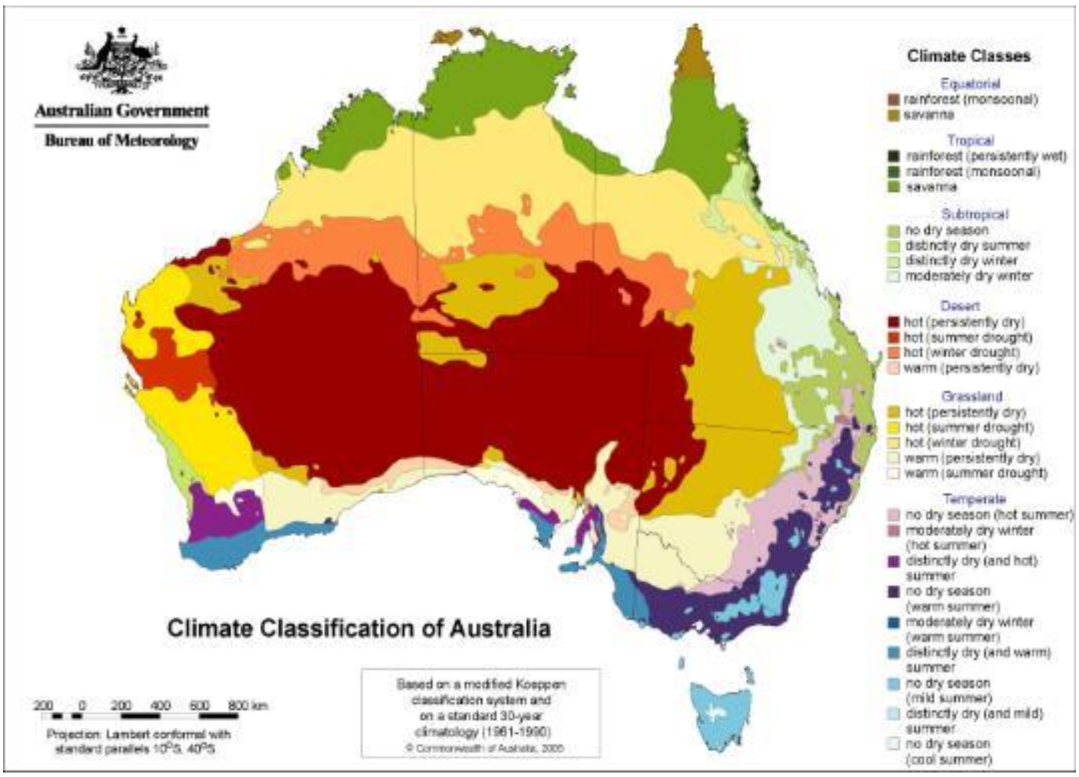

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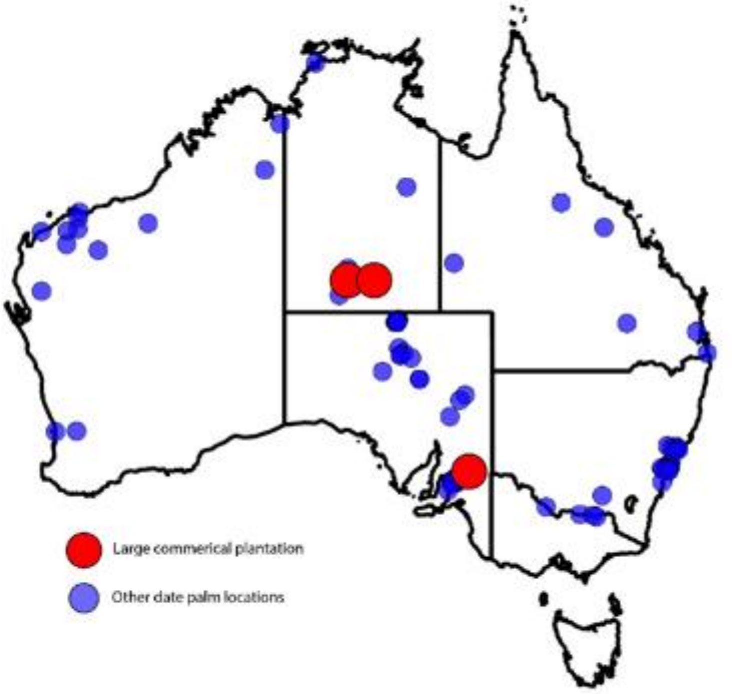

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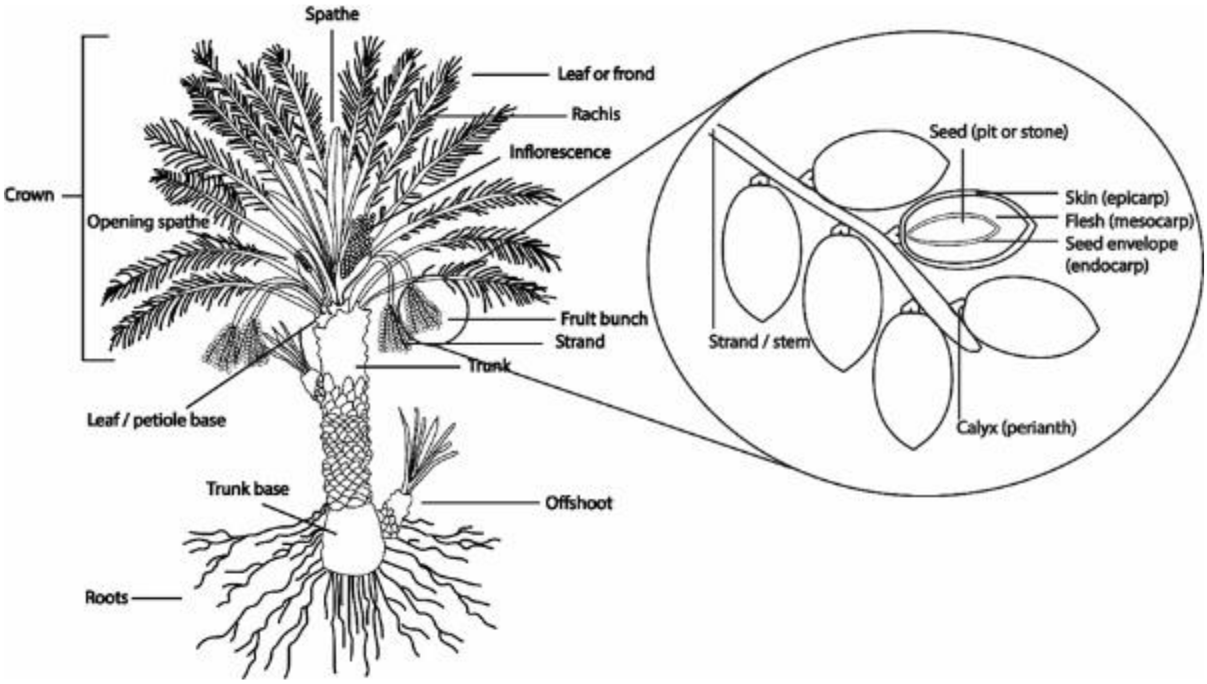


Acronyms and abbreviations

Term or abbreviation	Definition
ACT	Australian Capital Territory
ALOP	Appropriate level of protection
APVMA	Australian Pesticides and Veterinary Medicines Authority
BA	Biosecurity Advice
BCE	Before Common Era
BICON	Australia's Biosecurity Import Conditions System
BIRA	Biosecurity Import Risk Analysis
CABI	CAB International, Wallingford, UK
CAPQ	Central Administration of Plant Quarantine, Cairo Egypt
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EP	Existing policy
FAO	Food and Agriculture Organization of the United Nations
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
ISPM	International Standard for Phytosanitary Measures
MENA	Middle East and North Africa
NSW	New South Wales
NPPO	National Plant Protection Organisation
NT	Northern Territory
PC	Phytosanitary Certificate
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 Australian Government Department of Agriculture and Water Resources
UAE	United Arab Emirates
USA	United States of America
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, loose, fresh dates for human consumption (fruit with greater than 30 per cent moisture content) from the Middle East and North Africa (MENA) region.

For the purposes of this analysis, the MENA region is taken to comprise Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Pakistan, Palestinian Territories, Qatar, Saudi Arabia, Syria, Tunisia, Turkey, the United Arab Emirates (UAE) and Yemen.

Because the major quarantine pests of fresh dates are similar or the same in most date producing areas, the Australian Government Department of Agriculture and Water Resources (the department) considered it appropriate to conduct this risk analysis as a regional review of biosecurity import requirements.

Grouping these market access requests into one risk analysis, and expanding it to a regional review relevant to 21 date-producing countries and territories in the MENA region, is an innovative approach being trialled as a project funded by the Agricultural Competitiveness White Paper and is intended to increase the efficiency of the risk analysis process and reduce the number of outstanding market access requests. This approach will help to facilitate two-way trade and maintenance of Australia's international trade relations. Accordingly, this regional review is not based upon information of pest occurrences specific for any one exporting country. However, if an identified quarantine pest associated with fresh dates is present in any country across the Middle East and North Africa region then appropriate measures would need to be applied.

Currently, the importation of loose fresh dates for human consumption is permitted into Australia only from California, United States of America provided they are sourced and packed in an area which is free from all economically significant fruit flies, and that they meet all other Australian biosecurity requirements.

This final report recommends that the importation of loose, fresh dates to Australia from all commercial production areas of the MENA region also be permitted, subject to their meeting agreed biosecurity requirements as summarised in this review.

This final report contains details of all known pests with the potential to be associated with the importation of fresh dates from the MENA region 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 level of biosecurity risk to an acceptable level.

Eight pests have been identified in this risk analysis as requiring risk management measures. All of these pests are arthropods.

The eight quarantine pests requiring risk management measures are *Eutetranychus palmatus*, *Oligonychus afrasiaticus* (date dust mite), *Oligonychus pratensis* (Banks grass mite), *Bactrocera dorsalis* (Oriental fruit fly), *Bactrocera zonata* (peach fruit fly), *Ceratitis capitata* (Mediterranean fruit fly), *Planococcus ficus* (vine mealybug) and *Pseudococcus cryptus* (citriculus mealybug).

The recommended risk management measures take account of regional differences within Australia. Only one pest, *Pseudococcus cryptus* (citriculus mealybug), has been identified as a regional quarantine pest for Western Australia, requiring risk management measures because interstate quarantine regulations and enforcement exist.

Biosecurity risk is managed at many steps along the import pathway. As described in this report, a number of practices undertaken prior to planting, during crop production, and post-harvest can contribute to mitigating pest and disease risks. This final report recommends a range of risk management measures which, combined with operational systems to reduce the risks posed by the eight quarantine pests, will achieve the appropriate level of protection for Australia. Those measures include:

- consignment freedom for spider mites and mealybugs verified by pre-export visual inspection, and remedial action if found.
- area freedom for fruit flies, which may include specifically identified pest free areas, pest free places of production, and/or pest free production sites, or fruit treatment considered to be effective against all life stages of fruit flies (for example, cold disinfestation treatment).

Should a country wish to use one or more of the proposed measures of area freedom, cold disinfestation treatment or other alternative treatments to manage the risk posed by fruit flies, the exporting country's NPPO will need to provide an appropriate technical submission to the department for its consideration.

Every submission must, as appropriate:

- fulfil requirements as set out in ISPM 4 (FAO 2017a) and ISPM 10 (FAO 2016d) for area freedom for all relevant pests, and additionally ISPM 26 (FAO 2016g) for area freedom for fruit flies, and/or
- demonstrate the processes and procedures for the registration, approval and audit of disinfestation treatment facilities.

Written technical submissions on the draft report were received from eight stakeholders. The final report takes into account stakeholder comments on the draft report. The department has made a number of changes to the risk analysis following consideration of stakeholder comments on the draft report and subsequent review of the literature. These changes include:

- amendments to the text in the pest categorisation table (Appendix A) to clarify the pathway association of several arthropods with fresh date fruit, for example the spider mites *Oligonychus biharensis* and *Oligonychus senegalensis, Raoiella indica* (red palm mite), *Epuraea luteola* (pineapple sap beetle), *Cicadulina bipunctata* (maize orange leafhopper) and *Ommatissus lybicus* (dubas bug).
- the addition of Appendix B 'Issues raised in stakeholder comments', which summarises key stakeholder comments, for example on *Rhynchophorus ferrugineus* (red palm weevil), and how they were considered in the final report.
- amendments to date production areas and export statistics for Tunisia
- 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 a zero risk, approach to the management of biosecurity risks. This approach is expressed in terms of the ALOP for Australia, which is defined in the *Biosecurity Act 2015* as providing a high level of protection aimed at reducing risk to a very low level, but not to zero.

Australia's risk analyses are undertaken by the Australian Government Department of Agriculture and Water Resources 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 scientific advice).

Further information about Australia's biosecurity framework is provided in the *Biosecurity Import Risk Analysis Guidelines 2016* located on the Australian Government Department of Agriculture and Water Resources website.

1.2 This risk analysis

1.2.1 Background

Australia has import conditions for semi-dried and dried dates (moisture content 30 per cent or less) from all countries. The importation of loose, fresh dates (moisture content above 30 per cent, individual fruit on short stems) for human consumption is currently permitted only from California, USA under production conditions of area freedom for fruit flies.

This risk analysis is in response to formal market access requests from Egypt, Iran, Iraq, Morocco, Saudi Arabia, Tunisia, and the United Arab Emirates for fresh dates to the Australian market.

On the basis of these requests, this risk analysis has been expanded to cover the entire Middle East and North Africa (MENA) region. For the purposes of this analysis, the MENA region is taken to comprise Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Pakistan, Palestinian Territories, Qatar, Saudi Arabia, Syria, Tunisia, Turkey, the United Arab Emirates (UAE) and Yemen.

The MENA region produces the majority of the world's date fruit, and it is expected that this regional risk analysis will provide policy to guide assessment of future market access requests for fresh dates to Australia.

On 24 August 2016, the department announced the formal commencement of this risk analysis, advising that it would be progressed as a review of biosecurity import requirements for the purposes of section 174 of the *Biosecurity Act 2015*.

In July 2017, officers from the department visited major date production areas in the United Arab Emirates, and in September 2017 visited Saudi Arabia and Morocco to observe production systems and packing house operations. The objectives of the visits were to gain an understanding of the available pest and production information, and packing house operations.

The pests identified as potentially associated with fresh date fruit from the MENA region are mostly the same as, or similar to those that have been assessed previously by the department on fresh dates from California, USA or other horticultural commodities, and for which appropriate measures are already established.

1.2.2 Description of fresh dates

The date fruit is classified botanically as a berry consisting of a single seed surrounded by a fibrous, parchment-like endocarp, a fleshy mesocarp and the fruit skin (epicarp). Each fruit is attached to the strand (spikelet) by a calyx or cap (perianth) (Figure 1).

Fresh dates are of plump, wrinkle-free appearance with skin colours varying from yellow, red, brown to black depending on variety. Generally 'khalal' stage dates overlapping slightly with early 'rutab' stage are considered as 'fresh dates'.

Date fruit development progresses through five stages (Figure 2) that collectively take up to 200 days (6–8 months) from pollination to full maturation at the 'tamar' (tamr) stage (Barreveld 1993; Hodel & Johnson 2007; Kader & Hussein 2009; Siddiq, Aleid & Kader 2014; Zaid 2002). These stages, referred to by their Arabic denominations, are:

Hababauk

The first developmental stage after pollination of 4–5 weeks in duration. Hababauk is the term for the female flower and the period just after pollination when the young fruit is creamy white before gradually changing to green at the kimri stage. The hababauk stage is sometimes considered to form part of the next 'kimri' stage (Siddiq, Aleid & Kader 2014).

Kimri (Khimri)

The second and longest developmental stage of date fruit which is of 9–14 weeks in duration. The still developing fruit is botanically mature, but not full sized, and contains up to 85 per cent moisture content. There is a rapid increase in fruit size, weight, moisture content and reducing sugar content during this stage. The fruit is elongated, greenish in colour, with a hard texture and a high tannin concentration. The fruit is inedible by direct consumption but can be used for making chutney or pickles.

Khalal (Khalaal, Biser, Bisr)

A stage of about 6 weeks beginning about 22 weeks after pollination, when the date fruit gains maximum size and weight, with the sugar converted mainly to sucrose. During this stage the tannins begin to precipitate causing a loss of astringency, and at this stage dates are mainly consumed raw as fresh fruit. The dates are physiologically mature, hard and crisp in texture, with a moisture content of about 45–75 per cent, and bright yellow, red or brown to black in colour depending on variety.

Rutab

A stage of about 4 weeks beginning about 28 weeks after pollination. In this stage the dates lose water, becoming softer and sweeter as sucrose is converted to invert or reducing sugars (glucose and fructose). At this stage the moisture content is 30–45 per cent. The dates are soft and succulent, less astringent and are partially or wholly brown in colour. This stage is considered the start of ripening. At this stage many cultivars of dates are eaten fresh.

Tamar (Tamr, Tamer)

The final stage of development lasts from 2–4 weeks, with the fruit developing highest sweetness, lowest astringency due to enzymatic changes and highest concentration of reducing sugars, especially glucose and fructose, with no or very low sucrose and a moisture content of less than 30 per cent. Tamar stage dates can be stored for months to years without spoiling. The dates have a texture ranging from soft and pliable to firm or hard, and a typical wrinkled appearance depending on the variety. Tamar dates are amber to dark brown, bluish or almost black in colour.

Figure 2 Examples of the different stages of dates for human consumption: a) khalal stage, b) rutab stage and c) tamar stage. The appearance of each stage can differ with date variety.

1.2.3 Scope

The scope of this risk analysis is to consider the biosecurity risk that may be associated with the importation of commercially-produced, loose fresh date fruit (*Phoenix dactylifera*) from the MENA region, for human consumption in Australia.

For the purposes of this risk analysis, loose fresh dates are defined as single fruit with a moisture content above 30 per cent, with skin, flesh and seeds, including a cap and a small portion of stem. Multiple fruits must not be attached to the same portion of stem.

This risk analysis covers all commercially-produced fresh date fruit of all cultivars/varieties from the major production provinces and/or regions of the countries/territories of the Middle East and North Africa, as listed in section 1.2.1, in which they are grown for export.

1.2.4 Existing policy

International policy

Import policy exists for fresh date fruit from the state of California, USA. The fresh dates must be sourced and packed in an area which is free of all economically significant fruit flies.

In addition, there are established import conditions for semi-dried and dried dates (below 30 per cent moisture content) for all countries. Import conditions also exist for a number of fresh fruits from several Middle East and North African countries, including Pakistan. The potential pests of biosecurity concern identified for fresh date fruit from the MENA region are the same as, or similar to those commodities for which import conditions exist. Examples of key pest groups and associated commodities are provided in Table 1.1.

Table 1.1 Existing policies for quarantine pests

Species groups	Existing policy
Spider mites	Table grapes from China (Biosecurity Australia 2011a), bananas from the Philippines (Biosecurity Australia 2008b), apples from China (Biosecurity Australia 2010) and mangosteens from Indonesia (DAFF 2012)
Fruit flies	Citrus from Egypt (Biosecurity Australia 2002a); truss tomatoes from the Netherlands (DAFF 2003); persimmons from Japan, Korea and Israel (DAFF 2004c); sweet oranges from Italy (Biosecurity Australia 2005a); mangoes from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a, 2011c), Pakistan (Biosecurity Australia 2011b), Indonesia, Thailand and Vietnam (Department of Agriculture and Water Resources 2015)
Mealybugs	Persimmons from Japan, Korea and Israel (DAFF 2004c); sweet oranges from Italy (Biosecurity Australia 2005a); mangoes from Taiwan (Biosecurity Australia 2006b) and Tahitian limes from New Caledonia (Biosecurity Australia 2006a)

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 bicon.agriculture.gov.au/BiconWeb4.0.

The department has considered all the pests 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.

Domestic arrangements

The Australian Government is responsible for regulating the movement of goods such as plants and plant products into and out of Australia. However, the state and territory governments are responsible for plant health controls within their individual jurisdiction. Legislation relating to resource management or plant health may be used by state and territory government agencies to control interstate movement of plants and their products. Once plant and plant products have been cleared by Australian Government biosecurity officers, they may be subject to interstate movement conditions. It is the importer's responsibility to identify, and ensure compliance with all requirements.

1.2.5 Contaminating pests

In addition to the pests of fresh date fruit from the MENA region that are assessed in this risk analysis, there are other organisms that may arrive with the imported commodity. These organisms could include pests of other crops or predators and parasitoids of other arthropods. The department considers these organisms to be contaminating pests that could pose human health and phytosanitary risks. These risks are identified and addressed using existing operational procedures that require a 600 unit inspection of all consignments, 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.

1.2.6 Consultation

On 24 August 2016 the department notified stakeholders in Biosecurity Advice 2016-29 of the formal commencement of a review of biosecurity import requirements for fresh date fruit from the MENA region.

Prior to and after announcement of this review the department communicated with Australian date growers regarding this risk analysis process, including through direct meetings (face to face and teleconferences).

The department has engaged with Egypt, Iran, Iraq, Morocco, Pakistan, Saudi Arabia, Tunisia, and the United Arab Emirates as well as Australian state and territory governments during the preparation of this report. The department provided a draft pest categorisation to Australian state and territory agricultural departments for their advance consideration of regional pests, prior to the formal release of the draft report.

The draft report was released on 31 July 2018 (Biosecurity Advice 2018-17) for comment by stakeholders, for a period of 60 days that concluded on 28 September 2018. The department received eight written technical submissions on the draft report. All submissions were carefully considered and, where relevant, changes were made to the final report. A summary of major stakeholder comments and how they were considered is contained in Appendix B.

Further consultation with domestic stakeholders was undertaken during and after close of the stakeholder comment period.

In addition, the department also released two biosecurity fact sheets in August 2016 and January 2017 to explain the rationale and timing of the review process, and to ensure accurate information was available to stakeholders.

1.2.7 Next Steps

This final report will be published on the department's website with a notice advising stakeholders of its release. The department will notify the proposer, the registered stakeholders and the WTO Secretariat about the release of the final report. Publication of this final report represents the end of the risk analysis process. The biosecurity requirements recommended in this final report will form the basis of the conditions published in the Biosecurity Import Conditions (BICON) system and subsequently for any import permits issued.

2 Method for pest risk analysis

This chapter sets out the method used for the pest risk analysis (PRA) in this report. The Australian Government Department of Agriculture and Water Resources has conducted this PRA in accordance with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: Framework for pest risk analysis (FAO 2016b) and ISPM 11: Pest risk analysis for quarantine pests (FAO 2017b) 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 2018). A pest is 'any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products' (FAO 2018). 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 2018).

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.

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

2.1 Stage 1 Initiation

Initiation identifies the pest(s) and pathway(s) that are of biosecurity 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 2018).

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 2018).

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 to Table 4.3.

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 2017b). 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 typical 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 2018). 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 2018). 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 2018) and ISPM 11 (FAO 2017b).

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 more than one criterion has an impact of 'F'; or a single criterion has an impact of 'F' and each remaining criterion an 'E'.	Extreme
2	A single criterion has an impact of 'F'; or all criteria have an impact of 'E'.	High
3	One or more criteria have an impact of 'E'; or all criteria have an impact of 'D'.	Moderate
4	One or more criteria have an impact of 'D'; or all criteria have an impact of 'C'.	Low
5	One or more criteria have an impact of 'C'; or all criteria have an impact of 'B'.	Very Low
6	One or more but not all criteria have an impact of 'B', and all remaining criteria have an impact of 'A'.	Negligible

2.2.4 Estimation of the unrestricted risk

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

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

Table 2.5 Risk estimation matrix

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

2.2.5 The appropriate level of protection (ALOP) for Australia

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

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

2.2.6 Adoption of outcomes from previous assessments

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

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

The 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 importation pathway. Similarly, the estimate of potential consequences associated with a pest species is also independent of the importation 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.

Group PRAs that were applied to this risk analysis are:

- The *Final group pest risk analysis for thrips and orthotospoviruses on fresh fruit, vegetable, cut-flower and foliage imports* (Department of Agriculture and Water Resources 2017b), 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 proposed phytosanitary measures (or combination of measures) is evaluated, using the same approach as used to evaluate the unrestricted risk, to ensure the restricted risk for the relevant pest or pests achieves the ALOP for Australia.

ISPM 11 (FAO 2017b) 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 Middle East and North Africa's commercial production practices for fresh dates

This chapter provides information on the export capabilities of countries, and pre-harvest, harvest and post-harvest practices used for the production of fresh date fruit across the Middle East and North Africa (MENA) region. Multiple sources were used to determine these practices including information provided by several countries in the MENA region, visits to three countries by the Department of Agriculture and Water Resources and literature sources (Al-Khayri, Jain & Johnson 2015a, b; Manickavasagan, Mohamed Essa & Sukumar 2012; Siddiq, Aleid & Kader 2014; The Emirates Center for Strategic Studies and Research 2003).

3.1 Assumptions used in estimating unrestricted risk

An analysis of the commercial practices used in the production of fresh dates indicated that many are similar across the plantations of the MENA region.

The Australian Government Department of Agriculture and Water Resources visited date production areas in the United Arab Emirates in July 2017, and in Saudi Arabia and Morocco in September 2017, to verify the pest status and to observe the harvest, processing and packing procedures for export of fresh dates. The department's observations and additional information provided during the visits confirmed the production and processing procedures described in this chapter as commercial production practices for fresh dates for export.

Because this review is considering multiple countries/territories with varying though similar production and pest management procedures, the report makes few assumptions about the production practices involved. Therefore only basic standards of date palm management and postharvest handling practices are assumed to have occurred when assessing the pest risks. These practices are outlined below. However, it is assumed that all fresh dates will be sourced from commercial growers and exported from packing facilities registered with the relevant NPPO.

In assessing the likelihood of pest introduction to Australia the production, harvest and post-harvest production practices for fresh dates, as described in this chapter, are regarded as baseline commercial practices that are expected to be implemented for all regions and for all fresh dates within the scope of this analysis, by all countries/territories intending to export fresh dates to Australia. Countries/territories in the MENA region proposing to export fresh dates to Australia will be expected to meet these minimum baseline commercial production and pest management practices or equivalent alternative practices. Where a specific practice described in this chapter is taken into account to estimate the unrestricted risk, it is clearly identified and explained in Chapter 4.

3.2 Fresh date production areas

Date palm, *Phoenix dactylifera,* is an important food plant cultivated mostly in the arid areas of the world (Wakil, Faleiro & Miller 2015; Zaid et al. 2002). The earliest evidence of date palm cultivation occurs as early as 4000 BCE in Ur, lower Mesopotamia, in what is now present-day Iraq (Al-Khayri, Jain & Johnson 2015a; Al Mashhadani 2014; Erskine et al. 2004; Hodel & Johnson 2007; Janick & Paull 2008; Zaid et al. 2002). In the Nile Valley, date palm cultivation goes back to 3000 BCE (Erskine et al. 2004). However the exact origin of the date palm is not known with certainty.

The spread of date palm occurred over many centuries along two main routes (Zaid et al. 2002), firstly from Iraq eastwards towards Iran, into the Indus Valley, Pakistan and NW India, and secondly from Egypt westwards towards Libya, the Maghreb and Sahel countries, Spain, and finally to the New World. The date palm was introduced to Tunisia by the Phoenicians who, from the 3rd millennium BCE, spread the cultivation of date palms throughout the Mediterranean region (Al-Khayri, Jain & Johnson 2015a).

Date palm plantations are now distributed between 10 °N and 39 °N latitude, but occur mostly between 24 °N and 34 °N in the MENA region (Al-Khayri, Jain & Johnson 2015a; Zaid 2002). The importance of the date palm to the economies of several date-producing countries is based on its ability to withstand severe climatic conditions, water stress and salinity. Around 60 per cent of the world's date palms exist in North Africa and the Middle East, where it is considered important to the life and culture of the people in those regions (Wakil, Faleiro & Miller 2015).

Production of fresh dates is widespread across the MENA region and represents the large majority of the world's date production. Date production in this region has been steadily increasing over the last five years (FAO 2016a), and Maps 4 to 11 highlight the date-growing areas in the countries that have requested market access. The largest producers in the world are currently Egypt, Iran, Algeria, Saudi Arabia, the United Arab Emirates and Iraq (FAO 2016a). The date growing production and processing practices identified in these countries are considered representative for the MENA region.

As the world's largest producer, Egypt grows dates in many parts of the country with production centered on desert oases and the river Nile (Map 4). Information provided by the Egyptian government identified the main date growing governorates as New Valley, Asswan, El Giza, Kalubia and El-Sharkia (Ministry of Agriculture and Land Reclamation 2002). Published information confirms this, as well as indicating that fresh dates tend to be grown along the Nile Delta and the north Mediterranean coast (Al-Khayri, Jain & Johnson 2015a).

Tunisia is also a large date exporting country in the MENA region that ranks as the world's largest exporter in terms of value. Tunisian dates account for 23% of the value of world trade (APII 2017; ONAGRI 2018). Information supplied by Tunisia indicates that dates are grown mostly in the south of the country in the four governorates of Tozeur, Kébili, Gabès and Gafsa (Map 5) (Ministére de l'Agriculture 2013; ONAGRI 2018). On the bases of geographical and bioclimatic factors, Tunisia distinguishes the continental oases of Djerid (Tozeur and Nefta) and Nefzaoua (Kébili and Douz), the coastal oases of Gabès and the high altitude oases of Gafsa. Overall there are 261 oases distributed as follows: Kébili, 140 oases (54 per cent); Tozeur, 74 oases (28 per cent); Gabès, 35 oases (13 per cent) and Gafsa, 12 oases (5 per cent) (APII 2017). Additional literature has shown that the governorate of Tatouine also has a significant date palm sector (Al-Khayri, Jain & Johnson 2015a), and that the governorates of Kairouan, Kasserine and Sfax have no significant date palm production. Most of Tunisia's production comes from oases located in the Governorates of Tozeur and Kebili (APII 2017).

In Morocco the date palm is grown in several areas located on the southern flank of the Atlas Mountains in the pre-Saharan and Saharan regions along the rivers (wadis) and around oases and permanent wells (khettaras). Most of the production is located in four zones, Ouarzazate-Zagora (Draâ Valley), Errachidia (Tafilalet and Ziz valleys), Tata, Akka and Figuig (Map 6) accounting for nearly 97 per cent of the Moroccan palm groves (Al-Khayri, Jain & Johnson 2015b; CPPS & RD-ONSSA 2017).

Iran is the second largest producer of dates producing approximately 1.2 million tonnes per year on 200,000 hectares (PPO 2017). Date palm is grown in 13 of the 31 Iranian provinces with more than 98 per cent of the date palm plantations located in the southern belt of Iran. The main producing provinces that account for 95 per cent of total annual production are Kerman, Khuzestan, Sistan & Baluchestan, Bushehr, Hormozgan and Fars (Map 7) (Al-Khayri, Jain & Johnson 2015b; PPO 2017).

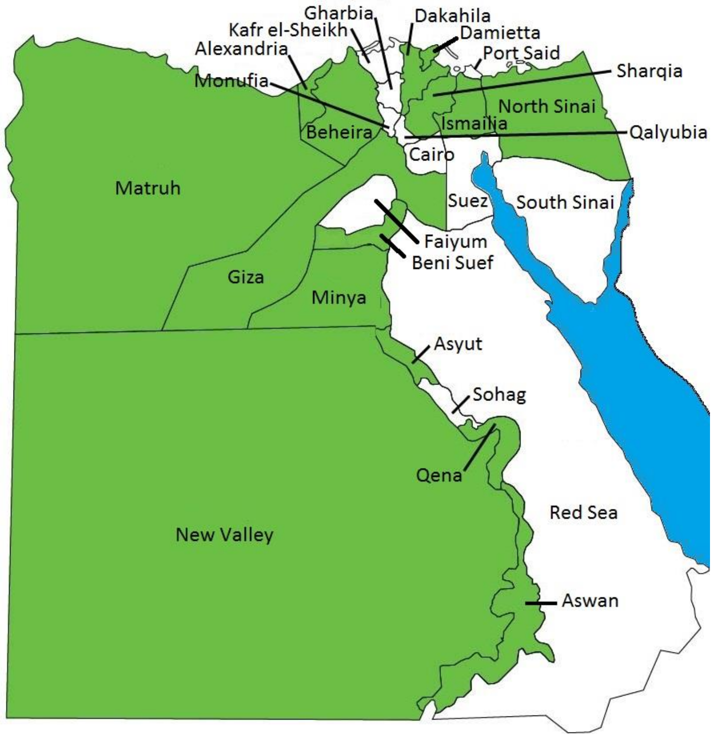
The UAE grows date palms in almost every region. Production is focused primarily in the Emirate of Abu Dhabi (Al-Khayri, Jain & Johnson 2015b; The Emirates Center for Strategic Studies and Research 2003), which accounts for the largest share of date production of approximately 45 per cent. Smaller levels of production also occur around Dubai in the middle of the country, as well as in other areas in the north and east of the country (Map 8) (Abu Dhabi Farmers' Services Centre 2012; Al-Khayri, Jain & Johnson 2015b; Salem 1998; The Emirates Center for Strategic Studies and Research 2003).

In Iraq, the main production of dates is centred around the Euphrates and Tigris rivers and includes the cities and governorates of Babylon, Karbala, Basra, Baghdad, Diyala and Dhi Qar (Iraqi Dates Processing & Market Company 2013), with the main production areas of Babil and Baghdad (Al-Khayri, Jain & Johnson 2015b). Published data indicates that 14 of Iraq’s 18 governorates are identified as growing dates (shown in Map 9), with the largest volume of production occurring in Baghdad and Diyala (Al-Khayri, Jain & Johnson 2015b).

Similar to the UAE, Saudi Arabia produces dates in every region of the country (Al-Khayri, Jain & Johnson 2015b). Riyadh produces most of the dates from Saudi Arabia, while the surrounding regions contribute the majority of remaining production. While all regions are involved in date production, some regions contribute less than one per cent of total production (Map 10) (Al-Khayri, Jain & Johnson 2015b).

Pakistan is the sixth largest producer of dates producing around 526 749 tonnes in 2013 (FAO 2016a) grown over 93 088 hectares (Al-Khayri, Jain & Johnson 2015b). Date palm is grown in all four provinces of Pakistan with Balochistan and Sindh Provinces accounting for about 90 per cent of the total date production in Pakistan (Map 11). The main date-producing areas are Kech (Turbat) and Panjgur in Balochistan and Khairpur and Sukkur in Sindh Province (Al-Khayri, Jain & Johnson 2015b). The remaining 10 per cent of total harvested area is carried out in the provinces of Punjab and Khyber Pakhtunkhwa located in northern Pakistan (Al-Khayri, Jain & Johnson 2015b).

Map 4 Date production areas in Egypt



Source: Date production areas are shown in green. Based on information provided by Egypt, supplemented by Al-Khayri, Jain and Johnson (2015a).

Map 5 Date production areas in Tunisia

Source: Date production areas are shown in green. Based on information provided by Tunisia, supplemented by Al-Khayri, Jain and Johnson (2015a).

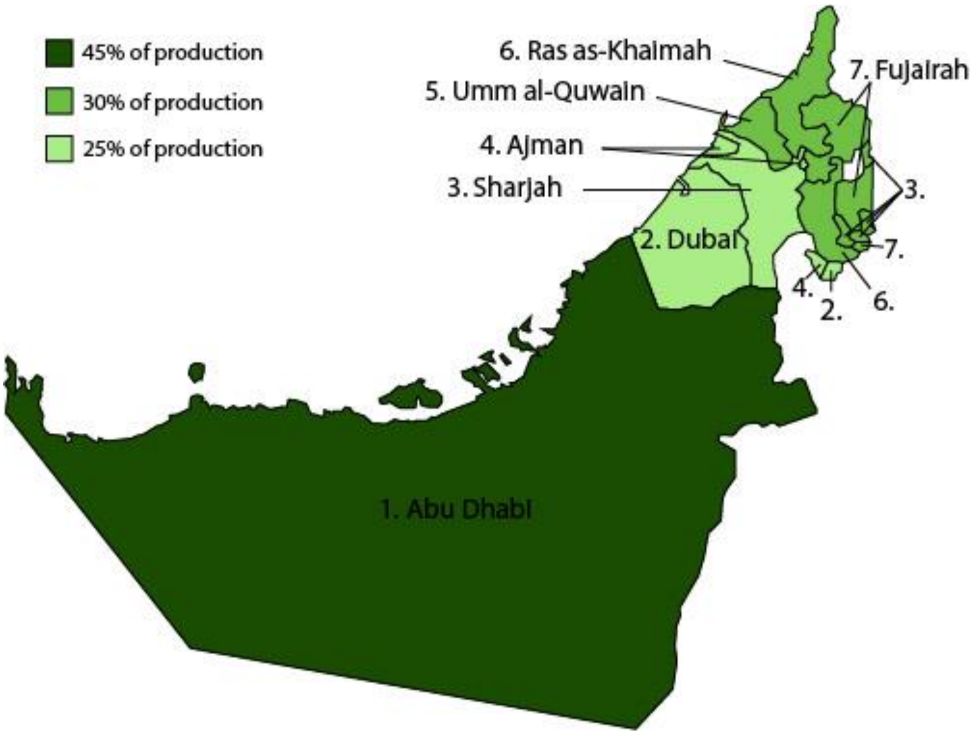
Map 6 Date production areas in Morocco

Source: Date production regions in Morocco based on information provided by Morocco (CPPS & RD-ONSSA 2017), supplemented by Al-Khayri, Jain and Johnson (2015b).

Map 7 Date production areas in Iran

Source: Date production areas are shown in green. Based on information provided by Iran (PPO 2017), supplemented by Al-Khayri, Jain and Johnson (2015b).

Map 8 Percentage of date production in the Emirates of the UAE

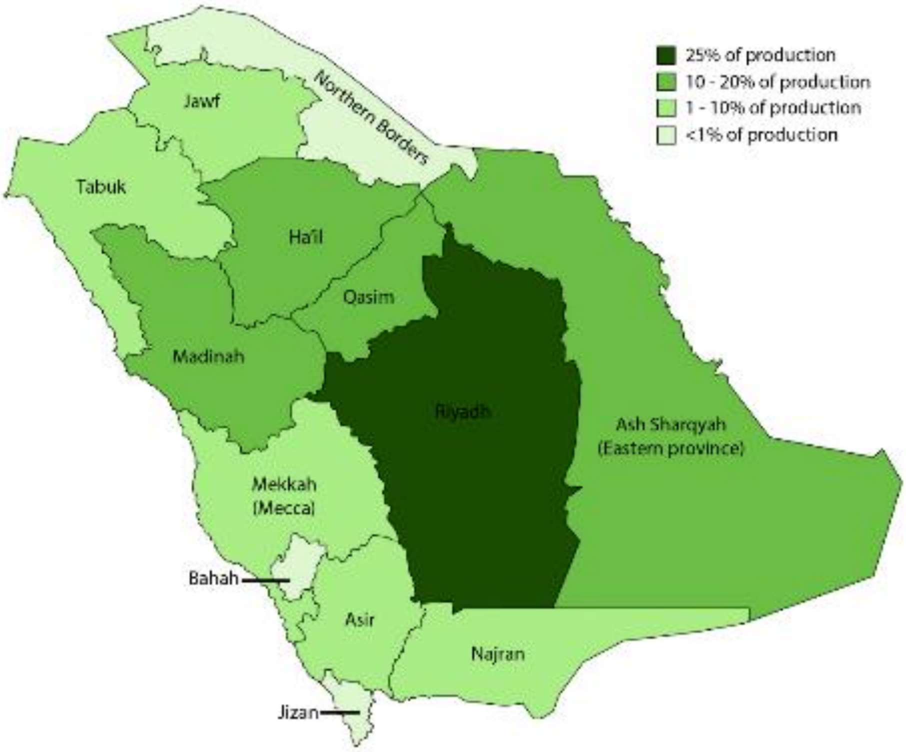


Source: Based on information provided by UAE, supplemented by Al-Khayri, Jain and Johnson (2015b) and Salem (1998).

Map 9 Date production areas in Iraq

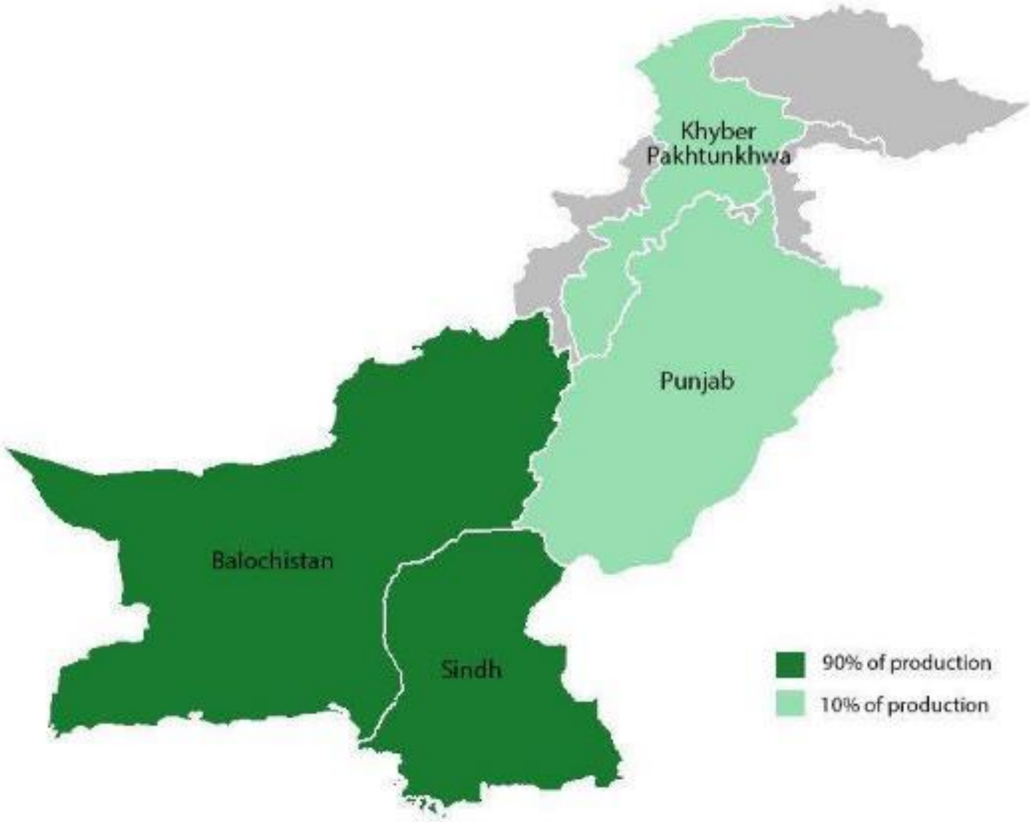
Source: Date production areas are shown in green, based on information provided by Iraq, supplemented by Al-Khayri, Jain and Johnson (2015b).

Map 10 Date production areas in Saudi Arabia



Source: Date production areas are shown in green based on information by Al-Khayri, Jain and Johnson (2015b).

Map 11 Main date production areas in Pakistan



Source: Main date production areas are shown in green based on information by Al-Khayri, Jain and Johnson (2015b)

3.3 Climate in production areas

The climate of the MENA region is hot and dry, with extreme heat common in summer. Average maximum monthly temperatures range from 28 degrees Celsius in winter to 45 degrees Celsius or more in summer, and average minimum monthly temperatures range from 3 degrees Celsius in winter to 24 degrees Celsius in summer (Figure 3) (World Weather Online 2017). In the east of the MENA region, the climate becomes more tropical, with Pakistan experiencing monsoonal seasons (World Weather Online 2017). For the large majority of countries/territories in the region (with the notable exception of Pakistan), an extreme hot and dry period is experienced from June to August, with minimal or no rain (World Weather Online 2017). Rainfall increases as temperatures cool in November and December (World Weather Online 2017). The winter season occurs in the early months of the year (January to March in Dubai, November to February in Islamabad), which is characterised by lower temperatures that can fall below freezing in Pakistan and 15 degrees Celsius in UAE (World Weather Online 2017).

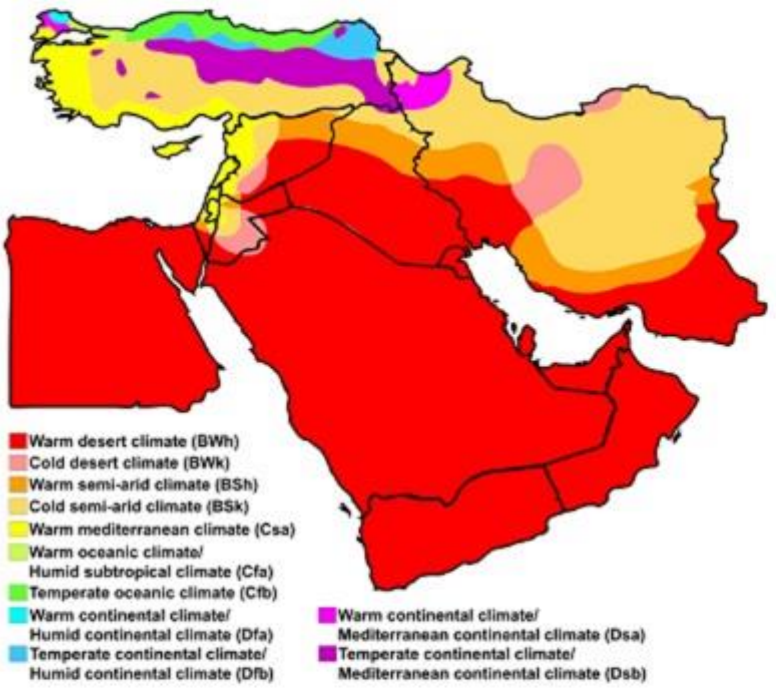
The arid and hyper-arid regions of North Africa and the Middle East are well known for their hot, dry, dusty, southerly winds (50 degrees Celsius and below 30 per cent relative humidity) that blow from the Sahara. Generally it is referred to as the sirocco, but it is called chergui in Morocco, ghibly in Libya, and khamsin in Egypt and the Middle East (Buyckx 1994). These winds cause marked climatic variations, and may occur 30 to 90 days per year. The temperature rises above 40 degrees Celsius and the relative air humidity drops to 5 to 10 per cent or less.

The date palm requires a long, intensely hot summer without rain or excessive humidity for five to seven months from pollination to harvesting to successfully produce fruit (Zaid et al. 2002). It is thus ideally suited to the semi-arid and arid desert regions of the Middle East and North Africa.

Using the Köppen-Geiger classification the climate of the region can broadly be classified as a BWh climate (warm desert climate) (see Map 12 to Map 14); the BWh classification typically denotes an arid, hot, desert climate with a mean annual temperature greater than or equal to 18 degrees Celsius (Peel, Finlayson & McMahon 2007). The desert climate is characterised by extreme heat during the day, an abrupt drop in temperature at night, and very low rainfall. As noted above, the average summer temperatures in the hottest regions is about 45 degrees Celsius, but daily readings of 54 degrees Celsius are not unusual. The heat becomes intense shortly after sunrise and lasts until sunset (World Weather Online 2017).

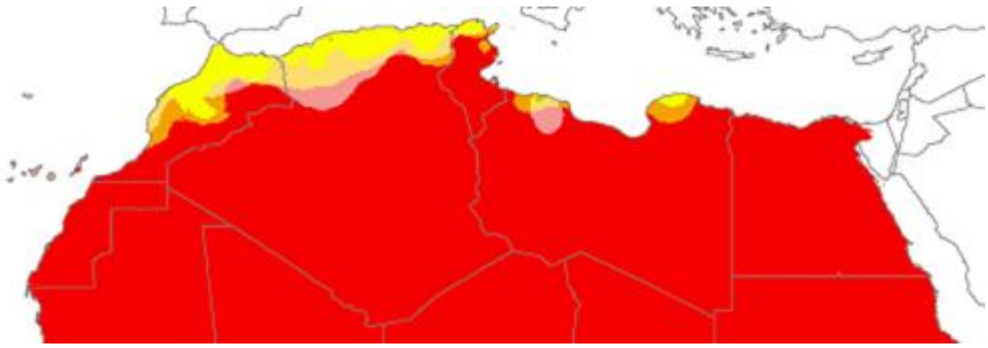
The monsoonal season in Pakistan can present challenges for date-growing enterprises. During the months of July and August rainfall can exceed 100 millimetres in many areas, reaching 150 millimetres in some regions (World Weather Online 2017). This high level of rainfall can lead to higher incidences of fungal infection than are seen in other parts of the MENA region (Sindh Board of Investment 2010).

Map 12 A guide to the Middle East region Köppen climatic zones



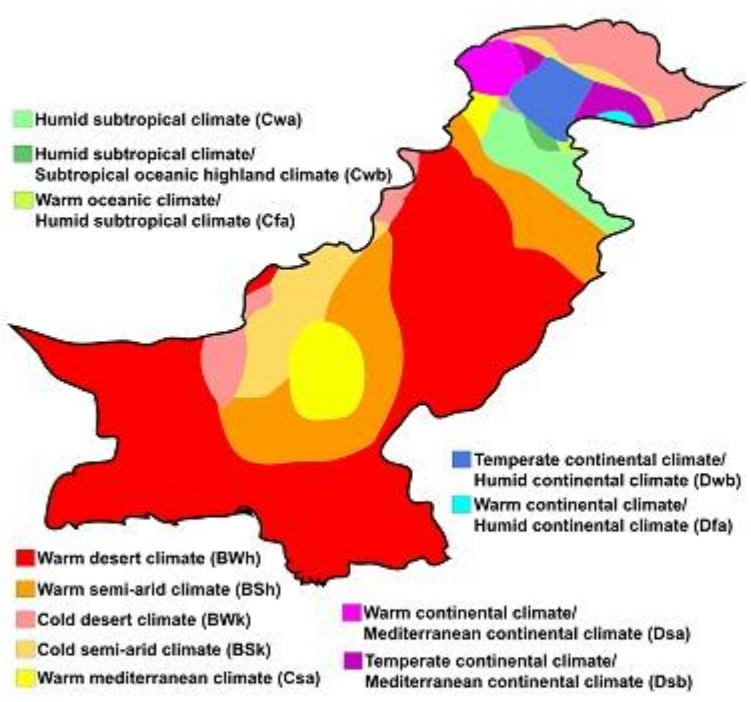
Source: Peel, Finlayson and McMahon (2007). (Creative Commons Attribution-Share Alike 4.0 Unported license creativecommons.org/licenses/by-sa/4.0/legalcode)

Map 13 A guide to the North African region Köppen climatic zones



Source: Modified from Peel, Finlayson and McMahon (2007). (Creative Commons Attribution-Share Alike 4.0 Unported license creativecommons.org/licenses/by-sa/4.0/legalcode)

Map 14 A guide to the Köppen climatic zones of Pakistan



Source: Peel, Finlayson and McMahon (2007). (Creative Commons Attribution-Share Alike 4.0 Unported license creativecommons.org/licenses/by-sa/4.0/legalcode)

Figure 3 Maximum and minimum temperatures and mean monthly rainfall in main date palm production areas

Source: World Weather Online (2017).

3.4 Pre-harvest

3.4.1 Cultivars

The date palm is thought to be one of the world's earliest cultivated fruit trees (Jain, Al-Khayri & Johnson 2011) with around 3,000 to 4,000 cultivars known to exist (Al Mashhadani 2014; Hodel & Johnson 2007; Jain, Al-Khayri & Johnson 2011). Three main cultivar groups exist: soft fruit (for example, cultivars Barhee, Halawy, Khadrawy, Medjool), semi-dry fruit (for example, cultivars Dayri, Deglet Noor, Zahidi) and dry fruit (for example, cultivar Thoory). Popular date varieties include Medjool, Deglet Noor (Deglet Nour), Barhee (Barhi), Zahidi, Khadrawy and Sayer. Fresh date varieties (khalal and rutab stage) that are likely to be exported include Naghal, Khunaizy, Khalas, Lulu, Fard, Zaghloul, Samany, Hayany, Ben-Eisha, Amhat, Om-Elferakh, Hillawi, Khadrawi and Bergy (Abu Dhabi Farmers' Services Centre 2012; Al-Khayri, Jain & Johnson 2015a, b; Al Mashhadani 2014; Iraqi Dates Processing & Market Company 2013). These cultivars represent up to 45 per cent of production in some countries from the MENA region (Al-Khayri, Jain & Johnson 2015a). Fresh date cultivars such as Khalas are also in the top ten most commercially popular date varieties in Saudi Arabia (Al-Abdoulhadi et al. 2011).

3.4.2 Cultivation practices

Date palms are dioecious (two sexes) plants that bear either male or female flowers. As the tallest member of the genus *Phoenix*, date palms reach a full height of up to 30 metres, and can take three to seven years to sexually mature. Date palms are good crops in desert areas as they are drought tolerant, can utilise underground water, tolerate extreme heat and cold, and can produce economically viable fruit for up to 50 years (Al-Khayri, Jain & Johnson 2015a; Hodel & Johnson 2007; Jain, Al-Khayri & Johnson 2011; Siddiq, Aleid & Kader 2014). Date palms cultivated in the typical desert environment flower once each year, in spring in the Northern Hemisphere; this habit appears to be governed by climate (Jain, Al-Khayri & Johnson 2011). In years of exceptional rainfall, a second flowering in the same year can occur (Jain, Al-Khayri & Johnson 2011).

Figure 4 Typical young commercial palm plantation in the United Arab Emirates

Propagation

Commercial plants are produced by vegetative propagation (offshoot or tissue culture propagation), or by using sexual propagation (seeds). Offshoots, used in vegetative propagation, are taken from axillary buds from the trunk of young trees and planted in the ground, producing a clone that is true to the parent plant (Al-Khayri, Jain & Johnson 2015b, a; Hodel & Johnson 2007; Janick & Paull 2008; Siddiq, Aleid & Kader 2014). Offshoots are ideally planted from late spring to early summer (Janick & Paull 2008).

Tissue culture propagation has become more common in recent years due to the spread and threat of Bayoud disease, which has proven difficult to control (Janick & Paull 2008). Bayoud disease, also known as Fusarium wilt, destroyed around two-thirds of all date palms in Morocco in less than a century, where they had previously existed for centuries (Al-Khayri, Jain & Johnson 2015a; CPPS & RD-ONSSA 2017). Tissue culture is the preferred method of propagating date palms for selecting disease-resistant varieties (Al-Khayri, Jain & Johnson 2015a) such as those resistant to Bayoud. By taking meristematic tissues (undifferentiated cells), a large number of true plantlets with characteristics similar to offshoots can be created (Janick & Paull 2008).

Seed propagation is not as common as vegetative propagation as it produces individuals with differing fruit qualities, harvesting times and production potential (Al-Khayri, Jain & Johnson 2015b, a; Erskine et al. 2004; Siddiq, Aleid & Kader 2014). Growing date palms from seeds also means that 50 per cent of propagated plants will be male, which will not produce date fruit (Jain, Al-Khayri & Johnson 2011; Siddiq, Aleid & Kader 2014; The Emirates Center for Strategic Studies and Research 2003).

Figure 5 Tissue culture propagation of Mejhool date variety

Planting

The method of planting date palm offshoots varies from country to country. Offshoots are usually planted in depressions in the soil, generally with some protection from the elements while they establish and grow. Planting usually occurs between January and June, with the exact timing varying between countries (Jain, Al-Khayri & Johnson 2011; Siddiq, Aleid & Kader 2014).

Palm trees propagated using tissue culture techniques produce large numbers of true-to-type plantlets, and are generally derived from cultivars that show superior fruit traits and/or have disease resistance to pathogens such as the soil-borne fungus *Fusarium oxysporum* f.sp. *albedinis,* the causative agent of Bayoud disease. Tissue cultured plants are acclimatised for a period of 6 to 12 months in protected premises (Figure 6), and have at least one pinnate leaf blade before planting out. Young palm trees first planted out are commonly given some environmental protection by being surrounded with a tent of pruned palm fronds.

Figure 6 Mejhool seedlings in pots in a greenhouse for acclimatisation prior to planting out

Irrigation

While date palms are highly drought tolerant and can live in very dry climates, they still require a periodic water source (Janick & Paull 2008). For optimum fruit growth farmers aim to irrigate before pollination and during bunch development (Chao & Krueger 2007). Recommendations for irrigation range from only two periods during the year (summer and winter) in the UAE (Al Mashhadani 2014) to as many as 12 times each year (Jain et al. 2007). The most common and oldest irrigation method in the region is flooding, often through mechanical pumping of sub-surface water (Jain, Al-Khayri & Johnson 2011; Janick & Paull 2008; Tengberg 2012). Other common and traditional irrigation methods involve taking advantage of water in naturally formed oases and wells (Jain, Al-Khayri & Johnson 2011; Tengberg 2012). These natural sources allow date palms to grow in extremely dry countries with large desert areas such as Tunisia and the UAE (Al-Khayri, Jain & Johnson 2015b, a; Jain, Al-Khayri & Johnson 2011). Egypt and Iraq have also utilised large rivers such as the Nile and the Euphrates respectively. In older Egyptian plantations date palms are organised in 10 metres by 10 metres basins, providing uniform areas for irrigation (Jain, Al-Khayri & Johnson 2011). More recently the use of drip and bubbler irrigation has become increasingly common throughout the region (Figure 7)(Hodel & Johnson 2007).

Figure 7 Modern drip irrigation system in common use in commercial plantations

Fertilisation

Fertilisation of date palms is a common practice in all MENA regions. The timing, type and amount of fertilisation varies among and within countries, but usually occurs after harvesting (Al Mashhadani 2014; Janick & Paull 2008). Use of fertilisers is important to increase fruit quality and weight as date palm plantations in the MENA region often lack key soil elements, such as nitrogen (Al-Khayri, Jain & Johnson 2015b, a; Al Mashhadani 2014; Jain, Al-Khayri & Johnson 2011; Janick & Paull 2008; The Emirates Center for Strategic Studies and Research 2003).

Traditional fertilisation methods dominate the date palm industry, though modern chemical products are increasingly being adopted (Al-Khayri, Jain & Johnson 2015b; Siddiq, Aleid & Kader 2014). Fertilisation with inorganic elements includes use of nitrogen, ammonium nitrate, phosphate, zinc sulphate and boric acid (Al-Khayri, Jain & Johnson 2015a; Hodel & Johnson 2007; Khayyat et al. 2007; Siddiq, Aleid & Kader 2014). Inorganic fertilisers can be applied in various manners including as solids, sprays or by injection into date palm trunks (Abo-Rady, Ahmed & Ghanem 1987; Al-Khayri, Jain & Johnson 2015b, a). In Tunisia on average only 150 grams of inorganic fertilisers are used per palm, compared to around 20 to 50 kilograms of manure per plant (Al-Khayri, Jain & Johnson 2015a; Al Mashhadani 2014; Khayyat et al. 2007).

Pollination

Pollination of female flowers is essential to ensure fruit is produced. Date palms are predominately pollinated manually, with male flowers or pollen from healthy trees being directly inserted into female spathes (Al-Khayri, Jain & Johnson 2015a; Al Mashhadani 2014). Alternatively, strands of male flowers are cut from a tree and two or three are placed between the female inflorescences (Al-Khayri, Jain & Johnson 2015a; Hodel & Johnson 2007; The Emirates Center for Strategic Studies and Research 2003). Between 60 to 80 per cent of female spathes need to be pollinated for fruit production to occur (Chao & Krueger 2007; Hodel & Johnson 2007; Janick & Paull 2008). Pollination activities occur as soon as farmers notice spathes opening (around January to March) in order to forestall natural pollination via wind or insects (Al-Khayri, Jain & Johnson 2015a; Al Mashhadani 2014; Hodel & Johnson 2007). One male date palm can be used to pollinate between 25 and 50 female date palms (Al-Khayri, Jain & Johnson 2015a; Janick & Paull 2008; The Emirates Center for Strategic Studies and Research 2003).

In the palm plantations visited by department staff in Morocco, Saudi Arabia and the UAE, mechanical pollination was a widely used method. This technique requires pollen to be mixed with a filler such as talc, bleached wheat flour or walnut-hull dust, usually in a ratio of 1:10, before application. This mixture is then machine-sprayed onto the opened female spathes from ground level. This technique reduces labour costs and improves efficiency of pollination, enabling palms to be pollinated several times in a short period of time (Zaid et al. 2002).

Bunch Management

In order to maximise production of quality fruit, several bunch management techniques are employed. After pollination it is common practice to tie growing fruit bunches to leaf stalks in order to help support the weight of the fruit; this is commonly referred to as 'bunch bending' (Al-Khayri, Jain & Johnson 2015b, a; Chao & Krueger 2007; Hodel & Johnson 2007; Janick & Paull 2008). This typically occurs when bunches have reached 75 per cent of their final weight (Janick & Paull 2008).

Bunches of dates are often thinned to increase individual fruit size, reduce damage from humidity, increase overall fruit quality, and advance ripening (Al-Khayri, Jain & Johnson 2015a; Al Mashhadani 2014; Chao & Krueger 2007; Hodel & Johnson 2007). Farmers can thin production by removing whole bunches, reducing the number of strands in a bunch, or reducing the number of fruit per strand (Al-Khayri, Jain & Johnson 2015a; Al Mashhadani 2014; Chao & Krueger 2007; Hodel & Johnson 2007). Bunch thinning typically occurs in two stages. The first stage is performed during February to March, after the female spathes have opened, and usually before pollination, when strands are thinned from each spathe. The second stage is conducted during mid-March to mid-May when bunches are thinned to maintain from six to eight bunches per date palm (Al Mashhadani 2014).

Quality of bunches is also often maintained and improved by bagging with brown or white paper, cotton, nylon or other bags (Figure 8) (Al-Khayri, Jain & Johnson 2015a; Al Mashhadani 2014; Chao & Krueger 2007; Hodel & Johnson 2007; Siddiq, Aleid & Kader 2014; Wakil, Faleiro & Miller 2015). The practice of 'bunch bagging' helps protect fruit from damage caused by high humidity, rain, sunburn, and pests such as birds, rodents and insects (Al-Khayri, Jain & Johnson 2015a; Al Mashhadani 2014; Chao & Krueger 2007; Hodel & Johnson 2007; Siddiq, Aleid & Kader 2014; Wakil, Faleiro & Miller 2015). Bagging typically starts when date fruit starts to ripen into the khalal stage (Al Mashhadani 2014; Hodel et al. 2012).

Figure 8 Date bunches bagged for protection against insect pests and birds

3.4.3 Pest management

Commercially grown date fruits and date palms are susceptible to a number of pests and diseases (Table 3.1). The main reported pests of concern in the MENA region are date moths, the red palm weevil, and a number of fungal diseases (Wakil, Faleiro & Miller 2015; Zaid et al. 2002). Farmers commonly apply a variety of pesticides to help manage these problems. Physical barriers and cultural practices such as removing old leaves and excess trunk fibre are employed to control pest loads.

Some producers in palm plantations visited by departmental staff did not see a need to treat for pests. However, most non-organic system plantations did use chemical treatments. On the organic plantations visited non-chemical methods were used, such as the use of chickens to control weeds and pests, pheromone traps for red palm weevil, light traps to monitor date moths, and spraying of Neem tree extract, especially when date moth was apparent. Some organic producers also used chemicals permitted under their organic certification program.

Table 3.1 Pests and a range of management options as stated by countries seeking market access for fresh dates into Australia

Pest/pathogen group	Scientific names	Management
Date moths and butterflies	*Batrachedra amydraula, Arenipses sabella, Cadra cautella, C. calidella, C. elutella, C. figulilella, Virachola livia*	• Removal of fibrous strands from base of terminal fronds. • Pheromone lures and spraying with insecticides. • Fruit bagging.
Spider mites	*Oligonychus afrasiaticus, O. pratensis*	• Regular monitoring and surveillance of date palms. • Removal of fibrous material from trunk and base of terminal fronds. • Removal, collection and incineration of infested dates before the mites spread and disperse to overwinter refugia. • Removal of ground weeds that provide overwinter refugia. • Spraying foliage with water during the day. • Spraying with chemical acaricides. • Spraying with environmentally-friendly pesticides.
Scales	*Parlatoria blanchardii, Fiorinia fioriniae*	• Removal of lower leaves after egg laying activity observed. • Use of offshoots free of scales. • Use of yellow sticky traps/tape to attract adults. • Use of environmentally friendly pesticides such as oils. • Spraying with chemical insecticides. • Use of biological control agents such as the predatory ladybird beetle *Chilocorus bipustulatus* var *iranensis.*
Palm weevils	*Rhynchoporus ferrugineus*	• Removal of fibrous strands from the base of terminal fronds. • Avoiding pruning or wounding palm trees during warmer months. • Trunk injections of insecticides to target larvae. • Use of pheromone traps for mass adult trapping. • Spraying adults with chemical insecticides. • Enforcement of domestic quarantine regulations for transport of palm trees.
Sap sucking insects	*Ommatissus lybiscus*	• Light traps to detect presence, followed by spraying with chemical insecticides if needed. • Removal of lower leaves after egg laying activity observed. • Use of yellow sticky traps/tape to attract adults. • Cultural practices in plantations with a suitable distance left between tree rows to minimise cross-infection.
Stem borers	*Oryctes elegans*, *Oryctes* spp., *Jebusea hammerschmidti*, *Phonapate frontalis*	• Removal of dead and decaying frond tissue to remove egg laying sites. • General plantation hygiene. • Use of poisonous baits. • Spraying with chemical insecticides. • Use of light traps to attract adults.

Pest/pathogen group	Scientific names	Management
		• Avoiding excessive watering to prevent waterlogging and subsequent tree stress.
Trunk borers	*Microcerotermes diversus*	• Spraying and dusting trunk with insecticides. • Removal of alternative hosts such as weeds and dry grasses from plantation ground. • Regular irrigation and fertilisation to avoid tree stress. • Ploughing ground around base of trees.
Fungus Black scorch	*Ceratocystis paradoxa*	• General plantation hygiene and prevention of stem borers to reduce entry infection sites. • Using ozonated water to reduce contamination and sterilise date fruit surface.
Fungus Inflorescence rot Khamedj disease	*Mauginiella scattae*	• Spraying with fungicides. • Removal and destruction of infected inflorescences and spathes. • Removal and burning of fronds in late summer and early autumn after harvest. • Maintaining regular irrigation and fertilisation regimes to avoid tree stress.
Fungi Fruit rots	*Alternaria alternata*, *Botryodiplodia* sp., *Cladosporium* sp., *Aspergillus japonicus*, *Nigrospora* sp., *Baecilamyces* sp., *Fusarium lateritium*, *F. moniliforme*, *Penicillum* sp.	• Maintaining regular irrigation and fertilisation regimes to avoid tree stress. • Cultivation of soil and improvement of drainage in heavy soils. • Fallowing infected areas for several years after removal and destruction of infected palm trees. • Fruit bagging. • Using ozonated water to reduce contamination and sterilise date fruit surface.

Source: Pest management strategies based on information provided by countries supplemented by Al-Khayri, Jain and Johnson (2015a, 2015b); (Siddiq, Aleid & Kader 2014)

3.5 Harvesting and handling procedures

Dates can be harvested in multiple ways including:

- removing whole bunches intact from the palm tree, or
- picking individual fruit from the strands, or
- collection from the bottom of protective bags enclosing date bunches after they have fallen from the strands.

Fresh dates are harvested early in the season just before, or as they mature around May-July, although this can extend into October depending on the variety (Al Mashhadani 2014; Chao & Krueger 2007; The Emirates Center for Strategic Studies and Research 2003). Mechanical harvesting is possible, but the majority of harvesting is still done by manual means (Figure 9) (Al-Khayri, Jain & Johnson 2015b, a; Chao & Lee 1966; Siddiq, Aleid & Kader 2014). Pickers reach the crown of the date palm by climbing the trees, using ladders, or using mechanical lifts (Al-Khayri, Jain & Johnson 2015b, a; Chao & Lee 1966; Siddiq, Aleid & Kader 2014). Fruit bunches are cut from the palm and are placed on mats, before they are carefully moved to packing houses (Al-Khayri, Jain & Johnson 2015b, a; Chao & Lee 1966; Siddiq, Aleid & Kader 2014).

Figure 9 Manual harvesting of dates in Saudi Arabia

3.6 Post-harvest

Harvested date fruit being transported from plantations to packing houses requires protection to prevent damage to the soft and sensitive fruit (Siddiq, Aleid & Kader 2014). Dates are typically packed into large transport bins or racks early in the morning to minimise drying (Siddiq, Aleid & Kader 2014; Zaid 2002). Dates on bunches must have minimal exposure to shaking, in order to keep the dates on the bunches (Zaid 2002). Dates were observed by departmental officers being transported to packing houses in bunches enclosed in protective bags, in wooden trays with wire mesh bottoms, and in plastic bins in utilities and small flatbed trucks (Figure 10 to Figure 12).

Figure 10 Bunches of dates being transported to the packing house in bags

Figure 11 Wooden trays used for transporting dates to a packing house

Figure 12 Plastic crates used for transporting dates to the packing house

3.6.1 Packing house

Harvested dates are taken to a packing house either as a bunch enclosed in a protective bag, or in large plastic or wooden bins. Upon arrival at packing houses, dates go through several processes designed to preserve the highest quality of the fruit and manage any infestation by pests. Previously, packing houses such as shown in (Figure 15), conducted mandatory fumigation of dates on arrival to completely clean the dates of any pests (eggs, pupae, larvae or adults) and protect from subsequent infestation (Al-Khayri, Jain & Johnson 2015b, a; Chao & Lee 1966; Janick & Paull 2008; Siddiq, Aleid & Kader 2014; The Emirates Center for Strategic Studies and Research 2003; Zaid et al. 2002). However, fumigation of dates prior to grading and packing does not now appear to be routinely practised across the region. The use of methyl bromide has largely been discontinued in line with the Montreal Protocol. Across the region, use of novel alternative treatments such as phosphine, ethyl formate with carbon dioxide, and ozonation (use of nitrogen and ozone modified atmospheres) is being practised. Radio frequency (RF) treatment is also being trialled in some countries.

Figure 13 Grading and sorting of dates in the packing house

Figure 14 Dates being cleaned and graded ready for packing

Figure 15 Fumigation chambers in a major packing house

Some packing houses also wash dates to remove dirt and other contaminants (Figure 16), and then dry the fruit with hot air blasting (Al-Khayri, Jain & Johnson 2015b, a; Chao & Lee 1966; Janick & Paull 2008; The Emirates Center for Strategic Studies and Research 2003).

Figure 16 Dates being washed ready for packing

Dates are usually graded and sorted by hand (Figure 13) (Chao & Krueger 2007; Zaid 2002), with electronic device grading being utilised in some large commercial establishments. However, some form of mechanical sorting device was installed in most establishments visited by the department. Grading of fruit aims to remove poor quality and damaged fruits, or fruits with skin separation (Janick & Paull 2008; Siddiq, Aleid & Kader 2014; The Emirates Center for Strategic Studies and Research 2003; Zaid 2002).

Fresh dates may be stored at refrigerated temperatures to extend their shelf-life before exportation (Chao & Krueger 2007). Many producers and exporters spoken to during the verification visits by the department used some form of cold storage such as freezing at minus 18 degrees Celsius for two to three weeks, to maintain date freshness. Packing of fresh dates is important to protect the dates from damage. Fresh dates are often packed into cardboard

(Figure 17) or plastic boxes with relevant information stickered on top of the boxes (Janick & Paull 2008; Zaid 2002).

Figure 17 Cardboard boxes for the export of rutab dates

Not all countries in the MENA region have well established commercial production standards for dates (The Emirates Center for Strategic Studies and Research 2003). However, during verification visits many highly developed and technically capable date processing plants, with well-developed standards, were observed.

Export procedures

Uniform pre-export inspections to the same standard are unlikely to occur across the entire MENA region. Quality controls before transportation for export can include weighing of fruit/packages, assessment of fruit for uniformity, damage or defects, and for moisture content (Zaid 2002). Phytosanitary certificates are issued to indicate that consignments of dates meet specified phytosanitary import requirements, including for example, that the commodity has been inspected and found to be free of pests and diseases, and is in conformity with the certifying statement of the appropriate model certificate (FAO 2016e; Zaid 2002).

3.6.2 Transport

Transportation of fresh dates from the MENA region to Australia will occur by either air freight or sea shipment. Air freight transport is anticipated to take about one day, and is the most viable option of transporting fresh date fruit. The use of sea shipments is also possible, however sea freight can take between 15 and 50 days to arrive in Australia, depending on port of origin from the MENA region (SeaRates 2016). Such a long transport time would require well controlled cold-storage containers in order to maintain fruit quality.

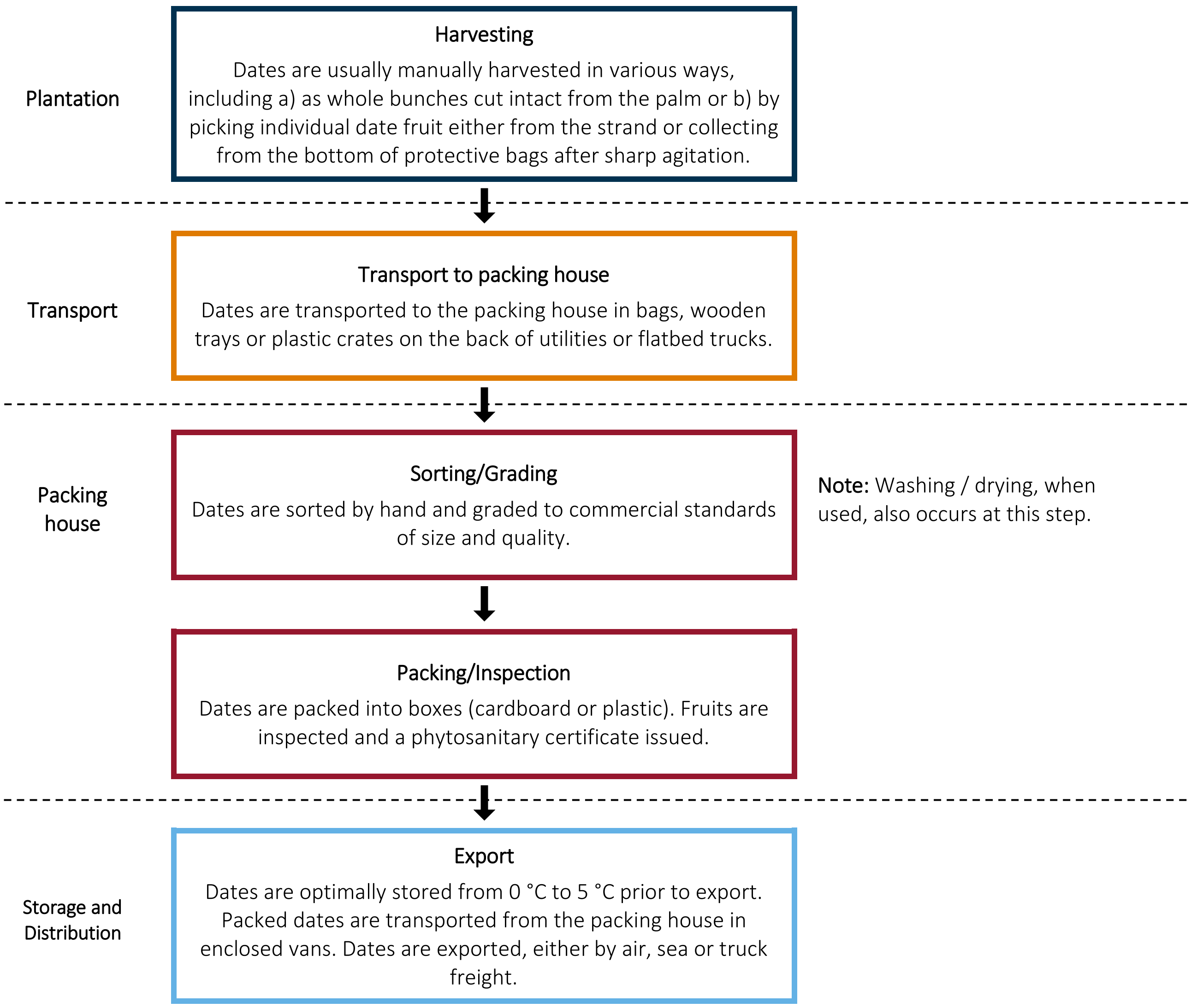
Level of fruit moisture is an essential characteristic of date fruit that affects its quality and storage stability (Siddiq, Aleid & Kader 2014). The safe moisture content for storage of dates is between 24 and 25 per cent (Barreveld 1993; Siddiq, Aleid & Kader 2014). Fresh dates with a moisture content above 30 per cent (khalal and rutab stages), as assessed in this analysis, have a relatively short shelf life due to their high moisture content, and are prone to rapid deterioration in storage. Therefore, for optimum shelf life, these fruits must be handled and marketed using cold-chain technology, as for any other perishable commodity (Siddiq, Aleid & Kader 2014). Most often it is considered that fresh dates should be cooled to 0 degrees Celsius and transported under refrigeration (0 degrees Celsius to 2 degrees Celsius and 90 to 95 per cent relative humidity) to maintain quality (Kader & Hussein 2009). Khalal dates should be stored at 0 degrees Celsius and 85 to 95 per cent relative humidity to reduce water loss, and to delay ripening to the rutab stage, and maintain their textural and flavour quality (Kader & Hussein 2009).

Figure 18 Cold room for storage of dates

Storage and transport at low temperatures (Figure 18) is the most important tool for maintaining quality of dates because it minimizes loss of colour, flavour, and textural quality. It also delays development of sugar spotting, reduces incidence of mould, yeast, and insect infestation, and prevents development of syrupiness (due to conversion of sucrose into reducing sugars) and souring of excessively moist dates (Kader & Hussein 2009).

The overall process of production of fresh dates for export is summarised in Figure 19. It is noted that not all countries and areas in this region will produce fresh dates using this precise methodology, as there are no standard production practices adopted for the entire region.

Figure 19 Summary of typical plantation and post-harvest steps for fresh dates grown in the Middle East and North Africa region for export



3.7 Export capability

3.7.1 Production statistics

Most of the MENA region's date production is for the domestic market. For example, in 2016 a total of approximately 8 million tonnes was produced by the entire MENA region, of which only approximately 1 million tonnes was exported (approximately 14 per cent of production). Estimates of production of each country in the MENA region are presented in Table 3.2.

Table 3.2 Production of dates (fresh, dried and semi-dried) from the individual countries in the Middle East and North Africa region in 2016

Region	Production (tonnes)
Egypt	1 694 813
Iran (Islamic Republic of)	1 065 704
Algeria	1 029 596
Saudi Arabia	964 536
United Arab Emirates	671 891
Iraq	615 211
Pakistan	494 601
Oman	348 642
Tunisia	241 000
Libya	173 546
Morocco	125 329
Kuwait	98 366
Yemen	57 726
Israel	43 200
Turkey	34 592
Qatar	28 877
Jordan	13 401
Bahrain	10 627
Syrian Arab Republic	4 319
Palestinian Territory	3 479
Lebanon	No data
Total	8 158 576

Source: FAO (2016a).

3.7.2 Export statistics

Exports of dates from the MENA region have increased during recent years. Export volumes of the biggest exporters from the region for fresh, dried and semi-dried dates are provided in Table 3.3.

Table 3.3 Export volumes of dates (fresh, dried and semi-dried) from the Middle East and North Africa region in 2016

Region	Export (tonnes)
Iraq	292 018.3
United Arab Emirates	250 258.8
Pakistan	148 031.7
Iran (Islamic Republic of)	128 045.5
Saudi Arabia	106 134.3
Tunisia	103 232.2
Israel	60 749.6
Algeria	28 221.6
Egypt	17 669.2
Oman	14 242.8
Jordan	5 091.1
Turkey	4 747.3
Palestinian Territory	1 933.2
Morocco	387.4
Kuwait	368.3
Lebanon	334.8
Libya	215.0
Syrian Arab Republic	19.1
Bahrain	15.4
Yemen	7.3
Qatar	No data
Total	1 161 723.0

Source: International Trade Centre (2016).

3.7.3 Export season

Fresh date harvests occur during the months of June to December in the MENA region, and it is expected that fresh dates will be exported during, or just after, this period.

4 Pest risk assessments for quarantine pests

Quarantine pests associated with fresh date fruit from the Middle East and North Africa (MENA) region have been identified in the pest categorisation process (Appendix A), and are listed in Table 4.1 to Table 4.3. This chapter assesses the likelihood of the entry (importation and distribution), establishment and spread of these pests, and the economic, including environmental, consequences these pests may cause if they were to enter, establish and spread in Australia.

Assessments of risks associated with these pests are presented in this chapter unless otherwise indicated. Most of the pest species and all of the pest groups considered here have been assessed previously by the department. Therefore, the outcomes of previous assessments have been adopted for these pests, unless new information is available that suggests the risk would be different for this commodity. Further explanation of the adoption of previous assessments is outlined here.

The assessment of the likelihood of importation of pests of fresh dates that have been assessed previously involves case-by-case consideration of factors relevant to the importation of fresh dates from the MENA region with those assessed previously. Such factors include the commodity type, prevalence of the pest, and typical commercial production practices. After comparing these factors and reviewing the latest literature, the department has considered it appropriate in many cases not to reassess the likelihood of pest importation with fresh dates from the MENA region, on the grounds that the outcome of reassessment would be comparable to that concluded in previous assessments. In addition, where changes to likelihood ratings for importation would not alter the unrestricted risk estimate (URE), there is no need to reassess the likelihood of importation.

The need to reassess the likelihood of distribution for pests previously assessed is considered on a case-by-case basis by comparing factors relevant to the distribution of fresh dates from the MENA region with those of commodities assessed previously. These factors include the commodity type, time of year at which import takes place, and availability and susceptibility of hosts during the time of import. After comparing these factors and reviewing the latest literature, the previously assessed ratings of likelihood of distribution have been adopted where the department considers that the likelihood of distribution for fresh dates from the Middle East and North Africa region would be comparable to that determined in the previous assessments.

The likelihoods of establishment and spread of a pest in the PRA area will be comparable regardless of the fresh fruit commodity/country pathway on which the pest is imported into Australia, as these likelihoods relate specifically to events that occur in the PRA area and are independent of the importation pathway. The consequences of the presence of a pest are also independent of the importation pathway.

Table 4.1 lists quarantine pests associated with fresh date fruit from MENA countries that were considered in the pest categorisation process (Appendix A) and for which the department considered that a full pest risk assessment was required.

Table 4.2 lists pests for which the department adopted the URE from previous assessments.

Table 4.3 lists pests for which the department considers that the differences in the information relating to the likelihood of importation is sufficient to warrant the reassessment of this component. The remaining likelihood ratings and consequence estimates are adopted from previous assessments.

Some pests identified in this assessment have been recorded in some regions of Australia, but due to interstate quarantine regulations and enforcement are considered pests of regional concern. The acronym for the state or territory for which the regional pest status is considered, such as ‘WA’ (Western Australia), is used to identify these organisms.

Fresh dates harvested, packed, stored and transported for export to Australia may need to travel variable distances to ports. While the assessments of the unrestricted risk undertaken in this risk analysis do not impose any mandatory measures during storage and transport, common commercial practices, such as cold storage, may impact on the survival of some pests.

Table 4.1 Quarantine pests of fresh date fruit for which a full pest risk assessment is conducted

Pest	Common name
Lesser date moth [Lepidoptera: Batrachedridae]	
Batrachedra amydraula	lesser date moth
Date moths [Lepidoptera: Pyralidae]	
Aphomia sabella	greater date moth
Cadra calidella	date moth; carob moth
Pomegranate butterfly [Lepidoptera: Lycaenidae]	
Virachola livia	pomegranate butterfly

Table 4.2 Quarantine pests of fresh date fruit for which the URE outcome is adopted from previous assessments

Pest	Common name
Spider mites [Prostigmata: Tetranychidae]	
Eutetranychus palmatus	spider mite
Oligonychus afrasiaticus (EP)	date dust mite
Oligonychus pratensis (EP)	banks grass mite
Armoured scales [Hemiptera: Diaspididae]	
Fiorinia phoenicis (EP)	long scale
Mealybugs [Hemiptera: Pseudococcidae]	
Planococcus ficus (EP)	vine mealybug
Pseudococcus cryptus (EP, WA)	citriculus mealybug

EP: Species has been assessed previously and import policy already exists.
WA: Pest of biosecurity concern for Western Australia.

Table 4.3 Quarantine pests of fresh date fruit for which some of the likelihood ratings and consequence estimates are adopted from previous assessments

Pest	Common name
Fruit flies [Diptera: Tephritidae]	
Bactrocera dorsalis (EP)	Oriental fruit fly
Bactrocera zonata (EP)	peach fruit fly
Ceratitis capitata (EP)	Mediterranean fruit fly

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

4.1 Date moths

Batrachedra amydraula*, *Aphomia sabella* and *Cadra calidella

This assessment focuses on three date moths, the lesser date moth (*Batrachedra amydraula*) that belongs to the Batrachedridae family, and the greater date moth (*Aphomia sabella*) and carob or date moth (*Cadra calidella*) that both belong to the Pyralidae family. These moths have been grouped together because of their similar biologies, are predicted to pose a similar biosecurity risk, and to therefore require similar mitigation measures. In this assessment, the term 'date moths' is used to refer to these three species. The scientific name is used when information refers to a specific species.

Batrachedridae is a small family of moths occurring throughout the tropical regions of Africa and the Americas (Perring, El-Shafie & Wakil 2015) as well as temperate regions of both the northern and southern hemispheres (Prashantha et al. 2013). Moths from the Batrachedridae family feed on a range of plants including palms (Prashantha et al. 2013), rushes and sedges (Watts et al. 2013), and on plant parts including inflorescences (Cock & Burris 2013), fruits (Perring, El-Shafie & Wakil 2015) and stems (Watts et al. 2013).

Many Pyralidae moths are of economic significance and are important pests of agriculture as fruit or stalk borers, miners, or leaf tiers (Howard et al. 2001). They attack crop species such as citrus, corn, eggplant, lima bean and castor bean (Avidov & Harpaz 1969a). Perhaps the most damaging species of pyralid is the almond moth (*Cadra cautella*), which is found worldwide, including in Australia, and whose larva attacks grains, fresh fruit, nuts, dried fruit, flour, bran, cacao beans, chocolate, crackers and many other agricultural commodities (Avidov & Harpaz 1969a; Hagstrum et al. 2013).

The pyralid moths *Aphomia sabella* (previously *Arenipses sabella* (Karsholt & Nieukerken 2018)) and *Cadra calidella* (previously *Ephestia calidella* Guenée, 1845), are pests of concern for date palm. *Aphomia sabella* has been reported to cause damage to the inflorescences, spathes, stalks (rachises) and immature or ripe fruits of date palms (Blumberg 2008; Imam 2012; Kehat & Greenberg 1969; Talhouk 1969). It is considered one of the more serious pests of dates in Saudi Arabia (Talhouk 1991) and the Sinai region of Egypt (El-Sherif, Elwan & Abd-El-Razik 1998). *Cadra calidella* causes damage to fruits of date palm before harvest and may fly into stores or be carried there on the product (Avidov & Harpaz 1969b; Cox 1975a)., *Cadra calidella* is often recorded as a pest of dried fruit, especially dates and carobs, in commercial storage (Cox 1975b). It is found on a broader range of products than *A. sabella*, and is reported to attack almond, castor bean, hazelnut, grain, fig, and other dried fruit and nuts in storage (Avidov & Harpaz 1969b; Hagstrum et al. 2013; Prevett 1968). Perring, El-Shafie and Wakil (2015) state that it is a generalist feeder, only occasionally noted in association with dates.

Batrachedra amydraula is a widespread and damaging pest of date fruit throughout the MENA region, and is distributed from Libya in the west through the Arabian Peninsula to Iran and Pakistan in the east. It is likely that this pest is present in most date plantations that produce fruit for export. *Aphomia sabella* occurs in almost all the date growing areas of the MENA region and northern India (Blumberg 2008; Perring, El-Shafie & Wakil 2015). It is principally a field pest that can also be present in harvested commodities (Perring, El-Shafie & Wakil 2015). *Aphomia sabella* is also recorded feeding on fruit of the Canary Island date palm (Kehat & Amitai

1967), a species often planted as an ornamental. *Cadra calidella* originates in the Mediterranean, where it is probably a true stored products pest (Aitken 1963). It is distributed from Morocco to Saudi Arabia and Iraq in the east (CABI 2018a; Carpenter & Elmer 1978).

Batrachedra amydraula (lesser date moth) is considered one of the main pests of concern for date production. It can occur in high numbers across the MENA region, and is capable of causing significant damage. *Batrachedra amydraula* has only been reported as a pest of date palm (*Phoenix dactylifera*) (Blumberg 2008; Michael 1970; Michael & Habib 1971; Perring, El-Shafie & Wakil 2015). Blumberg (2008) states that the lesser date moth is highly specific to date palm, and no reports are known of infestation of other host plants by this moth. There is a single, unverified record of three-leaf derris (*Derris trifoliata*) as a host plant in a British Natural History Museum database(Gerson & Applebaum 2017; Robinson et al. 2018). However, this record is considered likely to be erroneous.

All three date moths have four life stages: egg, larva, pupa and adult. Females of *B. amydraula* lay eggs singly on new fruits or bunch strands (Blumberg 1975; Michael & Habib 1971; Perring, El-Shafie & Wakil 2015; Talhouk 1969). *Aphomia sabella* lays its eggs singly on the outer and inner sides of the tips of spathes and other tender vegetative organs such as leaflets and mid-ribs of young fronds (Talhouk 1969). Under laboratory conditions, fertilised eggs of *C. calidella* are laid on or near small slices of date provided as food, in groups ranging from two to four, or in chains, while unmated females lay their eggs in heaps (Hammad, El-Deeb & Abdel-Wahed 1965).

The larva of *B. amydraula* has five instars before pupation, and can reach a length of up to 12 millimetres. Larvae feed on the flesh and seeds of date fruits, entering near or through the calyx (Al-Antary, Al-Khawaldeh & Al-Alawi 2014; Perring, El-Shafie & Wakil 2015). Each larva feeds on three to four fruit before pupation (Blumberg 2008; Michael & Habib 1971; Perring, El-Shafie & Wakil 2015).

Aphomia sabella larvae are hairy, dark pink to grey-black in colour, and reach a length of 28 to 35 millimetres (Blumberg 2008). *Cadra calidella* has five larval instars before pupation, and the mature larva is pink or reddish in colour, measuring 10 to 13 millimetres in length (Hammad, El-Deeb & Abdel-Wahed 1965).

Ecological studies have shown that *B. amydraula* has two or three overlapping generations annually in the field (Al-Antary, Al-Khawaldeh & Al-Alawi 2014; Blumberg 1975; Carpenter & Elmer 1978; Talhouk 1969; Venezian & Blumberg 1982), depending on environmental conditions. Hussain (1963b) reports that *A. sabella* has two generations per year in palm plantations in Iraq, although Kehat and Greenberg (1969) concluded that it had the capacity for three to four generations between April and September, on the basis of continuous laboratory rearing. No information on the number of generations produced by *C. calidella* could be found. However, a closely related species, *C. cautella*, produces at least four to five generations annually (Avidov & Harpaz 1969a).

Batrachedra amydraula can also complete multiple generations in stored dates (Carpenter & Elmer 1978; Sadeghi, Baniameri & Marouf 2012; Shayesteh, Marouf & Amir-Maafi 2010), and it is thus possible that this pest could be introduced into new regions through movement of infested date fruit (Perring, El-Shafie & Wakil 2015).

The risk scenario of concern is thus the presence of pupae, developing larvae or eggs of *B. amydraula*, *A. sabella* or *C. calidella* within or on imported fresh date fruit.

4.1.1 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 date moths will arrive in a viable condition in Australia with the importation of fresh dates from the MENA region is assessed as Low.

The following information provides supporting evidence for this assessment.

Date moths are present in date-growing regions of the Middle East and North Africa region.

- *Batrachedra amydraula* has been recorded in multiple countries including Bahrain, Egypt, Iran, Iraq, Israel, Kuwait, Libya, Oman, Pakistan, Qatar, Saudi Arabia, UAE and Yemen (Blumberg 1975; Carpenter & Elmer 1978; Perring, El-Shafie & Wakil 2015).
- *Aphomia sabella* has been recorded in Algeria, Egypt, Iran, Israel, Iraq, Jordan, Kuwait, Libya, Oman, Saudi Arabia, as well as India and Sudan (Al-Zadjali, Abd-Allah & El-Haidari 2006; Al Antary, Al-Khawaldeh & Ateyyat 2015b; Blumberg 2008; Kehat & Amitai 1967; Khairi, Elhassan & Bashab 2010).
- *Cadra calidella* has been recently reported to occur in Algeria, Egypt and Iraq (CABI 2018a), with earlier records also listing it in Libya, Morocco and Saudi Arabia (Carpenter & Elmer 1978).

Rates of date moth infestations vary across the MENA region.

- Kakar et al. (2010) reported *B. amydraula* infestation rates in dates on the palm tree of up to 12 per cent in Pakistan. Al-Antary, Al-Khawaldeh and Al-Alawi (2014) reported an infestation rate ranging from 11 to 19 per cent in Jordan.
- *Batrachedra amydraula* can cause serious damage in date palm in Egypt, Iran, Iraq, Israel and Libya (Blumberg 1975; Carpenter & Elmer 1978).
- Reports of fruit losses, in unmanaged situations, range from 50 to 75 per cent in Iran (Latifian 2012; Perring, El-Shafie & Wakil 2015) and the UAE (Latifian 2012), and up to 90 per cent in Pakistan (Kakar et al. 2010).
- These levels of damage suggest populations of *B. amydraula* can reach high levels at some locations and in some years.
- Imam (2012) reported that *A. sabella* attacks date palms in high numbers, with infestation levels up to 89 per cent in untreated date palms. In countries with small populations of *A. sabella*, infestation rates were lower, with about 5 to 15 per cent of the crop affected (Carpenter & Elmer 1978). In Iraq, Hussain (1963b) reported up to 70 per cent of palm trees being infested by *A. sabella*.
- In the field, there are only two periods of abundance per year of *A. sabella* – a spring and a late autumn generation that both become sufficiently large to be of economic importance (Hussain 1963b). Damage occurs during a short period in spring, when inflorescences, young fruits and fruit stalks are attacked (Kehat & Greenberg 1969). The rate of date bunch infestation fluctuates widely from year to year (Blumberg 2008; Kehat & Greenberg 1969).

- Al Antary, Al-Khawaldeh and Ateyyat (2015a) recorded infestation rates of 45 and 55 per cent on date bunches at harvest at two date plantations in the Jordan Valley.
- In the date plantations of the Eastern Province of Saudi Arabia, Talhouk (1969) found attacks of *A. sabella* to be very rare. Almost all the observed damage caused by caterpillars was due to *B. amydraula*.
- The level of infestation of fresh dates in the field by *C. calidella* is not known with certainty. *Cadra calidella* has not been reported as a major pest of date palms. Avidov and Harpaz (1969b) state that major infestations in plantations in Israel have never occurred. Burks et al. (2015) also state that *C. calidella* has only occasionally been noted in association with dates.

Date moths have multiple generations per year.

- *Batrachedra amydraula* has two to three overlapping generations annually in the field (Al-Antary, Al-Khawaldeh & Al-Alawi 2014; Blumberg 1975; Carpenter & Elmer 1978; Howard et al. 2001; Michael & Habib 1971; Talhouk 1969; Venezian & Blumberg 1982).
- The first generation of larvae begins to appear as date fruit first begin to form on the palm (Kakar et al. 2010). Overlapping generations continue to appear as fruits develop, typically stopping prior to the fruit ripening (Al-Antary, Al-Khawaldeh & Al-Alawi 2014; Blumberg 1975; Kakar et al. 2010; Perring, El-Shafie & Wakil 2015). As developmental times vary for date fruit across the region, so too do infestation times; these begin from late March (Israel), early April (Pakistan) or late April (Egypt) and continue until early July (Israel), August (Pakistan) or early September (Egypt) (Al-Antary, Al-Khawaldeh & Al-Alawi 2014; Blumberg 1975; Kakar et al. 2010).
- Larvae of the third (last) generation do not complete their development, but undergo diapause in the larval stage (Blumberg 1975, 2008; Carpenter & Elmer 1978; Michael & Habib 1971) emerging as adults the following spring (Blumberg 1975; Michael & Habib 1971).
- The emergence of *B. amydraula* adults from the overwintering population coincides with the beginning of flower pollination (Kakar et al. 2010).
- Hussain (1963b) reports *A. sabella* has two generations per year in palm plantations in Iraq. Adults of the overwintering generation appear during March and April, while adults of the following generation appear during summer from July to September (Hussain 1963b; Talhouk 1969).
- In Israel, Blumberg (2008) states that *A. sabella* may develop four generations between April (spring) and September (autumn) each year. Nevertheless, field observations in Israel have established that only two generations develop in date plantations, one in spring and the other in the late autumn (Kehat & Greenberg 1969). Most economic damage is caused in spring and early summer, with yearly damage varying from light to severe (Imam 2012; Kehat & Greenberg 1969).
- No information on the number of generations produced by *C. calidella* in the field could be found. However,information is available for closely related species, for example *C. cautella* produces at least four to five generations annually (Avidov & Harpaz 1969a) and *C. figulilella* has three to four generations annually (Gerson & Applebaum 2017).

Date moths lay their eggs on dates at various stages of development as well as date palm vegetative structures.

- *Batrachedra amydraula* lays its eggs on date palm inflorescences (Talhouk 1969), on developing fruit clusters and petioles (Kakar et al. 2010) or on immature fruit (Talhouk

1969) depending on the generation. Eggs are laid either individually or in batches of two to five (Michael & Habib 1971).

- Eggs of *B. amydraula* are predominately laid while the fruit is still small and unripe (green and less than 1 centimetre in diameter) (Kakar et al. 2010; Perring, El-Shafie & Wakil 2015), and hatch within six to eight days (Michael & Habib 1971; Perring, El-Shafie & Wakil 2015).
- Michael and Habib (1971) recorded eggs of *B. amydraula* still hatching around the end of August, and larvae continuing to feed during September in the Sinai Province of Egypt (coinciding with the harvest of fresh dates in Egypt). Late season presence of eggs and larvae such as this has been reported to be uncommon (Blumberg 2008; Perring, El-Shafie & Wakil 2015).
- It is unclear whether late season eggs or larvae of *B. amydraula* are associated with late season fruit varieties, or with fruit late in their developmental cycle. As the majority of fruit is attacked while still small and unripe (Perring, El-Shafie & Wakil 2015), it seems more likely that, with respect to an overlap of *B. amydraula* oviposition activity and the harvest period, immature fruit from varieties that develop late in the season, as opposed to fruit near harvest, would be attacked.
- *Aphomia sabella* lays its eggs singly on the outer and inner sides of tips of spathes and other tender vegetative organs such as leaflets and mid-ribs of young fronds (Talhouk 1969). Caterpillars of the first generation in March initially feed on the soft tips of unopened spathes, tender fronds of young leaves and date bunches. After the spathes have opened, the caterpillars then feed on the inflorescences and immature dates, and mine into fruit stalks at the point where the strands arise (Blumberg 2008; Kehat & Greenberg 1969; Levi-Zada et al. 2014).
- Previously Gough (1917) initially noted that *C. calidella* prefers to lay its eggs on semi-dry or dry dates, rather than fresh dates at the khalal or rutab stage of development.
- Later research by Gough (1918) at Khargeh Oasis, Egypt found that *C. calidella* lays its eggs on both dates in the bunch as well as fallen date fruit.
- In Israel Avidov and Harpaz (1969b) found that *C. calidella* lays its eggs on dates at various stages of development, including while ripening on the tree.

Date moth larvae are associated with dates during the growing season.

- Date fruit is commonly fed on by *B. amydraula* and *A. sabella*, and occasionally by *C. calidella* (Blumberg 2008; Levi-Zada et al. 2014; Perring, El-Shafie & Wakil 2015; Talhouk 1991).
- Larvae of *B. amydraula* feed on flesh of fresh dates at the kimri, khalal and rutab stages, but do not attack tamar or fully matured dates (Al-Antary, Al-Khawaldeh & Al-Alawi 2014).
- First generation larvae of *B. amydraula* appear as date fruit first begin to develop on the palm, and feed on both newly formed inflorescences and hababauk stage fruit (Perring, El-Shafie & Wakil 2015). Second and third generation larvae cause damage to developing fruit in the kimri stage (Perring, El-Shafie & Wakil 2015).
- Larvae of *B. amydraula* enter fruit by chewing a hole near or through the calyx to penetrate fruits to feed on the pulp and soft immature seed (Al-Antary, Al-Khawaldeh & Al-Alawi 2014; Blumberg 2008; Perring, El-Shafie & Wakil 2015).
- Development of *B. amydraula* from egg to adult of the first and second generations takes from about three weeks at 30 to 35 degrees Celsius (Talhouk 1969) to about six weeks at 25 degrees Celsius (Gerson & Applebaum 2017).
- Approximately 80 per cent of date fruits attacked by *B. amydraula* are between 0.6 and 1.0 centimetre in diameter (Blumberg 2008; Eitam 2001). Harvesting of fresh dates typically

begins early in the khalal or rutab developmental stage, when dates are between 2 to 3 centimetres in diameter (Barreveld 1993; Siddiq, Aleid & Kader 2014).

- Larvae of the summer generation of *A. sabella* are found mainly in unripe fruit on the ground, whereas those of the autumn generation are found in ripening fruit on bunches (Blumberg 2008; Talhouk 1991). Larvae burrow through the centre of the date bunch, leading to secondary invasion by rot-causing bacteria and fungi and eventual decay of the entire bunch (Al Antary, Al-Khawaldeh & Ateyyat 2015b; Blumberg 2008; Carpenter & Elmer 1978; Talhouk 1969).
- *Aphomia sabella* is reported to prefer Deglet Noor, Sayer, Zahidi, Succari and Sultana date palm varieties (Carpenter & Elmer 1978; Sudhersan 2013). These varieties are likely to be exported to Australia. Al Antary, Al-Khawaldeh and Ateyyat (2015b) stated that *A. sabella* preferred to feed on the hababauk and kimri developmental stages.
- The varieties Khadrawy, Halawy and Barhee are not as heavily attacked by *A. sabella* in Israeli date palm plantations (Kehat & Greenberg 1969).
- Gough (1917) studying *C. calidella* in the Khargeh Oasis, Egpyt, found that growing dates are not attacked by *C. calidella* larvae, which only attack fallen or harvested semi-dried and dried date fruit. Soft varieties of dates that are eaten immediately after harvest, were not attacked by *C. calidella*.
- On the other hand, Mesbah, El-Kady and El-Sayed (1998) found *C. calidella* infesting both
- ripening and dry dates in plantations as well as in drying yards and storages in the Siwa Oasis, Egypt.
- At Salhieh, in the Delta region of Egypt, the *C. calidella* population differs in its habits from the Khargeh and Dakhleh Oases populations (Gough 1917). The larvae of the Delta region population attacks growing dates by boring into the interior from the sides, rather than through the calyx end (Gough 1917).
- However, both Avidov and Harpaz (1969b), Mesbah, El-Kady and El-Sayed (1998) and Hill (2007) state *C. calidella* develops on date fruit while still on the tree, most commonly just before harvest. It is therefore uncertain if *C. calidella* is actually feeding inside fresh dates during the harvest period.

Date moth larvae pupate outside the date fruit, usually in cryptic places on the palm tree.

- Larvae of *B. amydraula* leave date fruit to pupate (Blumberg 2008; Michael & Habib 1971; Perring, El-Shafie & Wakil 2015; Talhouk 1991).
- Last generation *B. amydraula* larvae undergo diapause in elongated white silken cocoons, preferring well-hidden sites such as inside fibres at the bases of fronds, the crowns of trees or under dead tissues around the trunk (Perring, El-Shafie & Wakil 2015; Talhouk 1991), or occasionally in the soil (Blumberg 1975; Michael & Habib 1971).
- Talhouk (1969) states that mature *A. sabella* larvae exit date fruit to spin white, elongated cocoons in protected localities, usually between badly infested dead inflorescences in the spathes, or occasionally between the frond bases and fibres in the palm crown (Hussain 1963b). Blumberg (2008) reports that overwintering larvae of *A. sabella* are also found at the base of the trunk and in date fruits on the ground.
- Mature larvae of *C. calidella* usually leave dates in which they have been feeding to find a secluded spot to spin their cocoons, often incorporating fine particles of the surrounding matrix for camouflage, or occasionally spinning their cocoon inside the date cavity between the outer skin (epicarp) and seed (Gough 1917).

Date moth larvae could be present in low numbers during the harvesting period.

- *Batrachedra amydraula* larvae attack date fruit throughout the fruit growing period from initial development until the fruit begins to ripen (Blumberg 2008; Perring, El-Shafie & Wakil 2015).
- Numbers of third generation *B. amydraula* larvae decrease considerably as fruit begins to ripen on the tree. Infestation rates become almost negligible in most areas once fruit is ripe. By the time fruit is harvested, larvae have typically disappeared (Al-Antary, Al-Khawaldeh & Al-Alawi 2014; Blumberg 1975, 2008; Kakar et al. 2010).
- *Batrachedra amydraula* larvae are not found on bunches or on decaying fruit during autumn and winter, indicating that the occurrence of larvae and their damage is restricted to a relatively short period during the hababauk and kimri developmental stages in spring (Blumberg 2008; Venezian & Blumberg 1982).
- Khalal and rutab stage dates have been reported to be attacked by *B. amydraula*, although the pest is uncommon in date palm plantations during harvesting period (Al-Antary, Al-Khawaldeh & Al-Alawi 2014; Michael & Habib 1971).
- *Batrachedra amydraula* larvae undergo five instars inside date fruit and the final generation can continue to develop inside fruit until early in the harvesting season (Michael & Habib 1971). As a result late-developing larvae may still be present inside khalal stage fruit during harvest, based on the information that harvesting can begin from mid-May to mid-July in Abu Dhabi (Al Mashhadani 2014).
- Research in Egypt has shown that the final generation *B. amydraula* larvae leave the fruit in September to overwinter at the bases of leaves and in the remains of dry bunches (Michael & Habib 1971). Given the Egyptian harvest season commences in August (Ministry of Agriculture and Land Reclamation 2002), there is a possibility that fresh khalal and rutab stage dates could be attacked before harvest. As a result late-developing larvae may still be present inside fruit during harvest.
- The abundance of *A. sabella* decreases considerably during summer prior to harvest, and larvae leave date fruit to overwinter in other parts of the palm tree such as at the base of the trunk and in fruits on the ground (Blumberg 2008; Hussain 1963b; Kehat & Greenberg 1969). In southern Israel, Kehat and Greenberg (1969) found the larval population of *A. sabella* decreased considerably during May (late spring) and no larvae were found on date bunches during summer. During winter, only a few mainly fully-grown larvae were found in the axils of young shoots or between leaf bases in the palm crown (Kehat & Greenberg 1969). As larvae of the autumn generation can be found in ripening fruit on bunches (Blumberg 2008; Kehat & Greenberg 1969), late developing larvae may still be present inside fruit during harvest. In northern Israel, Kehat and Greenberg (1969) observed very few larvae present during the harvest season in autumn.
- Once fully developed, *C. calidella* larvae usually leave date fruit and undergo a wandering phase in order to find a place to spin a cocoon in which to overwinter (Gough 1917). Given the fact that *C. calidella* larvae can sometimes pupate in the cavity of date fruit (Gough 1917), late-developing larvae may still be present inside fruit during harvest.

Larval feeding on dates causes visible damage to the fruit.

- In the early stages of infestation the only visible sign of *B. amydraula* larval attack is the visible entry hole near the calyx, and the presence of frass and webbing around it (Michael 1970; Michael & Habib 1971; Perring, El-Shafie & Wakil 2015).

- Date fruit in later stages of attack by larvae of *B. amydraula* often have very visible signs of damage. The typical sign of infestation is the presence of red, dry dates among the normal green ones in the bunch (Gielis 2007).
- A *B. amydraula* larva seldom eats more than a third of a fruit before it seeks another one, and may damage three or four fruits during its lifetime (Latifian 2012).
- To prevent infested fruit from dropping, the larva spins a web around the fruit and the strand (Michael 1970; Talhouk 1969). Small dried fruits can be seen tied or hanging by silken threads produced by larvae (Ali & Hama 2016).
- Some reports state that infested fruits are often completely hollow and usually fall to the ground before full ripening (El-Sherif, Elwan & Abd-El-Razik 1998; Perring, El-Shafie & Wakil 2015). However, in Oman, many infested khalal stage dates do not fall to the ground until up to four weeks after infestation (Elwan 2000).
- Feeding by *A. sabella* larvae leaves obvious signs of damage to date palm vegetative structures. Holes bored into spathes and fruit stalks often reach a length of 10 centimeters, and can be occupied by several larvae (Blumberg 2008; Carpenter & Elmer 1978). Larval activity is recognised by the presence of considerable quantities of silken webbing with dark brown pellets of frass attached. Attacked plant parts often become secondarily infected by rot-causing bacteria and fungi, making the damage more noticeable (Blumberg 2008).
- High levels of *A. sabella* infestation result in entire bunches of dates withering and dropping from the tree (Carpenter & Elmer 1978). The larvae of the summer generation of *A. sabella* mainly attack ripe dates. They burrow through the center of the bunch, causing decay of the entire bunch (Blumberg 2008).
- Date fruits attacked by *A. sabella* lose their deep green colour, turn yellow or grey, and wither (Hussain 1963b). Infested fruit are also filled with frass and plant matter that is very noticeable (Avidov & Harpaz 1969b; Talhouk 1969).
- Mature larvae of *C. calidella* cover badly infested dates with silken webbing that is also noticeable (Gough 1917).
- While most infested fruits have signs of damage, with frass and webbing clearly visible, for fruit attacked late in the season by neonate larvae, signs of damage would be harder to detect. Fresh dates showing obvious signs of infestation are likely to be removed during harvesting or packing house processes.

Cadra calidella and to a lesser extent *B. amydraula* can complete their life cycle on date fruits in storage.

- *Cadra calidella* is a recognised stored product pest (Franqueira 1955; Hagstrum et al. 2013; Prevett 1968). In commercial storage, *C. calidella* is often recorded as a pest of dried fruit, especially dates and carobs (Cox 1974, 1975b; Gough 1917, 1918).
- There are a small number of reports stating that *B. amydraula* is able to persist for multiple generations in storage. Incidents reportedly occurred after infested dates from the field were transferred to a packing house in Iran (Sadeghi, Baniameri & Marouf 2012) and a warehouse in Iraq (Shayesteh, Marouf & Amir-Maafi 2010). This suggests eggs can be laid onto mature fruit when in storage.
- It is not known if *B. amydraula* can persist in both stored fresh and dried dates (khalal, rutab and tamar stage) or if they only persist in fresh dates (khalal and rutab stage). However, *B. amydraula* has been reported to be unable to attack dried tamar stage dates (Al-Antary, Al-Khawaldeh & Al-Alawi 2014). Furthermore, the main exporters of dried dates to Australia (such as Iran) are countries where *B. amydraula* has well-established populations. Australia has never intercepted *B. amydraula* (or any member of the Batrachedridae family)

on dried dates from any country. This indicates that that the association of *B. amydraula* with stored dried dates is very low.

- Pupae of *A. sabella* also occur in stored dates (Carpenter & Elmer 1978) but there is little evidence that this species reproduces in storage (Burks et al. 2015).

There have been no specific studies conducted on low temperature survival but the ability to enter an arrested state of development (diapause) suggests date moths may survive cold transport.

- *Batrachedra amydraula* possesses the ability to enter diapause. Third generation last instar larvae diapause inside cocoons during the winter months in order to protect themselves from unfavourable climatic conditions (Blumberg 1975; Perring, El-Shafie & Wakil 2015). Initiation of larval diapause in late summer and its termination in early spring is triggered by changes in day length (Blumberg 1975).
- Most larvae of *A. sabella* enter a diapause in autumn and winter in the field (Kehat & Greenberg 1969). In the laboratory, even at the relatively high temperatures maintained during winter, *A. sabella* larvae entered diapause (Kehat & Greenberg 1969).
- Prevett (1968) found a weak larval diapause in *C. calidella* at 25 degrees Celsius and 50 per cent relative humidity, and an extended diapause at 22.5 degrees Celsius and the same relative humidity. Cox (1975b) concluded that short day-length rather than low temperature was the main stimulus for diapause in temperate regions, although temperature played a secondary role in controlling the proportion of larvae entering diapause.
- Cooling of dates to below 10 degrees Celsius (preferably to 0 degrees Celsius) before transportation, or storage under the same temperatures (0 degrees Celsius to 10 degrees Celsius), at 65 to 75 per cent relative humidity, is recommended to maintain quality in fresh dates (Siddiq, Aleid & Kader 2014).
- Khalal dates are stored at 0 degrees Celsius at 85 to 95 per cent relative humidity to reduce water loss, delay ripening to the rutab stage, and maintain their textural and flavour quality (Siddiq, Aleid & Kader 2014).
- There is limited information on the temperatures that *C. calidella* can survive, although it is known that it can also undergo a diapause induced by short day-length and and low temperatures in temperate regions (Cox 1975b; Prevett 1968). Only diapausing larvae of third generation *B. amydraula* and autumn generation *A. sabella* are known to overwinter, and they are not known to be associated with fruit. There may be some potential for other stages of larvae to survive cold transport conditions, but this is uncertain. There is no available information relating to their survival at these temperatures.

Date moths are widespread damaging pests of date fruit throughout the MENA region. Date moths tend to lay their eggs prior to fruit set and maturity and on other palm vegetative structures. It is however, possible that eggs would be associated at low levels with harvested fresh dates at the khalal or rutab stage. There is evidence that *B. amydraula* and *C. calidella* caterpillars may be associated with fresh dates at the khalal and rutab stages. However, the larval populations are at low levels during the harvest period, with most larvae having left the fruit for a concealed pupation site. Further, dates showing obvious signs of infestation are likely to be detected and removed during processing, which would also reduce the possibility that date moths would be associated with commercial quality date fruit. The information presented indicates that there is only a small potential for consignments of fresh dates to contain viable early instar date moths that remain undetected during quality assurance processes. However, larvae that escape detection in routine packing house procedures may be able to survive transport to Australia.

The ability of the pests to survive management procedures, their known life cycles within date fruit, moderated by the fact that most larvae attack well before harvest and typically exit date fruit to pupate, and the fact that damage caused to date fruit is usually obvious, all support a likelihood estimate for importation of Low.

Likelihood of distribution

The likelihood that date moths will be distributed within Australia in a viable state as a result of the processing, sale or disposal of fresh dates from the MENA region, and subsequently transfer to a susceptible part of a host is assessed as Very Low.

The following information provides supporting evidence for this assessment.

It is likely that imported fresh dates for commercial sale will be sold in every state of Australia.

- It is expected that when fresh dates from the MENA region arrive in Australia they will be widely distributed for retail sale in many areas of the country. The major population centres are likely to receive the majority of the imported fruit.
- Human consumption is the intended use for the commodity in Australia. Any infested dates not consumed would provide a pathway for distribution. Date fruit with no obvious signs of infestation could potentially be distributed via the wholesale and retail trade, and waste material is likely to be generated.
- Date fruit with obvious symptoms of infestation will be unmarketable, and are unlikely to be sold within Australia.

Cold transport of fresh dates around Australia may not kill all date moth infestations.

- Any viable *B. amydraula* larvae would need to survive transportation and storage within Australia. While there have been no studies to determine the cold diapausing tolerance of *B. amydraula*, this species is known to overwinter as cocooned diapausing third instar larvae (Perring, El-Shafie & Wakil 2015; Shayesteh, Marouf & Amir-Maafi 2010). It is possible that diapausing *B. amydraula* may be able to survive wholesale/retail cold-chain conditions. There is also no study specifically examining the ability of non-diapausing *B. amydraula* to survive cold storage, so this is unknown.
- Larvae of *A. sabella* and *C. calidella* are known to enter diapause during the autumn - winter period (Kehat & Greenberg 1969; Prevett 1968), while *C. calidella* larvae hibernate in their cocoons during winter and only enter diapause when temperatures drop below 24 degrees Celsius (Prevett 1968). There are no studies specifically examining the ability of *A. sabella* or *C. calidella* to survive wholesale/retail cold-chain conditions.

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

- Individual consumers will distribute small quantities of fresh dates to a variety of urban, rural and wild environments. Small amounts of waste will be discarded in domestic compost.
- Commercial waste will also be discarded in Australia prior to retail sale for human consumption. Likewise, this date fruit waste will be discarded into managed waste disposal

systems and municipal garbage tips, and would therefore pose little risk of exposure to date palms.

Date moth larvae will need to complete development.

Two factors potentially limit the ability of date moths to successfully develop in dates, namely the time of year fresh dates are imported, and the condition of fresh date fruit discarded into the environment.

Time of year

- Imported fresh dates are likely to be imported into Australia at the time of harvest, from mid-May to September and shortly after. Australian grown khalal dates or fresh dates (semi-ripe) of *P. dactylifera* are harvested between February and April (Reilly, Reilly & Lewis 2010; Sirisena, Ng & Ajlouni 2015). Similarly, the fruiting season for *P. canariensis* occurs between February and April (Kirkland 2011). On arrival in Australia, the palms *P. dactylifera* and *P. canariensis* would lack dates at the right developmental stage for *B. amydraula* and *A. sabella* to complete development, and would most likely have to finish their development within infested imported fresh date fruit.
- On the other hand, larvae of *C. calidella* would be able to find alternative hosts such as dried fruit, especially dates and carobs, and nuts in which to complete their life cycles.
- Fresh date fruit imported after September, when temperatures across Australia are increasing, are more likely to support the development of date moths. However, this will depend on local conditions and could still be unfavourable in colder regions of Australia.

Condition of date fruit as a food source

- The condition of fresh date fruit is expected to deteriorate quickly in the environment. It is well known that once intact dates on the palm reach the khalal stage, moisture loss is rapid (Barreveld 1993).
- The ability of early instar larvae to mature into pupae in dates discarded into the environment will depend on the suitability of the fruit. In uncontrolled situations a range of saprophytes are likely to colonise the waste material and therefore compete for nutrients, limiting the ability of larvae to successfully complete development.
- The potential for date moths to be distributed successfully is increased by the ability of *B. amydraula* and *C. calidella* to persist in stored dates and other dried plant commodities. However, it is not known with any certainty if *A. sabella* can reproduce and persist in stored dates (Burks et al. 2015).
- *Batrachedra amydraula* can infest and persist for multiple generations in stored dates (Carpenter & Elmer 1978; Perring, El-Shafie & Wakil 2015; Sadeghi, Baniameri & Marouf 2012; Shayesteh, Marouf & Amir-Maafi 2010), making it possible for this pest to complete development and be introduced into new regions through the distribution of fresh dates to wholesalers and retailers.
- *Aphomia sabella* develops on immature or ripe dates and on the green fruits of *Phoenix canariensis* (Kehat & Greenberg 1969). Although pupae of *A. sabella* have been found in stored dates (Carpenter & Elmer 1978), there is little evidence that this species reproduces in storage (Burks et al. 2015).
- *Cadra calidella* attacks ripening date fruit before harvest and may fly into stores or be carried there on the product (Cox 1975a; Mesbah, El-Kady & El-Sayed 1998) and is a recognised stored product pest able to survive in dates and dried fruit in storage (Cox 1974, 1975b; Hammad, El-Deeb & Abdel-Wahed 1965; Prevett 1968).

- It is possible that *C. calidella* will be able to persist in stored dried dates at the tamar stage, or in other dried fruit commodities (Franqueira 1955; Gough 1917; Hammad, El-Deeb & Abdel-Wahed 1965) but not in fresh dates at the khalal or rutab stage.

Date moths would need to find a suitable host.

- The ability of adult date moths to fly increases their potential for distribution. No information could be found on how far these three species can fly. It is known that adults are able to survive for some period of time, often days. Given adults are small and delicate, it is considered unlikely that they have a long flight range.
- Date palms have a restricted distribution in Australia, with the major date-producing plantations confined to localities in central Australia and South Australia, with smaller plantings in Queensland and Western Australia (Kenna & Mansfield 1997). However, date palms are also grown as ornamentals in most Australian states and territories (AVH 2018).
- The Canary Island date palm (*Phoenix canariensis*) has a limited distribution in Australia (AVH 2018) being found in areas of south-east Australia (New South Wales, Victoria and South Australia), and Western Australia, as an ornamental tree.

Batrachedra amydraula is only able to attack date palm inflorescences and fruiting structures.

- *Batrachedra amydraula* mainly survives on newly-set and young green date fruits (Blumberg 2008), however, it can survive in stored dates (Carpenter & Elmer 1978; Sadeghi, Baniameri & Marouf 2012; Shayesteh, Marouf & Amir-Maafi 2010) which gives the potential for a newly-established population to persist.
- The only host of *B. amydraula* is the date palm (*Phoenix dactylifera*) (Blumberg 2008; Perring, El-Shafie & Wakil 2015). While date palms are present in most states and territories, there are a very small number of commercial date palm groves or plantations in Australia (Kenna & Mansfield 1997)—ornamental date palms are found very sporadically. This significantly reduces the potential that *B. amydraula* will find a suitable host in Australia.
- Suitable host material in the form of newly-developing flower and fruit bunches is only available for a short time. Date palms produce fruit only during a restricted time of the year, with flowering to fruit maturation usually occurring from mid-September to mid-March in the southern hemisphere (Kenna & Mansfield 1997). The harvest season for khalal (bisr) extends from July to September, in northern hemisphere production regions (Siddiq, Aleid & Kader 2014; The Emirates Center for Strategic Studies and Research 2003) so there is limited potential for date fruit imports to overlap with the initiation of flower and fruit development of date palms in Australia.

Aphomia sabella feeds on the fruit of two palm species.

- *Aphomia sabella* is known to feed on the fruit of two palm species, the date palm (*Phoenix dactylifera*) and the Canary Island date palm (*P. canariensis*) (Kehat & Greenberg 1969). These palms are grown throughout Australia in most states and territories (ALA 2018). While the date palm is present in most states and territories, it is found only sporadically. The Canary Island date palm has a limited distribution in Victoria, New South Wales and South Australia, and south-west Western Australia and is also sporadically distributed. There is potential for consumer waste to be discarded near these two hosts, either in the wild or in commercial plantations.

Cadra calidella attacks a small number of plant species, as well as dried fruits, grains and nuts.

- *Cadra calidella* attacks date palms, fig trees and carob trees (*Ceratonia siliqua*) (Avidov & Harpaz 1969b; Cox 1974; Prevett 1968). Date palms, figs and carob trees are grown throughout Australia, often in suburban areas, however, they are present only in small numbers and have limited distributions (ALA 2018).
- *Cadra calidella* is usually considered a stored product pest, with a preference for dried dates and carob pods (Alrubeai 1987; Cox 1975b). It is a generalist feeder recorded from several other commodities, including lentil (masur), maize, raisin, currant, dried fig, locust bean, and several nuts (Hagstrum et al. 2013; Hammad, El-Deeb & Abdel-Wahed 1965; Hill 2007). However, Cox (1975b) notes that *C. calidella* has very rarely been found infesting nuts. The ready availability of these commodities throughout the year would increase the potential for survival of *C. calidella*.

The possibility that date moths are capable of surviving storage and cold-chain transport temperatures during the commercial distribution of imported fresh dates around Australia, together with the ability of date moths to develop in dates, supports the contention that date moths may be able to successfully distribute to a new host in Australia. However, the ability of early instar larvae to successfully develop in discarded waste is limited, since several date fruit are required, and the low temperatures in the southern regions of Australia would be detrimental to larval development.

The limited availability of the lesser date moth’s only host, the date palm, and limited availability of actively growing date palm fruit, reduce the likelihood that it could find a susceptible date palm on which to lay its eggs. Similarly, the limited availability of actively growing date palm and Canary Island date palm fruit reduces the likelihood that *A. sabella* could find a susceptible palm on which to lay its eggs. Since *C. calidella* is able to complete its life cycle in stored products such as dates, dried figs and carobs, the potential for it to successfully distribute is increased. These factors support a likelihood estimate for distribution of Very Low for *B. amydraula* and *A. sabella*, and Low for *C. calidella* given its ability to survive on a range of stored fresh dried products.

Overall likelihood of entry

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

The likelihood that date moths will enter Australia as a result of trade in fresh dates from the MENA region and be distributed in a viable state to a susceptible host is assessed as Very Low.

4.1.2 Likelihood of establishment

The likelihood that date moths will establish within Australia, based on a comparison of factors in the source and destination areas, affecting pest survival and reproduction, is assessed as Low.

The following information provides supporting evidence for this assessment.

As *B. amydraula* is only able to feed on date palms the availability of its host plant will be limited.

- *Batrachedra amydraula* has only been reported feeding on date palm (*Phoenix dactylifera*) (Blumberg 1975, 2008; Perring, El-Shafie & Wakil 2015). Date palms are grown in small numbers in most Australian states and are distributed sporadically, with only a small number of commercial plantations (AVH 2018; Kenna & Mansfield 1997).

- Three-leaf derris (*Derris trifoliata* Lour. [Fabales: Fabaceae]) is also listed as a host of *B. amydraula* by Gerson and Applebaum (2017), and is included in the British Natural History Museum's database, HOSTS, as a host of *B. amydraula* in the Palaearctic region (Robinson et al. 2018).
- Identification of three-leaf derris as a host of *B. amydraula* is reported to be based on a single record in the literature, which cannot be identified or located. As there are no other records of this species as a host of *B. amydraula*, it is considered that the report of three-leaf derris as a host of *B. amydralua* may be erroneous.
- Three-leaf derris is a legume with disc-like fruits, usually containing only one seed. It grows in monsoon forest, vine thicket and beach forest, normally just above tide level (CSIRO 2010). It is restricted to tropical and subtropical areas, including East Africa, Asia and coastal Australia (Singapore National Parks Board 2013). In Australia it is distributed across tropical north-east Queensland and the Northern Territory (AVH 2018).
- In contrast, *B. amydraula* is found in hot, arid environments in the MENA region, corresponding with Köppen climatic zones BWh, BWk, BSh, BSk and Csa (Blumberg 2008; Peel, Finlayson & McMahon 2007; Perring, El-Shafie & Wakil 2015). There is no known overlap of its range with the climatic zones where three-leaf derris is distributed.
- Although three-leaf derris is listed as a host of several lepidopterans, including the dark caerulean butterfly (*Jamides bochus*), *Acanthoclita* sp., *Labdia philocarpa*, *Hypena iconicalis* and *Ectomyelois decolor*, none of these species are in the same family as *B. amydraula*, that is, the Batrachedridae (Horak 2006; Robinson et al. 2018; Singapore National Parks Board 2013).
- Further, *B. amydraula* has never been reported on any other leguminous host. All confirmed records of this species are on date palm (*Phoenix dactylifera*) (Blumberg 2008; Perring, El-Shafie & Wakil 2015).

Aphomia sabella feeds on fruits of two palm species.

- Larvae of *A. sabella* develop on the inflorescences, immature and ripe dates of the date palm (*Phoenix dactylifera*) and on green fruits of the Canary Island date palm (*P. canariensis*) (Kehat & Greenberg 1969). Date palms and Canary Island date palms are grown in small numbers in most Australian states.

Cadra calidella feeds on a broad range of host plants and stored products.

- In commercial storage, *C. calidella* is often recorded as a pest of dried fruit, especially dates and carobs (Alrubeai 1987; Cox 1975a, b; Prevett 1968). In the field it can attack ripening crops before harvest, and may fly into stores or be carried there on the dates or carob pods (Cox 1975a; Hammad, El-Deeb & Abdel-Wahed 1965; Mesbah, El-Kady & El-Sayed 1998). It is also known to feed on castor bean leaves (*Ricinus communis*) (Avidov & Harpaz 1969b).

Köppen climate maps show similarities between Australia and the MENA region.

- All three date moths are distributed throughout the MENA region in climates similar to those found in Australia. The climates in the regions where *B. amydraula*, *A. sabella* and *C. calidella* are found correspond to the Köppen climate classification zones BWh, BWk, BSh, BSk and Csa (warm desert climate, cold desert climate, warm semi-arid climate, cold semi-arid climate, and warm mediterranean climate respectively) (Peel, Finlayson & McMahon 2007). These same climate classification zones are present throughout inland Australia. This suggests that suitable climatic conditions for the establishment of *B. amydraula*, *A. sabella and C. calidella* are present in the arid (desert) and semi-arid inland regions of Australia.

Date moths require sexual reproduction to produce offspring.

- Sexual reproduction requires mating between male and female adults. Most moths locate mating partners via chemicals known as pheromones (Ando, Inomata & Yamamoto 2004). These help individuals locate each other across long distances, potentially increasing the chance of a breeding population being established from sparsely distributed individuals.
- Typically female moths emit long-range attractant sex pheromones, while males emit close-range courtship pheromones (Levi-Zada et al. 2014). A three-component sex pheromone has been identified in female *B. amydraula* that is released in a circadian rhythm, approximately one hour before sunrise (Levi-Zada et al. 2011; Levi-Zada et al. 2013). Levi-Zada et al. (2014) was unable to determine if *A. sabella* produces any long-range sex pheromones, but found that that the males produced several short-range chemicals, that could be male courtship pheromones. It is thought that *A. sabella* may also require host plant volatiles (air-borne chemicals) to facilitate long range attraction of a mate (Levi-Zada et al. 2014).
- On the other hand, *C. calidella* females produce long-range attractant sex pheromones, as evidenced by their adoption of the calling position, that is to raise their abdomens and expose their pheromone-producing glands (Cox 1974).
- The long-range sex pheromones emitted by the female excite the male and induce long-range attraction and pre-copulatory behaviour (Arn 1991). Even with the aid of sex pheromones, in small populations of date moths whose individuals are widely dispersed over the landscape, a successful meeting of males and females is not certain, due to abiotic factors, for example, inclement weather.

Date moths produce multiple generations per year.

- *Batrachedra amydraula* has been observed to produce continuous generations when temperatures are above 20 degrees Celsius. It has at least three overlapping generations per year in Iraq (Ali & Al-Anbaky 2014; Mohammad et al. 2014), Israel (Blumberg 2008; Navon et al. 1999), eastern Saudi Arabia, Pakistan (Kakar et al. 2010; Talhouk 1969) and Iran (Shayesteh, Marouf & Amir-Maafi 2010).
- Hussain (1963b) reports that *A. sabella* has two generations per year in palm plantations in Iraq, corresponding to two periods of adult abundance per year. Although Kehat and Greenberg (1969) concluded that it had the capacity for three to four generations between April and September, on the basis of continuous laboratory rearing, but only two generations in the field, Imam (2012) noted *A. sabella* has two generations under Siwa Oasis conditions in Egypt.
- Published reports of the number of generations of *C. calidella* in the field are not available. However,information is available for closely related *Cadra* species, for example *C. cautella* produces at least four to five generations annually (Avidov & Harpaz 1969a) and *C. figulilella* has three to four generations annually (Gerson & Applebaum 2017).

The reproductive potential of *B. amydraula*, *A. sabella* and *C. calidella* differs.

- *Batrachedra amydraula* females lay from eight to ten eggs per day (Shayesteh, Marouf & Amir-Maafi 2010) either individually or in batches of two to five (Michael & Habib 1971), and produce from 25 to 45 eggs during their lifetime (Shayesteh, Marouf & Amir-Maafi 2010).
- *Aphomia sabella* females lay on average from 285 eggs at 25 degrees Celsius to 328 eggs at 27 degrees Celsius, with a maximum of 441 eggs being laid by a single female at 27 degrees Celsius (Kehat & Greenberg 1969).

- Under laboratory conditions *C. calidella* can produce from 124 to 299 eggs, with an average of 219 eggs at 24 degrees Celsius (Hammad, El-Deeb & Abdel-Wahed 1965) indicating a high reproductive potential from a single generation.

Batrachedra amydraula, *Aphomia sabella* and *Cadra calidella* overwinter in diapause state.

- At the end of the third generation, fifth instar larvae of *B. amydraula* overwinter in a diapause state (Blumberg 2008; Perring, El-Shafie & Wakil 2015).
- In autumn and winter most larvae of *A. sabella* enter diapause until the following spring (Kehat & Greenberg 1969; Talhouk 1991).
- Mature larvae of the Mediterranean species *C. calidella* are known to overwinter in a diapause state in temperate regions, with a proportion of the population entering a pre-pupal diapause (Prevett 1968).
- Induction of diapause in *C. calidella* is determined by a combination of photoperiod and temperature, although temperature plays a secondary role in controlling the proportion of larvae entering diapause (Alrubeai 1987; Cox 1975b).
- Franqueira (1955) observed that *C. calidella* larvae hibernate from mid-September until April on dried figs in Portugal. He reported that hibernation did not commence until the ambient temperature had begun to fall below 24 degrees Celsius and a relative humidity above 60 per cent.
- Prevett (1968) found *C. calidella* to have a weak larval diapause at 25 degrees Celsius and 50 per cent relative humidity, and a stronger diapause at 22.5 degrees Celsius.

Several egg and larval parasitic wasps present in Australia may have limited impacts on date moths.

- *Batrachedra amydraula* is known to be attacked by the larval parasitoids *Goniozus swirskiana* (Argaman 1992; Eitam 2001; Sadeghi, Baniameri & Marouf 2012), *Habrobracon hebetor* (including its synonym *H. brevicornis*) (Blumberg et al. 2001; Hammad, Kadous & Ramadan 1983; Kinawy & Al Siyabi 2013), *Hymenobosmina* sp. (Michael & Habib 1971), the egg and larval parasitoid *Phanerotoma flavitestacea* (Hammad, Kadous & Ramadan 1983), and several species of egg parasitoids of the genus *Trichogramma* including *T. cacoeciae*, *T. evanescens* and *T. principium* (Alrubeai et al. 2014; Eitam 2001).
- The parasitic wasp *H. hebetor*, and other species of parasitic wasps of the genera *Goniozus*, *Phanerotoma* and *Trichogramma* are present in Australia (ABRS 2018), however it is not known if the Australian species of these egg or larval parasitoids would have any significant effect in limiting the establishment of *B. amydraula* in Australia.
- The three larval parasitic wasps, *H. hebetor*, *G. swirskiana* and *P. flavitestacea* that attack *B. amydraula* in the MENA region are ineffective in providing effective short-term control, due to their generally low natural levels of parasitism (Eitam 2001; Hammad, Kadous & Ramadan 1983).
- Research has shown that the parasitic wasps *T. evanescens* and *T. principium* can be effective in reducing lesser date moth infestations at both hababauk and kimri stages (Mohammad et al. 2011).
- Perring, El-Shafie and Wakil (2015) state that no effective parasitoids or predators are currently used for the management of *B. amydraula* in date palms in the MENA region. This suggests that control of *B. amydraula* with parasitoids alone might either not be possible or economically viable.

- During the peak activity period for *A. sabella* in spring, several parasitic wasps of the family Braconidae can be seen in association with adult moths (Blumberg 2008). In Iran, parasitic braconid wasps of the genera *Apanteles* and *Macrocentrus* also attack *A. sabella* (Gharib 1969).
- Ants, spiders and pseudoscorpions also prey upon young larvae of *A. sabella* overwintering in the crowns of date palms (Talhouk 1991) and are thought to be important in the control of caterpillars (Blumberg 2008). However, Levi-Zada et al. (2014) state that no efficient natural enemies have been recorded for the greater date moth (*A. sabella*).
- In the Eastern Province of Saudi Arabia, the external larval parasitoid, *H. hebetor* and the internal ovo-larval parasitoid, *Phanerotoma flavitestacea*, were found parasitising the immature stages of the date moths, *B. amydraula*, *A. sabella*, *C. cautella* and *Ephestia elutella* (Hammad, Kadous & Ramadan 1983). It is not known if Australian species of these braconid parasitoids would have any significant effect on limiting the establishment of *B. amydraula*, *A. sabella* and *C. calidella*.

The climatic similarity of inland Australia with the MENA region where date palms are grown, the presence of some date palms, the relatively high fecundity of *A. sabella* and *C. calidella*, and the ability to generate several overlapping generations per year, support a positive assessment of potential for establishment. An important moderating factor for establishment to occur is the requirement for male and female date moths to successfully mate in order to ensure reproduction. However, the facts that *B. amydraula* can only complete development on date palm and *A. sabella* can only complete development on two palm species (*P. dactylifera* and *P. canariensis*), palms which are sparsely dispersed across the landscape, while *C. calidella* can complete development on date palms as well as several dried fruit commodities, and the requirement to mate in order to produce viable eggs, support a likelihood estimate for establishment of Low.

4.1.3 Likelihood of spread

The likelihood that date moths will spread within Australia, based on comparison of factors in the source and destination areas affecting the expansion of the geographic distribution of the pest, is assessed as Moderate.

The following information provides supporting evidence for this assessment.

Batrachedra amydraula, *A. sabella* and *C. calidella* are found in hot, arid environments, and temperatures in Australia may be suitable for spread.

- *Batrachedra amydraula*, *A. sabella* and *C. calidella* are found throughout the hot, arid environments of the MENA region (Blumberg 2008; Perring, El-Shafie & Wakil 2015) corresponding to the Köppen climate classification zones BWh, BWk, BSh, BSk and Csa (warm desert climate, cold desert climate, warm semi-arid climate, cold semi-arid climate, and warm Mediterranean climate respectively) (Peel, Finlayson & McMahon 2007).
- These same climate zones are present throughout inland Australia (Peel, Finlayson & McMahon 2007) and areas of the east and west coast, and would be suitable for the spread of these three species of date moths.
- The reported ability of *B. amydraula* to produce continuous generations at temperatures exceeding 20 degrees Celsius (Shayesteh, Marouf & Amir-Maafi 2010) and the overwintering habit of the third generation final larval stage, mean that temperatures in some areas of Australia are likely to support the spread of *B. amydraula*.

- *Aphomia sabella* has at least two generations per year, with a spring and autumn peak, and this, together with its ability to enter diapause in autumn and winter, would enable *A. sabella* to survive periods of extreme conditions and act as a mechanism to synchronise adult emergence in spring (Alrubeai 1987; Howe 1962) and support its spread in Australia.
- The total development period of *C. calidella* from egg hatch to adult emergence ranges from 31 to 40 days (Alrubeai 1987) or 25 to 80 days depending on diet, photoperiod, temperature and relative humidity (Cox 1975a, b). A closely related phycitine moth *Cadra cautella*, with a similar biology and life cycle, produces four to five generations a year (Avidov & Harpaz 1969a).
- The ability of portions of populations of *C. calidella* to diapause and overwinter in the prepupal stage, would support its spread in less hospitable environments in Australia.
- The ability to utilise several stored products as a food source (Avidov & Harpaz 1969b; Hagstrum et al. 2013; Prevett 1968) also increases likelihood of spread of *C. calidella* in Australia.

The presence of natural barriers in Australia could limit the spread of *B. amydraula*, *A. sabella* and *C. calidella*.

- Date palm plantations are found in small pockets throughout inland Australia, with individual trees sparsely distributed elsewhere.
- The existence of large climatic differentials and long geographic distances separating date plantations and individual date palms will limit the natural spread of these date moths.

Batrachedra amydraula, *A. sabella* and *C. calidella* could potentially spread by the movement of infested date fruit or nursery stock in domestic trade.

- The transportation of infested date fruit during domestic trade would aid the movement of date moths within and between date plantations and suburban areas. If infested fruits from Australian plantations where date moths had become established were sold in domestic markets, date moths might spread to other parts of Australia.
- *Batrachedra amydraula* can persist as a pest of stored dates (Sadeghi, Baniameri & Marouf 2012). *Cadra calidella* is a known stored product pest of several commodities, including dried fruit, especially dates and carobs (Alrubeai 1987; Cox 1975a, b; Prevett 1968).The movement of non-commercial infested dried fruit, including dates, would present an opportunity for long-distance spread of these species.
- The reported lack of ability of *B. amydraula* to infest plants other than date palms, and the very noticeable damage they cause to fruits, decreases the likelihood *B. amydraula* would be spread via domestic trade across Australia.
- Similarly, as *A. sabella* is only able to utilise two palm species as a food source, and the very noticeable damage they cause to fruits, would also decrease the likelihood of long-distance spread via domestic trade.
- Diapausing date moth larvae that seek out cryptic places in which to spin their cocoons (Blumberg 2008; Hussain 1963b; Michael & Habib 1971; Perring, El-Shafie & Wakil 2015; Talhouk 1969; Talhouk 1991) could be spread in Australia by the interstate movement of ornamental nursery stock. However, the use of tissue culturing by industry, which is already in use, would limit spread to commercial production sites. Additionally, interstate quarantine controls on the movement of nursery stock in Australia would reduce the likelihood of spread of date moths.

It is likely *B. amydraula*, *A. sabella* and *C. calidella* can fly some distance.

- The ability of adult date moths to fly increases their likelihood of spread. It is known that adults can fly and are able to survive for some period of time, often days. *Batrachedra amydraula* adults can live from six to 10 days on average (Shayesteh, Marouf & Amir-Maafi 2010), *A. sabella* from seven to eight days at 25 degrees Celsius (Imam 2012; Kehat & Greenberg 1969) and 10 to 12 days at 27 degrees Celsius (Kehat & Greenberg 1969), and *C. calidella* from six to seven days (Hammad, El-Deeb & Abdel-Wahed 1965). Given this, it is possible that an adult could locate a suitable mate and host plant and start a new colony. No information could be found on how far these three species can fly. However, adults are small and delicate; *B. amydraula* has a wing-span of 11 to 14 millimetres (Perring, El-Shafie & Wakil 2015), *A. sabella* a wing-span of 33 to 42 millimetres (Al Antary, Al-Khawaldeh & Ateyyat 2015b; Burks et al. 2015) and *C. calidella* a wing-span of 11 to 24 millimetres (Hagstrum et al. 2013). They are therefore considered unlikely to have an extensive flight range.

Potential natural enemies in Australia may limit the spread of *B. amydraula*, *A. sabella* and *C. calidella*.

- Several parasitic wasps of the genera *Goniozus*, *Habrobracon*, *Hymenobosmina*, *Parasierola* and *Phanerotoma* attack the larvae of *B. amydraula* (Argaman 1992; Blumberg et al. 2001; Eitam 2001; Hammad, Kadous & Ramadan 1983; Kinawy & Al Siyabi 2013; Sadeghi, Baniameri & Marouf 2012).
- *Habrobracon hebetor* and several unidentified species of parasitic wasps of the family Braconidae frequently parasitise *A. sabella* in Egypt and Israel (Blumberg 2008; Hussain, Eid & EI-Saadny 2016).
- The parasitic wasps *Phanerotoma leucobasis* and unidentified species of *Macrocentrus* and *Apanteles* are recorded from *A. sabella* in the MENA region (Kinawy & Al Siyabi 2013). Pseudoscorpions (*Strobilochelifer spinipalpis*) are known to prey upon the larvae of *A. sabella* in the crown of palm trees (Kinawy & Al Siyabi 2013).
- Egg parasitoids of the genus *Trichogramma* also attack *B. amydraula* (Alrubeai et al. 2014; Eitam 2001) in the MENA region, but are not reported to play a significant role in reducing *B. amydraula* populations.
- The parasitoid wasp of the family Pteromalidae, *Dibrachys cavus* (now considered a synonym of *D. microgastri* (Peters & Baur 2011)) has been recorded from *C. calidella* (Hagstrum et al. 2013), but is known as a facultative hyperparasitoid of other parasitic wasps (Peters & Baur 2011) and may not have a significant role in in reducing *C. calidella* populations.
- Hussain, Eid and EI-Saadny (2016) record other predators of date moths such as the lacewing, *Chrysoperla carnea*, and anthocorid bugs, *Orius* sp. and *Xylocoris flavipes*.
- It is not known if other generalist predators present in Australia, such as anthocorid bugs, ants, green lacewings, pseudoscorpions and spiders would have any significant impact on populations of date moths.
- However, even the deliberate use of parasitoids and predators provides only limited control, suggesting that activity of natural enemies would not decrease the likelihood that these three date moths could spread to any great extent.

The suitable climatic conditions and natural environment across inland Australia where date palms are mainly grown, the possible movement of infested nursery stock between production areas, and the possibility of weather-mediated long-range dispersal support the potential of these moths to spread. The limited host availability, the existence of large climatic differentials and long geographic distances between date palm production areas, existing interstate quarantine controls on the movement of nursery stock, and the likely limited flying ability of these small, fragile moths all moderate this potential and support a likelihood estimate of spread of Moderate.

4.1.4 Overall likelihood of entry, establishment and spread

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

The overall likelihood that date moths will enter Australia as a result of trade in fresh dates from the Middle East and North Africa region, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is assessed as Very Low.

4.1.5 Consequences

The potential consequences of the establishment of date moths in Australia have been estimated according to the methods described in Table 2.3.

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

Impact scores for consequences are summarised in Table 4.4.

Table 4.4 Summary of consequences for *B. amydraula*, *A. sabella* and *C. calidella*

Consequences criterion	Impact (magnitude and geographic scale)	Impact score
Direct impact on plant life or health	Significant at the local level Minor significance at the district level.	C
Direct impact on other aspects of the environment	Indiscernible at the local level	A
Indirect impact on eradication and control	Significant at the local level Minor significance at the district level.	C
Indirect impact on domestic trade	Major significance at the local level Significant at the district level Minor significance at the regional level.	D
Indirect impact on international trade	Minor significance at the local level.	B
Indirect impact on non-commercial criteria or the environment	Minor significance at the local level.	B
Overall consequences rating	–	Low

The following information provides supporting evidence for the assessment of consequences.

Direct impact on plant life or health

Impact score: **C**

The direct impact of *B. amydraula, A. sabella* or *C. calidella* on plant life or health would be significant at the local level and of minor significance at the district level, resulting in an impact score of 'C'. *Batrachedra amydraula* is considered one of the key pests throughout the Middle

East and North Africa region, attacking almost all date palm varieties (Ali & Hama 2016; Blumberg 2008; Kinawy & Al Siyabi 2013; Mashal & Abeidat 2006). Perring, El-Shafie and Wakil (2015) state that *B. amydraula* is a serious pest of date palm that causes severe yield losses. Kehat and Greenberg (1969) note that *A. sabella* is a known pest of date palms throughout the Middle East and North Africa region. Al Antary, Al-Khawaldeh and Ateyyat (2015b) and Mashal and Abeidat (2006) state that *A. sabella* causes a significant reduction in date production in Jordan, with losses ranging between 40 and 90 per cent. Imam (2012) claims that *A. sabella* is one of the most devastating pests threatening palm trees in Siwa Oasis, Egypt. Hammad, El-Deeb and Abdel-Wahed (1965) and Hussain, Eid and EI-Saadny (2016) also claim *C. calidella* is a dangerous pest of date palm late in the season.

Batrachedra amydraula is considered one of the most damaging pests to date fruits in the MENA region (Carpenter & Elmer 1978). However, the pest status of this species is disputed, with Hill (1983) listing it as a minor pest and both Howard et al. (2001) and Talhouk (1991) claiming it is beneficial in thinning fruits, leading to an increase in date size and harvestable yields. Zaid et al. (2002) also considers these three moths to be minor pests, and/or ones that do not cause damage of any economic importance. Blumberg (2008) considers *C. calidella* as a minor or accidental pest of date palm, of rare occurrence in Israel.

Batrachedra amydraula is restricted to date palm (*Phoenix dactylifera*) and would only affect the date industry in Australia. *Aphomia sabella* is only known to attack two palms, *P. dactylifera* and its close relative, the Canary Island date palm (*P. canariensis*), and would affect the date industry and nursery trade.

Cadra calidella attacks date fruit, both in the field and in storage, as well as several other dried fruit and nut commodities in storage, and could affect both the date industry as well as several other dried horticultural commodity-based industries.

In many MENA countries no satisfactory control measures are implemented for *B. amydraula*, and when proper controls are not in place *B. amydraula* can quickly become a limiting factor to date production (Perring, El-Shafie & Wakil 2015). If controls were not put in place there could be significant damage to date palm health and plantation viability.

The damage to date fruits by *B. amydraula* includes larval feeding within immature dates at the hababauk stage just before ripening, both on the plant as well as in storage. In date palm plantations, most infested fruits drop to the ground in severe infestations, potentially causing losses in fruit yield of up to 75 per cent or more (Carpenter & Elmer 1978; Elwan 2000) and as high as 100 per cent in the Hajri variety (Aljirradi & Bamiftah 2001). Larvae seldom eat more than one-third of a fruit before moving onto another, and can attack as many as three to four fruits during their development, thus increasing the damage (Blumberg 2008). Approximately 80 per cent of fruit damage occurs during the hababauk stage, when fruits are between 0.6 and 1.0 centimetre in diameter (Blumberg 2008; Eitam 2001).

Infestations are also known to occur in stored dates. In such conditions *B. amydraula* can survive and produce several generations per year, meaning that populations can remain viable for long periods of time in a protected environment (Carpenter & Elmer 1978; Perring, El-Shafie & Wakil 2015; Sadeghi, Baniameri & Marouf 2012). Such infestations need to be controlled and are likely to result in increased costs to retailers and wholesalers, leading to economic losses at the local level and minor losses at the district level.

Damage is caused by the two generations of *A. sabella* (Blumberg 2008) within a short period, in spring and early summer, when inflorescences and young fruits are attacked (Kehat & Greenberg 1969). The intensity of infestation fluctuates widely from year to year (Kehat & Greenberg 1969) and in most cases, *A. sabella* infestations do not require specific application of insecticides. Chemical treatments applied against other date pests, including *B. amydraula*, may be sufficient in preventing date fruit damage (Blumberg 2008).

Cadra calidella often occurs together with three other species of stored-product moths, *C. cautella*, *C. figulilella*, and *Ephestia elutella* causing similar damage in stored products (Avidov & Harpaz 1969a). Proper sanitation prevents reproduction of all these species of date moths in the factory and storehouse (Avidov & Harpaz 1969a). Such infestations need to be controlled and the presence of *C. calidella* would not add significantly to costs of retailers and wholesalers beyond those already incurred from stored-product moths already in Australia.

Direct impact on other aspects of the environment

Impact score: **A**

The direct impact of *B. amydraula*, *A. sabella* or *C. calidella* on other aspects of the environment would be indiscernible at the local, district, regional and national levels, resulting in an impact score of 'A'. This is because the impact of these three date moths on native moths, or competition for resources locally with these organisms, is unlikely to occur.

Given that there are no verified reports of *B. amydraula* attacking any plant other than date palm, or of *A. sabella* attacking any palms other than *Phoenix dactylifera* or *P. canariensis*, neither is expected to have any impact on native Australian plants, or compete for resources with the Australian moth fauna. *Cadra calidella* is an acknowledged stored product pest that can attack fresh dates in the field and in storage, and is not expected to impact on Australian native plants.

Indirect impact on eradication and control

Impact score: **C**

The indirect impact of *B. amydraula*, *A. sabella* or *C. calidella* on eradication and control would be significant at the local level and of minor significance at the district level, resulting in an impact score of 'C'. This is because the impact would be expected to threaten economic viability through an increase in costs associated with crop monitoring, consultant's advice, containment, eradication and pest control on infested date palms at the local level.

Once an exotic pest such as *B. amydraula*, *A. sabella* or *C. calidella* becomes established in Australia, it is necessary to control, manage and monitor the pest. Until recently, densities of *B. amydraula* overseas were monitored by inspection of fruit for larval damage (Perring, El-Shafie & Wakil 2015). Currently densities of this pest are estimated using both light traps (Kakar et al. 2010; Kinawy, Arissian & Guillon 2015) and pheromone lures (Al-Jorany, Al-Jboory & Hassan 2015; Levi-Zada et al. 2011; Levi-Zada et al. 2013). Use of these technologies would increase production costs in Australia.

Chemical control has been the main method used for date moths worldwide (Ali & Al-Anbaky 2014). However, the trend is now towards the use of environmentally-friendly pesticides in combination with bio-control agents in an integrated pest management (IPM) program (Perring, El-Shafie & Wakil 2015). Control of date moths would be likely to involve a control program that incorporates cultural, physical, biological and chemical control methods (Ali & Hama 2016; Gerson & Applebaum 2017; Kinawy & Al Siyabi 2013), which would lead to increased production costs.

Existing date palm horticultural practices may also need to be altered to control these moths, which may be detrimental to the successful operation of IPM programs already in place for the control of other pests. Existing IPM programs may be disrupted because of the need to re-introduce or increase the use of less environmentally-friendly insecticides that may lead to a subsequent increase in the cost of production.

Recent research has highlighted the potential presence of endosulfan resistance in *B. amydraula* (Blumberg 2008; Perring, El-Shafie & Wakil 2015; Venezian & Blumberg 1982). However, endosulfan is not approved for use in Australia in any state or territory, and there are no other reports of date moths developing resistance to commmonly used insecticides.

Indirect impact on domestic trade

Impact score: **D**

The indirect impact of *B. amydraula*, *A. sabella* or *C. calidella* on domestic trade would be of major significance at the local level, significant at the district level, and of minor significance at the regional level, resulting in an impact score of 'D'. This is because the impact would be expected to threaten economic viability through a large reduction of trade, or loss of domestic markets at the local level. Biosecurity measures may be introduced and enforced to prevent the movement of plant material out of the initial incursion area, which would have a significant economic impact on plant industries and businesses at the district level. The introduction of a new pest to a state or territory would disrupt interstate trade, due to biosecurity restrictions imposed on domestic movement of the host commodity, that is, dates. This is expected to be of minor significance at the regional level.

The presence of any of these three date moths could have some impact on trade among states with date-growing industries. While the date industry in Australia is relatively small, the nature of these pests means there is potential for them to cause damage to emerging and existing date plantations. As such, states with larger date industries may put movement restrictions in place to limit the spread of date moths among plantations.

Indirect impact on international trade

Impact score: **B**

The indirect impact of *B. amydraula*, *A. sabella* or *C. calidella* on international trade would be of minor significance at the local level, and indiscernible at the district, regional and national levels, resulting in an impact score of 'B'. This is because the impact would not be expected to threaten economic viability through a large reduction of trade or loss of international markets at the local level. *Batrachedra amydraula* and *A. sabella* are considered key pests attacking date fruits in nearly all date palm-growing areas of the MENA region, and the presence of these pests is unlikely to impact trade with these nations.

The presence of *B. amydraula*, *A. sabella* or *C. calidella* has the potential to cause a small impact to international trade. Australia currently trades only small quantities of dates internationally, the majority of which are repackaged imports of dried dates. Trade of this kind is unlikely to be impacted, as there would be minimal chance for infestation by these three date moths. However, future international trade of Australia's domestically-grown fresh dates could be impacted for countries where these pests currently do not occur.

Indirect impact on the environment

Impact score: **B**

The indirect impact of *B. amydraula*, *A. sabella* or *C. calidella* on the environment would be of minor significance at the local level, and indiscernible at the district, regional and national levels, resulting in an impact score of 'B'. This is because the introduction of date moths may result in the additional use of pesticides for their control, as well as the review and/or replacement of elements of current IPM programs. Changing or replacing biological control agents that are part of current IPM programs might result in increased costs for growers at the local level.

The increased application of pesticides required to control these pests on fresh dates could affect the environment, but is not expected to have any significantly greater effect than the present use of insecticides. The insecticides often used in controlling *B. amydraula* and *A. sabella* are bio-insecticides (Perring, El-Shafie & Wakil 2015) such as *Bacillus thuringiensis* sprays and spinosad. These sprays are likely to have only a minor impact on the environment. Physical control methods, such as bagging bunches with plastic or cloth bags, would also be an effective control measure with negligible environmental impacts.

Cadra calidella should be treated as a stored product pest. Given that other stored product pests of dates, dried fruit and nuts, *C. cautella* and *C. figulilella*, are already present in Australia (Horak 1994), it is not expected that control measures for *C. calidella* would have any significantly greater effects than those of the present use of insecticides or other control measures in place for stored product pests.

4.1.6 Unrestricted risk estimate

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

Unrestricted risk estimate for *B. amydraula*, *A. sabella* and *C. calidella*	
Overall likelihood of entry, establishment and spread	Very low
Consequences	Low
Unrestricted risk	Negligible

As indicated, the unrestricted risk estimate for *B. amydraula*, *A. sabella* and *C. calidella* has been assessed as Negligible, which achieves the ALOP for Australia. Therefore, no specific risk management measures are required for these pests.

4.2 Pomegranate butterfly

Virachola livia

The pomegranate butterfly, or the pomegranate playboy (*Virachola livia;* synonym: *Deudorix livia*) belongs to the Lycaenidae family. The Lycaenidae is a large and diverse group of butterflies, containing the second highest number of species of all butterfly families (Fiedler 1996). More than two thirds of the species of the Lycaenidae family are restricted to one family or genus of host plants (Fiedler 1996). Most commonly, species from the Lycaenidae family feed on plants of the legume family; feeding on fruits is also a common trait (Avidov & Harpaz 1969b).

Virachola livia is considered a pest in the MENA region, and has been described as a polyphagous species (Larsen 1990). The primary hosts for this species are the green pods of several trees from the Fabaceae family (species of *Vachellia*, *Acacia*, and *Senegalia*), mainly *Vachellia nilotica* and *V. farnesiana* (formally members of the *Acacia* genus)(Avidov 1958; Awadallah, Azab & El-Nahal 1970; Gharbi 2010; Hanna 1939a; Ksentini, Jardak & Zeghal 2011; Larsen 1984; Sayed 2000). Pomegranates and dates have been recorded as important commercial hosts with the larvae of *V. livia* boring into the fruit (Abbas et al. 2008; Abd-Ella 2015; Ksentini, Jardak & Zeghal 2011; Obeidat & Akkawi 2002; Sayed 2000; Temerak & Sayed 2001; Temerak et al. 2014). Additionally, *V. livia* has a number of recorded secondary hosts, including faba beans (*Vicia faba*), Syrian mesquite (*Prosopis stephaniana*), carobs (*Ceratonia siliqua*) and tamarind (*Tamarindus indica*) (Abbas et al. 2008; Awadallah, Azab & El-Nahal 1970; Gharbi 2010; Ksentini, Jardak & Zeghal 2011; Müller et al. 2005; Obeidat & Akkawi 2002; Temerak & Sayed 2001).

There are also reports in the literature of other commercially grown species being utilised as hosts. Species such as tomatoes, guavas, loquats, oranges, peaches, and rice have been recorded as hosts (Abbas et al. 2008; Buxton 1923; Hanna 1939b; Ksentini, Jardak & Zeghal 2011; Müller et al. 2005; Temerak et al. 2014). However, the original reports of Buxton (1923) and Hanna (1939b) stating these species are hosts relate to a very small number of reported sightings or collections. Given that *V. livia* feeding is usually highly damaging to hosts, it is noteworthy that no recent studies that re-confirm these historic reports were found.

Virachola livia has four life stages: egg, larva, pupa and adult. Females lay eggs on the skin of the fruit or occasionally in the calyx of a pomegranate, and after three to four days the eggs hatch (Hanna 1939a). After hatching, larvae begin to eat their way into the fruit or seed if the fruit is unripe (Awadallah, Azab & El-Nahal 1970). The entry hole in pomegranate fruit increases in size as the larvae grow. Two days after penetration the hole measures less than 1 millimetre in diameter, but by the time the larvae is fully grown the entry hole has enlarged to 6 to 7 millimetres (Avidov & Harpaz 1969b). Larvae have been reported to mainly pupate in the fruit (Hanna 1939a), but may also pupate in the tree crown, or in concealed places on the tree (Avidov & Harpaz 1969b). Infestation of dates can cause the fruit to drop (Braham 2015; Hanna 1939a). All developmental stages (egg, larvae and pupae) are of concern when assessing the risk of importation.

All lifestages of *V. livia* are easily distinguished. Adult males' wings are brightly coloured (orange, brown, black), with wingspans of 18 to 22 millimetres and 25 to 32 millimetres for males and females respectively (Avidov & Harpaz 1969b). Both sexes have a body length of 8 to

12 millimetres (Avidov & Harpaz 1969b). Eggs are round and shiny green/grey in colour, with a diameter of 0.7 millimetres. Larvae have brown heads and grow up to 15 to 18 millimetres long and 5 to 6 millimetres wide. Pupa tend to be smaller than the larvae, with a length of 11 to 12 millimetres and a width of 5 to 6 millimetres. *Virachola livia* has multiple generations per year, with up to 6-8 generations reported, and 2-3 generations per year occurring in pomegranates and dates (Avidov & Harpaz 1969b; Awadallah, Azab & El-Nahal 1970; Gharbi 2010).

Adults are unlikely to pose any biosecurity risk for importation with fresh dates as they are likely to either be disturbed or detected during packing house processes.

The risk scenario of concern is thus the presence of developing eggs, larvae or pupae within or on imported fresh date fruit.

4.2.1 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 *Virachola livia* will arrive in Australia with the importation of fresh dates from the MENA region is assessed as Low.

The following information provides supporting evidence for this assessment.

Virachola livia is present in date-growing areas of the MENA region.

- *Virachola livia* has been recorded in Egypt, Iran, Iraq, Israel, Jordan, Oman, Pakistan, Tunisia, Saudi Arabia, Syria, United Arab Emirates and Yemen (Gerson & Applebaum 2017; Ksentini, Jardak & Zeghal 2011).
- *Virachola livia* has been reported as a moderately migratory species (Larsen 1984, 1990). Such species are described as being able to frequently migrate long distances, but do not require migration for completion of the life cycle (Larsen 1984, 1990). Migration usually occurs into the areas of the Eastern Mediterranean, with permanent colonies existing in sub-Saharan Africa, the Arabian Peninsula and Egypt (Larsen 1984, 1990).
- The migratory nature of *V. livia* means that while there have been reports of its presence in many countries within the region, it may only occasionally and/or temporarily migrate into some countries. For example, a report published in 2005 noted that since *V. livia* was last sighted in the UAE in the early 1990s, there had been no recorded sightings in the interim period (Naseer 2005).
- *Virachola livia* is not reported to diapause. In Egypt, all life stages of *V. livia* can be collected from November to February, with lowest activity recorded at the end of winter (Awadallah, Azab & El-Nahal 1970). Therefore, *V. livia* can be active all year if temperatures are not limiting. This observation is supported by studies showing eight generations per year are possible in Egypt (Awadallah, Azab & El-Nahal 1970).
- In dates and pomegranates, colonies of *V. livia* appear in summer (with some overlap into spring and autumn) (Müller et al. 2005), suggesting that migration is likely to overlap with the development and harvesting of date fruit in countries with no permanent colonies.
- *Virachola livia* has been found to attack dates at high levels towards the beginning of the harvesting season (Sayed 2000). Studies have found that date orchards in Egypt without appropriate controls, for example, spraying or bagging, can have infestations of up to 73 per

cent (Temerak et al. 2014). In orchards with fruit bagging, infestations were reduced by between 33 and 95 per cent (depending on timing of bagging).

- *Virachola livia* has only been reported as attacking dates in Egypt (Awadallah, Azab & El-Nahal 1970; Sayed 2000; Temerak et al. 2014).

Eggs are laid on the surface of fruit.

- *Virachola livia* typically oviposits eggs on the surface of host fruit including dates (Awadallah, Azab & El-Nahal 1970).
- In Eygpt, oviposition has been recorded in winter on *Vachellia farnesiana* when infestation levels are low. Egg laying increases through spring, and by summer (June), infestion levels are high. As the *Vachellia farnesiana* pods start to dry, *V. livia* females search for more suitable hosts such as pomegranates. In May, *V. livia* begins to oviposit on pomegranate fruit with infestions reaching high levels by the end of June (Awadallah, Azab & El-Nahal 1970).
- Dates are reported to be a host in Egypt with oviposition beginning in July. Only a single generation has been reported to occur on dates, with adults emerging in early September (Awadallah, Azab & El-Nahal 1970). Infestation during this time is reported to peak during August (Sayed 2000). By September, new pods have formed on *Vachellia farnesiana* and *V. livia* resumes oviposition on this preferred host (Awadallah, Azab & El-Nahal 1970). This time period for infestation overlaps with the harvest of dates in Egypt, which begins in mid August.
- Similarly, *V. livia* preferentially oviposits onto the pods of *Vachellia farnesiana* in Tunisia (Mkaouar, Dhahri & Jamaa 2016). Oviposition begins in April and three generations occur until July. Once the pods of *V. farnesiana* mature and are no longer green, *V. livia* moves into pomegranate orchards in July.
- In Saudia Arabia, Tiaf City area, oviposition has been recorded from April to September in pomegranates (Sayed et al. 2015).
- In Oman, oviposition has been recorded from May until mid August in pomegranates (Mokhtar & Al Nabhani 2016).
- In Israel eggs are laid in summer, with the first eggs being laid on pomegranate fruit in mid-May, reaching a peak during the second half of July (Avidov & Harpaz 1969b).
- The activity of *V. livia* indicates eggs can be laid over an extended period of the year. Therefore, eggs could be associated with date fruit across a range of maturities, including near harvest.
- Eggs are small in size (0.7 millimetre) (Avidov & Harpaz 1969b), are green-grey in colour, and are laid on the surface of dates. Dates have a smooth skin and therefore eggs could be detected during routine packing house procedures. However, due to the small size of the eggs, some date fruit infested with eggs may escape detection.

Larvae feeding on dates cause visible damage to the fruit.

- Larvae of *V. livia* will burrow into the flesh of the date, or into the seed if the date is unripe (Awadallah, Azab & El-Nahal 1970; Hanna 1939a). Burrowing larvae leave holes of one to seven millimetres in diameter, depending on the maturity of the larva (Awadallah, Azab & El-Nahal 1970).
- Plant juices can be exuded from the entry hole when the fruit is large and juicy, with frass often being present around the entrance (Avidov & Harpaz 1969b; Awadallah, Azab & El-Nahal 1970).

- Fruit infested by larvae often become infected by fungal rot (Avidov & Harpaz 1969b; Gharbi 2010). Fungal rots cause obvious symptoms and their introduction into pomegranates by *V. livia* has been reported to make the fruits unmarketable (Gharbi 2010).
- Towards the end of the growing season, infested pomegranates have been reported to often drop from the tree (Braham 2015). However no reports of infested date fruits dropping to the ground have been found, so it is not known if infested dates will drop from the palm tree prior to harvest.
- Fruits attacked by late instar larvae with obvious signs of damage (entry holes, ejected frass and/or rotting) are unlikely to meet commercial standards and be packed for retail sale.
- No reports can be found to suggest *V. livia* attacks date fruits at a particular developmental stage. It is therefore possible that dates at any stage of development can be attacked. This is supported by literature which, for example, has found that *V. livia* larvae were found in date fruits consistently between June (when dates are still immature) and September (harvest) (Temerak et al. 2014). Therefore, all larval instars may be associated with harvested dates.
- In the early stages of infestation, larvae bore into the fruit and eject unwanted material and frass (Awadallah, Azab & El-Nahal 1970; Mkaouar, Dhahri & Jamaa 2016). Dates are a smooth skinned fruit so it is possible that feeding by early instars would be detected during packing procedures. However, it is highly likely that later stage instars would be detected during packing procedures due to obvious signs of infestation.

Pupation can occur within date fruit.

- Pupation of larvae usually occurs within the fresh date fruit, however it also can occur on the crown or on concealed parts of the palm tree. Pupae occurring outside of the fruit are likely to be noticed due to their size (11 to 12 millimetres long and 5 to 6 millimetres wide) (Avidov & Harpaz 1969b; Awadallah, Azab & El-Nahal 1970). Pupae inside date fruit will be harder to detect directly. However, as pupation occurs after the larval feeding stage, which can be highly damaging, infested fruit harbouring *V. livia* pupae are unlikely to meet commercial standards, and likely to be removed during packing house procedures.

Virachola livia may be adversely affected by cold transport to Australia.

- *Virachola livia* is a well studied species due to its pest status, and no studies have been found which indicate it has the ability to enter diapause. A study by Awadallah, Azab and El-Nahal (1970) found that *V. livia* possesses no true diapause, instead during colder months the stages of development are prolonged.
- Larvae and pupae have significantly higher mortality rates in the colder months (approximately 50 per cent mortality) (Avidov & Harpaz 1969b), and mortality during cold transport is likely to increase. Further studies have found that eggs fail to hatch at 10 degrees Celsius and that larvae cannot complete development and instead die at 15 degrees Celsius (Awadallah, Azab & El-Nahal 1970).

Virachola livia is a damaging pest of date fruit that often migrates into date-growing areas during the warmer season. It is possible that *V. livia* eggs could be associated with date fruit at harvest and may escape detection during routine packing house procedures.

Larvae can also be associated with harvested fresh dates and might be hard to directly detect because they burrow into the fruit. However, larvae, particularly late instars, cause obvious signs of infestation due to presence of frass and the presence of rots, so that infested fruit is unlikely to be of commercial quality, and likely to be rejected at the packing house. Similarly, *V. livia* often pupates inside the fruit, but the obvious residual presence of larval damage would result in non-commercial fruit. It is more likely that dates that are infested with early instar larvae just before harvest are less likely to show external signs of infestation, and could thus escape detection during packing house procedures.

The ability of *V. livia* to burrow into fruit and potentially escape detection is moderated by the fact that late instar larvae and pupae cause visible signs of damage, and are likely to be removed at harvest or post-harvest. Eggs laid on the surface of the smooth-skinned date fruit may also be detected and the likely negative effect of cold transport on the survival of *V. livia* while intransit to Australia all support a likelihood estimate for importation of Low.

Likelihood of distribution

The likelihood that *V. livia* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of fresh dates from the MENA region, 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 dates for commercial sale will be sold in every state of Australia.

- It is expected that when fresh dates from the MENA region arrive in Australia they will be widely distributed for retail sale in many areas of the country. The major population centres are likely to receive the majority of the imported date fruit.
- Human consumption is the intended use for the commodity in Australia. Any infested dates not consumed would provide a pathway for distribution. Date fruit with no obvious signs of infestation could be potentially distributed via the wholesale and retail trade and waste material is likely to be generated.
- Date fruit with obvious symptoms of infestation are unmarketable and are unlikely to be sold within Australia.

Cold transport for fresh dates could potentially kill infestations of *V. livia*.

- Cold storage of fresh dates could limit the distribution of *V. livia*. Not all species of Lycaenidae possess the ability to enter diapause (Carey 1994), and *V. livia* is known to suffer from high larval and pupal mortality during colder months (Avidov & Harpaz 1969b; Awadallah, Azab & El-Nahal 1970). As such the distribution of V. livia in a viable state around Australia during transport in cold storage is likely to be reduced.

It is likely that infested fresh dates will be discarded into the environment.

- Individual consumers will distribute small quantities of fresh dates to a variety of urban, rural and wild environments.
- Commercial waste will also be discarded in Australia prior to retail sale for human consumption. *Virachola livia* requires fresh or developing fruit or seedpods in order to survive and develop.

It is unlikely *V. livia* will successfully develop in discarded imported fresh dates.

- There are two factors that would limit the ability of *V. livia* to successfully develop in fresh dates, namely the time of year the fresh dates are likely to be imported, and the condition of fresh date fruit discarded into the environment.

Time of year

- Khalal date fruits are harvested from mid-May to September in the MENA region. Imported fresh dates are therefore likely to be imported into Australia at or around this time. It is possible that eggs and early instar larvae might be associated with commercial fruit; fruit infested with later instars would not meet commercial quality standards due to obvious damage.

- *Virachola livia* activity is known to be temperature limited, and larvae do not complete development at or below 15 degrees Celsius (Awadallah, Azab & El-Nahal 1970).
- Populations of *V. livia* are known to significantly decline during the winter months in Egypt (Awadallah, Azab & El-Nahal 1970). Many areas of temperate Australia are very unlikely to support larval development during winter (for example, Melbourne has a mean maximum temperature of 14.2 degrees Celsius)(Bureau of Meteorology 2018).
- Imported fresh date fruit distributed to northern areas of Australia in winter (for example, Brisbane, which has a mean maximum temperature of 21 degrees Celsius) is likely to allow larval and pupal development due to warmer weather. However, development times are positively affected by temperature. For example, at 20 degrees Celsius larval development time is about 33 days, while at 30 degrees Celsius it can be completed in 13 days (Awadallah, Azab & El-Nahal 1970).
- Fresh date fruit imported between September and December, when temperatures across Australia are increasing, are more likely to support the development of *V. livia*. However, this will depend on local conditions and could still be largely unfavourable in colder regions of Australia.

Condition of date fruit as a food source

- The condition of fresh date fruit is expected to deteriorate quickly in the environment.
- Discarded fresh date fruit will be exposed to a range of environmental conditions. Fruit will be exposed to saprophytes and storage rot fungi in the environment. Fruit damaged by *V. livia* are reported to be attacked by fungal and bacterial rots (Avidov & Harpaz 1969b; Awadallah, Azab & El-Nahal 1970; Gharbi 2010)
- It is well known that once intact dates on the palm tree reach the khalal stage, moisture loss is rapid (Barreveld 1993). It is expected that discarded fresh date fruit detached from the transpiration stream and exposed to dry conditions will lose moisture even more rapidly. *Virachola livia* has only been reported attacking fresh dates attached to the date palm. Storage pests of dates are well studied (Avidov & Harpaz 1969b; Carpenter & Elmer 1978; Wakil, Faleiro & Miller 2015) and there are no reports of *V. livia* attacking dried dates in storage.

Virachola livia is able to attack a large number of plants.

- *Virachola livia* is a polyphagous species which can attack several crop and native or naturalised species. Crop species attacked include dates, pomegranates, carobs and faba beans (broadbeans). The primary hosts of *V. livia* are legume species (including *Acacia* or *Vachellia* species) (Awadallah, Azab & El-Nahal 1970; Hanna 1939a; Larsen 1984). These crop and native or naturalised host species are present in Australia and widely distributed. This increases the likelihood that *V. livia* will come into contact with a suitable host.
- *Virachola livia* is reported to be a migratory species (Larsen 1984, 1990) and therefore if it successfully develops into an adult, it is very likely to find a suitable host plant in Australia.

It is possible that infested fresh date fruit arriving in Australia would be distributed through Australia for commercial sale. The wide distrubition of potential host species in Australia would result in any discarded fruit, with or without symptoms of infestation, being discarded in the proximity of a host species. However, there are several factors that are expected to limit the successful distribution of *V. livia* to a new host. *Virachola livia* eggs and larvae are sensitive to temperature, and cold transport is expected to significantly increase mortality. It is expected the majority of imported fresh date fruit will be sold in the major population centres in temperate Australia, where winter temperatures are likely to be a significant limiting factor. Further, discarded fresh date fruit is very likely to deteriorate quickly, limiting available resources for larval development. All these factors would lower the risk of distribution. These factors support a likelihood estimate for distribution of Low.

Overall likelihood of entry

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

The likelihood that *V. livia* will enter Australia as a result of trade in fresh dates from the MENA region and be distributed in a viable state to a susceptible host is assessed as Very Low.

4.2.2 Likelihood of establishment

The likelihood that *V. livia* will establish within Australia based on a comparison of factors in the source and destination areas that affect pest survival and reproduction is assessed as Moderate.

The following information provides supporting evidence for this assessment.

Virachola livia is able to feed on a large number of plant species found in Australia.

- *Virachola livia* is a polyphagous species that attacks a large number of plants from the Fabaceae family, which are present in very high numbers throughout Australia. For example, the following species from the Fabaceae family which are abundant in Australia are known to be hosts for *V. livia*: *Vachellia farnesiana*, *Vachellia nilotica*, *Senegalia catechu*, *Senna bicapsularis*, *Dichrostachys cinerea* and *Tamarinus indica* (Awadallah, Azab & El-Nahal 1970; Gharbi 2010; Halperin & Sauter 1991; Ksentini, Jardak & Zeghal 2011; Temerak & Sayed 2001). These species have an extremely wide collective distribution, being present throughout all states and territories of Australia, and in high abundance in northern Australia (ALA 2018). It is also likely that due to biological similarities, closely related species of the Fabaceae family native to Australia could also be attacked.
- *Virachola livia* can infest several crop species found in Australia as both primary and secondary hosts. Both pomegranates and dates are present in Australia and commercially grown, though in low numbers (ALA 2018). A larger list of secondary commercially grown hosts is present in the literature, which includes carobs and faba beans (Abbas et al. 2008; Awadallah, Azab & El-Nahal 1970; Gharbi 2010; Ksentini, Jardak & Zeghal 2011; Temerak & Sayed 2001) which are found commonly throughout eastern Australia. These hosts species would give a small increase to the likelihood of *V. livia* establishing in Australia.
- Due to the high abundance and broad distribution of these host species in Australia, it is highly likely that *V. livia* would not be limited by suitable host fruits or fruiting bodies throughout the year. These species grow in both rural and urban settings, making it possible for *V. livia* to establish in a variety of environments and areas.
- The presence of host species in Australia significantly increases the likelihood of *V. livia* establishing.

In order to produce offspring sexual reproduction is required.

- *Virachola livia* reproduces sexually and can lay a moderate number of eggs. Reproduction requires the successful mating between male and female adults before viable eggs are produced. Most Lepidoptera (moths and butterflies) find mating partners via chemicals known as pheromones (Ando, Inomata & Yamamoto 2004); these help individuals locate each other across long distances. Using pheromones increases the chances of a breeding population being established from sparsely distributed individuals. Multiple species from the Lycaenidae family have been found to use sex pheromones (Andersson et al. 2007), therefore it is likely that *V. livia* uses sex pheromones to attract potential mates.

- However, as discussed in 'Likelihood of Distribution', it is likely that only a small number of eggs or larvae associated with imported fresh date fruit would successfully develop into adults. Adults that do emerge live for about 3 to 15 days, under laboratory conditions, depending on gender and access to nutrients (Awadallah, Azab & El-Nahal 1970). There are reports of the adults living for up to 14 days in the field in Israel (Avidov & Harpaz 1969b). Therefore, newly emerged adults will need to find a mate within a relatively short period of time.
- Mated females are reported to oviposit between 40 to 100 eggs on average, depending on the host being utilised (Gharbi 2010).

Köppen climate maps show similarities between Australia and the MENA region.

- *Virachola livia* is distributed throughout the Middle East, North Africa, sub-Saharan Africa and some Mediterranean countries in climates similar to those found in Australia. The climate in the regions where *V. livia* is found corresponds to the Köppen climate classification zones BWh, BWk, BSh, BSk, Aw, Csa, Csb, Cwa and Cwb (Peel, Finlayson & McMahon 2007).
- These same climate classification zones are present throughout northern, central and warm temperate Australia. This suggests that suitable climatic conditions for the establishment of *V. livia* are present in the arid (desert), semi-arid inland and northern tropical regions of Australia (Peel, Finlayson & McMahon 2007).

Australian winters could prevent establishment in some areas.

- A temperature of 15 degrees Celsius has been reported to cause complete larval mortality for *V. livia* on some host species (Awadallah, Azab & El-Nahal 1970). It has also been reported that 13 degrees Celsius is the minimum developmental threshold for *V. livia*, with development taking approximately one year under these conditions (Avidov & Harpaz 1969b).
- In the colder months of the year adults will often die before ovipositing (Avidov & Harpaz 1969b), and females will have under-developed ovaries with relatively small numbers of eggs (Hanna 1939a).
- After a discovery of *V. livia* in Greece (Müller et al. 2005), it was suggested that is was unlikely that *V. livia* could survive winter there. It was stated that the poor ability of larvae to withstand cold was the basis of this claim. Since this report was published there have been no further reports of *V. livia*'s presence in Greece, suggesting either that it did not establish, or the population is at low levels.
- Winter temperatures in many parts of Australia consistently drop below 15 degrees Celsius, so that the establishment of *V. livia* in these areas would be significantly reduced. Imports of fresh dates from the MENA region are expected to largely occur during the colder months in Australia, and as such, initial establishment would be highly unlikely in some areas.
- However, the temperatures in northern Australia are very likely to be suitable for *V. livia*. Temperatures in northern Australia, even during the colder winter months, remain moderate (typically above 15 degrees Celsius)(Bureau of Meteorology 2018), and as such a viable population is very likely to be able to establish in this area.

Multiple generations can be produced per year in the hosts found in Australia.

- *Virachola livia* has been observed to produce multiple generations per year providing suitable temperatures are present. When conditions are ideal *V. livia* can produce up to eight generations a year in Israel and Egypt (Avidov & Harpaz 1969b).
- Laboratory tests showed production of two to four generations per year, depending on host, in Tunisia (Gharbi 2010). Time taken for eggs to hatch at 27 degrees Celsius is three to eight days, larval development takes 14 to 30 days, and pupation 8 to 12 days (Gharbi 2010). At 20 degrees Celsius, development is slowed to 18.7 days for egg hatching, 33 days for larval development and 30 days for pupation (Hanna 1939a).

Biological and chemical control agents have shown to be effective in the control of *V. livia.*

- *Virachola livia* can be controlled through a variety of biological and chemical control agents. The biological control agent *Bacillus thuringiensis* is readily available in Australia as a pesticide and is recommended as a method of controlling existing lepidopteran pests (Herbison-Evans & Crossley 2018). Recent studies have also demonstrated its effectiveness in controlling *V. livia* (Abbas et al. 2008).
- Chemical control agents such as sprays of the bio-insecticide spinosad followed by methoxyfenozide 24 SC in a three week interval greatly reduced the infestation rate of dates. This treatment was so effective, infestation rates were reduced to between 0.3 to 0.6 per cent and larval penetration to below 2 per cent in Egypt (Temerak et al. 2014). Both spinosad and methoxyfenozide have been registered in all Australian states for use on a variety of agricultural products according to the Australian Pesticides and Veterinary Medicines Authority, making it reasonable to expect successful control of introduced *V. livia* populations within commercial plantations in Australia. It would be highly unlikely that chemical sprays would be used on native plants, such as native *Acacia* species.

Physical control methods have been shown to be effective in the control of *V. livia.*

- Physical control methods have been successful at controlling the establishment of *V. livia* in date palm and pomegranate plantations. Covering bunches with plastic bags enabled a significant reduction in the infestation rates of *V. livia* in dates by between 80 to 95 per cent, when applied early in the season (Sayed 2000). Bagging activity such as this is already practised in many domestic commercial date plantations. This suggests that an effective, though potentially costly, control method is available, making it reasonable to expect successful control of any introduced *V. livia* populations in Australia.
- Physical controls would not be present on native growing host plants from the Fabaceae family, and as such, will not stop the establishment of this pest.

Parasitic wasp species have shown promise for controlling *V. livia*.

- Alternative control options for *V. livia* are also available in the form of parasitic wasp species. *Telenomus* species are known to be highly effective parasitoids of *V. livia* (Abbas et al. 2008). While various *Telenomus* species have been recorded in Australia (ABRS 2018), it is not known if any of them would parasitise *V. livia*. Egg parasitoids such as *Trichogramma* species are known to parasitise *V. livia* but at a lower rate. While the species confirmed to parasitise *V. livia* are *Trichogramma brassicae* and *T. evanescens* there are no records of these species being present in Australia, however, other species in the genus are present and have been shown to parasitise new species (Steidle, Rees & Wright 2001). This suggests that parasitoids present in Australia may provide some level of control for *V. livia* if they were to utilise this new host.
- However, given the wide host range of *V. livia*, including many species where active management would not be undertaken, it is unlikely any of these controlling factors would significantly lessen the overall likelihood of establishment.

There are similarities of climate in many areas of Australia to that of *V. livia*'s current distribution. Throughout these areas of similar climate, there are a large number of host species available for *V. livia* to utilise without facing significant controls (for example, sprays or physical barriers). An important moderating factor is the requirement for mating to occur for successful reproduction. It is considered that the low numbers of adults emerging from imported fresh date fruit would be a limiting factor for *V. livia* successfully finding a mate. This evidence collectively supports a likelihood estimate for establishment of Moderate.

4.2.3 Likelihood of spread

The likelihood that *Virachola livia* 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 High.

The following information provides supporting evidence for this assessment.

Virachola livia has the ability to fly short distances.

- The ability of adult *V. livia* to fly will increase its likelihood of spreading. Adults are rapid fliers that can live for a fortnight (Avidov & Harpaz 1969b; Awadallah, Azab & El-Nahal 1970). Infestations have been found to be able to spread six to eight kilometres in the direction of the prevailing winds (Hanna 1939a). As such, it is highly likely that adults could colonise new areas without human-mediated assistance.
- *Virachola livia* has been recorded as a moderately migratory species (Larsen 1984, 1990). As a moderately migratory species, *V. livia* has the ability to distribute itself over large distances (Larsen 1984, 1990). *Virachola livia* has been reported to be able to spread into areas outside its main distribution area in the MENA region (Müller et al. 2005). As such it is highly likely that *V. livia* would be able to spread to new hosts with relative ease.

Extreme weather events could aid in the spread of *V. livia* throughout Australia.

- The dispersal of insects is often aided by weather events. Extreme weather events are likely to occur in Australia that would result in strong winds. Strong winds would aid the long distance dispersal of *V. livia*, over distances it would normally not fly unaided.

Temperatures in Australia could either aid or hinder the spread of *V. livia.*

- The climate zones present across the natural distribution of *V. livia* are also found in central, northern and parts of Southern Australia. The similar climate conditions in these areas would aid the spread of *V. livia*.
- Given the reported minimum developmental temperature of beteween 13 and 15 degrees Celsius (Avidov & Harpaz 1969b; Awadallah, Azab & El-Nahal 1970), winter conditions could limit the spread of *V. livia* in many areas of the south and east coast of Australia.
- No data is supplied on the highest developmental temperature, however given the wide distribution of *V. livia* in the MENA region, high temperatures found in Australia are not likely to impact its spread.

The ability of *V. livia* to complete its lifestyle on a number of hosts will aid its spread.

- *Virachola livia* completes its lifestyle on a large number of plant species which are found all over Australia. Given their ability to cover moderate distances as adults, and the average fecundity of 40 to 100 eggs (Gharbi 2010), it is highly likely that adults could locate a suitable host and start a founding population.

The spread of infected fruit for sale or as waste may aid the continual spread of *V. livia.*

- Domestic trade of agricultural products would aid the spread of *V. livia*. If infested host fruits from Australian orchards where *V. livia* has become established are sold domestically, *V. livia* may spread to other parts of Australia. The polyphagous nature of *V. livia* means that it may be spread via many potential domestically grown hosts, such as dates, pomegranates, carobs, faba beans and *Acacia* or *Vachellia* trees (which are prevalent in Australia). Larvae burrow into fruit and seed pods, and they may be inadvertently moved by domestic travellers and spread with fruits that are not grown commercially across Australia.
- Long-distance spread across the continent via domestic travellers would be limited by current domestic regulations, such as those in force in Western Australia and South Australia.
- As previously discussed it is possible, but less likely, that commerically grown fruit would spread *V. livia*.

The ability of *V. livia* to migrate over significant distances through flight, as well as the possibility of weather events aiding this flight, supports its ability to spread over large distances. Domestic trade and tourism would also likely increase the risk of spread. The large number of host species present in Australia also makes it likely that new hosts could be consistently found. Spread into temperate areas of Australia is likely to be limited by cooler temperatures. These considerations support a likelihood estimate of spread of High.

4.2.4 Overall likelihood of entry, establishment and spread

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

The overall likelihood that *Virachola livia* will enter Australia as a result of trade in fresh dates from the MENA region, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia is assessed as Very Low.

4.2.5 Consequences

The potential consequences of the establishment of *Virachola livia* in Australia have been estimated according to the methods described inTable 2.3.

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.

Table 4.5 Summary of consequences for *Virachola livia*

Consequences criterion	Impact (magnitude and geographic scale)	Impact score
Direct impact on plant life or health	Major significance at district level	E
Direct impact on other aspects of the environment	Indiscernible at any level	A
Indirect impact on eradication and control	Minor significance at district level	C
Indirect impact on domestic trade	Minor significance at district level	C
Indirect impact on international trade	Significant at the local level.	C

Consequences criterion	Impact (magnitude and geographic scale)	Impact score
Indirect impact on non-commercial criteria or the environment	Minor significance at the local level	B
Overall consequences rating	–	Moderate

Direct impact on plant life or heatlh

Impact score: **E**

The direct impact of *V. livia* on plant life or health would be of major significance at the district level, significant at the regional level and of minor significance at the national level, which has an impact score of 'E'. This is because the impact would be expected to cause a large decrease in production of commercial hosts, such as pomegranate, and irreversibly damage the intrinsic 'value' of the Australian native *Acacia* flora.

Virachola livia larvae damage fruits and seed pods by directly feeding on the flesh of fruits and seed within pods (Abbas et al. 2008; Avidov 1958; Awadallah, Azab & El-Nahal 1970). Further damage then occurs via the introduction of mould inside the fruit (Abbas et al. 2008; Avidov 1958; Awadallah, Azab & El-Nahal 1970). Both types of damage often ensures attacked fruit is no longer commercially viable. The main hosts for *V. livia* are pods of the Mimosoideae sub-family (which belongs to the Fabaceae family) (Ksentini, Jardak & Zeghal 2011). Dates and pomegranates appear to be the main secondary hosts for *V. livia*, though, as outlined below, it can take advantage of several horticultural commodities.

Virachola livia has been recorded causing extensive damage to dates and pomegranates (Ksentini, Jardak & Zeghal 2011; Temerak et al. 2014). Dates and pomegranates are both grown throughout Australia, though in small numbers (AVH 2018). While the industries for both these commodities appear to be relatively small, the impact they could have on commercial production could be significant at the local level. *Virachola livia* was recently introduced into Tunisia, where it caused significant damage to the pomegranate industry (Ksentini, Jardak & Zeghal 2011). In 2006 a total of 5.2 per cent of all pomegranate fruit produced by Tunisia was infested by *V. livia,* with feeding activity causing up to 52 per cent of fruit rots in some areas (Ksentini, Jardak & Zeghal 2011). In some areas of Egypt, up to 37.3 per cent of date bunches have been recorded as infested by *V. livia,* although it is not reported how many date fruit on those bunches were affected (Sayed 2000). As such, if *V. livia* was to be introduced into Australia, its presence could be damaging to the emerging Australian date and pomegranate industries.

Carob trees (*Ciratonia siliqua*) have also been reported as a host species for *V. livia*. The Australian carob industry, similar to the date and pomegranate, is still small and developing, with only a small number of growers, mostly located in South Australia. There are no reports describing the level of damage on commercial carob plantations by *V. livia*; as such it seems likely that it is less damaging to carobs than pomegranates and dates.

Virachola livia also attacks several plants belonging to the legume family (Fabaceae). *Vicia faba* (broad or faba beans) is a legume crop that has been reported as a host for *V. livia* (Awadallah, Azab & El-Nahal 1970). The average export value of *Vicia faba* is $168 million annually (Pulse Australia 2016). However, *Vicia faba* is widely grown in areas where *V. livia* is abundant, including Egypt (Nassib, Khalil & Hussein 1991), and no reports of *V. livia* causing economic damage to *Vicia faba* can be found.

Additional to several commercially grown hosts, *V. livia* has the ability to attack several non-commercial legume species. Legume species preferred by *V. livia* are from the sub-family Mimosoideae and the genera *Acacia*, *Senegalia* and *Vachellia* (*Senegalia* and *Vachellia* were formerly a part of *Acacia*) (Awadallah, Azab & El-Nahal 1970). The preferred host species are *Vachellia farnesiana* and *V. nilotica* (Avidov & Harpaz 1969b), both of which are common throughout Australia, though *V. nilotica* has been declared a weed of national significance (AVH 2018). *Virachola livia* attacks the seed pods of these species at the larval stage (Avidov & Harpaz 1969b; Larsen 1984, 1990). Similar species also attacked by *V. livia* that are present in Australia include *Senegalia modesta* and *Senegalia catechu* (both formally members of the *Acacia* genus) (ALA 2018; Awadallah, Azab & El-Nahal 1970).

Other non-commercial species of the legume family attacked by *V. livia* that are present in Australia (ALA 2018) include *Senna bicapsularis* (formally *Cassia bicapsularis*) and *Dichrostachys cinerea* (previously *Dichrostachys nutans*)(Awadallah, Azab & El-Nahal 1970). However, all these species (*Vachellia farnesiana*, *V. nilotica*, *Senegalia modesta*, *S. catechu*, *Senna bicapsularis* and *Dichrostachys cinerea*) are introduced alien species in Australia (Randall 2007), though some have become naturalised.

The Mimosoideae subfamily is an ecologically important and numerically abundant group of the Australia native flora (ANBG 2015). The broad host range of *V. livia* indicates it is likely to feed on a number of native species such as members of the *Acacia* if it were to establish in Australia.

Little research has been done on the impact *V. livia* has on the Mimosoideae subfamily, as they are of minimal economic importance in the MENA region. As a result, it is not well understood what the direct impacts on native Australian trees might be. What is well understood is that *V. livia* does not kill its host, and that feeding impact is limited to propagule destruction. If significant propagule destruction occurred, a potential impact could be reduced recruitment of seedlings, resulting in reduced numbers of naturally occurring native Mimosoideae species in Australia. However, any impact is uncertain; there are no reports of *V. livia* causing seed limitation on host plants. Taking this uncertainity into account, and the extremely wide distribution of native *Acacia* species (and other species from this subfamily) it is still possible that impacts could occur that are significant at the district level.

Direct impact on other aspects of the environment

Impact score: **A**

The direct impact of *V. livia* on other aspects of the environment would be indiscernible at the local, district, regional and national levels, which has an impact score of ‘A’. This is because the impact of *V. livia* on native butterflies or competition for resources locally with these organisms is unlikely to occur.

Virachola livia’s ability to persist year round by feeding on the seed pods of numerous species from the Mimosoideae subfamily could result in increased competition for native seed feeders. However, given the extremely large number of species in the Mimosoideae sub-family, it is unlikely that this would cause any discernible impact.

Similarily, due to the large numbers of potential host species in Australia from the Mimosoideae subfamily, the impact of individual plant species producing smaller number of seeds is unlikely to cause a discernible impact on other plant species.

Indirect impact on eradication and control

Impact score: **C**

The indirect impact of *V. livia* on eradication and control would be significant at the local level and of minor significance at the district level, which has an impact score of 'C'. This is because the impact would be expected to lead to a minor decrease in production but not expected to threaten the economic viability of production, through an increase in costs associated with crop monitoring, consultant's advice, containment, eradication and control of this pest on infested date palms at the local level.

A variety of chemical, biological and physical control agents have been effective at controlling *V. livia* on both date palms and pomegranates.

For date palms, there has been good success at controlling *V. livia* using spinosad at 20 mL per 100 L followed by methoxyfenozide 24 SC at 15 mL per 100 L in a three week cycle in field trials in Egypt (Temerak et al. 2014). These chemicals are currently registered for use in all Australian states. Other control methods, such as protecting bunches in plastic bags, have also shown large scale success at controlling *V. livia* on date palms (Sayed 2000), mitigating some environmental concern and potential damage. There appears to already be some use of bunch bags in date production in Australia, so this control method would require a smaller investment.

Some success has also been achieved with controlling *V. livia* on both pomegranates and date palms (Sayed et al. 2015) with *Bacillus thuringiensis*, a biological control agent already used in Australia. For pomegranates, chemicals such as methoxfenozide, pyridalyl, emamectin benzoate and indoxacarb have all been shown to significantly reduce infestations of *V. livia* (Abd-Ella 2015).

Use of chemical, biological and physical control agents have small, but significant associated cost. Chemical and biological control agents are likely to add significant costs to production. Physical control methods, will also take a significant amount of time, which would incur labour costs.

Indirect impact on domestic trade

Impact score: **C**

The indirect impact of *V. livia* on domestic trade would be significant at the local level and of minor significance at the district level, which has an impact score of 'C'. This is because the impact would be expected to lead to a minor decrease in production but not expected to threaten the economic viability of production, through an increase in domestic regulatory costs.

The presence of *V. livia* would have a minimal impact on domestic trade. If *V. livia* was established it would be unlikely to result in trade restrictions of dates, carobs, broad beans and pomegranates between states. These crops, with the exception of broad beans, are grown in very small amounts currently in Australia. Additionally, *V. livia* could easily spread by itself through most states using native *Acacia* and *Vachellia* species as hosts; as well, its moderately migratory behaviour would further reduce the need to restrict domestic trade. However, if *V. livia* only established in one geographic area, such as eastern Australia, its presence might result in trade restrictions into a state that could maintain freedom through significant physical barriers and/or effective regulation.

Indirect impact on international trade

Impact score: **C**

The indirect impact of *V. livia* on international trade would be significant at the local level and of minor significance at the district level, which has an impact score of 'C'.

The presence of *V. livia* would have a minimal impact on international trade. Australia currently exports very small quantities of dates and pomegranates to other countries (International Trade Centre 2016). Almost every country from the MENA region has populations of *V. livia* (Ksentini, Jardak & Zeghal 2011), meaning potential future trade to these countries would not be impacted. *Virachola livia* has the potential to impact future trade of dates and pomegranates to countries with comparably strict biosecurity laws, where *V. livia* is not present.

Indirect impact on the environment

Impact score: **C**

The indirect impact of *V. livia* on the environment would be significant at the local level and of minor significance at the district level, which has an impact score of 'C'.

Virachola livia could have an indirect minor impact on the environment. Application of pesticides or other control activities would be required to control this pest on its commercial host species, and could have minor indirect impacts on the environment. The insecticides often used in controlling *V. livia* are bio-insecticides, such as *Bacillus thuringiensis* spray, or have a low environmental impact. As such these sprays are likely to have only a minor impact on the environment. Physical control methods such as bagging bunches with nylon or plastic bags would also be an effective control that would have negligible environmental impacts.

The uncertain risk of *V. livia* reducing the population levels of species in the Mimosoideae subfamily means there is some potential for indirect flow-on impacts to the environment. If newly appearing niches in the environment are not taken by species in the Mimosoideae subfamily they are likely to be taken by other plant species. Changes such as these could have other flow-on impacts for other plant, animal and fungal species associated with the plants involved. As a result, minor changes to some local ecosystems could occur. However, it should be noted that it is unlikely that *V. livia* would cause large changes in the ecosystem by feeding on seeds given the large number of potential host species.

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 *Virachola livia*	
Overall likelihood of entry, establishment and spread	Very Low
Consequences	Moderate
Unrestricted risk	Very Low

As indicated, the unrestricted risk estimate for *V. livia* has been assessed as Very Low, which achieves the ALOP for Australia. Therefore, no specific risk management measures are required for this pest.

4.3 Spider mites

Oligonychus afrasiaticus (EP), *O. pratensis* (EP) and *Eutetranychus palmatus*

Eutetranychus palmatus (date palm mite), *Oligonychus afrasiaticus* (date dust mite) and *Oligonychus pratensis* (Banks grass mite) belong to the Tetranychidae or 'spider mite' family. The three species of spider mites assessed here have been grouped together because of their common biological characteristics and taxonomies, on the bases of which they are considered to pose similar risks and to require similar mitigation measures. In this assessment, the term 'spider mites' is used to refer to these three species. Scientific names are used when the information refers to an individual species.

Two species of the genus *Oligonychus* have been assessed previously for the pathway of bananas from the Philippines (Biosecurity Australia 2008b). Various other species of related spider mites of the genera *Amphitetranychus*, *Panonychus* and *Tetranychus* have been assessed in the import risk analyses for table grapes from China (Biosecurity Australia 2011a), apples from China (Biosecurity Australia 2010) and mangosteens from Indonesia (DAFF 2012). In these existing policies, the unrestricted risk estimate for spider mites was assessed as Low, which did not achieve the ALOP for Australia. Therefore, specific risk management measures are required for these pests on those pathways.

The department has assessed the likelihood of importation of the above-mentioned tetranychid mites on fresh dates from the MENA region pathway as being similar to the previous assessments of High for these species on other commodity/country pathways. Due to their small size (Blumberg 2008; Negm, De Moraes & Perring 2015; Vacante 2016), spider mite adults and immature stages may escape detection during harvesting and packing house processes. While the presence of large populations of spider mites may be obvious, some species produce little if any webbing (Blumberg 2008; Gerson, Venezian & Blumberg 1983), and the presence of a few mites and eggs lodged around the perianth of recently infested fresh dates (Negm, De Moraes & Perring 2015; Vacante 2016), for example, will be difficult to see. In summary, at low population densities damage to dates may not be obvious and the very small mites may possibly escape detection during harvest and packing house processes. For these reasons, the likelihood of importation of spider mites on fresh dates from the MENA region is considered identical to previously made assessments of High.

Previous assessments of spider mites on other commodity/country pathways rated the likelihood of distribution as Moderate. Fresh date fruit from a MENA country is expected to be distributed in Australia in a similar way to other fruit commodities assessed previously. Each of these spider mites has a wide host range, and host material is likely to be available for these pests all year in Australia, especially as these spider mites overwinter by surviving on alternative hosts such as grasses in ground-cover (Negm, De Moraes & Perring 2015). These spider mites spread passively by means of aerial dispersal (Talhouk 1969) and this is the most likely means by which a spider mite will reach a host plant from discarded fresh date fruit; it is noted however that passive dispersal often results in high levels of mortality if a spider mite does not find a suitable host. For these reasons, the likelihood of distribution of spider mites on fresh dates from the MENA region is considered identical to previously made assessments of Moderate.

The likelihood of establishment and spread of spider mites in Australia is also assessed as being identical to previous assessments. These likelihoods relate specifically to events that occur in Australia, and are principally independent of the importation pathway. The consequences of entry, establishment and spread of spider mites are also independent of the import pathway and are therefore consistent between pest risk assessments. Therefore, the existing ratings for the likelihood of entry, establishment and spread, and the rating for the overall consequences for spider mites have been adopted for fresh date fruit from the MENA region.

In addition, the department has reviewed the latest literature—for example Al-Atawi (2011); Al-Atawi, Kamran and Negm (2015); Al-Doghairi (2004); Al-Jboory and Al-Suaide (2010); Ben Chaaban, Chermiti and Kreiter (2011b, 2011a, 2012); Ben Chaabane and Chermiti (2009); Blumberg (2008); El-Shafie (2012); Khodayari et al. (2013); Negm, Alatawi and Aldryhim (2014); Palevsky, Lotan and Gerson (2010); Palevsky et al. (2003); Vacante (2016); Wakil, Faleiro and Miller (2015)—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 spider mites in the existing policies.

As noted, the likelihoods of importation and establishment for these spider mites on the fresh date fruit from the MENA region pathway are rated as High, while the likelihoods of distribution, spread, and the consequences of entry, establishment and spread, are each rated 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 Low. All likelihood ratings are set out in Table 4.7.

4.3.1 Unrestricted risk estimate

The unrestricted risk estimate for spider mites from the fresh date fruit from the MENA region 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 these pests.

4.4 Armoured scale

Fiorinia phoenicis (EP)

Fiorinia phoenicis, commonly referred to as the 'long scale' or the 'fiorinia date scale', belongs to the Diaspididae or 'armoured scale' family. Armoured scales are a highly polyphagous family, with some species feeding on hosts from 100 families of plants (Anderson et al. 2010). However, *F. phoenicis* has been recorded only on date palm (*Phoenix dactylifera*) (García Morales et al. 2018).

Several armoured scale species have been assessed previously in a number of existing import policies, for example, in the import risk analyses for limes from New Caledonia (Biosecurity Australia 2006a), fresh mango from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a), Pakistan (Biosecurity Australia 2011b), Indonesia, Thailand and Vietnam (Department of Agriculture and Water Resources 2015), Unshu mandarin from Japan (Biosecurity Australia 2009) and apple from China (Biosecurity Australia 2010). In these existing policies, the unrestricted risk estimate for armoured scales was assessed as Very Low, which achieves the ALOP for Australia. Therefore specific risk management measures are not required for those pests on this pathway.

The department has assessed the likelihood of importation of *F. phoenicis* on the fresh date fruit from the MENA region pathway as being similar to the previous assessments of High for armoured scale species on other commodity/country pathways. *Fiorinia phoenicis* can be associated with fresh dates, and feeding females produce a hard waxy shell that provides protection from environmental extremes. Due to their very small size (Attia 2013) adult scales may be difficult to detect during harvesting and packing house processes at low population densities. For these reasons, the assessed likelihood of importation of *F. phoenicis* on fresh dates from the MENA region is considered identical to previous assessments of High.

The likelihood of distribution of *F. phoenicus* on fresh dates from the MENA region pathway is also concluded to be similar to those for related armoured scales for commodities from previously assessed export areas. Previous assessments for armoured scales on other commodity/country pathways rated the likelihood of distribution as Low. Fresh date fruit from the MENA region are 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 dates pathway, as adult females are sessile and firmly attached to their host and are incapable of independent movement (Carver, Gross & Woodward 1991). The ability of *F. phoenicus* to disperse is limited to the first ('crawler') instar stage, and crawlers would be unlikely to survive for a long period off their only host, the date palm *Phoenix dactylifera* (Ker & Walker 1990). Abiotic factors such as unsuitable temperatures strongly influence the survival rate of crawlers during the dispersal stage (Watson 2018) resulting in high mortality. For these reasons, the department has determined the likelihood of distribution of *F. phoenicus* on the fresh date fruit from the MENA region pathway to be identical to previously-made assessments. Therefore the same rating of Low for the likelihood of distribution of *F. phoenicus* is adopted for the fresh date fruit from the MENA region pathway.

The likelihoods of establishment and spread of armoured scales in Australia from fresh date fruit from the MENA region are similar to those of previous assessments. Those likelihoods relate specifically to events that occur in Australia, and are principally independent of the importation pathway. The consequences of entry, establishment and spread of *F. phoenicis* are also independent of the importation pathway and are similar between pest risk assessments. Therefore, the existing ratings for the likelihoods of entry, establishment and spread, and the rating for the overall consequences for *F. phoenicis* have been adopted for the fresh date fruit from the MENA region pathway.

In addition, the department has reviewed the latest literature—for example Al-Antary, Al-Khawaldeh and Ateyyat (2014); Attia (2013); Elwan, El-Sayed and Serag (2011); García Morales et al. (2018); Radwan (2012)—and no new information has been identified that would significantly change the risk ratings for importation, distribution, establishment, spread and consequences, as set out for armoured scales in existing policies.

The likelihoods of importation and establishment for *F. phoenicis* on the fresh date fruit from the MENA region pathway are rated as High, and the likelihood of distribution and the consequences of entry, establishment, and spread are rated as Low. 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 Very Low. These likelihood ratings are set out in Table 4.7.

Unrestricted risk estimate

The unrestricted risk estimate for *Fiorinia phoenicis* from the fresh dates from the MENA region pathway is assessed as Very Low, 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 this pest.

4.5 Mealybugs

Planococcus ficus (EP) and *Pseudococcus cryptus* (EP, WA)

Planococcus ficus (vine mealybug) and *Pseudococcus cryptus* (citriculus mealybug) belong to the Pseudococcidae or 'mealybug' family. The mealybug species assessed here have been grouped together because of their related biologies and taxonomies, on the bases of which they are considered to pose similar risks and to require similar risk management measures. In this assessment, the term 'mealybugs' is used to refer to these two species. Scientific names are used when the information refers to an individual species.

Pseudococcus cryptus is not present in Western Australia and is a pest of regional concern for that state.

Several mealybug species have been assessed previously in a number of existing import policies, for example, in the import risk analyses for persimmon from Japan, Korea and Israel (DAFF 2004c), mango from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a), 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), and table grapes from China (Biosecurity Australia 2011a) and Japan (Department of Agriculture 2014). In these existing policies, the unrestricted risk estimate for mealybugs was uniformly 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 department has assessed the likelihood of importation of mealybugs on the fresh dates from the MENA region pathway as being similar to the previous assessments of High for these species on other commodity/country pathways. Mealybugs usually feed in protected areas on the undersides and/or axils of leaves of their hosts, but in population outbreaks, they can also be associated with fruit. Once a mealybug finds a suitable feeding site it anchors itself to the host plant with its mouthparts. A feeding mealybug can be difficult to dislodge, as it produces a waxy protective coating that may 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 likely that they will remain undetected during routine packing house procedures, especially at low population densities. For these reasons, the likelihood of importation of mealybugs on fresh dates from the MENA region is considered identical to previously made assessments of High.

Previous assessments of mealybugs on other commodity/country pathways rated the likelihood of distribution as Moderate. Fresh date fruit from the MENA region are expected to be distributed in Australia in a similar way to other fruit commodities assessed previously. Mealybugs have a wide host range, and suitable host material is likely to be available all year in Australia, especially as they can feed on leaves and stems when fruit is not available. The most active life stage is the 'crawler' or first instar, which is considered to be the most likely stage at which a mealybug will reach a host plant through its own activity. Mealybug nymphs and adult females are not capable of flight, but can potentially be carried by wind or on farm workers' clothes. Potential mealybug hosts include herbaceous plants growing in ground cover that could be found in areas where fresh date fruit may be discarded. However, as disposed fresh date fruit would deteriorate quickly in the environment, the mealybug crawlers would only have a limited timeframe to find a new host. For these reasons, the department considers the likelihood of distribution for mealybugs on the fresh date fruit from the MENA region 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 date fruit from the MENA region pathway.

The likelihoods of establishment and spread of mealybugs in Australia are similar to those of previous assessments. 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 mealybugs are also independent of the importation pathway, and are similar between pest risk assessments. Therefore, the existing ratings for the likelihood of entry, establishment and spread and the rating for the overall consequences for mealybugs have been adopted for fresh date fruit from the MENA region.

In addition, the department has reviewed the latest literature—for example Amarasekare et al. (2008); Basheer et al. (2016); García Morales et al. (2018); Karamaouna and Copland (2009); Kim, Song and Kim (2008); le Vieux and Malan (2013a); Marotta, Harten and Mahyoub (2001); Prasad et al. (2012); Varikou et al. (2010); Williams (2004)—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 mealybugs in existing policies.

The likelihoods of importation, establishment and spread for these mealybugs on the fresh date fruit from the MENA region pathway are rated as High, while the likelihood of distribution is rated as Moderate, and the consequences of entry, establishment, and spread are rated 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 4.7.

Unrestricted risk estimate

The unrestricted risk estimate for mealybugs from the fresh dates from the MENA region 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 these pests.

4.6 Fruit flies

Bactrocera dorsalis (EP), *Bactrocera zonata* (EP) and *Ceratitis capitata* (EP)

Bactrocera dorsalis (Oriental fruit fly), *Bactrocera zonata* (peach fruit fly) and *Ceratitis capitata* (Mediterranean fruit fly) belong to the Tephritidae or 'fruit fly' family. The fruit fly species assessed here have been grouped together because of their related biologies and taxonomies, on the bases of which they are considered to pose similar risks, and to require similar mitigation measures. In this assessment, the term 'fruit flies' is used to refer to these three species. Scientific names are used when the information refers to an individual species.

All three fruit fly species have been assessed previously in a number of existing import policies, for example, in the import risk analyses for mangoes from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a), Pakistan (Biosecurity Australia 2011b), Indonesia, Thailand and Vietnam (Department of Agriculture and Water Resources 2015), longan and lychee fruit from China and Thailand (DAFF 2004a), mangosteen from Thailand (DAFF 2004b), lychee from Taiwan and Vietnam (DAFF 2013), table grapes from China (Biosecurity Australia 2011a), Chile (Biosecurity Australia 2005b) and India (Australian Government Department of Agriculture and Water Resources 2016), sweet orange from Italy (Biosecurity Australia 2005a) and truss tomato from the Netherlands (DAFF 2003). In these existing policies, the unrestricted risk estimate for fruit flies was uniformly assessed as not achieving the ALOP for Australia, such that specific risk management measures are required for these pests.

Differences in commodity pathways, horticultural practices, climatic conditions and regional prevalences of these three species, as compared to those considered in existing policy, make it necessary to reassess the likelihood that *Bactrocera dorsalis*, *B. zonata* and *Ceratitis capitata* will be imported into Australia with fresh dates from the MENA region.

Tephritid fruit flies have a wide host range, and host material is likely to be available all year in Australia. The importation of fresh dates from the MENA region is expected to occur during a similar period to that for which other host fruit can currently be imported from Chile, China, India, Italy, Mexico, the Netherlands, Pakistan, the Philippines, Taiwan, Thailand and Vietnam. After importation, fresh dates from the MENA region will be distributed throughout Australia for retail sale in a similar way to host fruit from the above-mentioned countries.

The likelihoods of establishment and spread of fruit flies from fresh dates imported into Australia are also considered to be similar to those provided in the previous assessments identified above. These likelihoods relate specifically to events that occur in Australia, and are principally independent of the importation pathway. The consequences of fruit fly infestations are also independent of the importation pathway.

In addition, the department has reviewed the latest available literature—for example De Villiers et al. (2015); Fetoh, Gawad and Shalaby (2012); Hallman (2012); Hill et al. (2016); Huang and Chi (2014); Szyniszewska and Tatem (2014) and Myers et al. (2016)—and no new information has been identified that would significantly change the risk ratings for distribution, establishment, spread or consequences as set out for fruit flies in the existing policies.

4.6.1 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 *Bactocera dorsalis*, *B. zonata* and *Ceratitis capitata* will arrive in Australia with the importation of fresh date fruit from the MENA region is assessed as Low.

The following information provides supporting evidence for this assessment.

Bactocera dorsalis, *B. zonata* and *Ceratitis capitata* may be present in date-growing regions of the Middle East and North Africa.

- *Bactrocera dorsalis* has been recorded sporadically in the Middle East, including in the United Arab Emirates, Oman and Pakistan (Elwan 2000; Merz 2011; Qureshi & Mohiuddin 1982; Syed, Ghani & Murtaza 1970b). It is not as widely distributed in the MENA region as either *B. zonata* or *Ceratitis capitata*.
- *Bactrocera zonata* is present in the Middle East and North Africa including in Egypt, southern Iran, Iraq, Saudi Arabia, the UAE and Pakistan (CABI 2018a; Delrio & Cocco 2012; EPPO 2017; Syed, Ghani & Murtaza 1970a). Its distribution also includes many other countries outside the Middle East and North Africa (CABI 2018b).
- *Ceratitis capitata* is present in the Middle East and North Africa, including in Egypt, Morocco, Tunisia and Iran (Amin & Saafan 2013; Buyckx 1994; CABI 2018a). However, its distribution also includes many other countries outside the MENA region (Avidov & Harpaz 1969b; CABI 2018b; Liquido, Shinoda & Cunningham 1991).
- Egypt, Iran, Iraq, Morocco, Oman, Saudi Arabia, Tunisia, the United Arab Emirates and Pakistan all have significant date palm industries (Al-Khayri, Jain & Johnson 2015a, b).

Bactocera dorsalis, *B. zonata* and *Ceratitis capitata* may attack dates in the MENA region.

- In a survey of the insect pests associated with date palm trees in the Al-Dakhliya region of Oman, Elwan (2000) reported dates infested with maggots had produced *B. dorsalis* adults. It was not specified whether the dates were damaged, or had been collected from the ground or from the bunch on the tree.
- The FAO and IAEA (2000) has compiled a list of host fruits actually found infested with *B. zonata* larvae from the literature and personal contact with plant protection officials, but also do not list the state of the fruit when it was collected.
- *Phoenix dactylifera* has been listed as a host that should be included on any list of regulated hosts for quarantine purposes for *B. zonata* (FAO & IAEA 2000).
- A recent study by Amin and Saafan (2013) in Fayoum (Faiyum) Governorate, Egypt, found that *B. zonata* and *C. capitata* attack fallen half-ripe and ripe stages of date fruit, but the mature stage (either red or yellow) of date fruit was reportedly not attacked. The dates observed had been collected from the ground under the date palms.
- Infestation of date fruits occurred where mixed cultivation with mango, guava, fig, and citrus (especially navel orange) was practised (Amin & Saafan 2013).
- Varieties of date palms reported to be attacked include Amhat, Zaghloul, Balady and Siwi (Amin & Saafan 2013), all of which are likely to be used for export.

- In the coastal region of Pakistan, semi-ripe date fruits were reported to be attacked by *B. zonata* where the date palms were growing amongst heavily infested guavas (Syed, Ghani & Murtaza 1970a). Syed, Ghani and Murtaza (1970a) explained these infestations as occurring under heavy population pressure or due to the non-availability of its regular hosts. The reported attack by *B. zonata* was recorded on only a few semi-ripe date fruits.
- Buyckx (1994) reviewed the literature relating to date palm as a host plant for *C. capitata,* and concluded that the infestation of dates in the Maghreb is limited and of no economic importance.
- Buyckx (1994) recorded Medfly (*C. capitata*) infestations in dates from several countries, from the scientific literature, including Algeria, Libya, Morocco and Egypt, but did not specify the condition of the dates or whether they were damaged.

Bactocera dorsalis, *B. zonata* and *Ceratitis capitata* are reported to attack dates at low levels.

- In Egypt, *B. zonata* and *C. capitata* are reported to attack dates. Fallen mature date fruit (khalal, biser) were free of infestation by *B. zonata* and *C. capitata* whereas fallen half-ripe and ripe stages (rutab) were infested at a rate from 5 to 35 percent (Amin & Saafan 2013).
- *Bactrocera zonata* was the most common fruit fly in date plantations in Egypt, while *C. capitata* was rarely captured (Amin & Saafan 2013; Delrio & Cocco 2012).
- Populations of *B. zonata* and *C. capitata* were higher in date palm plantations that also grew other fruit crops such as mango, guava, fig and citrus interspersed with the date palms, compared to those plantations that consisted solely of date palms (Amin & Saafan 2013).
- Infestation rates of date fruit ranged from 5 to 35 per cent, with only *B. zonata* emerging from dates (Amin & Saafan 2013). The studies of Amin and Saafan (2013) in Egypt were based on fallen date fruits that had dropped to the ground under the date palms.
- Maggots of *C. capitata* have occasionally been found in small numbers in dates in the Upper Jordan Valley (Avidov & Harpaz 1969b). It was noted that *C. capitata* does not usually attack green young (unripe) fruit (Avidov & Harpaz 1969b).
- Avidov and Harpaz (1969b) have given an infestation index rating for *C. capitata* in dates of 1–2, where 1 is the lowest level of infestation and 5 is 100 per cent infestation. There was no mention of whether the fruit attacked was on the date palm tree.

Fresh date fruit is not considered a major host for *B. dorsalis*, *B. zonata* or *C. capitata.*

- Dates (*Phoenix dactylifera*) are listed as an 'other' host plant by CABI (2018b, 2018a) for *B. zonata* and *C. capitata*. Dates are not listed as a host plant for *B. dorsalis*.
- Thomas et al. (2016) lists date (*Phoenix dactylifera*) as a rarely infested host of *C. capitata*.
- According to the literature, date fruit is considered a poor host of *C. capitata,* but low levels of infestation are possible (Avidov & Harpaz 1969b). Gazit, Akiva and Gavriel (2014) state there are no reports of *C. capitata* causing damage to date fruit in Israel.
- Hendrichs and Hendrichs (1990) considered date palm as a non-host in Egypt, even though *C. capitata* was observed resting on the leaves and fruits of palms in an area surrounded by plantings of its favoured hosts – guavas, oranges, mangoes and grapes.
- Apart from date palm (*Phoenix dactylifera*) three other host plants of particular importance to the survival of *C. capitata* in the southern part of the Maghreb region of north Africa have been listed by Buyckx (1994) as argan tree (*Argania spinosa*), found only in Morocco, spineless opuntia cactus (*Opuntia ficus-indica*) and prickly pear (*O. vulgaris*), commonly used to delimit property boundaries.

Association of fruit flies with the commodity pathway appears to be limited.

- Little data exists on the infestation rates of dates by *B. dorsalis*. The study of Elwan (2000) only mentions that infested dates were collected from date plantations in Oman, with no mention of whether the dates had fallen to the ground or were collected from the date bunch. This study was the first report of wild *B. dorsalis* attacking dates, and it made no mention of the level of infestation in the dates (Elwan 2000).
- Subsequently, no further reports have been found on the host status of date fruit for *B. dorsalis*, suggesting that date is, at best, a non-preferred host.
- Syed, Ghani and Murtaza (1970a) state that dates are not a regular host of *B. zonata* and are attacked to a negligible extent in the coastal areas of Pakistan.
- *Ceratitis capitata* is a highly polyphagous species and its pattern of host relationships from region to region appears to relate largely to fruits that are available (CABI 2018a, b).
- Information presented by Avidov and Harpaz (1969b) supports this notion, as it was reported that *C. capitata* had one of the lowest levels of infestation on dates, while other fruit such as guava, apricot and peach had nearly 100 per cent infestation. This is also the case for *B. zonata* which prefers peach, guava and mango (Delrio & Cocco 2012). If these hosts are not available then hosts such as apricot, fig and citrus have been reported as secondary hosts (Delrio & Cocco 2012); there are no report of dates being a major host.
- Date fruit is rarely infested, and although dates that were 'green and moist' have produced adult *C. capitata* this was categorised as a 'chance infestation' (Back & Pemberton 1918; Liquido, Shinoda & Cunningham 1991).

Climate will influence infestation of dates by fruit flies.

- The temperature range required for the development of fruit flies is well studied. At low temperatures, development times for fruit flies are extended significantly and mortality increases for all life stages (Duyck, Sterlin & Quilici 2004). Lower development thresholds have been estimated from a linear regression model for the eggs and larvae of the three species assessed here.
- *Ceratitis capitata* needs a minimum temperature of 16 degrees Celsius to lay eggs (Avidov & Harpaz 1969b). Qureshi et al. (1993) found that at 15 degrees Celsius and 35 degrees Celsius the females of *B. zonata* failed to deposit eggs.
- Dates are harvested between June and December, which means that temperatures are unlikely to fall below the minimum development thresholds for these species. Therefore, immature stages could continue to develop normally at the lower temperatures experienced across the region during this period.
- Dry climate conditions have limited the spread and establishment of *B. dorsalis* across the MENA region. The high temperatures and low rainfall that occur throughout the region (World Weather Online 2017) have resulted in few areas that have a suitable climate for *B. dorsalis* (De Villiers et al. 2015).

High temperatures and low moisture contribute to poor survival of *Bactrocera dorsalis*, *B. zonata* and *Ceratitis capitata.*

- Many biological and environmental variables influence the distribution of fruit fly populations. These variables directly or indirectly affect the survival and development rates of different life stages, and also female fecundity. The most important variables appear to be temperature, moisture and availability of hosts (Fletcher 1987; Syed, Ghani & Murtaza 1970b). *Bactrocera* species require warm temperatures, with few if any days or nights of cold weather, in order to complete their life cycle (Margosian et al. 2007).

- Temperature affects the water relationships of different life stages, and tolerance of a particular maximum temperature is greater at higher humidity, which reduces the rate of water loss (Fletcher 1987). Temperature and relative humidity are considered two of the most important ecological factors affecting the survival and development rate of insects (Buyckx 1994; Younes & Akel 2010).
- High daytime temperatures where the daily maximum temperature rises above 36.7 degrees Celsius for 15 consecutive days, will kill mature adult *B. dorsalis* and will prevent newly emerging adults from becoming sexually mature by excessively shortening their natural longevity (Syed, Ghani & Murtaza 1970b).
- In arid and semi-arid regions of Pakistan, where average maximum temperatures during June and July reach 40.6 degrees Celsius and mean monthly temperatures of 32.2 degrees Celsius occcur, immature stages of *B. dorsalis* are lethally affected (Syed, Ghani & Murtaza 1970b).
- Lower temperatures in the mountainous regions, and higher temperatures in the plains and semi-deserts of Pakistan where date palms are grown, restrict the distribution of *B. dorsalis* (Syed, Ghani & Murtaza 1970b).
- De Villiers et al. (2015) considered desert areas unsuitable for fruit flies due to dry stress being a limiting factor. However, irrigation of date palms may alleviate the detrimental effects of dry stress for *B. dorsalis,* and enable it to survive in areas where it would ordinarily be unable to survive (De Villiers et al. 2015).
- Studies on the thermal tolerance of adult *C. capitata* showed a critical thermal minimum ranging from 5.4 to 6.6 degrees Celsius, and a critical thermal maximum of 42.4 to 43.0 degrees Celsius (Nyamukondiwa & Terblanche 2009; Pietersen, Terblanche & Addison 2017) using a dynamic method based on different ages, feeding states and gender. These maximum temperatures are consistently exceeded during summer in the semi-arid and hyper-arid (less than 100 millimetres mean annual rainfall) regions where date palms are grown in the MENA region.
- In semi-arid areas of the Maghreb countries (Morocco, Algeria, Libya and Tunisia) receiving less than 300mm of rain annually, *C. capitata* can exist only in those places where irrigation makes fruit production possible (Buyckx 1994).
- The developmental upper temperature threshold for *B. zonata* has been estimated as being higher than 35 degrees Celsius (Duyck, Sterlin & Quilici 2004; Qureshi et al. 1993). Fetoh, Gawad and Shalaby (2012) reported that at a constant 40 degrees Celsius *B. zonata* entered pupation but failed to emerge as an adult. The optimal temperature for development and survival of the immature stages occurs in the range of 25 to 30 degrees Celsius (Fetoh, Gawad & Shalaby 2012; Qureshi et al. 1993; Younes & Akel 2010).
- Qureshi et al. (1993) reported that egg hatch in *B. zonata* increased with temperature from 15 to 25 degrees Celsius, then decreased to zero at 35 degrees Celsius. No larvae completed development at 15 or 35 degrees Celsius, and no adult laid eggs at 30 or 35 degrees Celsius.
- Pupal survival of *B. zonata* was greatest at 25 and 30 degrees Celsius but decreased at 35 degrees Celsius, while adult longevity significantly increased from 15 to 25 degrees Celsius before significantly decreasing between 25 and 30 degrees Celsius (Qureshi et al. 1993).
- Fetoh, Gawad and Shalaby (2012) reported similar results with the length of the pupal period *of B. zonata* being affected by temperature, with pupal duration and adult emergence significantly increasing from 20 to 30 degrees Celsius, followed by a sudden decrease occurring at 35 degrees Celsius to 93.0 per cent mortality. No adult *B. zonata* emerged from pupae at 40 degrees Celsius.

- Duyck, Sterlin and Quilici (2004) reported survivorship of *B. zonata* larvae was highest over the range of 20 to 30 degrees Celsius and lowest at 15 degrees Celsius. Syed, Ghani and Murtaza (1970a) found *B. zonata* was still active in the semi-deserts of Pakistan where the temperature in June may go as high as 97 degrees Fahrenheit (36.1 degrees Celsius) (Syed, Ghani & Murtaza 1970a). Abul-Soad (2011) reported the major date producing region of Khairpur in Sindh Province, Pakistan experienced temperatures exceeding 50 degrees Celsius in summer, and in the date producing region of Baluchistan, Pakistan the growing season experienced dry hot weather, with an annual rainfall below 100 mm and strong dust-laden winds.
- At several places in Pakistan fruit attack by *B. zonata* was found before or after winter only when the mean monthly temperature was 62 degrees Fahrenheit (16.7 degrees Celsius) or above (Syed, Ghani & Murtaza 1970a). This was the temperature that Syed, Ghani and Murtaza (1970a) inferred to be the threshhold temperature for reproductive activity of *B. zonata* from these observations.
- These temperatures are considerably lower than the maximum temperatures that are consistently exceeded during summer in the semi-arid and hyper-arid regions of the date-growing regions of the MENA region (Buyckx 1994). These extreme climatic conditions are not conducive to the long term establishment of populations of *B. zonata*, *B. dorsalis* and *C. capitata*, in the majority of date growing regions.

Feeding damage on dates may not be readily seen.

- Outward signs of fruit fly infestation can be hard to see. Fruit flies lay eggs under the skin of fruit, with larvae feeding internally after hatching (Avidov & Harpaz 1969b; CABI 2018a; Christenson & Foote 1960; Talhouk 1969). Puncture sites caused by *C. capitata* egg-laying activities are not readily visible on non-citrus fruits (Avidov & Harpaz 1969b; Talhouk 1969). Thus, external signs of infestation cannot always be used to distinguish infested fruit (White & Elson-Harris 1992). No reports have been found documenting specific visible signs of fruit fly feeding damage on dates.
- Secondary damage caused to fruits by fruit flies can be easier to detect. Fruit that have been punctured by egg-laying or had larvae feed on the flesh have been reported to have internal rotting in many instances (Mau & Martin Kessing 2007).
- However, fruit rot due to secondary infection by bacterial or fungal agents would likely manifest late after the initial infestation. Thus newly-infested fruits are unlikely to show any visible signs of infestation, and will be unlikely to be noticed during packing-house procedures. Any date fruit showing signs of rotting is very unlikely to be packed for export.

Dates are transported at cold temperatures.

- Cooling of fresh dates to below 10 degrees Celsius (preferably to 0 degree Celsius) before transportation or storage under the same temperatures (0 to 10 degrees Celsius) and 65 to 75 per cent relative humidity is recommended to maintain quality (Siddiq, Aleid & Kader 2014).
- Khalal (Biser) dates should be stored at 0 degree Celsius and 85 to 95 per cent relative humidity to reduce water loss, delay ripening to the rutab stage, and maintain textural and flavour quality (Siddiq, Aleid & Kader 2014).

Eggs and larvae of *Bactrocera dorsalis*, *B. zonata*, and *Ceratitis capitata* could survive cold transport to Australia.

- The lower development thresholds for eggs and larvae of fruit flies are higher than the temperatures at which dates are exported. At low temperatures, development times for fruit flies are extended significantly, and mortality increases for all life stages (Duyck, Sterlin &

Quilici 2004). Lower development thresholds have been estimated from a linear regression model for the eggs and larvae of the two *Bactrocera* species and *C. capitata* assessed here.

- The lower development threshholds for eggs and larvae of *B. dorsalis* (as *B. papayae*) are 12.1 and 10.5 degrees Celsius respectively (Danjuma et al. 2014)
- For *B. zonata* the lower development thresholds for eggs and larvae are are 12.7 and 12.6 degrees Celsius respectively (Duyck, Sterlin & Quilici 2004).
- For *C. capitata* the lower developmental thresholds for the egg and larval stages were determined as 11.6 and 10.2 degrees Celsius respectively (Duyck & Quilici 2002).
- Research on the ability of *B. dorsalis*, *B. zonata*, and *C. capitata* to survive cold temperatures for extended periods in a range of fruits is well known.
- *Ceratitis capitata* can be controlled successfully after extended periods of cold. Gazit, Akiva and Gavriel (2014) demonstrated that *C. capitata* was significantly more sensitive to cold treatment when in date fruit than in mandarins. For mandarin, cold storage at 1.11 degrees Celsius for 15 days was considered to be an effective treatment for the elimination of *C. capitata*. Therefore current cold treatment schedules as published in the USDA schedule T107-L for *C. capitata* in citrus and T107-i for *C. capitata* in Barhi dates (USDA 2016), for example, 1.11 degrees Celsius or below for 14 days, will be adequate for use in fresh dates.
- A study by Myers et al. (2016) comparing the cold tolerance of six *Bactrocera* species found that the majority of the species responded the same way to phytosanitary cold treatment. Of the six species tested, *B. zonata* was one of the least cold tolerant.
- A study by Hallman et al. (2013b) determined that *B. invadens*, now synonymised with *B. dorsalis,* is less cold tolerant than *C. capitata*.

Fresh dates can be cold-stored for a period of weeks without noticeable damage to date quality.

- Fresh dates can undergo cold storage without damage. At zero degrees Celsius it was found that Barhi variety dates could be stored for 2 months without affecting the colour, firmness and eating quality (Al-Redhaiman 2004). Storage time at zero degrees Celsius could be extended up to 6 months if the concentration of carbon dioxide (CO_2) was increased to 20 per cent, also without affecting the colour, firmness and eating quality (Al-Redhaiman 2004).

Bactrocera dorsalis, *B. zonata* and *C. capitata* are present in countries across the MENA region. The climate of the majority of date-growing regions is unfavourable for fruit fly mating, development and survival for large parts of the year, particularly during the date-growing season and at harvest. All three fruit fly species are known to occasionally attack date fruit, but usually only attack dates that are half-ripe or ripe, but not mature. When other more preferred hosts are present, such as mango, guava, fig and citrus, both *B. zonata* and *C. capitata* are recorded as attacking date fruit only at low levels. Populations of both fruit fly species are highest in date plantations where date palms are grown interspersed with other fruit crops, rather than as a monoculture. The only confirmed reports of fruit flies attacking dates are for fruit that had dropped to the ground under the date palms. There are no confirmed reports that date fruit on the palm are attacked by fruit flies.

If infested date fruit remains attached to the strand and is harvested, infestation of date 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 if the infestation level is low. However, only immature fruit are reported to be attacked, it is likely that mature infested fruit will have had time to display symptoms. Since dates are stored and transported at temperatures that are below the development thresholds of all three fruit fly species, any immature stages present will not develop and mortality will occur.

The facts that (1) fruit flies are rarely reported from most date growing regions, (2) rarely attack date fruit, and apparently have only been recorded attacking fallen dates that are half-ripe or ripe but not mature, (3) there is a lack of literature reports on fruit flies attacking date fruit on the date palm trees, and (4) dates have been reported not to be a preferred host when other hosts such as peach, guava and mango are grown in close proximity, all support a likelihood estimate for importation of Low.

Likelihood of distribution

All three fruit fly species have been assessed previously in a number of existing import policies, for example, in the import policies for mango from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a), Pakistan (Biosecurity Australia 2011b), Indonesia, Thailand and Vietnam (Department of Agriculture and Water Resources 2015), longan and lychee fruit from China and Thailand (DAFF 2004a), mangosteen from Thailand (DAFF 2004b), lychee from Taiwan and Vietnam (DAFF 2013), table grapes from China (Biosecurity Australia 2011a), Chile (Biosecurity Australia 2005b) and India (Australian Government Department of Agriculture and Water Resources 2016), sweet orange from Italy (Biosecurity Australia 2005a) and truss tomato from the Netherlands (DAFF 2003). It is considered that *Bactocera dorsalis*, *B. zonata* and *Ceratitis capitata* would have the same likelihood of distribution as determined in these assessments, that is, High for *Bactrocera dorsalis* and *B. zonata,* and Moderate for *Ceratitis capitata*.

Overall likelihood of entry

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

The likelihood that *Bactocera dorsalis*, *B. zonata* and *Ceratitis capitata* will enter Australia as a result of trade in fresh date fruit from the MENA region and be distributed in a viable state to a susceptible host is assessed as Low.

4.6.2 Likelihood of establishment and spread

As indicated in previous assessments, this assessment of the likelihoods of establishment and spread for *Bactrocera dorsalis*, *B. zonata* and *Ceratitis capitata* is based on the assessments of commodities mentioned previously. Those assessments used the same methodology as described in Chapter 2 of this report. The ratings from those previous assessments are:

Likelihood of establishment:	High for *Bactrocera dorsalis*, *B. zonata* and *Ceratitis capitata*
Likelihood of spread:	High for *Bactrocera dorsalis* and *B. zonata* Moderate for *Ceratitis capitata*

4.6.3 Overall likelihood of entry, establishment and spread

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

The overall likelihood that *Bactrocera dorsalis*, *B. zonata* and *Ceratitis capitata* will enter Australia as a result of trade in fresh date fruit from the MENA region, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia has been assessed as Low.

4.6.4 Consequences

The potential consequences of the establishment of *Bactrocera dorsalis* in Australia have been estimated previously in assessments of imports of apples from China (Biosecurity Australia 2010), table grapes from China (Biosecurity Australia 2011a), longan and lychee fruit from China and Thailand (DAFF 2004a), mango from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a), Pakistan (Biosecurity Australia 2011b) and Indonesia, Thailand and Vietnam (Department of Agriculture and Water Resources 2015), lychee from Taiwan and Vietnam (DAFF 2013) and mangosteen from Thailand (DAFF 2004b).

The potential consequences of the establishment of *B. zonata* in Australia have been estimated previously in assessments of imports of mango from India (Biosecurity Australia 2008a), Pakistan (Biosecurity Australia 2011b) and Indonesia, Thailand and Vietnam (Department of Agriculture and Water Resources 2015), while the potential consequences of the establishment of *Ceratitis capitata* in Australia have been estimated previously in assessments of imports of table grapes fom Chile (Biosecurity Australia 2005b), sweet orange from Italy (Biosecurity Australia 2005a), truss tomatoes from the Netherlands (DAFF 2003) and citrus from Egypt (Biosecurity Australia 2002a). The overall consequences for all three species has been estimated to be High.

4.6.5 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 *Bactrocera dorsalis*, *B. zonata* and *Ceratitis capitata*	
Overall likelihood of entry, establishment and spread	Low
Consequences	High
Unrestricted risk	Moderate

The unrestricted risk estimates for *Bactrocera dorsalis*, *B. zonata* and *Ceratitis capitata* from the fresh date fruit from the MENA region pathway are 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 these pests.

4.7 Pest risk assessment conclusions

Key to Table 4.6 to Table 4.8.

Genus species (EP): pests for which policy already exists. The outcomes of previous assessments and/or reassessments in this risk analysis are presented in Table 4.6 to Table 4.8.

Genus species (Acronym for state/territory): state/territory in which regional quarantine pests have been identified

Likelihood for entry, establishment and spread

EES overall likelihood of entry, establishment and spread

Assessment of consequences from pest entry, establishment and spread

PLH plant life or health

OE other aspects of the environment

EC eradication, control

DT domestic trade

IT international trade

ENC environmental and non-commercial

A-G consequence impact scores are detailed in section 2.2.3

- A Indiscernible at the local level
- B Minor significance at the local level
- C Significant at the local level
- D Significant at the district level
- E Significant at the regional level
- F Significant at the national level
- G Major significance at the national level

URE unrestricted risk estimate. This is expressed on an ascending scale from negligible to extreme.

Table 4.6 Summary of unrestricted risk estimates for quarantine pests associated with fresh dates for which a full pest risk assessment is conducted

Pest name	Likelihood of						Consequences							URE
	Entry			Establishment	Spread	EES								
	Importation	Distribution	**Overall**				Direct		Indirect				**Overall**	
							PLH	OE	EC	DT	IT	ENC		
Date moths [Lepidoptera: Batrachedridae and Pyralidae]														
Batrachedra amydraula	Low	Very Low	**Very Low**	Low	Moderate	Very Low	C	A	C	D	B	B	Low	**Negligible**
Aphomia sabella	Low	Very Low	**Very Low**	Low	Moderate	Very Low	C	A	C	D	B	B	Low	**Negligible**
Cadra calidella	Low	Low	**Very Low**	Low	Moderate	Very Low	C	A	C	D	B	B	Low	**Negligible**
Pomegranate butterfly [Lepidoptera: Lycaenidae]														
Virachola livia	Low	Low	**Very Low**	Moderate	High	Very Low	E	A	C	C	C	C	Moderate	**Very Low**

Table 4.7 Summary of unrestricted risk estimates for quarantine pests associated with fresh dates for which some of the likelihood ratings and consequence estimates are adopted from previous assessments

Pest name	Likelihood of						Consequences	URE
	Entry			Establishment	Spread	EES		
	Importation	Distribution	**Overall**					
Spider mites [Acarina: Tetranychidae]								
Eutetranychus palmatus	High	Moderate	**Moderate**	High	Moderate	Low	Moderate	**Low**
Oligonychus afrasiaticus (EP)	High	Moderate	**Moderate**	High	Moderate	Low	Moderate	**Low**
Oligonychus pratensis (EP)	High	Moderate	**Moderate**	High	Moderate	Low	Moderate	**Low**
Armoured scales [Hemiptera: Diaspididae]								
Fiorinia phoenicis (EP)	High	Low	**Low**	High	Moderate	Low	Low	**Very Low**
Melaybugs [Hemiptera: Pseudococcidae]								
Planococcus ficus (EP)	High	Moderate	**Moderate**	High	High	Moderate	Low	**Low**

Pest name	Likelihood of						Consequences	URE
	Entry			Establishment	Spread	EES		
	Importation	Distribution	**Overall**					
Pseudococcus cryptus (EP, WA)	High	Moderate	**Moderate**	High	High	Moderate	Low	**Low**

Table 4.8 Summary of unrestricted risk estimates for quarantine pests associated with fresh dates for which some of the likelihood ratings and consequence estimates are adopted from previous assessments

Pest name	Likelihood of						Consequences	URE
	Entry			Establishment	Spread	EES		
	Importation	Distribution	**Overall**					
Fruit flies [Diptera: Tephritidae]								
Bactrocera dorsalis (EP)	Low	High	**Low**	High	High	Low	High	**Moderate**
Bactrocera zonata (EP)	Low	High	**Low**	High	High	Low	High	**Moderate**
Ceratitis capitata (EP)	Low	Moderate	**Low**	High	Moderate	Low	High	**Moderate**

4.8 Summary of assessment of quarantine pests

This section provides a summary of the assessment of quarantine pests (shown in Figure 20).

The pest categorisation process (Appendix A) identified 119 pests of date production in the MENA region. Of these 119 pests:

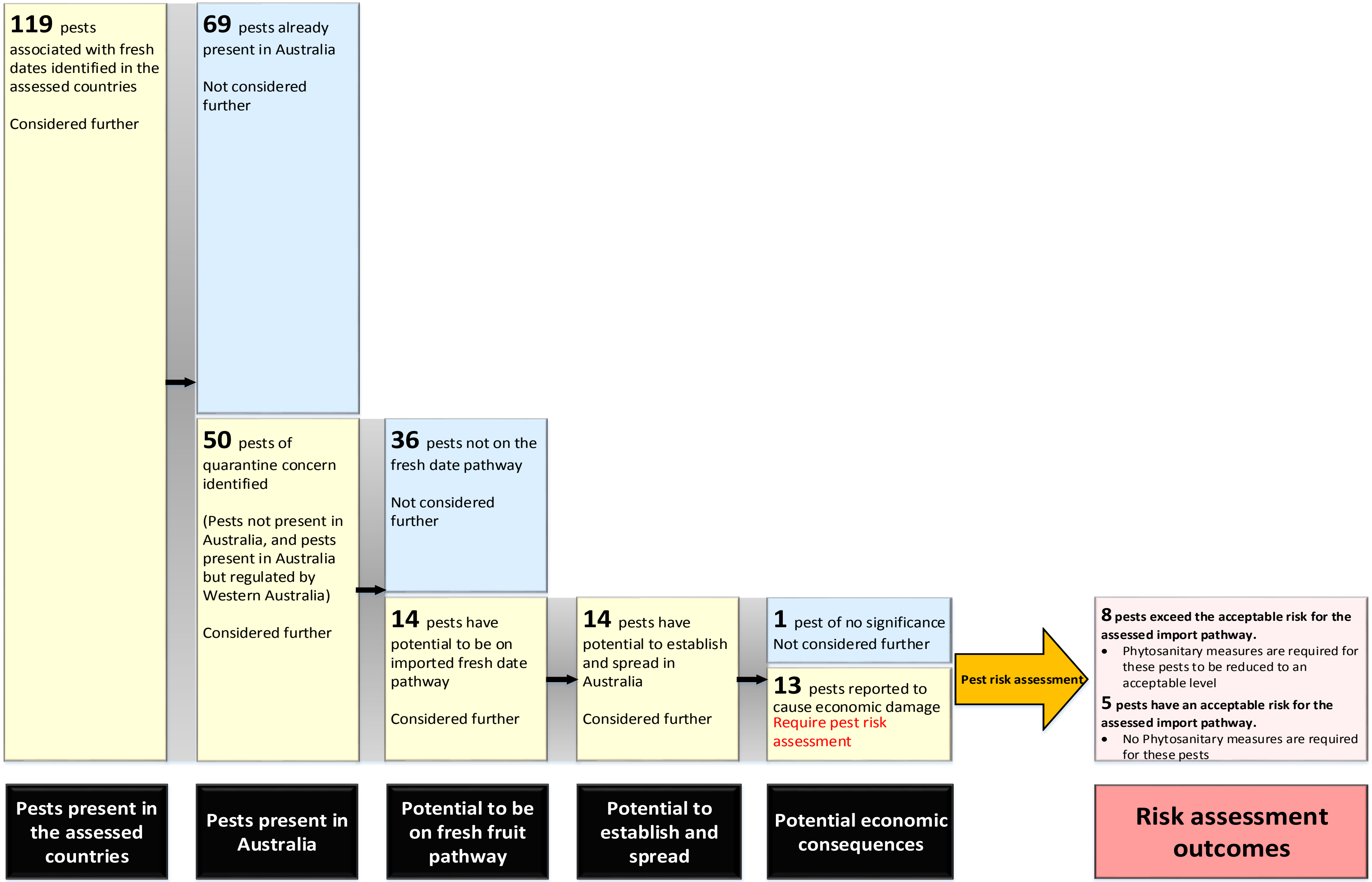
- 69 pests are already in Australia, and not under official control (and therefore were not further considered);
- 36 of these pests were assessed as not having potential to be on the pathway of fresh dates (and therefore were not further considered);
- 1 other pest was assessed as not being of potential economic consequence (and therefore was not further considered).

In total, 106 pests were therefore excluded from processes of intensive pest risk assessment. The 13 remaining pests required further consideration, as presented in pest risk assessments in Sections 4.1–4.7, and summarised in Table 4.6 to Table 4.8.

Of the pest risk assessments for the remaining 13 pests:

- the risks for 5 pests were assessed as achieving Australia's appropriate level of protection (so that no specific risk management measures are required). These 5 pests are:
  - Lesser date moth (*Batrachedra amydraula*);
  - Greater date moth (*Aphomia sabella*);
  - Date or carob moth (*Cadra calidella*);
  - Pomegranate butterfly (*Virachola livia*); and
  - Armoured scale (*Fiorinia phoenicis*).
- the risks for the eight remaining pests were assessed as not achieving Australia's appropriate level of protection, and therefore these eight pests require application of risk management measures. These 8 pests are:
  - Spider mite (*Eutetranychus palmatus*);
  - Date dust mite (*Oligonychus afrasiaticus*);
  - Banks grass mite (*Oligonychus pratensis*);
  - Vine mealybug (*Planococcus ficus*);
  - Citriculus mealybug (*Pseudococcus cryptus*);
  - Oriental fruit fly (*Bactrocera dorsalis*);
  - Peach fruit fly (*Bactrocera zonata*); and
  - Mediterranean fruit fly (*Ceratitis capitata*).

Figure 20 Summary of assessment of quarantine pests



5 Pest risk management

This chapter provides information on the management of quarantine pests identified as having an unrestricted risk level that does not achieve the appropriate level of protection (ALOP) for Australia. The recommended risk management measures are described in this chapter.

5.1 Pest risk management measures and phytosanitary procedures

Pest risk management evaluates and selects options for measures to reduce the risk of entry, establishment or spread of quarantine pests for Australia where they have been assessed to have an unrestricted risk level that does not achieve the ALOP for Australia. In calculating the unrestricted risk, existing commercial production practices in the MENA region have been considered, as have post-harvest procedures and methods for the packing of fruit.

In addition to the MENA region's existing commercial production systems and packing house operations for fresh dates, and minimum border procedures in Australia, specific pest risk management measures, including operational systems, are recommended to achieve the ALOP for Australia.

In this chapter, the Australian Government Department of Agriculture and Water Resources has identified risk management measures that may be applied to consignments of fresh dates sourced from the MENA region. 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 2012 to 2017

Since 2012, fresh date consignments imported into Australia have only come from the USA (California). During the period spanning May 2012 to April 2017, 33 consignments of fresh dates were imported into Australia, totalling 111,770 kilograms. Data for imports indicate the presence of very few pests, including unidentified *Aspergillus*, *Penicillium* and bacterial species, all of which are considered to be contaminant organisms that will be actioned under current policy. This policy requires that the Australian Government Department of Agriculture and Water Resources undertake an assessment to determine the quarantine status of these organisms, and whether phytosanitary action is required.

In addition to pests on fresh dates, specimens of *Cadra calidella* (date moth) have been intercepted on four commercial consignments of dried dates.

5.1.2 Pest risk management for quarantine pests

The pest risk analysis identified the quarantine pests listed in Table 5.1as having an unrestricted risk level that does not achieve the ALOP for Australia. Therefore, risk management measures are required to manage the risks posed by these pests and the recommended measures are listed inTable 5.1.

Table 5.1 Risk management measures recommended for quarantine pests of fresh dates from the Middle East and North Africa region

Pest	Common name	Measures
Spider mites		
Eutetranychus palmatus *Oligonychus afrasiaticus* (EP) *Oligonychus pratensis* (EP)	spider mite date dust mite banks grass mite	Consignment freedom verified by pre-export visual inspection and remedial action if live pests are found **a**
Fruit flies		
Bactrocera dorsalis (EP) *Bactrocera zonata* (EP) *Ceratitis capitata* (EP)	Oriental fruit fly peach fruit fly Mediterranean fruit fly	Area freedom **b** OR Fruit treatment considered to be effective against all life stages of fruit flies (for example, cold disinfestation treatment or irradiation at a minimum of 150 Gy **c**)
Mealybugs		
Planococcus ficus (EP) *Pseudococcus cryptus* (EP, WA)	vine mealybug citriculus mealybug	Consignment freedom verified by pre-export visual inspection and remedial action if live pests are found **a** OR Irradiation at a minimum of 400 Gy **c**

a Remedial action (depending on the location of the inspection) may include treatment of 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 and/or pest free production sites. **c** The use of irradiation on fresh dates is subject to approval by Food Standards Australia New Zealand. **EP** Species has been assessed previously and import policy already exists. **WA** Western Australia.

Risk management measures recommended here are based on existing policies for the import of persimmon fruit from Japan, Korea and Israel (DAFF 2004c), citrus from Egypt (Biosecurity Australia 2002a), Unshu mandarin from Japan (Biosecurity Australia 2009), mangoes from India (Biosecurity Australia 2011c), Indonesia, Thailand and Vietnam (Department of Agriculture and Water Resources 2015), longans and lychees from China and Thailand (DAFF 2004a), apples from China (Biosecurity Australia 2010), sweet oranges from Italy (Biosecurity Australia 2005a) and global pineapple (Biosecurity Australia 2002b), which include the recommended measures for most of the pests identified in Table 5.1of this report.

Based on these existing policies there has been trade in persimmons from Korea and Israel (over 1000 tonnes), citrus from Egypt (over 1000 tonnes), mangoes from India and Vietnam (over 26 tonnes), and longan and lychees from China and Thailand (over 400 tonnes) (International Trade Centre 2016). These policies have successfully managed the pests associated with these pathways.

This report recommends that when the following risk management measures are applied, the restricted risks for all identified quarantine pests will achieve the appropriate level of protection (ALOP) for Australia. These measures are:

for spider mites–

- consignment freedom verified by pre-export visual inspection and remedial action if live pests are found (5.1.3).

for fruit flies–

- area freedom, or fruit treatment (such as cold disinfestation treatment or irradiation at a minimum of 150 Gy) (5.1.4).

for mealybugs–

- consignment freedom verified by pre-export visual inspection and remedial action if live pests are found, or irradiation at a minimum of 400 Gy (5.1.5).

5.1.3 Management of *Eutetranychus palmatus*, *Oligonychus afrasiaticus* and *Oligonychus pratensis*

To manage the risk of *Eutetranychus palmatus*, *Oligonychus afrasiaticus* and *Oligonychus pratensis* the Australian Government Department of Agriculture and Water Resources recommends as a measure the option of consignment freedom verified by pre-export visual inspection, and remedial action if live pests are found. The objective of the recommended measure is to reduce the risks associated with these pests to achieve the ALOP for Australia.

Recommended measure: Pre-export visual inspection and remedial action if live pests are found

All consignments of fresh dates exported to Australia must be inspected by the exporting country's NPPO, and found free of these mites. Export consignments found to contain these pests will be subject to remedial action. Remedial action may include withdrawing the consignment from export to Australia or, if available, applying approved treatment to ensure that the pests are no longer viable.

5.1.4 Management of *Bactrocera dorsalis*, *Bactrocera zonata* and *Ceratitis capitata*

To manage the risk of *Bactrocera dorsalis*, *Bactrocera zonata* and *Ceratitis capitata* the Australian Government Department of Agriculture and Water Resources recommends as measures the options of area freedom, cold disinfestation treatment or irradiation. The objective of the recommended measures is to reduce the risks associated with these pests to achieve the ALOP for Australia.

Recommended measure 1: Area freedom

Area freedom (including use of accredited pest free areas, pest free places of production, or pest free production sites) is a measure that can be applied to manage the risks posed by *B. dorsalis*, *B. zonata* and *C. capitata*. The requirements for establishing pest free areas, pest free places of production, and pest free production sites are set out in ISPM 4: Requirements for the establishment of pest free areas (FAO 2017a), ISPM 10: Requirements for the establishment of pest free places of production and pest free production sites (FAO 2016d) and, more specifically, ISPM 26: Establishment of pest free areas for fruit flies (Tephritidae) (FAO 2016g).

Bactrocera dorsalis, *B. zonata* and *C. capitata* are reported throughout the MENA region, with at least one of the species found in almost every country or territory (CABI 2018a, b; CABI & EPPO 1997; Elwan 2000; Merz 2011; Qureshi & Mohiuddin 1982). Should a country wish to use area freedom as a measure to manage the risk posed by *B. dorsalis*, *B. zonata* or *C. capitata*, the exporting country's NPPO will need to provide an appropriate submission to the Australian Government Department of Agriculture and Water Resources for its consideration. A submission demonstrating area freedom must fulfil requirements as set out in ISPM 4 (FAO 2016c), ISPM 10 (FAO 2016d) or ISPM 26 (FAO 2016g), and its adoption will be subject to approval by the Australian Government Department of Agriculture and Water Resources.

As noted in ISPM 26, various factors can influence considerations of specific requirements for acceptance and verification of area freedom, including climatic and geographic factors that can influence fruit fly survival and population characteristics, and an historical lack of records for the presence of fruit fly. The Australian Government Department of Agriculture and Water Resources notes that the distribution and abundance of fruit flies within the MENA region can vary considerably. In the MENA region, there are many areas where there are no reports of fruit flies being present. Further, many areas (for example, hyper-arid deserts) have climates that are expected to be extremely unfavourable to the establishment of fruit flies (see section 4.3). For export plantations located in areas that are historically free of fruit flies and have unfavourable climatic conditions, verification of fruit fly absence through trap monitoring could be the basis for recognising area freedom.

Recommended measure 2: Cold disinfestation treatment

Cold disinfestation treatment has been used since the early 20th century as an effective treatment method to provide phytosanitary control of fruit flies for a variety of fruits grown around the world (Heather & Hallman 2008).

Australia has current policy for cold disinfestation treatment of fruit flies for various horticultural commodities, including cold disinfestation treatment for both *C. capitata* and *B. zonata* in citrus from Egypt (Biosecurity Australia 2002a), *C. capitata* in persimmons from Japan, Korea and Israel (DAFF 2004c), and of *B. dorsalis* in longans, lychees and nectarines from China (DAFF 2004a; Department of Agriculture and Water Resources 2016b).

Cold disinfestation treatment for *C. capitata* in fresh dates is considered an effective treatment for killing all life stages (Gazit, Akiva & Gavriel 2014). A study by Hallman et al. (2013a) determined that *B. invadens* (now synonymised with *B. dorsalis*) is less cold tolerant than *C. capitata*. Since both *B. dorsalis* and *B. zonata* are reported to have a similar cold tolerance (Myers et al. 2016) the cold disinfestation treatment schedule for *C. capitata* is considered to be efficacious for all three species.

A treatment regime consistent with the USDA treatment schedule for fresh Barhi dates from Israel (USDA-APHIS 2008) is recommended by Australia.

Thus, the Australian Government Department of Agriculture and Water Resources recommends the following specifications for temperatures and exposure times where cold disinfestation treatment is utilised:

- fruit held at 1.11 °C or below for 14 days, or
- fruit held at 1.67 °C or below for 16 days, or
- fruit held at 2.22 °C or below for 18 days.

Should a country in the MENA region wish to use pre-shipment cold disinfestation treatment as a phytosanitary measure, the relevant NPPO would need to provide a submission to the Australian Government Department of Agriculture and Water Resources that demonstrates it has processes and procedures for the registration, approval and audit of treatment facilities. The Australian Government Department of Agriculture and Water Resources may request on-site verification of the treatment facilities.

Both pre-shipment and in-transit cold disinfestation treatment must fulfil the requirements as set out in the Australian phytosanitary treatment application standard for cold disinfestation treatment (Department of Agriculture and Water Resources 2017a).

Recommended measure 3: Irradiation

The International Plant Protection Convention (IPPC) acknowledges the suitability of application of ionising irradiation as a phytosanitary treatment for regulated pests or articles in ISPM 18: Guidelines for the use of irradiation as a phytosanitary measure (FAO 2016f), and recommends a minimum absorbed dose of 150 gray (Gy) to prevent the emergence of adult tephritid fruit flies in ISPM 28 Annex 7: Irradiation treatment for fruit flies of the family Tephritidae (generic) (FAO 2017c).

Should a country wish to use irradiation as a measure to manage the risk posed by fruit flies, the exporting country's NPPO will need to provide an appropriate technical submission to the department for its consideration. The use of irradiation as a measure to manage the risk posed by fruit flies is subject to an approval process of the irradiation facility demonstrating that the plant's treatment facilities meet requirements to effectively irradiate products. Required information includes registration by the responsible certifying authority, standard operating procedures and work instructions, the ability to document procedures to ensure fresh dates are appropriately treated and safeguarded post-treatment, and to ensure compliance with treatment requirements.

Currently, irradiated fresh dates 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 dates (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).

The Australian Government Department of Agriculture and Water Resources recommends a treatment schedule of 150 Gy minimum absorbed dose, consistent with ISPM 28 Annex 7: Irradiation treatment for fruit flies of the family Tephritidae (generic) (FAO 2017c) for *C. capitata*, *B. zonata* and *B. dorsalis*. Use of this measure will not be accepted until approved by FSANZ.

The use of irradiation as a phytosanitary measure is subject to the Australian Government Department of Agriculture and Water Resources' approval of the irradiation facilities identified by an NPPO from the MENA region. Should any country in the MENA region wish to use irradiation as a phytosanitary measure, the relevant NPPO would need to provide a submission to the Australian Government Department of Agriculture and Water Resources. The submission must fulfil requirements as set out in ISPM 18 (FAO 2016f).

5.1.5 Management for *Planococcus ficus* and *Pseudococcus cryptus*

To manage the risk of *Planococcus ficus* and *Pseudococcus cryptus* the Australian Government Department of Agriculture and Water Resources recommends consignment freedom verified by visual inspection, and remedial action if any live pests are found. The objective of the proposed measure is to reduce the risk associated with these pests to achieve the ALOP for Australia.

Irradiation treatment is considered a suitable remedial action for control of mealybugs. However, as noted in section 5.1.4, the use of irradiation on fresh date fruit has not yet been approved by FSANZ.

Recommended measure 1: Pre-export visual inspection and remedial action if found

All consignments of fresh dates exported to Australia must be inspected by the exporting country's NPPO and found free of the mealybugs *Ps. cryptus* and *Pl. ficus*. Export consignments found to contain either of these pests must be subject 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 pests are no longer viable.

Recommended measure 2: Irradiation treatment

The Australian Government Department of Agriculture and Water Resources recommends a treatment schedule of 400 Gy minimum absorbed dose (USDA 2016), consistent with ISPM 18: Guidelines for the use of irradiation as a phytosanitary measure (FAO 2016f). As described in section 5.1.4, use of this measure will not be accepted until approved by FSANZ and the irradiation facility and processes have been approved by the department.

The use of irradiation as a phytosanitary measure is subject to the Australian Government Department of Agriculture and Water Resources' approval of the irradiation facilities identified by an NPPO from the MENA region. Should any country in the MENA region wish to use irradiation as a phytosanitary measure, the relevant NPPO would need to provide a submission to the Australian Government Department of Agriculture and Water Resources. The submission must fulfil requirements as set out in ISPM 18 (FAO 2016f).

5.1.6 Consideration of alternative measures

Consistent with the principle of equivalence detailed in ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2017b), the Australian Government Department of Agriculture and Water Resources will consider any alternative measure proposed by an NPPO from the MENA region, providing that it demonstrably manages the target pest to achieve the ALOP for Australia. Evaluation of such measures will require a technical submission from an NPPO from the MENA region that details the proposed measures, including suitable information to support the claimed efficacy, for consideration by the Australian Government Department of Agriculture and Water Resources

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 dates from the MENA region. This is to ensure that the recommended risk management measures have been met and are maintained.

5.2.1 A system of traceability to source plantations

The objectives of the recommended procedure are to ensure that:

- fresh dates are sourced only from date plantations producing commercial quality fruit, and

- date plantations from which fresh dates are sourced can be identified, so that any investigation and corrective action can be targeted rather than applied to all contributing plantations, in the event that live pests are intercepted.

It is recommended that exporting NPPOs from the MENA region establish systems to enable traceability of all sources of fresh dates exported to Australia. The exporting country's NPPO will be responsible for ensuring export commodity growers are aware of pests of biosecurity concern to Australia and agreed risk management measures.

5.2.2 Registration of packing houses and treatment providers and auditing of procedures

The objectives of this recommended procedure are to ensure that:

- fresh dates from the MENA region are sourced only from packing houses and treatment providers processing commercial quality fresh dates approved by the exporting country's NPPO, and
- treatment providers are capable of applying a treatment that suitably manages the target pests.

Export packing houses must be registered with the exporting country's NPPO before the commencement of harvest each season. The list of registered packing houses must be kept by the exporting country's NPPO. The NPPO of the exporting country is required to ensure that registered packing houses are suitably equipped and have a system in place to carry out the specified phytosanitary activities. Audit records of the exporting country's NPPO must be made available to the Australian Government Department of Agriculture and Water Resources upon request.

In circumstances where fresh dates undergo treatment prior to export, such processes must be undertaken by treatment providers that have been registered with and audited by the exporting country's NPPO for that purpose. Records of the exporting country's NPPO registration requirements and audits are to be made available to the Australian Government Department of Agriculture and Water Resources upon request.

Approval of treatment providers must include verified operability of suitable systems to ensure compliance with treatment requirements. This may include:

– documented procedures to ensure fresh dates are appropriately treated and safeguarded post-treatment
– staff training to ensure compliance with procedures
– record-keeping procedures
– suitability of facilities and equipment
– compliance with the exporting country's NPPO system of oversight of treatment application.

5.2.3 Packaging, labelling and containers

The objectives of this recommended procedure are to ensure that:

- fresh dates intended for export to Australia and their associated packaging are not contaminated by quarantine pests or regulated articles (as defined in ISPM 5: Glossary of phytosanitary terms (FAO 2018)).

- unprocessed packaging material (for example, unprocessed plant materials which are not permitted entry, or may vector pests identified as not being on the pathway, or pests not known to be associated with fresh dates) is not imported with the fresh dates.
- all wood material, containers and transport methods (non-commodity) used in packaging of fresh dates complies with the Non-commodity information requirements policy (Department of Agriculture and Water Resources 2016a)
- secure packaging is used for export of fresh dates to Australia to prevent re-infestation during storage and transport, and to prevent escape of pests during clearance procedures on arrival in Australia. All packaging must meet Australia's secure packing options published on BICON at https://bicon.agriculture.gov.au/BiconWeb4.0/ViewElement/Element/Index?elementPk=155045&caseElementPk=908972.
- the packaged fresh dates are labelled with sufficient identification for purposes of traceability. This may include:
  - for treated product: the treatment facility name/number and treatment identification reference/number
  - for commodity where the measures include plantation freedom/area freedom: the plantation's reference/number
  - for commodity where phytosanitary measures are applied at the packing house: packing house reference/number.

Export packing houses and treatment providers (where applicable) must ensure clean, new packaging, and labelling are appropriate to maintain phytosanitary status of the export consignments.

5.2.4 Specific conditions for storage and movement

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

Fresh dates for export to Australia that have been treated and/or inspected must be kept secure and segregated at all times from any fruit for domestic or other markets, and untreated/non pre-inspected product, to prevent mixing or cross-contamination.

5.2.5 Freedom from trash

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

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

5.2.6 Pre-export phytosanitary inspection and certification by the exporting NPPO from the Middle East and North Africa region

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

All consignments must be inspected in accordance with official procedures for visually-detectable quarantine pests and other regulated articles (including soil, animal and plant debris), at a standard 600 unit sampling rate per phytosanitary certificate, or equivalent.

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

Each PC must include:

– a description of the consignment (including traceability information)
– details of disinfestation treatments (for example, methyl bromide fumigation) which includes date, concentration, temperature, duration and/or attached fumigation certificate (as appropriate)
– any other statements that may be required.

5.2.7 Phytosanitary inspection by the Australian Government Department of Agriculture and Water Resources

The objectives of this recommended procedure are to ensure that:

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

On arrival in Australia, the Australian Government Department of Agriculture and Water Resources will:

– assess documentation to verify that the consignment is as described on the phytosanitary certificate, that required phytosanitary actions have been undertaken, and that product security has been maintained.
– verify that the biosecurity status of consignments of fresh dates from a country in the MENA region meet Australia's import conditions. When inspecting consignments, the department will use random samples of 600 units per phytosanitary certificate.

5.2.8 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 any other import requirement is addressed, as appropriate.

Any consignment that fails to meet Australia's import conditions will be subject to 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 date consignments from any exporting country are repeatedly non-compliant, the Australian Government Department of Agriculture and Water Resources reserves the right to suspend imports (either of all imports, or imports from specific sources) and to conduct an audit of the risk management systems. Imports will recommence only when the Australian Government Department of Agriculture and Water Resources 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 a contaminant pest, is reported on fresh dates in a country in the MENA region or detected on arrival in Australia, it will be assessed by the Australian Government Department of Agriculture and Water Resources to determine its quarantine status and whether phytosanitary action is required.

Assessment will also be required 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 this 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 with any country/territory, the Australian Government Department of Agriculture and Water Resources will verify the implementation of agreed import conditions and phytosanitary measures, including of registration, operational procedures and treatment providers, where applicable. This may involve representatives from the Australian Government Department of Agriculture and Water Resources visiting areas in the MENA region that produce fresh dates for export to Australia.

5.4.2 Review of policy

The Australian Government Department of Agriculture and Water Resources will review the import policy after the first year of trade. In addition, the department reserves the right to review the import policy as deemed necessary, including if there is reason to believe that any pest or phytosanitary status in the MENA region has changed.

The NPPO of an exporting country from the MENA region must inform the Australian Government Department of Agriculture and Water Resources immediately on detection in their country of any new pest of fresh dates that might be of potential biosecurity concern to Australia.

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 Australian Government Department of Agriculture and Water Resources 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 (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 (legislation.gov.au) or through the FSANZ website (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 date fruit from the MENA region are based on a comprehensive scientific analysis of relevant literature.

The Australian Government Department of Agriculture and Water Resources considers that the risk management measures recommended in this report will provide an appropriate level of protection against the pests identified as associated with the trade of fresh date fruit from the MENA region.

Appendix A: Initiation and categorisation for pests of fresh date fruit from the Middle East and North Africa region

This table identifies pests that have the potential to be present on fresh date fruit grown in the MENA region using minimal 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* (Department of Agriculture and Water Resources 2017b) 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 (present within Australia), except for pests that are present but under official control, and/or are 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 acronyms 'EP, and 'WA' are used. The acronym 'EP' (existing policy) is used for pests that have previously been assessed by Australia and for which import policy exists. The acronym WA is used to identify organisms that have been recorded in some regions of Australia but, due to interstate quarantine regulations, are considered pests of regional concern to Western Australia.

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

Appendix A does not provide a comprehensive list of all pests associated with fresh date production, and it does not include soil-borne pests and pathogens, or wood-borers and root pests, as these are not directly related to the export pathway of fresh date fruit. Other pests that may occasionally be detected in trade, but which are not specifically associated with fresh date fruit, are not categorised 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 inspection will be actioned as appropriate, 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. As official lists of accepted and rejected fungal names become available, these accepted names will be adopted.

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
ARTHROPODS						
Acarina (Prostigmata)						
Aceria kenyae Keifer, 1966 Synonym: *Cisaberoptus kenyae* (Keifer, 1966) [Eriophyidae] Mango leaf mite	Yes. Present in Middle East and North Africa (PPO 2017)	Yes. NT, WA (Knihinicki & Boczek 2002; Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Brevipalpus phoenicis (Geijskes, 1936) [Tenuipalpidae] False spider mite	Yes. Present in Middle East and North Africa (PPO 2017)	Yes. NSW, NT, SA, WA (Plant Health Australia 2018; Poole 2010).	Assessment not required	Assessment not required	Assessment not required	No
Eutetranychus orientalis (Klein, 1936) [Tetranychidae] Oriental spider mite	Yes. Present in Middle East and North Africa (Migeon & Dorkeld 2017)	Yes. NSW, NT, Qld, WA (CSIRO 2017; Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Eutetranychus palmatus Attiah, 1967 [Tetranychidae] Spider mite	Yes. Present in Middle East and North Africa (Migeon & Dorkeld 2017; Palevsky, Lotan & Gerson 2010)	No records found	Yes. This pest occurs on fronds of date palms throughout the year, infesting young green dates and fruit strands during mid-summer causing distinctive damage (Ben-David, Ueckermann & Gerson 2013; Blumberg 2008; Palevsky, Lotan & Gerson 2010; Wakil, Faleiro & Miller 2015). However, due to the small size of the mites, low populations may escape detection in the date plantation.	Yes. The host range of this species is limited to three families (Migeon & Dorkeld 2017; Wakil, Faleiro & Miller 2015). On palms it is recorded from five palms including date palm (*Phoenix dactylifera*) (Blumberg 2008; Palevsky, Lotan & Gerson 2010). It has also been found on butternut squash (*Cucurbita moschata*) (Al-Atawi 2011) as well as cotton (*Gossypium* sp.) (Bolland, Gutierrez & Flechtmann 1998). All of these hosts are widely distributed throughout Australia, including in major cities (AVH 2018). The current distribution in the MENA region, and host range, although limited, suggests that this pest has the potential to establish and spread in Australia.	Yes. This species infests date palm fruits and fronds. It damages fruit by depositing exudates mixed with shed mite skins, webbing and dust (Blumberg 2008). Irregular chlorotic scars of the damaged feeding areas occur along the middle to distal part of the fruit (Palevsky, Lotan & Gerson 2010) that results in the downgrading of the marketable value of the dates, which then become unsuitable for export (Palevsky, Lotan & Gerson 2010; Wakil, Faleiro & Miller 2015)	Yes

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Oligonychus afrasiaticus (McGregor, 1939) [Tetranychidae] Date dust mite	Yes. Present in Middle East and North Africa (Migeon & Dorkeld 2017; PPO 2017)	No records found	Yes. Green dates are infested at the kimri stage. Mite numbers increase throughout summer from May to September, when fruits begin to yellow and the water content is greater than 84% (Talhouk 1969). Heavy infestations of date fruits and strands are covered with a dense dusty webbing. Infested dates become reddish, produce gum-like exudations, shrivel and may split resulting in scarred dates (Ben Chaaban, Chermiti & Kreiter 2011b; Palevsky, Borochov-Neori & Gerson 2005; Palevsky et al. 2003). However, due to the small size of the mites, low populations may escape detection in the date plantation.	Yes. *O. afrasiaticus* is primarily a pest of date palm but is recorded on six host plants from three families, including blady grass (*Imperata cylindrica*), rye grass (*Lolium* sp.), sugar cane, *Sorghum bicolor*, maize, rock melon and egg plant (Ben Chaaban, Chermiti & Kreiter 2011b; Migeon & Dorkeld 2017; Palevsky et al. 2003; Wakil, Faleiro & Miller 2015). These hosts are widely distributed throughout Australia (AVH 2018). This species is widely distributed throughout North Africa and the Middle East (Migeon & Dorkeld 2017) and spreads passively by aerial dispersal (Talhouk 1969). The current distribution and host range indicates that this pest has the potential to establish and spread in Australia.	Yes. This species attacks young green date fruits covering bunches with dusty, dense webbing. Infested dates become reddish, produce gum-like exudations, shrivel and may split, greatly reducing their market value. Heavy infestations cause economic losses due to the webbing making fruit unsuitable for both eating and processing (Gerson & Applebaum 2017; Wakil, Faleiro & Miller 2015). Date fruits are also affected by a significant reduction in sugar content (Ben Chaabane & Chermiti 2009). During the 1990s inspite of applications of miticides outbreaks of *O. afrasiaticus* caused substantial economic damage in Israel (Palevsky et al. 2003, 2004)	Yes (EP)

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Oligonychus biharensis (Hirst, 1924) [Tetranychidae]	Yes. Present in Middle East and North Africa (PPO 2017)	Yes. Qld (Davis 1968; Halliday 2000). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2018).	No. On leaves (Jeppson, Keifer & Baker 1975). This species feeds on upper and lower leaf surfaces of its host plants preferably near the petioles of mature leaves causing characteristic bronzing of the leaves. Prolonged feeding results in crinkling and subsequent drying and defoliation of infested leaves (Kaimal & Ramani 2011; Kaimal 2016; Vacante 2016).	Assessment not required	Assessment not required	No
Oligonychus coffeae (Nietner, 1861) [Tetranychidae] Tea red-spider mite	Yes. Present in Middle East and North Africa (Migeon & Dorkeld 2017; PPO 2017)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2018; Poole 2010).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Oligonychus pratensis (Banks, 1912) Synonym: *Paratetranychus heteronychus* Ewing, 1922 [Tetranychidae] Banks grass mite	Yes. Present in Middle East and North Africa (Migeon & Dorkeld 2017; Negm, De Moraes & Perring 2015)	No records found	Yes. This mite feeds on palm fronds and date fruit (Gispert, Farrar & Perring 2001). It first infests date fruit during the early kimri growth stage or before the fruit ripens and changes colour (Elmer 1965; Wakil, Faleiro & Miller 2015). Feeding on the epidermis of pre-khalal dates results in scarred fruit (Carpenter & Elmer 1978), with severely damaged fruits often turning brown (Stickney, Barnes & Simmons 1950). Fruits harden prematurely, shrivel and crack (Elmer 1965). Infested dates are clearly visible being covered with webbing that collects dust (Jeppson, Keifer & Baker 1975). However, due to the small size of the mites, low populations may not result in obvious damage and may escape detection during harvesting and packing house procedures.	Yes. Wide host range feeding on host plants in 10 families including watermelon (*Citrullus lanatus*), gourds, okra, and and at least 70 grass species including maize, sorghum, wheat and ryegrass (*Lolium* sp.) as well as several palms including date palm (Migeon & Dorkeld 2017; Stickney, Barnes & Simmons 1950). This mite is widely distributed in North Africa, the Middle East, North, central and South America as well as Asia (China, India, Pakistan, Russia, Thailand) (Migeon & Dorkeld 2017; Wakil, Faleiro & Miller 2015). It spreads by means of aerial dispersal and reproduces without a mate (Wakil, Faleiro & Miller 2015). The current distribution, wide host range and asexual reproduction indicate that this pest has the potential to establish and spread in Australia.	Yes. No estimates of damage or loss on hosts other than dates could be found. However, it is a serious pest of many grasses and grain crops in Africa, central America, India, Pakistan and the US, including maize, sorghum and wheat (Jeppson, Keifer & Baker 1975; Vacante 2016). Damaged date fruits are down-graded in the packing house, being unsuitable for fresh consumption and diverted to the processed date market at a loss to the grower. Before the introduction of a suitable acaricide in 1998, annual losses and control costs to the Californian date industry were estimated at between 1 and 2.5 million US dollars (Wakil, Faleiro & Miller 2015)	Yes (EP)

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Oligonychus senegalensis Gutierrez & Etienne, 1981 Note: According to Palevsky et al. (2003) this species was misidentified as *O. tylus* Baker & Pritchard, 1960 by Gerson, Venezian and Blumberg (1983). [Tetranychidae] Spider mite	Yes. Present in Middle East and North Africa (Migeon & Dorkeld 2017)	No records found	No. This species is primarily a pest of rice and sorghum and is considered a very minor species component of the spider mite guild that infests date palms, causing no economic damage (Blumberg 2008). It has only been recorded as a pest on date palms in Israel, occurring rarely on damaged date fruit (Ben-David, Ueckermann & Gerson 2013; Palevsky et al. 2003). Gerson, Venezian and Blumberg (1983) reported this species causes date fruits to become hard, with a shrivelled, cracked epicarp covered in webbing which in the later stages of infestation envelope the entire bunch. Such visibly damaged and unsightly fruits are likely to be culled during harvest, processing and quality control processes in the packing house	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Phyllotetranychus aegyptiacus Sayed, 1938 [Tenuipalpidae] False spider mite	Yes. Present in Middle East and North Africa (Beard et al. 2016)	No records found	No. This species commonly occurs on date palm fronds (El-Halawany, Abdel-Samad & El-Naggar 2001; Smith Meyer & Gerson 1980). No evidence was found to suggest that this pest is associated with fresh date fruit.	Assessment not required	Assessment not required	No
Raoiella indica Hirst, 1924 [Tenuipalpidae] Red palm mite	Yes. Present in Middle East and North Africa (Beard et al. 2016; Hoy, Peña & Nguyen 2015)	No records found	No. Eggs are attached to the leaf surface. It typically lives and feeds on the deep tissue layers of the under-surfaces of mature leaves or both surfaces of leaflets, usually along the midrib (Gerson, Venezian & Blumberg 1983). It feeds through the stomata (Cocco & Hoy 2009; Hoy, Peña & Nguyen 2015; Jeppson, Keifer & Baker 1975; Ochoa et al. 2011; Welbourn 2006)	Assessment not required	Assessment not required	No
Tenuipalpus omani De Moraes, Al-Shanfari & Silva, 2011 [Tenuipalpidae] False spider mite	Yes. Present in Middle East and North Africa (de Moraes, Al-Shanfart & da Silva 2011)	No records found	No. This species occurs on the leaves of date palm (*Phoenix dactylifera*) (de Moraes, Al-Shanfart & da Silva 2011)	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Tenuipalpus pareriophyoides Smith-Meyer & Gerson, 1981 [Tenuipalpidae] False spider mite	Yes. Present in Middle East and North Africa (Smith Meyer & Gerson 1980)	No records found	No. Recorded on date palm (*Phoenix dactylifera*) (Smith Meyer & Gerson 1980; Wakil, Faleiro & Miller 2015). No report of an association with fresh date fruit was found.	Assessment not required	Assessment not required	No
Tetranychus urticae Koch, 1836 Synonym: *Tetranychus bimaculatus* Harvey, 1892 [Tetranychidae] Two-spotted spider mite	Yes. Present in Middle East and North Africa (Migeon & Dorkeld 2017)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (CSIRO 2017; Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Coleoptera						
Carpophilus dimidiatus (Fabricius, 1792) [Nitidulidae] Corn-sap beetle	Yes. Present in Middle East and North Africa (Löbl & Smetana 2007)	Yes. NSW, NT, Qld, SA, Tas., WA (CSIRO 2017; Leschen & Marris 2005; Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Carpophilus hemipterus (Linnaeus, 1758) [Nitidulidae] Dried fruit beetle	Yes. Present in Middle East and North Africa (Jelínek & Hájek 2011; Löbl & Smetana 2007)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (CSIRO 2017; Leschen & Marris 2005; Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Carpophilus mutilatus Erichson, 1843 [Nitidulidae] Confused sap beetle	Yes. Present in Middle East and North Africa (Jelínek & Hájek 2011; Löbl & Smetana 2007)	Yes. NSW, NT, Qld, WA (Leschen & Marris 2005; Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Coccotrypes dactyliperda (Fabricius, 1801) [Curculionidae: Scolytinae] Palm seed borer; date stone beetle	Yes. Present in Middle East and North Africa (CABI 2018a; Wood & Bright 1992)	Yes. NSW, NT, Qld (CSIRO 2017; Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Epuraea luteola Erichson, 1843 Synonym: *Haptoncus luteolus* (Erichson, 1843) [Nitidulidae] Pineapple sap beetle; yellow nitidulid	Yes. Present in Middle East and North Africa (Jelínek & Hájek 2011; Löbl & Smetana 2007)	Yes. NSW (Plant Health Australia 2018). Listed as a Declared Organism (Prohibited (section 12)) as *Haptoncus luteolus* for WA (Government of Western Australia 2018)	No. Most nitidulids are saprophagous and are attracted to decaying and fermenting plant material or sap oozing from wounds on trees (Ewing & Cline 2004; Myers 2016). *Epuraea luteola* is primarily associated with decaying fruit (Ewing & Cline 2004; Hinton 1945). It is also a pest of dried fruit (Myers 2016). Nitidulids are known to attack all kinds of previously damaged fruit (Avidov & Harpaz 1969b).	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Rhynchophorus ferrugineus (Olivier, 1790) [Curculionidae] Red palm weevil	Yes. Present in Middle East and North Africa (Al-Khayri, Jain & Johnson 2015b, a; CABI 2018a, b; Fiaboe et al. 2012)	No. Absent: pest records invalid (Pullen, Jennings & Oberprieler 2014). Listed as a Declared Pest, Prohibited (section 12) (C1 Prohibited) for WA (Government of Western Australia 2018).	No. Eggs laid in wounds in the trunk or base of palm fronds; larvae bore towards the interior of the palm and are found feeding in the bole, stem or crown of the palm tree; larvae and adults may destroy the interior of the palm tree (Azam & Razvi 2001; Blumberg 2008; CABI 2018a, b; Hussain et al. 2013; Kinawy & Al Siyabi 2013; Wakil, Faleiro & Miller 2015)	Assessment not required	Assessment not required	No
Urophorus humeralis (Fabricius, 1798) [Nitidulidae] Pineapple beetle	Yes. Present in Middle East and North Africa (CABI 2018a; Jelínek & Hájek 2011; Löbl & Smetana 2007)	Yes. NT, WA (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Diptera						

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Bactrocera dorsalis (Hendel, 1912) Synonyms: *Bactrocera papayae* Drew & Hancock, 1994 (Papaya fruit fly). This species as well as *Bactrocera invadens* Drew, Tsuruta & White, 2005 and *B. philippinensis* Drew & Hancock, 1994 have recently been synonymised with *B. dorsalis* (Schutze et al. 2015). [Tephritidae] Oriental fruit fly	Yes. Present in Middle East and North Africa (CABI 2018a, b; CABI & EPPO 1997; Elwan 2000; Merz 2011; Qureshi & Mohiuddin 1982)	No. Eradicated from mainland Australia (Hancock et al. 2000)	Yes. Eggs are laid below the skin of the host fruit; larvae feed internally on pulp (CABI 2018a). This species has been reared from date fruit (Elwan 2000)	Yes. Large host range feeding on many commercial crops including apple, guava, mango, peach and pear (CABI 2018a, b) and a tolerance of both forest and non-forest habitats (Allwood et al. 1999). It is widely distributed throughout mainland Asia, sub-Saharan Africa, Oceania and introduced to Hawaii (Drew & Hancock 1994; Drew & Romig 2013). The incursion of this pest (as *B. papayae*) into north Qld, which demonstrated a potential for establishment and spread during the mid-1990s, was subsequently eradicated (Cantrell, Chadwick & Cahill 2002)	Yes. This species is one of the most serious fruit fly pests in the Asian and African regions, with a very wide host range, including many cultivated crops such as banana, capsicum, carambola, guava, mango, orange, papaya, pear and plum (CABI 2018a, b). Damage levels range from 4–30% to as much as 100% of unprotected fruit (CABI 2018a; Peña, Mohyuddin & Wysoki 1997). The economic impact to Australia would arise both from quarantine restrictions imposed by important domestic and foreign markets and from direct yield losses due to infested fruit.	Yes (EP)

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Bactrocera zonata (Saunders, 1841) [Tephritidae] Peach fruit fly	Yes. Present in Middle East and North Africa (Amin & Saafan 2013; CABI 2018a, b; EPPO 2017)	No records found	Yes. *Bactrocera zonata* lays its eggs in batches under the skin of host fruit. Larvae bore their way into the interior of the host fruit feeding internally on the pulp for 1–3 weeks before emerging to pupate in the ground (CABI 2018a; FAO & IAEA 2000). This species has been reared from date palm fruit in localities where regular hosts were not readily available due to heavy population pressure (Syed, Ghani & Murtaza 1970a)	Yes. Extremely wide host range feeding on plant hosts belonging to 19 genera in 15 families including apple, citrus, guava, mango and peach (Allwood et al. 1999; White & Elson-Harris 1994) as well as date (Alzubaidy 2000). Susceptible hosts are grown widely across Australia. Widespread across tropical Asia (Drew & Romig 2013) and a known invasive species (CABI 2018b). This suggests there are suitable environments for this pest to establish and spread in areas of Australia.	Yes. Known in India and South-East Asia as a serious pest of tropical and subtropical fruits causing crop losses of 25–100% in peach, apricot, guava and fig crops in India (CABI 2018a). In Pakistan damage levels of 25–50% in guava fruit are reported (Siddiqui et al. 2003; Syed, Ghani & Murtaza 1970a) while in Egypt infestation rates of 20% in apricot and citrus are reported (Saafan, Foda & Abdel-Hafez 2005). This species has increased its host range to important commercial crops such as citrus, mango, eggplant, tomato, apple, and loquat (El-Samea & Fetoh 2006)	Yes (EP)

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Ceratitis capitata (Wiedemann, 1824) [Tephritidae] Mediterranean fruit fly	Yes. Present in Middle East and North Africa (Buyckx 1994; CABI 2018a)	Yes. Present in WA only, but under official control (Dominiak & Daniels 2012; Plant Health Australia 2018). Listed as a regulated quarantine pest (Section 10 List A Pest) for Tas. (DPIPWE 2016).	Yes. Hard or semi-ripe fruit is preferred for egg laying with larval feeding eventually reducing attacked fruit to a juicy inedible mass (Thomas et al. 2016). The stage preceding date fruit maturation is conducive to larval growth while the later rutab and tamar stages are not infested by fruit flies (Buyckx 1994). Date is a rarely infested host of this pest (Liquido, Shinoda & Cunningham 1991)	Yes. A polyphagous pest, feeding on the fruit of many plants such as citrus, peach, pear, apple, apricot, fig, plum, kiwifruit, quince, grape, sweet cherry, pomegranate and strawberry (CABI 2018a). Mediterranean type climates that favour the establishment of this species occur in various parts of Australia. Adults are able to fly up to 20 kilometres (Fletcher 1989) allowing them to spread.	Yes. A highly damaging pest, particularly in citrus and peach. It can also transmit fruit-rotting fungi. Damage to fruit crops can sometimes reach 100% (CABI 2018a)	Yes (EP)
Drosophila melanogaster Meigen, 1830 [Drosophilidae] Vinegar fly	Yes. Present in Middle East and North Africa (Al Antary, Al Khawaldeh & Ateyyat 2014; CABI 2018a; Gerson & Applebaum 2017)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (CSIRO 2017; Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Zaprionus indianus Gupta, 1970 [Drosophilidae] African fig fly	Yes. Present in Middle East and North Africa (Alawamleh et al. 2016; CABI 2018a)	No records found	No. *Zaprionus indianus* is unable to lay its eggs through the intact skin of date fruit and uses natural openings or wounds for egg laying (Moussa 2009; Steck 2005; Tidon, Leite & Leão 2003). It does not attack undamaged fruit (Joshi et al. 2014) and intact unbroken date fruit is unlikely to be infested due to its thick skin (Janick & Paull 2008).	Assessment not required	Assessment not required	No
Hemiptera						
Aonidiella orientalis (Newstead, 1894) [Diaspididae] Oriental scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018; PPO 2017)	Yes. NT, Qld, WA (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Asarcopus palmarum Horváth, 1921 [Caliscelidae] Date bug	Yes. Present in Middle East and North Africa (Bourgoin 2018)	No records found	No. Feeds on the stalks of inflorescences and on soft protected tissues of the frond bases of date palms. However, it can also feed further along the rachis of unexpanded fronds (Blumberg 2008; Howard et al. 2001)	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Aspidiotus destructor Signoret, 1869 [Diaspididae] Transparent scale; coconut scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018; PPO 2017)	Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Aspidiotus nerii Bouché, 1833 [Diaspididae] Oleander scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Chrysomphalus aonidum (Linnaeus, 1758) [Diaspididae] Circular black scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	Yes. NSW, NT, Qld, Tas., WA (CSIRO 2017; Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Chrysomphalus dictyospermi (Morgan, 1889 [Diaspididae] Spanish red scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018; PPO 2017)	Yes. NSW, NT, Qld, SA (CSIRO 2017; Plant Health Australia 2018). Listed as a Declared Pest, Prohibited (section 12) (C1 Prohibited) for WA (Government of Western Australia 2018).	No. Mostly found on leaves and occasionally on branches; leaves are the preferred feeding site (CABI 2018a; García Morales et al. 2018)	Assessment not required	Assessment not required	No

Cicadulina bipunctata (Melichar, 1904) Synonym: *Cicadulina bipunctella* (Matsumura, 1908) [Cicadellidae] Maize orange leafhopper	Yes. Present in Middle East and North Africa (Alhudaib et al. 2007b, a; CABI 2018a; Khatri et al. 2011)	Yes. NT, WA (Plant Health Australia 2018). Not listed as a regulated quarantine pest (Section 10 List A Pest) for Tas. (DPIPWE 2016). Because *C. bipunctata* is the main insect vector for the newly detected phytoplasma disease Al-Wijam in date palm plantations (Abo-El-Saad, Alhudaib & Al Ajlan 2014; Alhudaib et al. 2007c, a) (a disease that is absent from Australia), the potential to be on the pathway needs to be assessed.	No. Adults and immature stages feed on the above-ground stems or leaves of plants, especially grasses, sucking plant sap from phloem or xylem (Dietrich 2008; Howard et al. 2001). Leafhoppers are rarely found in the foliage of tall palms but occasionally found on low-growing palms near grasses and other herbaceous plants, which probably serve as their principal hosts (Howard et al. 2001). Leafhoppers have excellent jumping abilities and when disturbed immediately jump or move to the other side of the leaf or twig (Carver, Gross & Woodward 1991; Evans 1966) and would be unlikely to remain with harvested date fruit. It would be very unlikely that commercial quality fresh dates would be infested with this species.	Assessment not required	Assessment not required	No
Ceroplastes actiniformis Green, 1896	Yes. Present in Middle East and North Africa	No records found.	No. Found on leaves (USDA-APHIS 2008).	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
[Coccidae] Soft scale	(García Morales et al. 2018)					
Coccus hesperidum Linnaeus, 1758 [Coccidae] Soft brown scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018; PPO 2017)	Yes. All states and territories (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Dysmicoccus brevipes (Cockerell, 1893) [Pseudococcidae] Pineapple mealybug	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	Yes. NSW, NT, Qld, WA (CSIRO 2017; Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Fiorinia fioriniae (Targioni Tozzetti, 1867) [Diaspididae] Fiorinia scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	Yes. NSW, NT, Qld, SA, Vic., Tas. (CSIRO 2017; Plant Health Australia 2018). Listed as a Declared Pest, Prohibited (section 12) (C1 Prohibited) for WA (Government of Western Australia 2018).	No. *Fiorinia fioriniae* is associated with the leaflets (pinnae), rachises and bases of date palm fronds (El-Shafie 2012). It feeds on the underside of palm frond leaflets often aligned along the veins causing chlorosis of the leaf tissues due to the injection of toxic saliva while feeding (Watson 2018). Howard et al. (2001) notes armoured scales commonly infest the third or fourth oldest palm fronds.	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Fiorinia phoenicis Balachowsky, 1967 [Diaspididae] Long scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018; PPO 2017; Radwan 2012; Wakil, Faleiro & Miller 2015)	No records found	Yes. Infests date palm fronds, especially the older fronds as well as date fruit. It is found all year round causing yellowing of the leaflets (pinnae) and drying of fronds with populations decreasing during winter (December to February). As the population increases this scale moves to the older fronds and date bunches first before the younger fronds (Attia 2013; Elwan, El-Sayed & Serag 2011; Hassan, Radwan & El-Sahn 2012; Radwan 2012).	Yes. The only recorded host is date palm (*Phoenix dactylifera*) (García Morales et al. 2018) which is widely distributed, although localised, in arid regions of NT, Qld, SA and WA (AVH 2018) as well as being grown as an ornamental in major cities. This scale is distributed from Egypt, across the Arabian Peninsula and Middle East to Iran (García Morales et al. 2018; Radwan 2012). The current distribution and host range although limited suggests that this pest has the potential to establish and spread in Australia.	Yes. The quality of infested date fruit is affected so as to make them less marketable (Elwan, El-Sayed & Serag 2011; Radwan 2012)	Yes (EP)
Hemiberlesia lataniae (Signoret, 1869) [Diaspididae] Latania scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	Yes. NSW, NT, Qld, WA (CSIRO 2017; Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Icerya aegyptiaca (Douglas, 1890) [Monophlebidae] Egyptian fluted scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	Yes. NSW, NT, Qld, WA (CSIRO 2017; Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Icerya purchasi Maskell, 1879 [Monophlebidae] Cottony cushion scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	Yes. NSW, NT, Qld, SA, Vic., Tas., WA (CSIRO 2017; Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Ischnaspis longirostris (Signoret 1882) [Diaspididae] Black thread scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	Yes. NT, Qld, SA (García Morales et al. 2018; Plant Health Australia 2018; Watson 2018). Listed as a Declared Pest, Prohibited (section 12) (C1 Prohibited) for WA (Government of Western Australia 2018).	No. *Ischnaspis longirostris* is usually found on palm fronds, preferring the undersurface of leaflets (pinnae), as well as petioles. Its feeding causes the development of chlorotic spots on the leaflets and occasionally also on fruit (Howard et al. 2001; Watson 2018). This species is shiny black in colour, covered in a light bloom and is extremely long and narrow (3.5 mm) making the elongate leech-shaped scales very conspicuous. It prefers the undersurface of leaflets, and damaged dates with chlorotic spots are unlikely to be harvested.	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Maconellicoccus hirsutus (Green, 1908) [Pseudococcidae] Hibiscus mealybug	Yes. Present in Middle East and North Africa (García Morales et al. 2018; Talhouk 1993; Williams 1996)	Yes. NSW, NT, Qld, SA, Vic., WA (CSIRO 2017; Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Nipaecoccus viridis (Newstead, 1894) [Pseudococcidae] Spherical mealybug	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	Yes. NT, Qld, WA (CSIRO 2017; Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Ommatissus lybicus De Bergevin, 1930 Synonym: *Ommatissus binotatus* var. *lybicus* De Bergevin, 1930; *Ommatissus binotatus* Fieber, 1876 [Tropiduchidae] Dubas bug	Yes. Present in Middle East and North Africa (Asche & Wilson 1989; Bourgoin 2018; PPO 2017)	No records found	No. Eggs laid inside the midrib of leaf pinnae and fruit stalks (Hussain 1963a; Khalaf & Khudhair 2015), not on date fruit (Hussain 1963a). Adults and nymphs suck the sap from leaflets, frond midrib and fruit stalks of date palm, (Shah et al. 2012; Talhouk 1969). Its feeding produces copious amounts of honeydew that spreads over leaf surfaces and fruit which become contaminated with dust, larval exuviae and sooty mould (Talhouk 1969). Adults and nymphs jump quickly when disturbed and during the heat of the day in summer it hides between the bases of the young palm fronds (Hussain 1963a). Infested and poor quality fruit are likely to be removed during routine packing house processes and quality assurance activities.	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Oxycarenus hyalinipennis (Costa, 1843) [Lygaeidae] Cotton seed bug	Yes. Present in Middle East and North Africa (CABI 2018a; PPO 2017)	No records found	No. This species is principally a pest of cotton that requires seeds of Malvaceae to complete its development (Halbert & Dobbs 2010). During outbreaks this pest is recorded aggregating on various adjacent trees and shrubs including date palms and damaging date fruit by contaminating them with a pungent odour (Nakache & Klein 1992) indicating that adults and nymphs are present on date fruit. However, these bugs are highly mobile and will move away during harvest.	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Palmaspis phoenicis (Ramachandra Rao, 1922) Synonymy: *Asterolecanium phoenicis* Rao, 1922 [Asterolecaniidae] Date palm green pit scale	Yes. Present in Middle East and North Africa (Abbas Ali & El Nasr 1991; García Morales et al. 2018)	No records found	No. *Palmaspis phoenicis* principally feeds on the pinnae (leaflets), frond rachis (midrib), basal parts of the leaves and occasionally green fruits (kimri stage) (Blumberg 2008; García Morales et al. 2018; Razig 2014). Its feeding causes chlorosis and eventual desiccation of fronds and the shrinking and premature drying of fruits leading to fruit drop (Abbas Ali & El Nasr 1991; Gerson & Applebaum 2017).	Assessment not required	Assessment not required	No
Parlatoria blanchardi (Targioni Tozzetti, 1892) [Diaspididae] Date palm scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018; PPO 2017)	Yes. NSW, NT, Qld (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Parlatoria proteus (Curtis, 1843) [Diaspididae] Orchid parlatoria scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	Yes. NSW, NT, Qld, SA, WA (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Parlatoria ziziphi (Lucas, 1853) [Diaspididae] Black parlatoria scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	No. Although previously listed as present in NT (Plant Health Australia 2018), it is considered absent from Australia, since intensive plant pest surveillance activities over the last 20 years have failed to detect its presence (Smith, Bellis & Gillespie 2013).	No. Although it has been recorded on date palm, the host range of this species appears to be restricted to Rutaceae and records from other hosts are questionable (Blackburn & Miller 1984; Dekle 1976; USDA-APHIS 2008). *Parlatoria ziziphi* is recorded feeding exclusively on citrus and is rarely recorded on other hosts (Fasulo & Brooks 1993). Howard et al. (2001) notes this species is a possible misidentification for *P. blanchardi*.	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Perindus binudatus Emeljanov, 1989 [Cixiidae] Date palm offshoot hopper	Yes. Present in Middle East and North Africa (Mokhtar 2009; Sultanate of Oman 2016)	No records found	No. Adults of this species feed on palm fronds and leaflets (Sultanate of Oman 2016). The immature stage possibly feeds on roots in the soil (Sultanate of Oman 2016). When disturbed the insect rapidly jumps away to avoid danger (Sultanate of Oman 2016) and therefore is very unlikely to be associated with harvested fresh date fruit.	Assessment not required	Assessment not required	No
Phenacoccus solenopsis Tinsley, 1898 [Pseudococcidae] Cotton mealybug	Yes. Present in Middle East and North Africa (Abdul-Rassoul, Al-Malo & Hermiz 2015; García Morales et al. 2018)	Yes. NT, Qld (Charleston & Murray 2010; Plant Health Australia 2018). Listed as a Declared Pest, Prohibited (section 12) (C1 Prohibited) for WA (Government of Western Australia 2018).	No. Date palm (*Phoenix dactylifera*) is an incidental host only. *Phenacoccus solenopsis* was observed being carried by visiting birds and rodents to nearby trees such as date palms where it only survived a few days; date palm is not considered a true host plant (Abbas et al. 2010)	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Phoenicococcus marlatti Cockerell, 1899 [Phoenicococcidae] Red date scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	No records found	No. This species prefers protected areas such as on the white tissue of leaf bases and areas behind the fibre bands, deep down on the leaf bases and fruit stalks where it is humid and rarely on the inner surface of midribs of youngest unfolding leaves (Al-Khayri, Jain & Johnson 2015b; Stickney, Barnes & Simmons 1950; Wakil, Faleiro & Miller 2015). Only in the wetter coastal areas of California has this species been seen on the basal surfaces of dates but never in the drier areas (Stickney, Barnes & Simmons 1950). Since dates from the Middle East and North Africa will be coming from arid, semi-arid desert regions (Köppen climate classification: BWh) it is highly unlikely *P. marlatti* will be associated with fresh date fruit.	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Planococcus citri (Risso, 1813) [Pseudococcidae] Citrus mealybug	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	Yes. All states and territories (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Planococcus ficus (Signoret, 1875) [Pseudococcidae] Vine mealybug	Yes. Present in Middle East and North Africa (Cox 1989; García Morales et al. 2018)	No records found	Yes. Date palm is a reported host plant (Cox 1989) and *P. ficus* is an occasional pest of date palms feeding on the phloem sap (Daugherty 2013). However, *P. ficus* was frequently misidentified as *P. citri* prior to 1975 (Cox 1989) and may have been erroneously recorded from date palms. Otherwise, on palms mealybugs prefer folds, crevices and other protected sites and are often hidden in leaf axils but spread on to exposed surfaces of the crown shaft, petioles and fronds when populations are abundant (Howard et al. 2001). On other host plants (grape vines) adults and nymphs feed on flowers, fruit, and leaves (California Department of Food and Agriculture 2003)	Yes. Extremely wide host range feeding on plant hosts belonging to 23 families (García Morales et al. 2018). This mealybug can have up to four to six generations per year (Millar et al. 2002). It occurs predominantly in tropical and subtropical regions of the world in many countries including Argentina, Brazil, Egypt, France, Iran, Iraq, Israel, Lebanon, Mexico, Pakistan, Russia, Saudi Arabia, South Africa, Spain, Tunisia and United States of America (García Morales et al. 2018). Suitable environments with climates similar to these regions exist in various parts of Australia, suggesting that *P. ficus* has the potential to establish and spread in Australia.	Yes. This species is a key pest in vineyards worldwide (Millar et al. 2002; Walton & Pringle 2004b) as well as a known pest of figs and pomegranates (Cox 1989). It has the ability to destroy a grape crop and cause progressive weakening of vines through early leaf loss (Millar et al. 2002; Walton et al. 2006; Walton & Pringle 2004b). The pest is also a major transmitter of numerous viruses and diseases (Walton et al. 2006; Walton & Pringle 2004a). It also excretes large amounts of honeydew on grapes (Walton & Pringle 2004b) rendering fruit inedible and unmarketable (le Vieux & Malan 2013b)	Yes (EP)

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Platypleura arabica Myers, 1928 [Cicadidae] Arabian cicada	Yes. Present in Middle East and North Africa (El-Hawagry et al. 2015; Schedl 2008; Sultanate of Oman 2010)	No records found	No. Eggs are laid in young palm frond shoots. Immature stages feed on roots in the soil for two years before emerging as adults. Adults emerge during the summer season from April to August and suck sap from the trunk of its hosts (Sultanate of Oman 2010)	Assessment not required	Assessment not required	No
Pseudaspidoproctus hypheniacus (Hall, 1925) [Monophlebidae] Giant mealybug	Yes. Present in Middle East and North Africa (Elwan 2000; García Morales et al. 2018)	No records found	No. This species infests bases of palm fronds (Elwan 2000)	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Pseudaulacaspis pentagona (Targioni Tozzetti, 1886) [Diaspididae] White scale, Mulberry scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018; PPO 2017)	Yes. NSW, Qld (Plant Health Australia 2018). Listed as a Declared Pest, Prohibited (section 12) (C1 Prohibited) for WA (Government of Western Australia 2018).	Yes. Occurs on leaves, twigs and fruit of date palm (PPO 2017).	Yes. Polyphagous species feeding on hosts of 115 genera in 55 plant families (Watson 2018) including apple, cane berries, citrus, grape, mango, papaya, peach, persimmon, plum and several widely grown ornamental trees and shrubs (García Morales et al. 2018; Watson 2018). This species is already established in parts of Australia (Plant Health Australia 2018). The current distribution and wide host range suggest that this pest could establish and spread in WA.	No. The potential economic consequences should this species enter, establish and spread in WA was assessed as 'very low' using similar methodology to the Australian Government Department of Agriculture and Water Resources (Poole et al. 2011). Heavy infestation by this species can cause damage to plant health and reduce crop yield/marketability. However, existing control strategies for other economically important diaspid species present in WA are expected to limit the impact of this species (Poole et al. 2011).	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Pseudococcus cryptus Hempel, 1918 [Pseudococcidae] Citriculus mealybug	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	Yes. Detected at the tip of Cape York in 2007 and now limited to around Cairns, Qld which is south of Queensland's legislated Cape York Peninsula Pest Quarantine Area. Listed as a Declared Pest, Prohibited (section 12) (C1 Prohibited) for WA (Government of Western Australia 2018).	Yes. This species feeds on the branches, buds and fruit of its hosts (García Morales et al. 2018)	Yes. Wide host range feeding on host plants in 42 families including avocado, citrus, lychee and mango as well as several widely grown ornamental shrubs and trees (García Morales et al. 2018). Widely distributed in South and South East Asia, tropical Africa, eastern Mediterranean and South America (García Morales et al. 2018). The current distribution and wide host range suggest that this pest has the potential to establish and spread in Australia.	Yes. This species rapidly became a serious pest in citrus groves when accidentally introduced into Israel in 1937 (Blumberg, Ben-Dov & Mendel 1999; García Morales et al. 2018; Williams 2004). Damage to citrus has been associated with fruit and flower drop, wilting and general debilitation of the plant and also, importantly, with the unsightly appearance of the fruit covered in large quantities of honeydew on which sooty mould develops (Blumberg, Ben-Dov & Mendel 1999) that reduces the commercial value of the fruit.	Yes (EP, WA)
Pseudococcus longispinus (Targioni Tozzetti, 1867) [Pseudococcidae] Long-tailed mealybug	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Saissetia coffeae (Walker, 1852) [Coccidae] Hemispherical scale	Yes. Present in Middle East and North Africa (García Morales et al. 2018)	Yes. All states and territories (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Saissetia oleae (Olivier, 1791) [Coccidae] Black scale	Yes. Present in Middle East and North Africa (CABI 2018a)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Lepidoptera						

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Aphomia sabella (Hampson, 1901) Synonym: *Arenipses sabella* Hampson, 1901 [Pyralidae] Greater date moth	Yes. Present in Middle East and North Africa (Al Antary, Al-Khawaldeh & Ateyyat 2015b; Asselbergs 2007; Blumberg 2008; Burks et al. 2015; Carpenter & Elmer 1978)	No records found	Yes. Eggs generally laid on the inner and outer sides of the tip of the spathes and on the young leaflets of date palms. Larvae feed on young leaves, inflorescences, and green fruit, eating all parts including the seed and also burrowing into fronds (Blumberg 2008; Carpenter & Elmer 1978). Larvae bore into the base of fruit stalks mining a gallery 5–8 cm in length in which bacteria and fungi cause secondary damage (Al Antary, Al-Khawaldeh & Ateyyat 2015b; Carpenter & Elmer 1978; Levi-Zada et al. 2014). Heavy infestations cause the whole bunch to wither and fruit to shrivel and dry, but remain attached to strand (Blumberg 2008). However, early infestations may escape detection by routine commercial practices.	Yes. Host range restricted to date palm (*Phoenix dactylifera*) but sometimes Canary Island date palm (*P. canariensis*) is also attacked (Gerson & Applebaum 2017; Kehat & Greenberg 1969). Both palms are widely distributed, although localised, in drier areas of NT, Qld, SA and WA (AVH 2018). *Aphomia sabella* is distributed throughout North Africa and the Middle East from Algeria, Egypt, Iraq, Israel, Jordan, the Arabian Peninsula and Iran to India (Al Antary, Al-Khawaldeh & Ateyyat 2015b) – areas with similar climatic and environmental conditions to Australia. This indicates this pest has the potential to establish and spread in Australia.	Yes. Infestation by larvae destroys date fruit. This species is considered a serious economic pest of date palms, throughout its native range across north Africa, the Middle East, and northern India (Al Antary, Al-Khawaldeh & Ateyyat 2015b; Carpenter & Elmer 1978). In Iraq, 50% of the spathes and fruit bunches on 70% of the palms in some localities may be attacked (Hussain 1963b) while in Iran damage amounts to 5–15% of the crop (Gharib 1969)	Yes (EP)

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Batrachedra amydraula (Meyrick, 1916) [Batrachedridae] Lesser date moth	Yes. Present in Middle East and North Africa (Gielis 2007; PPO 2017; Wakil, Faleiro & Miller 2015)	No records found	Yes. Eggs are laid on immature date fruits and strands. Larvae enter the host fruit near its sepals, or less frequently at other sites, and feed on the pulp and immature seeds. Whilst large infested fruits usually drop after being attacked, smaller infested fruits usually remain attached to the strand by silken threads. Approximately 80% of the fruits are attacked while between 0.6–1.0 cm in diameter (Blumberg 2008). Heavily infested fruit bunches cease to grow and dry. Dates in storage may also be affected (Carpenter & Elmer 1978). However, early infestations may escape detection by routine commercial practices.	Yes. Main hosts are date palm (*Phoenix dactylifera*) and three-leaf derris (*Derris trifoliata*). These hosts are present across tropical north Qld and NT (AVH 2018). This pest is widely distributed across North Africa through the Middle East, the Arabian Peninsula to Iran, India and Pakistan (Blumberg 2008). The current distribution and host range suggests that this pest has the potential to establish and spread across northern Australia.	Yes. This moth may cause 50–70% yield losses due to fruit drop of dates. The first generation larvae infest several fruit before completing development, increasing the damage caused (Blumberg 2008; Gerson & Applebaum 2017). Late season infestation of large fruits may cause fruit decay and fermentation (Carpenter & Elmer 1978) leading to market loss.	Yes

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Cadra calidella (Guenée, 1845) Synonym: *Ephestia calidella* Guenée, 1845 [Pyralidae] (Oases) date moth; carob moth; dried fruit moth	Yes. Present in Middle East and North Africa (CABI 2018a; Carpenter & Elmer 1978; Hagstrum et al. 2013)	No records found	Yes. Eggs are laid singly or in groups on the surface of hanging dates as well as fallen date fruit, semi-dry dates being preferred (Gough 1917, 1918). *Cadra calidella* can attack ripening crops before harvest (Cox 1975a) with larvae developing on date fruit while still on the tree (Avidov & Harpaz 1969a; Mesbah, El-Kady & El-Sayed 1998). The larvae generally enter through the calyx end (Avidov & Harpaz 1969a). On fruits, infestations are most common in the field just before harvest (Hill 2007) and adults may fly into stores or be carried there on the product (Cox 1975a)	Yes. This pest is mainly a storage pest of carobs and dried fruit in Mediterranean countries but is known to attack dates in the field in Egypt (Gough 1917; Prevett 1968) and dried figs in Portugal (Franqueira 1955). It is distributed throughout Mediterranean countries (Prevett 1968), several European countries (France, Germany, Greece, Italy, Spain, United Kingdom) (Karsholt & Nieukerken 2018) as well as Iraq (Alrubeai 1987). The current distribution and host range suggests that this pest has the potential to establish and spread in Australia.	Yes. Larvae typically feed on dried fruits, especially dates, locust beans, nuts and cork (Hill 2007) leading to economic losses and unmarketability of damaged stored product. This species does not become well-established in stores; but larval diapause increases its pest potential (Hill 2007). Infestation of dates result in contamination and loss of volume (Zaid et al. 2002) and subsequent economic loss (Rees 2004)	Yes (EP)

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Ectomyelois ceratoniae (Zeller, 1839) Synonym: *Apomyelois ceratoniae* (Zeller, 1839) [Pyralidae] Carob moth	Yes. Present in Middle East and North Africa (CABI 2018a; Ksentini et al. 2010; Navarro, Donahaye & Calderon 1986; PPO 2017; Wakil, Faleiro & Miller 2015)	Yes. NSW, NT, SA, WA (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Spodoptera littoralis (Boisduval, 1833) [Noctuidae] Cotton leafworm	Yes. Present in Middle East and North Africa (CABI 2018a)	No records found	No. Although CABI (2018a) lists date palm (*Phoenix dactylifera*) as a minor host, no evidence has been found to suggest that this pest is associated with fresh date fruit.	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Virachola livia (Klug, 1834) Synonym: *Deudorix livia* (Klug, 1834) [Lycaenidae] Pomegranate butterfly	Yes. Present in Middle East and North Africa (Temerak et al. 2014), (CABI 2018a), (Gerson & Applebaum 2017; Larsen 1990)	No records found	Yes. The primary hosts of *V. livia* are green pods of the acacias *Vachellia farnesiana* and *V. nilotica*; when such pods are scarce it attacks pomegranate fruits (Gerson & Applebaum 2017) and can be an important pest attacking date fruit before harvest (Temerak et al. 2014). Eggs are laid on the surface of host fruits (Avidov & Gothilf 1960; Temerak & Sayed 2001). Larvae burrow into late developing date fruit (Hanna 1939a)	Yes. Hosts include pomegranates, Japanese plums, quinces, guavas, peaches, loquats, *Vachellia farnesiana*, *V. nilotica*, *Pithecellobium dulce*, as well as dates, (Ksentini, Jardak & Zeghal 2011; Larsen 1984; Temerak & Sayed 2001; Zhang 1994). It is distributed throughout Mediterranean countries, the Arabian Peninsula, Iran, Iraq and Pakistan (Gerson & Applebaum 2017; Ksentini, Jardak & Zeghal 2011). It is a moderately migratory species (Larsen 1984, 1990). The host range, migratory habits and current distribution of this pest in the Middle East and North Africa suggests there are suitable environments for it to establish and spread in Australia.	Yes. A major pest of pomegranate across the Middle East and North Africa where it causes commercial losses ranging from 15% in Turkey to as high as 31% in Oman (Abbas et al. 2008; Gerson & Applebaum 2017). Recorded from several commercial edible host fruits such as Japanese plum, quince, guava, peach, loquat and date (Ksentini, Jardak & Zeghal 2011; Larsen 1984; Temerak & Sayed 2001)	Yes
Thysanoptera						

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
No thrips species associated with commercially produced fresh date fruit were identified by relevant exporting countries/territories in the Middle East and North Africa region. Application of the group pest risk analysis for thrips and orthotospoviruses on fresh fruit, vegetables, cut-flower and foliage imports (thrips group PRA; (Department of Agriculture and Water Resources 2017b) did not identify any thrips that are associated with the fresh date fruit export pathway from the Middle East and North Africa region. A further literature search found no thrips species that are likely to be present on the fresh date fruit export pathway from the Middle East and North Africa region.						
BACTERIA						
Burkholderia caryophylli (Burkholder) Yabuuchi et al. 1993 Synonym: *Pseudomonas caryophylli* (Burkholder) Starr & Burholder) [Burkholderiaceae] Bacterial wilt (carnation)	Yes. Present in Middle East and North Africa (CABI 2018a)	Yes. NSW (Plant Health Australia 2018). Listed as a Declared Pest, Prohibited (section 12) (C1 Prohibited) for WA (Government of Western Australia 2018).	No. Enters plants through wounds subsequently colonising the vascular system of the stem, roots and leaves. The primary infection source is infected cuttings taken from symptomless mother plants (CABI 2018a)	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Erwinia chrysanthemi (Burkholder et al. 1953) Young et al. 1978 [Enterobacteriaceae] Bacterial wilt; Sudden decline of date palm	Yes. Present in Middle East and North Africa (Abdalla 2001; Elliott et al. 2004)	Uncertain as this species has recently been reclassified into multiple species and subspecies. The presence of this exact species in Australia cannot be assessed with confidence without in-depth molecular work.	No. This bacterial disease in young plantations 3 to 7 years old is characterised by a sudden loss of vigor with the appearance of blighted inner spears (unopened leaves) and death of the bud union in about 2 weeks. This species causes rotting of inner leaves and buds of date palms with the presence of structureless and foul-smelling mass near the center of the crown (Abdalla 2001; Elliott et al. 2004). Not known to be associated with fresh date fruit.	Assessment not required	Assessment not required	No
PHYTOPLASMA						

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Candidatus Phytoplasma asteris group 16SrI Al-Wijam disease	Yes. Present in Middle East and North Africa (Al-Awadhi et al. 2002; Alhudaib et al. 2007b; Ibrahim et al. 2011)	No records found	No. Symptoms include retardation in terminal bud growth, whole crown of leaves with rosetting symptoms after onset of the disease, yellow longitudinal lines (chlorotic streaks) on midribs of palm fronds, leaf stunting and marked reduction in fruit and stalk size progressing to no fruit production (Al Khazindar & Salam 2011; Alhudaib et al. 2007b, a; Ibrahim et al. 2011). Aster Yellows group phytoplasmas are graft- but not seed-transmissible and spread naturally by insect vectors, in particular leafhoppers (CABI 2018a; Weintraub & Beanland 2006).	Assessment not required	Assessment not required	No
CHROMALVEOLATA						
Diderma effusum (Schwein.) Morgan [Physarales: Didymiaceae] Pinhead spot	Yes. Present in Middle East and North Africa (Abdel-Azeem & Salem Fatma 2013; Süerdem, Karabacak & Dülger 2015)	Yes. NSW, NT, Qld, Vic. (ALA 2018; Plant Health Australia 2018), ACT, WA (AVH 2018; Western Australian Herbarium 2018).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Phytophthora sp. Similar to *P. palmivora* (E.J. Butler) E.J. Butler according to Djerbi (1983) [Peronosporales: Peronosporaceae] Belâat disease	Yes. Present in Middle East and North Africa (Abdelmonem & Rasmy 2007; El-Juhany 2010)	Uncertain. Species of *Phytophthora* are recorded in Australia (all states and territories) (Plant Health Australia 2018; Stukely 2012). However, the species assemblage may differ from that in the Middle East and North Africa region.	No. This pathogen is soilborne. It attacks entire clusters of young fronds resulting in their death which is subsequently followed by the infection and death of the terminal bud and then progression of the infection downwards in the trunk as a wet heart rot (Abdelmonem & Rasmy 2007; Abdullah, Lorca & Janson 2010; Zaid et al. 2002).	Assessment not required	Assessment not required	No
FUNGI						
Alternaria alternata (Fr.) Keissl. [Pleosporales: Pleosporaceae] Alternaria leaf spot; Calyx-end rot	Yes. Present in Middle East and North Africa (CABI 2018a; Farr & Rossman 2018; PPO 2017)	Yes. All states and territories (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Alternaria citri Ellis & N. Pierce [Pleosporales: Pleosporaceae] Stalk end rot	Yes. Present in Middle East and North Africa (CABI 2018a; Farr & Rossman 2018)	Yes. NSW, Qld, SA, WA (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Alternaria chlamydospora Mouch. [Pleosporales: Pleosporaceae]	Yes. Present in Middle East and North Africa (Bokhary 2010; Farr & Rossman 2018)	Yes. NSW, Vic., WA (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Armillaria tabescens (Scop.) Emel [Agaricales: Physalacriaceae] Armillaria root rot	Yes. Present in Middle East and North Africa (Farr & Rossman 2018)	Yes. Qld (Plant Health Australia 2018). Listed as a Declared Pest, Prohibited (section 12) (C1 Prohibited) for WA (Government of Western Australia 2018)	No. This species causes root rot of date palm (*Phoenix dactylifera*) (Farr & Rossman 2018). It is parasitic then saprotrophic, often on roots and occasionally the lower trunk area of trees (Sanagorski, Trulock & Smith 2013).	Assessment not required	Assessment not required	No
Aspergillus flavus Link: Fr. [Eurotiales: Trichocomaceae] Aspergillus ear rot	Yes. Present in Middle East and North Africa (CABI 2018a; Farr & Rossman 2018; Shenasi, Candlish & Aidoo 2002)	Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Aspergillus niger Tiegh. Synonym: *Aspergillus phoenicis* [Corda] Thom.; *Aspergillus brasiliensis* Varga, Frisvad & Samson [Eurotiales: Trichocomaceae] Collar rot; Black rot	Yes. Present in Middle East and North Africa (CABI 2018a; El-Juhany 2010; Farr & Rossman 2018; PPO 2017)	Yes. ACT, NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Aspergillus parasiticus Speare [Eurotiales: Trichocomaceae]	Yes. Present in Middle East and North Africa (CABI 2018a; Farr & Rossman 2018; HerbIMI 2018)	Yes. NSW, Qld (CABI 2018a; Plant Health Australia 2018). WA (HerbIMI 2018).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Bjerkandera adusta (Willd.) P. Karst Synonym: *Polyporus adustus* (Willd.) Fr. [Polyporales: Meruliaceae] Spongy white rot	Yes. Present in Middle East and North Africa (Farr & Rossman 2018; USDA-APHIS 2008)	Yes. NSW, Qld, SA, Tas., Vic., WA (AVH 2018; Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Botrytis cinerea Pers. [Helotiales: Sclerotiniaceae] Grey mould; Botrytis bunch rot	Yes. Present in Middle East and North Africa (Farr & Rossman 2018; HerbIMI 2018)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Ceratocystis paradoxa (Dade) C. Moreau Synonym: *Thielaviopsis paradoxa* (De Seynes) Höhn. (anamorph) [Microascales: Ceratocystidaceae] Black scorch; Medjnoon disease; Fool's disease	Yes. Present in Middle East and North Africa (Abdullah, Lorca & Janson 2010; CABI 2018a; El-Juhany 2010; Farr & Rossman 2018)	Yes. NSW, NT, Qld, SA, Vic., WA(Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Cochliobolus hawaiiensis Alcorn Synonym: *Curvularia hawaiiensis* (Bugnic.) Manamgoda, L. Cai & K.D. Hyde (anamorph); *Drechslera hawaiiensis* Bugnic. ex M.B. Ellis [Pleosporales: Pleosporaceae]	Yes. Present in Middle East and North Africa (Bokhary 2010; Farr & Rossman 2018)	Yes. Vic. (Plant Health Australia 2018), Qld (ALA 2018), WA (Shivas 1989).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Cochliobolus lunatus R.R. Nelson & Haasis Synonym: *Curvularia lunata* (Wakker) Boedijn [Pleosporales: Pleosporaceae]	Yes. Present in Middle East and North Africa (Bokhary 2010)	Yes. ACT, NSW, NT, Qld, Vic., WA (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Colletotrichum gloeosporioides (Penz.) Penz. & Sacc. Synonym: *Glomerella cingulata* (Stonem.) Spauld. & H Schrenk [Glomerellales: Glomerellaceae] Leaf necrosis; Pepper spot	Yes. Present in Middle East and North Africa (CABI 2018a; Farr & Rossman 2018)	Yes. All states and territories (Chakraborty et al. 1998; Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Coniothyrium palmarum Corda Synonym: *Microdiplodia palmarum* (Corda) Died. [Pleosporales: Coniothyriaceae]	Yes. Present in Middle East and North Africa (Farr & Rossman 2018)	No records found	No. On leaves and petioles of palm fronds (Farr & Rossman 2018).	Assessment not required	Assessment not required	No
Davidiella tassiana (De Not.) Crous & U. Braun Synonym: *Mycosphaerella tassiana* (De Not.) Johanson; *Cladosporium herbarum* (Pers.: Fr.) Link (anamorph) [Capnodiales: Mycosphaerellaceae] Brown leaf spot; taches brunes	Yes. Present in Middle East and North Africa (Ehsine, Belkadhi & Chaeib 2009; El-Juhany 2010)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Fusarium oxysporum Schltdl. f.sp. *albedinis* (Killian & Maire) W.L. Gordon [Hypocreales: Nectriaceae] Bayoudh disease	Yes. Present in Middle East and North Africa (Abdelmonem & Rasmy 2007; El-Juhany 2010)	No records found	No. This species is a soilborne fungus causing a vascular wilt of date palm characteristically affecting pinnae on one side of the leaf first, then the other and developing symptoms from the leaf base to the tip (Abdelmonem & Rasmy 2007; Abdullah, Lorca & Janson 2010; CABI 2018a).	Assessment not required	Assessment not required	No
Fusarium oxysporum Schltdl.: Fr. [Hypocreales: Nectriaceae] Note: This is a species complex that needs to be clearly defined.	Yes. Present in Middle East and North Africa (Abdalla et al. 2000; PPO 2017)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Fusarium proliferatum (Matsush.) Nirenberg ex Gerlach & Nirenberg [Hypocreales: Nectriaceae]	Yes. Present in Middle East and North Africa (Abdalla et al. 2000; Farr & Rossman 2018)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Fusarium solani (Mart.) Sacc. [Hypocreales: Nectriaceae] Note: This species represents a species complex with many physiological races adapted to specific hosts (Booth 1971). Root rot	Yes. Present in Middle East and North Africa (Bokhary 2010; Farr & Rossman 2018)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Elmer et al. 1997; Plant Health Australia 2018; Pung & Cox 1999; Sangalang et al. 1995)	Assessment not required	Assessment not required	Assessment not required	No
Gibberella baccata (Wallr.) Sacc. Synonym: *Fusarium lateritium* Nees: Fr. [Hypocreales: Nectriaceae]	Yes. Present in Middle East and North Africa (Farr & Rossman 2018; Mandeel 2005)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Gibberella intricans Wollenw. Synonym: *Fusarium equiseti* (Corda) Sacc. [Hypocreales: Nectriaceae]	Yes. Present in Middle East and North Africa (Farr & Rossman 2018; PPO 2017)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Gibberella fujikuroi (Sawada) Wollenw. Synonym: *Fusarium moniliforme* J. Sheld. [Hypocreales: Nectriaceae]	Yes. Present in Middle East and North Africa (Farr & Rossman 2018)	Yes. NSW, Qld, SA, Vic., WA (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Graphiola phoenicis (Moug. : Fr.) Poit. [Exobasidiales: Graphiolaceae] Palm leaf pustule; false smut	Yes. Present in Middle East and North Africa (El-Juhany 2010; Zaid et al. 2002)	Yes. NSW, NT, Qld, SA, Vic., WA (AVH 2018; Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Haematonectria haematococca (Berk. & Br.) Samuels & Nirenberg Synonym: *Nectria haematococca* Berk. & Broome [Hypocreales: Nectriaceae] Dry rot (potato)	Yes. Present in Middle East and North Africa (CABI 2018a; PPO 2017)	Yes. NSW, Qld (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Hyphodontia sambuci (Pers.) J. Eriksson Synonym: *Hyphoderma sambuci* (Pers.) Jülich; *Xylodon sambuci* (Pers.) Tura, Zmitr., Wasser & Spirin [Hymenochaetales: Schizoporaceae]	Yes. Present in Middle East and North Africa (Farr & Rossman 2018; Langer & Oberwinkler 1993; Rattan & Al-Dboon 1980)	Yes. NSW, Qld, Vic. (AVH 2018; Tura et al. 2011).	No. *Phoenix dactylifera* recorded as a host (Langer & Oberwinkler 1993; Tura et al. 2011). Occurs on bark and decorticated wood of trees (Tura et al. 2011). Common on inflorescence stalks, spathes, leaf-bases and sheathing leaf-fibres and associated with white-rot (Rattan & Al-Dboon 1980). No report of an association with fresh date fruit has been found.	Assessment not required	Assessment not required	No
Hypocrea rufa (Pers.) Fr. Synonym: *Trichoderma viride* Pers. [Hypocreales: Hypocreaceae]	Yes. Present in Middle East and North Africa (Farr & Rossman 2018)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (ALA 2018; Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Lasiodiplodia hormozganensis Abdollahzadeh, Zare & A.J.L. Phillips [Botryosphaeriales: Botryosphaeriaceae]	Yes. Present in Middle East and North Africa (Al-Sadi et al. 2013)	No records found	No. This pathogen was associated with root necrosis on date palm resulting in dieback in the UAE (Al-Sadi et al. 2013).	Assessment not required	Assessment not required	No
Lasiodiplodia theobromae (Pat.) Griffon & Maubl. Synonym: *Botryodiplodia theobromae* Pat.; *Diplodia theobromae* (Pat.) W Nowell [Botryosphaeriales: Botryosphaeriaceae] Root rot; Collar rot disease	Yes. Present in Middle East and North Africa (Al-Sadi et al. 2012; Al-Sadi et al. 2013; CABI 2018a; Farr & Rossman 2018; PPO 2017)	Yes. NSW, NT, Qld, SA, WA (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Macrophomina phaseolina (Tassi) Goid. [Botryosphaeriales: Botryosphaeriaceae] Charcoal rot	Yes. Present in Middle East and North Africa (Al-Sadi et al. 2012; Farr & Rossman 2018)	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 Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Mauginiella scaettae Cavara Synonym: *Geotrichum scaettae* (Cavara) Maire [Incertae sedis] Khamedj disease; Inflorescence rot	Yes. Present in Middle East and North Africa (Abdelmonem & Rasmy 2007; Carpenter & Elmer 1978; El-Juhany 2010; PPO 2017)	No records found	No. This pathogen attacks flowers and strands as the spathe emerges from the leaf base and may move on to the stalk of the inflorescence. Brownish or rusty areas develop on the non-opened spathe. Spores are short lived not surviving winter; the fungus survives as mycelium in old wood (Abdullah, Lorca & Janson 2010; Anselme & Baltzakis 1957; Carpenter & Elmer 1978; Ploetz et al. 2003). Al-Ani et al. (1971) demonstrated that the pathogen survives as mycelium in infected inflorescences remaining on palms from the previous season or within the infected leaf bases.	Assessment not required	Assessment not required	No
Neodeightonia phoenicum A.J.L. Phillips & Crous Synonym: *Diplodia phoenicum* (Sacc.) H.S. Fawc. & Klotz [Botryosphaeriales: Botryosphaeriaceae] Brittle leaf disease	Yes. Present in Middle East and North Africa (El-Juhany 2010)	Yes. Qld (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Oliveonia pauxilla (H.S. Jacks.) Donk Synonym: *Corticium pauxilla* Jacks. [Auriculariales: Incertae sedis]	Yes. Present in Middle East and North Africa (Rattan & Al-Dboon 1980)	Yes. SA (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Penicillium chrysogenum Thom. [Eurotiales: Trichocomaceae]	Yes. Present in Middle East and North Africa (Bokhary 2010; Farr & Rossman 2018)	Yes. NSW, Qld, Tas., Vic. (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Pestalotiopsis palmarum (Cooke) Steyaert Synonym: *Pestalotia palmarum* Cooke [Amphisphaeriales: Pestalotiopsidaceae] Grey blight; Grey palm leaf spot	Yes. Present in Middle East and North Africa (Farr & Rossman 2018; Mordue & Holliday 1971)	Yes. NSW, Qld, Vic., WA (Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Phanerochaete sordida (P. Karst.) J. Erikss. & Ryvarden Synonym: *Phanerochaete cremea* (Bres.) Parmasto [Polyporales: Phanerochaetaceae]	Yes. Present in Middle East and North Africa (Rattan & Al-Dboon 1980)	Yes. NSW, NT, Qld, SA, WA (AVH 2018; Plant Health Australia 2018).	Assessment not required	Assessment not required	Assessment not required	No
Pleospora herbarum (Pers.) Rabenh. Synonym: *Stemphylium herbarum* E.G. Simmons [Pleosporales: Pleosporaceae]	Yes. Present in Middle East and North Africa (Farr & Rossman 2018)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Rhizopus arrhizus var. *arrhizus* A. Fisch. [Mucorales: Rhizopodaceae] Fruit rot	Yes. Present in Middle East and North Africa (Bokhary 2010; Farr & Rossman 2018; HerbIMI 2018)	Yes. NSW, Qld, Vic. (Plant Health Australia 2018), WA (HerbIMI 2018).	Assessment not required	Assessment not required	Assessment not required	No
Thanatephorus cucumeris (A.B. Frank) Donk Synonym: *Corticium solani* (Prill. & Delacr.) Bourd. & Galz. [Ceratobasidiales: Ceratobasidiaceae]	Yes. Present in Middle East and North Africa (USDA-APHIS 2008)	Yes. All states and territories (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No
Thielaviopsis punctulata (Hennebert) A.E. Paulin, T.C. Harr. & McNew Synonym: *Chalaropsis punctulata* Hennebert; *Ceratocystis radicicola* (Bliss) C. Moreau; *Thielaviopsis radicicola* (Bliss) Z.W. de Beer & W.C. Allen [Microascales: Hypocreomycetidae] Black scorch; Date palm decline	Yes. Present in Middle East and North Africa (Al-Raisi et al. 2011; Al-Sadi et al. 2012; CABI 2018a; Farr & Rossman 2018; HerbIMI 2018)	Yes. State(s) not given (van Wyk et al. 2009)	Assessment not required	Assessment not required	Assessment not required	No
Trechispora farinacea (Pers.) Liberta [Trechisporales: Hydnodontaceae]	Yes. Present in Middle East and North Africa (Farr & Rossman 2018; Rattan & Al-Dboon 1980)	Yes. NSW, SA, Tas., Vic., WA (AVH 2018; Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Middle East and North Africa region	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Verticillium dahliae Kleb. [Incertae sedis: Plectosphaerellaceae] Verticillium wilt	Yes. Present in Middle East and North Africa (CABI 2018a)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2018)	Assessment not required	Assessment not required	Assessment not required	No

Appendix B: Issues raised in stakeholder comments

This section summarises key stakeholder comments raised in 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.

Comment 1: Concerns about red palm weevil (*Rhynchophorus ferrugineus*).

Response: Red palm weevil (*Rhynchophorus ferrugineus*) is a quarantine pest for Australia. Red palm weevil has been considered in this risk analysis at pest categorisation, Appendix A (see page 133). The department considers commercially grown and exported loose fresh dates to be an unlikely pathway for introducing red palm weevil and further information is included below.

Red palm weevil is native to South and South East Asia (Dembilio & Jaques 2015; Malumphy, Eyre & Anderson 2016; Rochat et al. 2017) where it is an important pest of coconut (*Cocos nucifera*), oil (*Elaeis guineensis*) and sago (*Metroxylon sagu*) palms (Hallett et al. 1993; Murphy & Briscoe 1999). Since the 1980s it has rapidly spread westward to the Arabian Peninsula, Middle East and countries of the Mediterranean basin where it has adapted to attacking date palm (*Phoenix dactylifera*) and Canary Island date palm (*P. canariensis*) (CABI 2018a, b; Faleiro 2006; Ferry & Gomez 2002; Malumphy, Eyre & Anderson 2016; Zaid et al. 2002).

The spread of the red palm weevil throughout most of the date palm growing areas of the MENA region is due to the unregulated movement of infested date palm offshoots and ornamental palm trees (Abuagla & Al-Deeb 2012; Aldryhim & Al-Bukiri 2003; Ferry & Gomez 2002; Fiaboe et al. 2012; Mukhtar et al. 2011; Murphy & Briscoe 1999).

The red palm weevil is a stem borer. Eggs are laid in wounds along the trunk, or in petioles, and also in wounds caused by the scarab beetle *Oryctes rhinoceros* (EPPO 2008). Larvae feed on the soft succulent palm tissues in regions of the palm trunk either close to the growing point, about 1 m below the crown, in the crown, at the bases of leaf petioles or in the lower part of the stem near the offshoots or where offshoots have previously been removed (Avand-Faghih 1996; CABI 2018a, b; EPPO 2008; Malumphy, Eyre & Anderson 2016; Murphy & Briscoe 1999; Soroker, El-Harari & Faleiro 2015; Zaid et al. 2002).

The adults are large (22 to 42 millimetres long), colourful orange-red insects with black markings (CABI 2018a; Malumphy, Eyre & Anderson 2016). Since the adults are highly visible and active, if they were accidentally associated with harvested date fruits, it is likely they would be removed during harvest, washing, manual grading, sorting and packing, before the fresh dates are secured under cold storage. Operational arrangements ensure that risk management measures are met and maintained, including that date fruit are inspected and secured to manage all potential contaminants (see section 5.2).

In addition, there is no history of interceptions of this pest on imported dried or semi-dry date fruit despite considerable trade occurring. However, should a live pest be detected on the fresh date fruit pathway during inspection it will be actioned. For example the consignment will be subjected to a remedial treatment (for example methyl bromide fumigation), or destroyed or re-exported (see section 5.2.8).

Comment 2: Concerns over the technical approach of grouping market access requests from eight MENA countries and adopting a single risk analysis for the MENA region, on the grounds it may not be appropriate if production and pest management procedures differ significantly between those countries/territories.

Response: Requests for market access for fresh dates from eight countries were integrated into a regional review because the major quarantine pests of fresh dates are the same, or from the same pest groups, in most date producing areas. All relevant pests in the region were considered as part of the review.

This procedure is an innovative approach being trialled as a project funded by the Agricultural Competitiveness White Paper, and is intended to increase the efficiency of the risk analysis process and reduce the number of outstanding market access requests.

It is acknowledged that there are varying production and pest management practices across the MENA region, and that not all countries in the MENA region have the same commercial production standards for dates. For this reason the risk assessments were based on a minimal production standard, taking into account possible regional differences and resulting in an unrestricted risk estimate assuming minimal production and pest management practices. These considerations are also discussed at section 3.1.

Comment 3: Concerns over the methodology used in the pest categorisation process, which resulted in several pests (for example, *Coccotrypes dactyliperda*, *Epuraea luteola*, *Zaprionus indianus*, *Chrysomphalus dictyospermi*, *Ommatissus lybicus*, *Palmaspis phoenicis*, *Parlatoria blanchardi*) not being considered to be associated with the pathway.

Response: The Australian Government Department of Agriculture and Water Resources has conducted the pest categorisation process in accordance with ISPM 11 (FAO 2017b). Section 2.1 of ISPM 11 states 'The categorisation process examines for each pest whether the criteria in the definition for a quarantine pest are satisfied' and 'The opportunity to eliminate an organism or organisms from consideration before in-depth examination is undertaken is a valuable characteristic of the categorisation process'.

Section 2.2.1.2 of ISPM 4 (FAO 2017a) also states that pest management, cultural and commercial procedures applied at the place of origin (application of plant protection products, handling, culling, roguing and grading) should be taken into account when determining the probability of a pest being associated with the pathway at origin.

The indicated pests are all considered unlikely to be associated with the commercial fruit pathway, and hence were not considered further. Conversely, all thirteen pests that did fulfil the criteria were assessed in detail, with spider mites, mealybugs and fruit flies ultimately assessed as requiring import risk management measures.

Other issues

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

- amendments to the pest categorisation table (Appendix A) to address some minor issues relating to taxonomy and common names (for example, *Oliveonia pauxilla*/*Corticium pauxilla* and *Ectomyelois ceratoniae*/carob moth)
- amendments to the text in the pest categorisation table (Appendix A) to clarify the pathway association of several arthropods with fresh date fruit, for example the spider mites *Oligonychus biharensis* and *Oligonychus senegalensis*, *Raoiella indica* (red palm mite), *Epuraea luteola* (pineapple sap beetle), *Cicadulina bipunctata* (maize orange leafhopper) and *Ommatissus lybicus* (dubas bug)
- amendments to date production areas and export statistics for Tunisia
- minor corrections, rewording and editorial changes for consistency, clarity and web-accessibility.

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 2018).
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 2018).
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 2018).
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 2018).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO 2018).
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 Australian Government Department of Agriculture and Water Resources.

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 2018).
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 2018).
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2018).
Fresh	Living; not dried, deep-frozen or otherwise conserved (FAO 2018).
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).
Hababauk	First developmental stage of date fruit – small, round, whitish – green colour, very small, appears after pollination and persists for up to 5 weeks (Siddiq, Aleid & Kader 2014; Zaid 2002). Sometimes spelled as Hababouk or Hababook.
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 2018).
Import permit	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2018).
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 2018).
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 2018).
Intended use	Declared purpose for which plants, plant products, or other regulated articles are imported, produced or used (FAO 2018).
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment (FAO 2018).
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 2018).
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO 2018).
Khalal	Third developmental stage of date fruit – fruit is yellow or red, mature, increased sugar content, ready for consumption as fresh fruit, high moisture content (45 to 75 or 85 per cent approximately) and lasts up to five weeks

Term or abbreviation	Definition
	(Hodel & Johnson 2007; Siddiq, Aleid & Kader 2014; Zaid 2002). Sometimes spelled and referred to as Khalaal, Khala, Balah, Biser or Bisr.
Kimri	Second developmental stage of date fruit – fruit is green, immature, hard, very high moisture content (85 per cent or higher), still developing and not full sized. Lasts nine to fourteen weeks (Hodel & Johnson 2007; Siddiq, Aleid & Kader 2014; Zaid 2002). Sometimes spelled as Chemri, Chimri, Khimri or Jimri.
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 2018). Within this report a 'lot' refers to a quantity of fruit of a single variety, harvested from a single production site during a single pick and packed at one time.
Maghreb (Maghrib)	Is usually defined as most of the region of northwest Africa west of Egypt. It now comprises essentially the countries/territories of Morocco, Algeria, Tunisia, Libya as well as including Mauritania and the territory of Western Sahara (controlled by Morocco).
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 2018).
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 2018).
Pathogen	A biological agent that can cause disease to its host.
Pathway	Any means that allows the entry or spread of a pest (FAO 2018).
Pest	Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2018).
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 2018).
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 2018).
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 2018).
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 2018).
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 2018).
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 2018).

Term or abbreviation	Definition
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 2018).
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2018).
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 2018).
Pest status (in an area)	Presence or absence, at the present time, of a pest in an area, including where appropriate its distribution, as officially determined using expert judgement on the basis of current and historical pest records and other information (FAO 2018).
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 2018).
Phytosanitary certification	Use of phytosanitary procedures leading to the issue of a phytosanitary certificate (FAO 2018).
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 2018). 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 2018).
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 2018).
Plantation	A contiguous area of date palms operated as a single entity. Within this report a single plantation is covered under one registration and is issued a unique identifying number.
Pleomorphic life cycle	A life cycle of organisms where different stages have a different morphology. Fungi with pleomorphic life cycles typically have a sexual reproductive stage (teleomorph) and/or an asexual reproductive stage (anamorph).
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 2018).
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 2018).
Production site	In this report, a production site is a continuous planting of date palms treated as a single unit for pest management purposes. If a plantation is subdivided into one or more units for pest management purposes, then each unit is a production site. If the plantation is not subdivided, then the plantation 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 2018).
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 2018).

Term or abbreviation	Definition
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 2018).
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 2018).
Regulated pest	A quarantine pest or a regulated non-quarantine pest (FAO 2018).
Restricted risk	Restricted risk is the risk estimate when risk management measures are applied.
Risk analysis	Refers to the technical or scientific process for assessing the level of biosecurity risk associated with the goods, or the class of goods, and if necessary, the identification of conditions that must be met to manage the level of biosecurity risk associated with the goods, or class of goods to a level that achieves the ALOP for Australia.
Risk management measure	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.
Rutab	Fourth developmental stage of date fruit – light brown in colour (though some yellow, red or green may remain), ripe, soft, sweet, ripe, moderate moisture content (30 to 45 per cent) and lasts up to four weeks (Hodel & Johnson 2007; Siddiq, Aleid & Kader 2014; Zaid 2002).
Sahel	The semiarid ecoclimatic region of western and north-central Africa extending from the Atlantic Ocean in the west to the Red Sea in the east along the southern edge of the Sahara desert. The region includes Senegal on the Atlantic coast, through parts of Mauritania, Mali, Burkina Faso, Niger, Nigeria, Chad and Sudan to Eritrea on the Red Sea coast (The Emirates Center for Strategic Studies and Research 2003).
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 2018).
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 2018).
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.
Tamar	Fifth developmental stage of date fruit – dull brown to black in colour, fully ripe, soft, wrinkled flesh, very sweet, low moisture content (less than 30 per cent) and will last for an extremely long period of time. Sometimes spelled as Tamr, Tamor or Tamer.
Trash	Soil, splinters, twigs, leaves and other plant material, other than fruit as defined in the scope of this risk analysis. 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 2018).
Unrestricted risk	Unrestricted risk estimates apply in the absence of risk management measures.

Term or abbreviation	Definition
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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