Australian Government

Biosecurity Australia

Final Report

Import Risk Analysis for Tahitian Limes from New Caledonia

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GLOSSARY OF TERMS AND ABBREVIATIONS.

Additional declaration	a statement that is required by an importing country to be entered on a Phytosanitary Certificate and which provides specific additional information pertinent to the phytosanitary condition of a consignment
ALOP	appropriate level of protection
Anamorph	the stage of a fungus characterised by asexual spores (conidia) or the absence of spores
AQIS	Australian Quarantine and Inspection Service
Area	an officially defined country, part of a country or all or parts of several countries
Arthropods	a phylum of invertebrate animals. The major classes are Insecta (insects), Arachnida (mites, spiders) and Crustacea (shrimps, prawns, crabs)
Biosecurity Australia	a prescribed agency within the Australian Government Department of Agriculture, Fisheries and Forestry
Consignment	a quantity of plant, plant products and/or other articles being moved from one country to another and covered, when required, by a single phytosanitary certificate (a consignment may be composed of one or more commodities or lots)
Contaminating pest	a pest that is carried by a commodity and, in the case of plants and plant products, does not feed directly on the commodity
Control (of a pest)	suppression, containment or eradication of a pest population
DAFF	Department of Agriculture, Fisheries and Forestry
DAVAR -NC	Direction des Affaires Vétérinaires Alimentaires et Rurales - New Caledonia
Endangered area	an area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss
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
Establishment	the perpetuation, for the foreseeable future, of a pest within an area after entry
FAO	Food and Agriculture Organization of the United Nations
Fresh	not dried, deep-frozen or otherwise conserved
ICA	Interstate Certification Assurance

ICON	AQIS Import Conditions database
Introduction	entry of a pest resulting in its establishment
IPPC	International Plant Protection Convention, as deposited in 1951 with FAO in Rome and as subsequently amended
IRA	Import Risk Analysis, an administrative process through which quarantine policy is developed or reviewed, incorporating risk assessment, risk management and risk communication
ISPM	International Standard on Phytosanitary Measures
National Plant Protection Organisation	official service established by a government to discharge the functions specified by the IPPC (DAFF is Australia's NPPO)
Non-quarantine pest	pest that is not a quarantine pest for an area
Official	established, authorised or performed by a National Plant Protection Organisation
Official control (of a regulated pest)	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
Pathogen	a parasite able to cause disease in a particular host or range of hosts. Pathogens include bacteria, fungi, nematodes, viroids and viruses
Pathway	the ordered sequence of steps leading to an outcome, or event
PBPM	Plant Biosecurity Policy Memorandum
Pest	any species, strain or biotype of plant, animal, or pathogenic agent, injurious to plants or plant products
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
Pest free area	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
Pest risk analysis	the process of evaluating biological or other scientific evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it

Pest risk assessment (for quarantine pests)	evaluation of the probability of the introduction and spread of a pest and of the associated potential economic consequences
Pest risk management (for quarantine pests)	evaluation and selection of options to reduce the risk of introduction and spread of a pest
Phytosanitary Certificate	certificate patterned after the model certificates of the IPPC
Phytosanitary measure	any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests
PRA area	area in relation to which a pest risk analysis is conducted
QP	Quarantine Proclamation
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
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.
Restricted risk	'Restricted' risk estimates are those derived when risk management measures are used
Spread	expansion of the geographical distribution of a pest within an area
SPS	Sanitary and Phytosanitary
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures
Stakeholders	Government agencies, individuals, community or industry groups or organisations, whether in Australia or overseas, including the proponent/applicant for a specific proposal
Teleomorph	the stage of a fungus characterised by sexual spores (ascospores, basidiospores, etc.)
Unrestricted risk	'Unrestricted' risk estimates are those derived in the complete absence of risk management measures
WTO	World Trade Organization

EXECUTIVE SUMMARY

This import risk analysis (IRA) recommends that fresh Tahitian lime fruit from New Caledonia be allowed entry into Australia subject to phytosanitary measures for fruit flies, citrus scab, mealybugs and little fire ant (as a contaminating pest). These pests require the use of risk management measures, in addition to New Caledonia's standard commercial production practices, to reduce the risk to a very low level to meet Australia's appropriate level of protection (ALOP).

A combination of risk management measures and operational systems will reduce the risk associated with the importation of fresh Tahitian limes from New Caledonia to meet Australia's ALOP, specifically:

- systems approach for fruit flies (*Bactrocera curvipennis*, *B. psidii*, *B. tryoni* and *B. umbrosa*), including specific phytosanitary requirements for fruit flies – certified mature green fruit;
- inspection and remedial action for mealybugs (*Ferrisia virgata* and *Nipaecoccus filamentosus*) and little fire ant (*Wasmannia auropunctata*);
- orchard control of citrus scab (*Sphaceloma fawcettii*); and
- supporting operational systems to maintain and verify phytosanitary status.

Australia initiated an import risk analysis (IRA) for the importation of Tahitian limes from New Caledonia in March 1999, following a request from the New Caledonian Government for market access in May 1996. Biosecurity Australia circulated the technical issues paper in August 2002, the draft IRA report in September 2003 and the revised draft IRA in February 2005. Stakeholder comments were considered and material matters raised have been incorporated into, or addressed in, this final IRA report.

The *Final Import Risk Analysis Report* contains the following:

- Australia's framework for biosecurity policy and import risk analysis, the international framework for trade in plants and plant products, Australia's current policy for importation of fresh Tahitian limes and information on the background to this IRA;
- an outline of the methodology and results of pest categorisation and risk assessment;
- risk management measures;
- final import conditions for Tahitian limes from New Caledonia;
- further steps in the IRA process; and
- a table of stakeholders who commented on the revised draft IRA report and a summary of the issues raised by these stakeholders.

Detailed risk assessments were conducted for the pests that were categorised as quarantine pests, to determine an unrestricted risk estimate for each organism. For those pests for which the unrestricted risk was estimated to be above Australia's ALOP, risk management measures were identified and selected.

Consultation with the Direction des Affaires Vétérinaires Alimentaires et Rurales - New Caledonia (DAVAR-NC), and input from stakeholders on the draft import conditions, has resulted in a set of final risk management measures. Details of these measures, including their objectives, are provided within this final IRA report.

Biosecurity Australia has made a number of changes in the risk analysis following consideration of stakeholder comments on the revised draft IRA report. These changes include:

- Removal of *Tetranychus neocaledonicus* from the risk assessments for quarantine pests. This pest was considered a quarantine pest for Western Australia due to its absence from this State. However, this species has now been recorded in Western Australia, and therefore now only appears in Appendix 1 of this IRA.
- Removal of *Coccus viridis* from the risk assessments for quarantine pests. This pest was considered a quarantine pest for Western Australia due to its absence from this State. However, this species has now been recorded in Western Australia, and therefore now only appears in Appendix 1 of this IRA.
- A reduction in the probability of the distribution of *Sphaceloma fawcettii* from moderate to low in the final IRA report, based on reconsideration of the factors necessary for the production and transfer of conidia from discarded fruit or fruit waste to a susceptible host.

BIOSECURITY FRAMEWORK

INTRODUCTION

This section outlines:

- The legislative basis for Australia's biosecurity regime;
- Australia's international rights and obligations;
- Australia's appropriate level of protection;
- Import Risk Analysis; and
- Policy determination.

AUSTRALIAN LEGISLATION

The *Quarantine Act 1908* and its subordinate legislation, including the *Quarantine Proclamation 1998*, is the legislative basis of human, animal and plant biosecurity in Australia.

Some key provisions are set out below.

Quarantine Act: Scope

Sub section 4 of the *Quarantine Act 1908* defines the scope of quarantine as follows.

In this Act, quarantine includes, but is not limited to, measures:

(a) *for, or in relation to:*

(i) the examination, exclusion, detention, observation, segregation, isolation, protection, treatment and regulation of vessels, installations, human beings, animals, plants or other goods or things; or

(ii) the seizure and destruction of animals, plants, or other goods or things; or

(iii) the destruction of premises comprising buildings or other structures when treatment of these premises is not practicable; and

(b) *having as their object the prevention or control of the introduction, establishment or spread of diseases or pests that will or could cause significant damage to human beings, animals, plants, other aspects of the environment or economic activities.*

Section 5D of the *Quarantine Act 1908* covers the level of quarantine risk.

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

(a) *the probability of:*

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

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

(b) *the probable extent of the harm.*

Section 5D of the *Quarantine Act 1908* includes harm to the environment as a component of the level of quarantine risk. Environment is defined in Section 5 of the *Quarantine Act 1908,* in that it:

> *includes all aspects of the surroundings of human beings, whether natural surroundings or surroundings created by human beings themselves, and whether affecting them as individuals or in social groupings.*

Quarantine Proclamation

The *Quarantine Proclamation 1998* is made under the *Quarantine Act 1908*. It is the principal legal instrument used to control the importation into Australia of goods of quarantine (or biosecurity) interest. The Proclamation empowers a Director of Quarantine to grant a permit to import.

Section 70 of the *Quarantine Proclamation 1998* sets out the matters to be considered when deciding whether to grant a permit to import:

> *Things a Director of Quarantine must take into account when deciding whether to grant a permit for importation into Australia*
>
> *(1) In deciding whether to grant a permit to import a thing into Australia or the Cocos Islands, or for the removal of a thing from the Protected Zone or the Torres Strait Special Quarantine Zone to the rest of Australia, a Director of Quarantine:*
>
> *(a) must consider the level of quarantine risk if the permit were granted; and*
>
> *(b) must consider whether, if the permit were granted, the imposition of conditions on it would be necessary to limit the level of quarantine risk to one that is acceptably low; and*
>
> *(ba) for a permit to import a seed of a kind of plant that was produced by genetic manipulation -- must take into account any risk assessment prepared, and any decision made, in relation to the seed under the Gene Technology Act; and*
>
> *(c) may take into account anything else that he or she knows that is relevant.*

Development of Biosecurity Policy

As can be seen from the above extracts, the legislation establishes the concept of the level of biosecurity (quarantine) risk as the basis of decision-making under Australian quarantine legislation.

Import risk analyses are a significant contribution to the information available to the Director of Animal and Plant Quarantine - a decision maker for the purposes of the Quarantine Proclamation. Import risk analysis is conducted within an administrative process – known as the IRA process (described in the *IRA Handbook*[1]).

The purpose of the IRA process is to deliver a policy recommendation to the Director of Animal and Plant Quarantine that is characterised by sound science, transparency, fairness and consistency. The key elements of the IRA process are covered in “Import Risk Analysis” below.

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[1] Biosecurity Australia (2003) *Import Risk Analysis Handbook*. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra

AUSTRALIA’S INTERNATIONAL RIGHTS AND OBLIGATIONS

It is important that import risk analyses conform with Australia’s rights and obligations as a WTO Member country. These rights and obligations derive principally from the World Trade Organization’s *Agreement on the Application of Sanitary and Phytosanitary Measures* (SPS Agreement), although other WTO agreements may also be relevant. Specific international guidelines on risk analysis developed under the International Plant Protection Convention (IPPC) and by the Office International des Epizooties (OIE) are also relevant.

The SPS Agreement recognises the right of WTO Member countries to determine the level of sanitary and phytosanitary protection they deem appropriate, and to take the necessary measures to achieve that protection. Sanitary (human and animal health) and phytosanitary (plant health) measures typically apply to trade in, or movement of, animal and plant based goods within or between countries. The SPS Agreement applies to measures that may directly or indirectly affect international trade and that protect human, animal or plant life or health from pests and diseases or a Member’s territory from a pest.

The SPS Agreement provides for the following:

- The right of WTO Member countries to determine the level of sanitary and phytosanitary protection (the appropriate level of protection, or ALOP) they deem appropriate;
- An importing Member has the sovereign right to take measures to achieve the level of protection it deems appropriate to protect human, animal or plant life or health within its territory;
- An SPS measure must be based on scientific principles and not be maintained without sufficient scientific evidence;
- An importing Member shall avoid arbitrary or unjustifiable distinctions in levels of protection, if such distinctions result in discrimination or a disguised restriction on international trade;
- An SPS measure must not be more trade restrictive than required to achieve an importing Member’s ALOP, taking into account technical and economic feasibility;
- An SPS measure should be based on an international standard, guideline or recommendation where these exist, unless there is a scientific justification for a measure which results in a higher level of SPS protection to meet the importing Member’s ALOP;
- An SPS measure conforming to an international standard, guideline or recommendation is deemed to be necessary to protect human, animal or plant life or health, and to be consistent with the SPS Agreement;
- Where an international standard, guideline or recommendation does not exist or where, in order to meet an importing Member’s ALOP, a measure needs to provide a higher level of protection than accorded by the relevant international standard, such a measure must be based on a risk assessment; the risk assessment must take into account available scientific evidence and relevant economic factors;
- Where the relevant scientific evidence is insufficient, an importing Member may provisionally adopt SPS measures on the basis of available pertinent information. In such circumstances, Members shall seek to obtain the additional information necessary for a more objective assessment of risk and review the SPS measure accordingly within a reasonable period of time;
- An importing Member shall accept the measures of other countries as equivalent, if it is objectively demonstrated that the measures meet the importing Member’s ALOP.

AUSTRALIA'S APPROPRIATE LEVEL OF PROTECTION (ALOP)

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

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

ALOP can be illustrated using a 'risk estimation matrix' Table 1. The cells of this matrix describe the product of likelihood[2] and consequences — termed 'risk'. When interpreting the risk estimation matrix, it should be remembered that, although the descriptors for each axis are similar ('low', 'moderate', 'high' etc.), the vertical axis refers to *likelihood* and the horizontal axis refers to *consequences*.

Table 1: Risk estimation matrix

Likelihood of entry, establishment or spread	Negligible impact	Very low	Low	Moderate	High	Extreme impact
High likelihood	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 likelihood	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk

Consequences of entry, establishment or spread

The band of cells in Table 1 marked 'very low risk' represents Australia's ALOP, or tolerance of loss.

Risk Management and SPS Measures

Australia's plant and animal health status is maintained through the implementation of measures to facilitate the importation of products while protecting the health of people, animals and plants.

Australia bases its national measures on international standards where they exist and where they deliver the appropriate level of protection from pests and diseases. However, where such standards

[2] The terms "likelihood" and "probability" are synonymous. "Probability" is used in the *Quarantine Act 1908* while "likelihood" is used in the WTO SPS Agreement. These terms are used interchangeably in this IRA Report.

do not achieve Australia's level of biosecurity protection, or relevant standards do not exist, Australia exercises its right under the SPS Agreement to take appropriate measures, justified on scientific grounds and supported by risk analysis.

Australia's approach to addressing requests for imports of animals, plants and their products, where there are biosecurity risks, is, where appropriate, to draw on existing sanitary and phytosanitary measures for similar products with comparable risks. However, where measures for comparable biosecurity risks have not previously been established, further action would be required to assess the risks to Australia and determine the sanitary and phytosanitary measures needed to achieve Australia's ALOP.

IMPORT RISK ANALYSIS

Description

In animal and plant biosecurity, an import risk analysis identifies the pests and diseases relevant to an import proposal, assesses the risks posed by them and, if those risks are unacceptable, specifies the measures that could be taken to reduce those risks to an acceptable level. These analyses are conducted via an administrative process (described in the *IRA Handbook*) that involves, among other things, notification to the WTO, consultation and appeal.

Undertaking IRAs

Biosecurity Australia may undertake an IRA if:

- there is no relevant existing biosecurity measure for the commodity and pest/disease combination; or
- a variation in established policy is desirable because pests or diseases, or the likelihood and/or consequences of entry, establishment or spread of the pests or diseases could differ significantly from those previously assessed.

Environment and human health

When undertaking an import risk analysis, Biosecurity Australia takes into account harm to the environment as part of its assessment of biosecurity risks associated with the potential import.

Under the *Environment Protection and Biodiversity Conservation Act 1999*, Environment Australia may assess proposals for the importation of live specimens and their reproductive material. Such an assessment may be used or referred to by Biosecurity Australia in its analyses.

Biosecurity Australia also consults with other Commonwealth agencies where they have responsibilities relevant to the subject matter of the IRA (e.g. Food Standards Australia New Zealand (FSANZ) and the Department of Health and Ageing).

The IRA process in summary

The process consists of the following major steps:

***Initiation*:** This is the stage where the identified need for an IRA originates.

***Scheduling and Scoping*:** At this stage, Biosecurity Australia considers all the factors that affect scheduling. Consultation with States, Territories and other Commonwealth agencies is involved. There is opportunity for appeal by stakeholders at this stage.

***Risk Assessment and Risk Management*:** Here, the major scientific and technical work relating to risk assessment is performed. There is detailed consultation with stakeholders.

***Reporting*:** Here, the results of the IRA are communicated formally. There is consultation with States and Territories. The Interim Chief Executive of Biosecurity Australia then delivers the biosecurity policy recommendation arising from the IRA to the Director of Animal and Plant Quarantine. There is opportunity for appeal by stakeholders at this stage.

POLICY DETERMINATION

The Director of Animal and Plant Quarantine makes the policy determination, which is notified publicly.

METHOD FOR PEST RISK ANALYSIS

The technical component of an IRA for plants or plant products is termed a ‘pest risk analysis’, or PRA. Biosecurity Australia conducts PRA’s in accordance with the International Standards for Phytosanitary Measures Publication Number 11 *Pest Risk Analysis for Quarantine Pests including analysis of environmental risks* (ISPM 11). A summary of the requirements of ISPM 11 is given in this section plus descriptions of the methodology used to meet these requirements in this IRA. This summary is given to provide a description of the methodology used for this IRA and to provide a context for the technical information that is provided later in this document.

A PRA comprises three discrete stages:

- Stage 1: initiation of the PRA
- Stage 2: pest risk assessment
- Stage 3: pest risk management.

The *initiation* of a risk analysis involves the identification of the pest(s) and pathway(s) of concern that should be considered for analysis. *Risk assessment* comprises pest categorisation, assessment of the probability of introduction and spread, and assessment of the potential economic consequences (including environmental impacts). *Risk management* describes the evaluation and selection of options to reduce the risk of introduction and spread of a pest.

STAGE 1: INITIATION OF THE PRA

This PRA was initiated in March 1999 by the market access request from Direction des Affaires Vétérinaires Alimentaires et Rurales - New Caledonia (DAVAR - NC) in May 1996 to export commercially produced fresh Tahitian lime fruit from New Caledonia into Australia for human consumption.

The aim of the initiation stage is to identify the pest(s) and pathway(s) (e.g. commodity imports) that are of quarantine concern and should be considered for risk analysis in relation to the identified PRA area.

The “PRA area” is defined in this PRA as Australia or in the case of regional quarantine pests the “PRA area” is defined as the area of Australia that has regional freedom from the pest. The “endangered area” is defined as any area within Australia, where susceptible hosts are present, and in which ecological factors favour the establishment of a pest that might be introduced in association with Tahitian lime fruit from New Caledonia.

STAGE 2: PEST RISK ASSESSMENT

Risk assessment describes the process of identifying pests of biosecurity concern, and estimating the risk (the probability of entry, establishment or spread, and the magnitude of the potential consequences) associated with each.

This pest risk assessment was carried out in accordance with IPPC standards and reported in the following steps:

- pest categorisation;

- assessment of probability of entry, establishment or spread; and
- assessment of potential consequences (including environmental impacts).

Pest risk assessment needs to be only as complex as is technically justified by the circumstances. ISPM 11 allows a specific PRA to be judged against the principles of necessity, minimal impact, transparency, equivalence, risk analysis, managed risk and non-discrimination.

Pest categorisation

Pest categorisation is a process to examine, for each pest, whether the criteria for a quarantine pest are satisfied. That is, whether the pests identified in Stage 1 (Initiation of the PRA) are 'quarantine pests' or not.

As stated in ISPM 11, 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. An 'endangered area' is an area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss. Under IPPC and FAO terminology, 'official control' means the active enforcement of mandatory phytosanitary procedures with the objective of eradication or containment of quarantine pests or the management of regulated non-quarantine pests.

On the basis of these definitions, the process of pest categorisation is summarised by the IPPC in the five elements outlined below:

- *Identity of the pest*. The identity of the pest should be clearly defined to ensure that the assessment is being performed on a distinct organism, and that biological and other information used in the assessment is relevant to the organism in question. If this is not possible because the causal agent of particular symptoms has not yet been fully identified, then it should have been shown to produce consistent symptoms and to be transmissible.

  The taxonomic unit for the pest is generally a species. The use of a higher or lower taxonomic level should be supported by a scientifically sound rationale. For levels below the species, this should include evidence demonstrating that factors such as differences in virulence, host range or vector relationships are significant enough to affect phytosanitary status.

  Where a vector is involved, the vector may also be considered a pest to the extent that it is associated with the causal organism and is required for transmission of the pest.

- *Presence or absence in the endangered area*. The pest should be absent from all or part of the endangered area.

- *Regulatory status*. If the pest is present but not widely distributed in the PRA area, it should be under official control or be expected to be under official control in the near future.

- *Potential for establishment and spread in the PRA area*. Evidence should be available to support the conclusion that the pest could become established or spread in the PRA area. The PRA area should have ecological/climatic conditions, including those in protected conditions, suitable for the establishment and spread of the pest. Where relevant, host species (or near relatives), alternate hosts and vectors should be present in the PRA area.

- *Potential for economic consequences in the endangered area*. There should be clear indication that the pest is likely to have an unacceptable economic impact (including environmental impact) in the PRA area.

Pest categorisation was conducted in two stages for this IRA.

- A list of pests of Tahitian limes for New Caledonia was categorised according to the presence or absence of each pest in Australia (or regions within Australia) and the association of each pest with mature Tahitian lime fruit. This stage of the categorisation was released in the *Technical Issues Paper: Import Risk Analysis (IRA) for the Importation of Tahitian limes from New Caledonia* in August 2002.
- The second stage of pest categorisation was documented in the draft IRA report, released in September 2003 and the revised draft IRA report, released in February 2005. This stage was based on the categorisation of each pest absent from Australia or clearly defined regions within Australia and associated with Tahitian lime fruit according to (a) its potential to become established or spread in Australia, and, (b) the potential for economic consequences. Categorisation of establishment or spread potential and potential for economic consequences was dichotomous, and expressed using the terms 'feasible' / 'not feasible', and 'significant' / 'not significant', respectively.

This final IRA report presents the results of the risk assessment and risk management measures for those pests determined to be above Australia's ALOP.

Assessment of the probability of entry, establishment or spread

Details on assessing the 'probability of entry', 'probability of establishment' and 'probability of spread after establishment' of a pest are given in ISPM 11. A synopsis of these details is given below, followed by a description of the qualitative methodology used in this IRA.

Probability of entry

The 'probability of entry' describes the probability that a quarantine pest will enter Australia as a result of trade in a given commodity, be distributed in a viable state to an endangered area and subsequently be transferred to a suitable host.

Steps identified in ISPM 11 relevant to PRA initiated by a pathway are:

- *Probability of the pest being associated with the pathway at origin* – e.g. prevalence in the source area, occurrence of life stages that would be associated with the commodity, volume and frequency of movement along the pathway, seasonal timing, pests management, cultural and commercial procedures applied at the place of origin;
- *Probability of survival during transport or storage* – e.g. speed and conditions of transport and duration of the lifecycle, vulnerability of the life-stages during transport or storage, prevalence of the pest, effects of commercial procedures applied;
- *Probability of pest surviving existing pest management procedures*; and
- *Probability of transfer to a suitable host* – e.g. dispersal mechanisms, whether the imported commodity is sent to few or many destination points in the PRA area, time of year at which import takes place, intended use of the commodity, risks from by-products and waste.

The probability of entry may be divided for administrative purposes into the following components:

- **The probability of importation**: the probability that a pest will arrive in Australia when a given commodity is imported; and

- **The probability of distribution**: the probability that the pest will be distributed (as a result of the processing, sale or disposal of the commodity) to the endangered area, and subsequently be transferred to a suitable site on a susceptible host.

In breaking down the probability of entry into these two components, Biosecurity Australia has not altered the original meaning. The two components have been identified and separated to enable onshore and offshore pathways to be described individually.

The probability of importation and the probability of distribution are obtained from pathway scenarios depicting necessary steps in: the sourcing of the commodity for export; its processing, transport and storage; its utilisation in Australia; and the generation and disposal of waste.

Probability of establishment

In order to estimate the probability of establishment of a pest, reliable biological information (life cycle, host range, epidemiology, survival, etc) should be obtained from the areas where the pest currently occurs. The situation in the PRA area can then be compared with that in the areas where it currently occurs and expert judgement used to assess the probability of establishment. Examples provided in ISPM 11 of factors to consider are:

- Availability, quantity and distribution of hosts in the PRA area;
- Environmental suitability in the PRA area;
- Potential for adaptation of the pest;
- Reproductive strategy of the pest;
- Method of pest survival; and
- Cultural practices and control measures.

Probability of spread after establishment

In order to estimate the probability of spread of the pest, reliable biological information should be obtained from areas where the pest currently occurs. The situation in the PRA area can then be carefully compared with that in the areas where the pest currently occurs and expert judgement used to assess the probability of spread. Examples provided in ISPM 11 of factors to consider are:

- Suitability of the natural and/or managed environment for natural spread of the pest;
- Presence of natural barriers;
- The potential for movement with commodities or conveyances;
- Intended use of the commodity;
- Potential vectors of the pest in the PRA area; and
- Potential natural enemies of the pest in the PRA area.

Method for evaluating the probability of entry, establishment or spread

Evaluation and reporting of likelihoods can be done qualitatively, semi-quantitatively or quantitatively. For qualitative evaluation, likelihoods assigned to steps in the scenarios are categorised according to a descriptive scale – e.g. ‘low’, ‘moderate’, ‘high’ etc. – where no attempt has been made to equate descriptors with numeric values or scores. For semi-quantitative evaluation, likelihoods are given numeric ‘scores’ (eg. 1, 2, 3), or probabilities and/or probability intervals (e.g. 0–0.0001, 0.0001–0.001, 0.001-0.01, 0.01-1). For quantitative evaluation, likelihoods are described in purely numeric terms.

Each of these three approaches to likelihood evaluation has its advantages and constraints and the choice of approach depends on both technical and practical considerations. For this IRA, likelihood was evaluated and reported qualitatively using the terms described in Table 2.

Table 2: Nomenclature for qualitative likelihoods

Likelihood	Descriptive definition
High	The event would be very likely to occur
Moderate	The event would occur with an even probability
Low	The event would be unlikely to occur
Very low	The event would be very unlikely to occur
Extremely low	The event would be extremely unlikely to occur
Negligible	The event would almost certainly not occur

Qualitative likelihoods can be assigned to individual steps or to the probability that all the steps will occur. If the likelihoods have been assigned to individual steps then some form of 'combination rule' is needed for calculating the probability that all steps will occur. For this IRA, the likelihoods were combined using a tabular matrix, as shown in Table 3.

Table 3: Matrix of rules for combining descriptive likelihoods

	High	Moderate	Low	V. Low	E. Low	Negligible
High	High	Moderate	Low	V. Low	E. Low	Negligible
Moderate		Low	Low	V. Low	E. Low	Negligible
Low			V. Low	V. Low	E. Low	Negligible
Very low				E. Low	E. Low	Negligible
E. low					Negligible	Negligible
Negligible						Negligible

In this IRA, qualitative likelihoods were assigned to the probability of entry (comprising an importation step and a distribution step), the probability of establishment and the probability of spread. In other IRAs, it may be considered relevant to assign qualitative likelihoods to additional steps. This would depend on the complexity of the issue and the information that was available. For example, within the importation step, separate qualitative likelihoods could be assigned to the probabilities that source fruit is infested, that the pest survives packinghouse procedures and that it survives storage and transport.

The procedure for combining likelihoods is illustrated in Table 4. The example assigns hypothetical values to the probability of importation (low) and the probability of distribution (moderate), which are then combined to give a probability of entry (low). The likelihoods are combined using the 'rules' provided in Table 3. The probability of entry is then combined with hypothetical likelihoods assigned to the probability of establishment (high) and probability of spread (very low) to give the overall probability of entry, establishment or spread (very low).

Table 4: Qualitative evaluation of the imported fruit scenario

Step	Qualitative descriptor		Product of likelihoods
Probability of importation	Low		
Probability of distribution	Moderate		
➔ Probability of entry		➔	Low
Probability of establishment	High	➔	Low
Probability of spread	Very low		
➔ Probability of entry, establishment or spread		➔	Very low

Assessment of consequences

The basic requirements for the assessment of consequences are described in the SPS Agreement, with Article 5.3 stating that:

"Members shall take into account as relevant economic factors: the potential damage in terms of loss of production or sales in the event of the entry, establishment or spread of a pest or disease; the costs of control or eradication in the territory of the importing Member; and the relative cost-effectiveness of alternative approaches to limiting risks"

Assessment of consequences is also referred to in Annex A of the SPS Agreement in the definition of risk assessment:

"The evaluation of the likelihood of entry, establishment or spread of a pest or disease within the Territory of an importing Member according to the sanitary or phytosanitary measures which might be applied, and of the associated potential biological and economic consequences"

Further detail on assessing these "relevant economic factors" or "associated potential biological and economic consequences" for plant-based analysis is given under the "potential economic consequences" section in ISPM 11. This ISPM separates the consequences into "direct" and "indirect" and provides examples of factors to consider within each. These examples are listed below under the headings where they may be considered in an IRA. This is followed by a description of the methodology used in this IRA.

In this IRA, the term "consequence" is used to reflect the "relevant economic factors", "associated potential biological and economic consequences" and "potential economic consequences" terms as used in the SPS Agreement and ISPM 11 respectively.

Direct pest effects

Plant life or health

ISPM 11 provides the following examples that could be considered for the direct consequences on plant life or health:

- Known or potential host plants;
- Types, amount and frequency of damage;
- Crop losses, in yield and quality;
- Biotic factors (e.g. adaptability and virulence of the pest) affecting damage and losses;
- Abiotic factors (e.g. climate) affecting damage and losses;
- Rate of spread;
- Rate of reproduction;
- Control measures (including existing measures), their efficacy and cost;
- Effect of existing production practices; and
- Environmental effects.

Any other aspects of the environment

ISPM 11 provides the following examples that could be considered for the direct consequences on any other aspects of the environment:

- Environmental effects (*listed as a general example in ISPM 11*);
- Reduction of keystone plant species;
- Reduction of plant species that are major components of ecosystems (in terms of abundance or size), and endangered native plant species (including effects below species level where there is evidence of such effects being significant); and
- Significant reduction, displacement or elimination of other plant species.

Indirect pest effects

Eradication, control, etc.

ISPM 11 provides the following examples that could be considered for the indirect consequences on eradication, control, etc.:

- Changes to producer costs or input demands, including control costs;
- Feasibility and cost of eradication or containment;
- Capacity to act as a vector for other pests; and
- Resources needed for additional research and advice.

Domestic trade and International trade

ISPM 11 provides the following examples that could be considered for the indirect consequences on domestic and international trade (the two are considered separately):

- Effects on domestic and export markets, including particular effects on export market access; and
- Changes to domestic or foreign consumer demand for a product resulting from quality changes.

Environment

ISPM 11 provides the following examples that could be considered for the indirect consequences on the environment:

- Environmental and other undesired effects of control measures;
- Social and other effects (e.g. tourism);
- Significant effects on plant communities;
- Significant effects on designated environmentally sensitive or protected areas;
- Significant change in ecological processes and the structure, stability or processes of an ecosystem (including further effects on plant species, erosion, water table changes, increased fire hazard, nutrient cycling, etc.);
- Effects on human use (e.g. water quality, recreational uses, tourism, animal grazing, hunting, fishing); and
- Costs of environmental restoration.

Method for assessing consequences in this IRA

The relevant examples of direct and indirect consequences from ISPM 11 are considered for each of the broad groups (as listed above) and estimates of the consequences are assigned. The broad groups are shown in table form in the 'Risk Assessments for Quarantine Pests' section of this document.

The direct and indirect consequences were estimated based on four geographic levels. The terms 'local', 'district', 'regional' and 'national' are defined as:

Local: an aggregate of households or enterprises — e.g. 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, such as the 'North West Slopes and Plains' or 'Far North Queensland'.

Region: a geographically or geopolitically associated collection of districts — generally a State, although there may be exceptions with larger States such as Western Australia.

National: Australia-wide.

The consequence was described as 'unlikely to be discernible', of 'minor significance', 'significant' or 'highly significant':

- an '*unlikely to be discernible*' consequence is not usually distinguishable from normal day-to-day variation in the criterion
- a consequence of '*minor significance*' is not expected to threaten economic viability, but would lead to a minor increase in mortality/morbidity or a minor decrease in production. For non-commercial factors, the consequence is not expected to threaten the intrinsic 'value' of

the criterion — though the value of the criterion would be considered as 'disturbed'. Effects would generally be reversible.

- a '*significant*' consequence would threaten economic viability through a moderate increase in mortality/morbidity, or a moderate decrease in production. For non-commercial factors, the intrinsic 'value' of the criterion would be considered as significantly diminished or threatened. Effects may not be reversible.
- a '*highly significant*' consequence would threaten economic viability through a large increase in mortality/morbidity, or a large decrease in production. For non-commercial factors, the intrinsic 'value' of the criterion would be considered as severely or irreversibly damaged.

The values were translated into a qualitative score (A–F) using the schema outlined in Table 5.

Table 5: The assessment of local, district, regional and national consequences

Impact score	Local	District	Regional	National
F	-	-	-	Highly significant
E	-	-	Highly significant	Significant
D	-	Highly significant	Significant	Minor
C	Highly significant	Significant	Minor	Unlikely to be discernible
B	Significant	Minor	Unlikely to be discernible	Unlikely to be discernible
A	Minor	Unlikely to be discernible	Unlikely to be discernible	Unlikely to be discernible

Level

The overall consequence for each pest was achieved by combining the impact scores (A–F) for each direct and indirect consequence using a series of decision rules. These rules are mutually exclusive, and are addressed in the order that they appeared in the list — for example, if the first rule does not apply, the second rule is considered. If the second rule does not apply, the third rule is considered and so on until one of the rules applies:

- Where the impact score of a pest with respect to any direct or indirect criterion is 'F', the overall consequences are considered to be 'extreme'.
- Where the impact scores of a pest with respect to more than one criterion are 'E', the overall consequences are considered to be 'extreme'.
- Where the impact score of a pest with respect to a single criterion is 'E' and the impact scores of a pest with respect to each remaining criterion are 'D', the overall consequences are considered to be 'extreme'.
- Where the impact score of a pest with respect to a single criterion is 'E' and the impact scores of a pest with respect to remaining criteria is not unanimously 'D', the overall consequences are considered to be 'high'.
- Where the impact scores of a pest with respect to all criteria are 'D', the overall consequences are considered to be 'high'.
- Where the impact score of a pest with respect to one or more criteria is 'D', the overall consequences are considered to be 'moderate'.

- Where the impact scores of a pest with respect to all criteria are ‘C’, the overall consequences are considered to be ‘moderate’.
- Where the impact score of a pest with respect to one or more criteria is considered ‘C’, the overall consequences are considered to be ‘low’.
- Where the impact scores of a pest with respect to all criteria are ‘B’, the overall consequences are considered to be ‘low’.
- Where the impact score of a pest with respect to one or more criteria is considered ‘B’, the overall consequences are considered to be ‘very low’.
- Where the impact scores of a pest with respect to all criteria are ‘A’, the overall consequences are considered to be ‘negligible’.

Method for determining the unrestricted risk estimate

The unrestricted risk estimate for each pest is determined by combining the likelihood estimates of entry, of establishment and of spread with the overall expected consequences, using a risk estimation matrix (Table 1). The unrestricted risk is then compared with Australia’s ALOP to determine the need for appropriate risk management measures. Australia’s ALOP is represented in this matrix by the row of cells marked ‘very low risk’.

STAGE 3: PEST RISK MANAGEMENT

Risk management describes the process of identifying and implementing measures to manage risks so as to achieve Australia’s appropriate level of protection, or tolerance for loss, while ensuring that any negative effects on trade are minimised.

To implement risk management appropriately, it is necessary to formalise the difference between ‘unrestricted’ and ‘restricted’ risk estimates. Unrestricted risk estimates are those derived in the absence of specific risk management measures, or following only internationally accepted baseline risk management procedures. By contrast, restricted or mitigated risk estimates are those derived when ‘risk management’ is applied. In the case of this IRA Report, unrestricted risk is the risk associated with fruit produced to the standard achieved through normal practices of production, quality control, packing, transport and shipment from the specified areas, as described in documentation provided by DAVAR-NC.

The conclusions from pest risk assessment are used to decide whether risk management is required and if so, the strength of measures to be used. Since zero-risk is not a reasonable option, the guiding principle for risk management is to manage risk to reduce the risk to, or below, an acceptable level that can be justified and is feasible within the limits of available options and resources.

The unrestricted risk estimate is determined by the examination of the outputs of the assessments of the probability of entry, establishment or spread and the consequence. If the risk is found to be unacceptable, then the first step in risk management is to identify possible phytosanitary measures that will reduce the risk to, or below, an acceptable level.

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

Examples given of measures commonly applied to traded commodities include:

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

The result of the pest risk management procedure will be either that no measures are identified which are considered appropriate or the selection of one or more management options that have been found to lower the risk associated with the pest(s) to an acceptable level. These management options form the basis of phytosanitary regulations or requirements.

Method for pest risk management in this IRA

The requirement for risk management is determined by comparing the unrestricted risk estimate for each pest with Australia’s ALOP. Where the estimate of unrestricted risk does not exceed Australia’s ALOP, risk management is not required. Where the unrestricted risk estimate exceeds Australia’s ALOP, risk management measures are required to reduce the risk to an acceptable level.

Using the risk estimation matrix, risk management measures are required when the unrestricted risk estimate is low, moderate, high or extreme. Risk management measures are not required when the unrestricted risk estimate is very low or negligible.

Risk management measures were identified for each pest as required and are presented in the Risk Management section of this document. The proposed phytosanitary regulations based on these measures are presented in the Import Conditions section of this document.

PROPOSAL TO IMPORT TAHITIAN LIMES FROM NEW CALEDONIA

BACKGROUND

AQIS received an application from DAVAR-NC in May 1996 seeking access for Tahitian limes to Australia. In response to this application, AQIS requested further technical information from DAVAR-NC. DAVAR-NC responded to AQIS's request and provided various technical submissions between 1996 and 1999. This information included pests and diseases recorded as being associated with Tahitian limes and statistics on the citrus industry in New Caledonia.

The full report of non-host status studies of four economic fruit fly species on Tahitian limes conducted by New Caledonian authorities (Sales & Paulaud, 1995) was provided to AQIS in 1999. The methodology of the non-host status studies followed the procedures described in New Zealand National Agriculture Security Service (NASS) Standard 155.02.01.08 "Specification for Determination of Fruit Fly Host Status as a Treatment" (Anon., 1991a).

Stakeholders were advised in March 1999 of the commencement of an IRA for Tahitian limes from New Caledonia. Further information on the integrated pest management schedule recommended to export lime growers in New Caledonia was submitted to AQIS in September 1999.

Changes to the internal structure of DAFF resulted in the formation of Biosecurity Australia on 6 October 2000. Biosecurity Australia is responsible for the IRA function that was formerly the responsibility of AQIS.

The technical issues paper (TIP) for this IRA, notified in Plant Biosecurity Policy Memorandum (PBPM) 2002/38, was released for stakeholder comment on 26 August 2002. The TIP included background to the IRA and preliminary results of pest categorisation. Biosecurity Australia received comments from five stakeholders on the TIP, which were considered and material matters raised were incorporated into, or addressed in, the draft IRA report.

The draft IRA report, notified in PBPM 2003/28, was released for stakeholder comment on 23 September 2003. The draft IRA report included the pest categorisation, the pest risk analysis for quarantine pests, the proposed risk management measures and the draft import conditions for this IRA. Biosecurity Australia received comments from five stakeholders on the draft IRA report.

A revised draft IRA report, notified in 2005/05, was released for stakeholder comment on 1 March 2005. This met the Australian Government's 2004 election commitment that all IRAs currently in progress would be reviewed and reissued for stakeholder consultation and comment, to further emphasise the rigour and transparency of Australia's science based quarantine policy. Stakeholder comments on the draft IRA report were considered and material matters raised were incorporated into, or addressed in, the revised draft IRA report.

Biosecurity Australia received comments from four stakeholders on the revised draft IRA report within the comment period. These comments were considered and material matters raised have been incorporated into, or addressed in, this final IRA report. The Eminent Scientists Group (ESG) has considered Biosecurity Australia's responses to these stakeholders' comments and provided its report to the Director of Animal and Plant Quarantine, with a copy to the Chief Executive of Biosecurity Australia. The recommendations of the ESG have been incorporated into the final IRA report where appropriate.

Biosecurity Australia responded to comments on the revised draft IRA report, received from DAVAR-NC on the 21 November 2005, outside the formal consultation process.

ADMINISTRATION

Timetable

The section “Further steps in the Import Risk Analysis process” presented later in this report lists the steps for completion of this IRA.

Scope

This IRA considers quarantine risks that may be associated with the importation of fresh Tahitian limes from New Caledonia into Australia for human consumption and provides management measures where relevant, to reduce the risks to an acceptable level. In this IRA, fresh Tahitian limes are defined as the harvested individual fresh fruits of *Citrus latifolia* Tanaka with all vegetative parts removed and that have been cultivated, harvested, packed and transported to Australia under standard commercial conditions.

Contaminating pests

In addition to potential pests directly associated with Tahitian limes in New Caledonia, there are other organisms that may be carried by the fruit (present on the import pathway). Biosecurity Australia considers these as contaminating pests, which can pose quarantine risks. These risks are addressed for most contaminating pests by AQIS’s standard inspection procedures. For this IRA, Biosecurity Australia categorised and assessed the little fire ant as a contaminating pest in the same way as pests directly associated with the fruit.

AUSTRALIA’S CURRENT QUARANTINE POLICY FOR IMPORTS OF FRESH TAHITIAN LIMES

The Commonwealth Government is responsible for regulating the movement of plants and plant products into and out of Australia. However, the State and Territory governments are primarily responsible for plant health controls within Australia. 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.

International policy

Currently, Australia allows the importation of fresh limes of: *C. latifolia* (Tahitian lime), *C. aurantifolia* (West Indian lime), *C. hysterix* (Kaffir lime) and *C. limonia* (Rangpur lime) from New Zealand, Spain and the USA (Arizona, California and Texas only). *Citrus latifolia* and *C. aurantifolia* are permitted from Egypt.

Further details of the import requirements for limes are available at the AQIS website: http://www.aqis.gov.au/icon

Domestic arrangements

The Interstate Certification Assurance (ICA) scheme (http://www.dpi.qld.gov.au/health/4145.html) facilitates interstate trade in plants and plant products in Australia. It recognises pest free areas within Australia and ensures produce entering such areas is free of specific pests of quarantine concern. The scheme is accepted by all Australian States and the Northern Territory and is based on documented operational procedures developed by interstate quarantine authorities in conjunction with industry. It provides a harmonised approach to the audit and accreditation of businesses throughout Australia and the mutual recognition of Plant Health Assurance Certificates accompanying consignments of produce moving within or between States and Territories. Interstate quarantine authorities maintain the right to inspect certified produce at any time and to refuse to accept a certificate where produce is found not to conform to specific requirements.

States and Territories within Australia have accepted ICA arrangements for domestic trade of horticultural commodities that are susceptible to Queensland fruit fly infestation. Tahitian limes produced in Queensland fruit fly infestation areas are allowed movement interstate under ICA-15: "*Mature green condition of passion fruit, Tahitian limes and black sapotes*". Tahitian lime fruit certified for the "*mature green condition*" under this quarantine policy needs to comply with two requirements: mature green and unbroken skin.

Mature green fruit has skin free from yellow colouring.

Unbroken skin the skin has no pre-harvest crack, puncture, pulled stem or other break that penetrates through to the flesh and has not healed with callus tissue.

THE TAHITIAN LIME INDUSTRY IN NEW CALEDONIA

Tahitian limes are produced in New Caledonia using in-field treatments for pests and diseases (including citrus scab) and post harvest cleaning and grading processes. The in-field control treatments are set out in Figure 1: Pest and disease control program of Tahitian limes in New Caledonia. The post harvest processes of Tahitian limes are set out in Figure 2: Post harvest processing of Tahitian limes for export.

Figure 1: Pest and disease control program of Tahitian limes in New Caledonia

	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Treatment	
Crop cycle	Pruning	Vegetative development			Main flowering and fruit set		Fruit growth			Main harvesting			**Target**	**Active ingredient**
Pest and disease control program	**x**	**x**		**x**		**x**		**x**		**x**	**x**	**x**	- mealy bugs - scales - scab	Petroleum oil + Copper oxide (20 %)
					x		**x**		**x**				- mites - scab	Petroleum oil + Mancozèbe 75 %
									x	**x**	**x**	**x**	- fruit flies	protein hydrolysate + chlorpyrifos
									spot treatment on each tree					
								(x)		**(x)**		**(x)**	- cicadas - crusader bugs (*Myctis profana*)	Deltamethrine 2.75 %
		(x)		**(x)**									- phytophthora	Phosphoric acid

x : periodic treatment

(x) : prompt treatment as necessary

(x) : used by few growers

Figure 2: Post-harvest processing of Tahitian limes for export

Receipt of product

Identifying the product with the grower's identity number

Bathing in bicarbonate of soda solution (1% concentration)

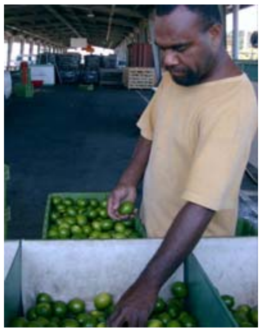
Sorting: oleocellosis, stylar end rot, scab and any other pest damage ⇒ product removed

Brushing and waxing (citrus wax)

Drying

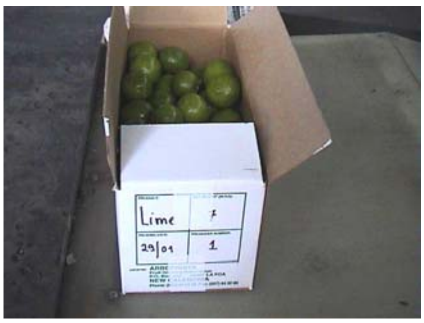
Grading (diameter size)
Small: 45 – 55 mm
Medium: 55 – 60 mm
Large: > 60 mm

All of these steps are done on a citrus processing line



Packing in cartons

Weighing (9 kg net weight) and carton labelling (size, producer's number)



Phytosanitary inspection by SIVAP inspectors

Fumigation (if necessary)

Storing the product at 10°C ready for shipment

Additional monthly treatments are performed in the packinghouse to ensure the area is free of insects. Fruit-flies and ants are especially targetted.

PEST CATEGORISATION

The quarantine pests for Tahitian limes from New Caledonia have been determined through a comparison of the pests recorded on limes in New Caledonia and Australia (present or absent, or present but with restricted/limited distribution and under official control [Appendix 1]), presence on the pathway under consideration [Appendix 2], and potential for establishment or spread and potential for consequences [Appendix 3]. A number of pests are present in Australia but absent from Western Australia (based on advice provided to Biosecurity Australia by the Department of Agriculture Western Australia) and these pests are considered further in this IRA. Pests that do not meet the definition of a quarantine pest are not considered further in the PRA. Plant pests (weeds) were not considered to be potential pests for orchard crops of Tahitian lime as the structure of the fruit is not a receptacle for weed seeds.

The quarantine pests for Tahitian limes from New Caledonia, determined through this process of pest categorisation, are listed in Table 6. These pests require detailed risk assessment since they meet the IPPC criteria for a quarantine pest, specifically:

- the pest is known to be associated with Tahitian limes in New Caledonia;
- the pest is absent from Australia, or has a limited distribution and is under official control;
- the pest has the potential to be on the pathway;
- the pest has the potential for establishment or spread in Australia; and
- the pest has the potential for consequences.

The detailed risk assessments for these quarantine pests are provided in the next section. Information on quarantine pests is provided in Appendix 4 (datasheets) and the risk assessment section.

Table 6: Quarantine pests of Tahitian limes from New Caledonia

Scientific name	Common name
ARTHROPODS	
Diptera (flies)	
Bactrocera curvipennis (Froggatt) [Diptera: Tephritidae]	banana fruit fly
Bactrocera psidii (Froggatt) [Diptera: Tephritidae]	South Sea guava fruit fly
Bactrocera tryoni (Froggatt) [Diptera: Tephritidae]	Queensland fruit fly
Bactrocera umbrosa (Fabricius) [Diptera: Tephritidae]	breadfruit fly
Hemiptera (scales, mealybugs)	
**Ferrisia virgata* (Cockerell) [Hemiptera: Pseudococcidae]	striped mealybug
**Lepidosaphes gloverii* (Packard) [Hemiptera: Diaspididae]	glover scale
Lopholeucaspis cockerelli (Grandpré & Charmoy) [Hemiptera: Diaspididae]	diaspine scale
**Morganella longispina* (Morgan) [Hemiptera: Diaspididae]	plumose scale
Nipaecoccus filamentosus (Cockerell) [Hemiptera: Pseudococcidae]	mealybug
Parlatoria cinerea Deane & Hadden [Hemiptera: Diaspididae]	tropical grey chaff scale
**Pinnaspis aspidistrae* (Signoret) [Hemiptera: Diaspididae]	fern scale
**Pseudaonidia trilobitiformis* (Green) [Hemiptera: Diaspididae]	trilobite scale
**Unaspis citri* Comstock [Hemiptera: Diaspididae]	citrus snow scale
Hymenoptera (ants)	
Wasmannia auropunctata (Roger) [Hymenoptera: Formicidae]	little fire ant
PATHOGENS	
Fungi	
Sphaceloma fawcettii Jenkins	citrus scab
Meliola citricola Syd. & P. Syd.	black mildew

*WA only – this species is a quarantine pest for the State of Western Australia due to its absence from this State

RISK ASSESSMENTS FOR QUARANTINE PESTS

A detailed risk assessment is presented in this PRA for each of the quarantine pests identified through the process of pest categorisation. Each risk assessment involved the "assessment of the probability of entry, establishment or spread" and "assessment of consequences" as described in the Section titled "Method for Pest Risk Analysis". The unrestricted risk posed by each quarantine pest for Tahitian limes from New Caledonia was estimated by combining the probabilities of entry, of establishment and of spread with the estimate of associated potential consequences. The unrestricted risk estimates were then compared with Australia's appropriate level of protection (ALOP) to determine which quarantine pests presented an unacceptable level of risk requiring consideration of risk mitigation options.

Probability estimates of entry, of establishment and of spread and estimates of associated potential consequences are supported by relevant biological information. Due to similarities in pest biology, and consequent similarities between the risk assessments for some of the pests, the descriptions below are based, where relevant, on groupings of the pests. Detailed information on the biology and economic importance of each quarantine pest or pest group is provided in the datasheets in Appendix 4 of this IRA.

The risk assessments were conducted on the basis of standard cultivation, harvesting and packing activities involved in the commercial production of Tahitian lime fruit in New Caledonia. These activities include in-field treatment of pests and post-harvest treatment of fungal diseases.

FRUIT FLIES

Bactrocera curvipennis (Froggatt) (banana fruit fly), *B. psidii* (Froggatt) (South Sea guava fruit fly), *B. tryoni* (Froggatt) (Queensland fruit fly) and *B. umbrosa* (Fabricius) (breadfruit fly).

Introduction and spread probability

Probability of importation

The likelihood that fruit flies will arrive in Australia with the importation of fresh Tahitian limes from New Caledonia: **Moderate**.

Infestation of limes is generally lower than for other tropical fruits (Hennessey *et al*., 1992).

When a fruit fly oviposits in citrus fruit, tissue around the oviposited puncture grows as a protuberance, or a sting may turn brown after a few days or the rind around a sting may turn yellow making it easy to identify the attacked fruits (Yang, 1991). Fruit in this condition is likely to be detected. However, a new sting caused by a recent infestation may not be easily seen, therefore the efficacy of detecting fruit fly infested fruit can be lower than for other insects.

Probability of distribution

The likelihood that fruit flies will be distributed to the endangered area as a result of the processing, sale or disposal of Tahitian lime fruit from New Caledonia: **Moderate**.

There is a high probability of fruit fly larvae surviving shipment due to their ability to tolerate cold temperatures and the availability of an ample food supply. Some fruit fly larvae may survive the cold storage temperature of 1± 0.5°C for up to 16 days (Hill *et al*., 1988). Adult flies cannot survive more than a few days without feeding.

The commodity may be distributed throughout Australia for retail sale. The intended use of the commodity is human consumption, however waste material would be generated.

Eggs laid in fruit prior to harvest may hatch and produce viable larvae within stored fruit, fruit at the point of sale or fruit that has been purchased. Larvae may then develop into adult flies, which are able to move directly from fruit into the environment.

Wholesalers, retailers or consumers discard fruit with spoiled flesh or visible larvae. Larvae would then complete their development within the discarded fruit and move into the environment.

Probability of entry

The likelihood that fruit flies will arrive in Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, and be distributed to the endangered area: **Low**.

The overall probability of entry is determined by combining the likelihoods of importation and of distribution using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Probability of establishment

The likelihood that fruit flies will establish based on a comparative assessment of factors in the source and destination areas considered pertinent to the ability of the pest to survive and propagate: **High**.

To avoid establishment and spread of pests, a threshold limit must not be exceeded. This threshold limit is the smallest number of pests capable of establishing a colony. It was suggested that a limit of 10 mating pairs or 300 individuals (with random sex) is the minimum necessary for establishment of bi-parental species (Baker *et al.*, 1990). However, such an estimate may be too high for fruit flies. Unlike other species, one infested fruit is likely to contain more than one larva.

Where an infested fruit with three fruit fly larvae is discarded in suitable areas, with factors affecting mortality rate taken into account, such as predators, disease, adverse microclimate, finding suitable mating partners and the availability of a suitable host, it is expected that less than two individuals would survive. Therefore, to complete a life cycle and establish a colony, more than three individual fruit fly larvae from infested fruit must be imported in the same shipment and transported into endangered areas. This is likely to occur without management measures. Based on this information, it was assessed that without management to reduce the risk, the probability of a fruit fly colony establishing from infested fruits was high.

Probability of spread

The likelihood that fruit flies will spread based on a comparative assessment of those factors in the area of origin and in Australia considered pertinent to the expansion of the geographical distribution of the pest: **Moderate**.

Once established, the spread potential of fruit flies will be high because they possess many characters that facilitate successful colonisation. These include a high reproductive rate (Anon, 1983), broad environmental tolerances and a broad host range of both commercial and wild species, which are widespread in Australia (CABI, 2004).

There are restrictions in place in Australia on the movement of fruit to prevent the spread of fruit flies, including Queensland fruit fly and exotic species.

Established detection (including a national fruit fly trap surveillance network), containment and eradication procedures are used to control outbreaks of Queensland fruit fly (Meats et al., 2003) and exotic fruit fly species (QDPI, 2003) in Australia.

Probability of entry, establishment or spread

The overall likelihood that fruit flies will enter Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, be distributed in a viable state to suitable hosts, establish in that area or subsequently spread within Australia: **Low**.

The probability of entry, establishment or spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Consequences

Consequences (direct and indirect) of fruit flies: **High**.

Criterion	Estimate
Direct consequences	
Plant life or health	D — Fruit flies can cause direct harm to a wide range of plant hosts and are estimated to have consequences of minor significance at the national level.
Any other aspects of the environment	B — There may be significant consequences of these pests for native plants at a local level, which would be unlikely to be discernible at a national level.
Indirect consequences	
Eradication, control etc.	E — The control program adds considerably to the cost of production of the host fruit, costing between $200-900 per ha depending on the variety of fruit produced and the time of harvest (Anon., 1991b). An extensive outbreak of Queensland fruit fly was discovered in Perth, Western Australia in 1989, leading to a very expensive eradication program (Yeates, 1990). Fruit flies are estimated to have significant consequences at the national level.
Domestic trade	D — The presence of fruit flies in commercial production areas may have a significant effect at the regional level due to any resulting interstate trade restrictions on a wide range of commodities.
International trade	D — Fruit flies are regarded as the most destructive horticultural pests in the world. While they can cause considerable yield losses in orchards and suburban backyards, the major consequence facing Australian horticultural industries is the negative effect they have on gaining and maintaining export markets. Fruit flies are estimated to have consequences of minor significance at the national level.
Environment	A — Although additional pesticide applications or other control activities would be required to control these pests on susceptible crops, any impact on the environment is unlikely to be discernible.

Note: Refer to Table 5 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the approach taken to consequence assessment.

Unrestricted risk estimate

The unrestricted risk estimate is determined by combining the overall 'probability of entry, establishment or spread' with the 'consequences' using the risk estimation matrix (Table 1): **Moderate**.

SCALES

**Lepidosaphes gloverii* (Packard) (glover scale), *Lopholeucaspis cockerelli* (Grandpre′ & Charmoy) (diaspine scale), **Morganella longispina* (Morgan) (plumose scale), *Parlatoria cinerea* Deane & Hadden (tropical grey chaff scale), **Pinnaspis aspidistrae* (Signoret) (fern scale), **Pseudaonidia trilobitiformis* (Green) (trilobite scale) and **Unaspis citri* Comstock (citrus snow scale).

* WA only – this species is a quarantine pest for the State of Western Australia due to its absence from this State.

Introduction and spread probability

Probability of importation

The likelihood that scales will arrive in Australia with the importation of fresh Tahitian lime fruit from New Caledonia: **High**.

Some citrus orchards in New Caledonia are very likely to be infested by these scale species. It is very likely that fruit sent to be packed for export will contain some of these pests as field control may not give complete control of scales (Taverner & Bailey, 1995).

Scale insects are sessile, often inconspicuous and usually live around the sepal or under the calyx of the fruit from flowering onwards. The crawlers feed upon plant juices by inserting their piercing-sucking mouthparts into the host plant. They generally remain anchored to the host permanently. Therefore, they may be difficult to clean or detect during fruit sorting, especially at low population levels (Taverner & Bailey, 1995).

The standard washing procedure in the packing-lines will remove some of these pests but is unlikely to be highly effective without post harvest treatment (Bailey & Brown, 1999; Taverner & Bailey, 1995).

Interceptions of these species have been made on produce imported into New Zealand from the Pacific area (Downs, pers. comm., 1999; Williams & Watson, 1988).

Probability of distribution

The likelihood that scales will be distributed to the endangered area as a result of the processing, sale or disposal of fresh Tahitian lime fruit from New Caledonia: **Low**.

The pests are likely to survive storage and transportation because scale insects generally tolerate cold temperatures and overwinter at various stages of growth.

The commodity may be distributed throughout Australia for retail sale. The intended use of the commodity is human consumption but waste material would be generated.

It is likely that only a small number of imported fruit or fruit residues would be discarded in close proximity to a host.

The lack of mobility of mature female scales, the low mobility of crawlers (first nymphal instar) and the short life span of males makes it unlikely that scales will transfer from discarded waste to a host.

The unassisted movement of scale species occurs within a host plant, not between host plants.

Probability of entry

The likelihood that scales will arrive in Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, and be distributed to the endangered area: **Low**.

The overall probability of entry is determined by combining the likelihoods of importation and of distribution using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Probability of establishment

The likelihood that scales will establish based on a comparative assessment of factors in the source and destination areas considered pertinent to the ability of the pest to survive and propagate: **High**.

Scales are highly polyphagous and host plants are common in Australia. Lemon/lime trees are commonly grown in urban areas in Australia.

The probability of establishment of these species is considered high due to their high reproductive rate and adaptability, even though a number of natural enemies known to attack diaspine scales are present in Australia.

Most of these scales are already recorded in Australia (AICN, 2004; CIE, 1977; CIE, 1981), except *Lopholeucaspis cockerelli* and *Parlatoria cinerea*.

Existing control programs may be effective for some hosts (e.g. broad spectrum pesticide applications) but not all hosts.

Probability of spread

The likelihood that scales will spread based on a comparative assessment of those factors in the area of origin and in Australia considered pertinent to the expansion of the geographical distribution of the pest: **Moderate**.

Experiments in orchards in South Australia demonstrated that crawlers and males of the armoured scale *Aonidiella aurantii* were carried up to 312 m by wind and are able to establish themselves on suitable hosts following dispersal (Willard, 1974).

The spread of *Parlatoria* spp. depends on relative humidity and temperature (Gerson, 1980). They cannot spread well under low relative humidity and high temperatures. Australia has a wide climate range and many areas are suitable for the establishment and spread of scale insects. Many scale insects have shown the ability to adapt to new hosts and new environments (Hanks & Denno, 1994; McClure, 1983; Schvester, 1985).

Adults and nymphs may be moved within and between orchards or other commercial production sites with the movement of equipment, personnel and infested plant material (Dreistadt *et al*., 1994).

Short-range dispersal can occur through the movement of crawlers in wind currents or by biological or mechanical vectors (Willard, 1974). Long-range movement of scales occurs when gravid females are transferred *in situ* with the vegetative material upon which they are feeding EPPO, 2005).

Probability of entry, establishment or spread

The overall likelihood that scales will enter Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, be distributed in a viable state to suitable hosts, establish in that area or subsequently spread within Australia: **Low**.

The probability of entry, establishment or spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Consequences

Consequences (direct and indirect) of scales: **Low**.

Criterion	Estimate
Direct consequences	
Plant life or health	C — Scales can cause direct harm to a wide range of plant hosts and have also been reported as disease vectors. It is estimated that the consequences are unlikely to be discernible at the national level and of minor significance at the regional level.
Any other aspects of the environment	A — There are no known consequences of these pests on other aspects of the environment.
Indirect consequences	
Eradication, control etc.	C — Programs to minimise the impact of these pests on host plants are likely to be costly and include pesticide applications and crop monitoring. Scales are estimated to have consequences that are unlikely to be discernible at the national level and significant at the district level.
Domestic trade	B — The presence of these pests in commercial production areas may have a significant effect at the local level due to any resulting interstate trade restrictions on a wide range of commodities. These restrictions may lead to a loss of markets, which in turn would be likely to require industry adjustment.

International trade	B — The presence of these pests in commercial production areas of a range of commodities (e.g. *Citrus* spp., *Vitis vinifera*, *Carica papaya*) may have an effect due to possible limitations to access to overseas markets where these pests are absent.
Environment	A — Pesticides required to control scales are estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the local level.

Note: Refer to Table 5 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the approach taken to consequence assessment.

Unrestricted risk estimate

The unrestricted risk estimate is determined by combining the overall 'probability of entry, establishment or spread' with the 'consequences' using the risk estimation matrix (Table 1): **Very low**.

MEALYBUGS

**Ferrisia virgata* (Cockerell) (striped mealybug) and *Nipaecoccus filamentosus* (Cockerell) (mealybug).

* WA only – this species is a quarantine pest for the State of Western Australia due to its absence from this State.

Introduction and spread probability

Probability of importation

The likelihood that mealybugs will arrive in Australia with the importation of fresh Tahitian lime fruit from New Caledonia: **High**.

Some citrus orchards in New Caledonia are very likely to be infested by these mealybug species. Mealybugs usually live around the calyx of the fruit, from flowering onwards. They generally remain anchored to the host. Therefore, they may be difficult to clean or detect during fruit sorting, especially at low population levels (Taverner & Bailey, 1995).

Honeydew, the waste product of the mealybug feeding process, is a growth medium for sooty mould fungi. Fruit with sooty moulds may be detected during pre-export inspections.

Routine washing procedures undertaken within the packinghouse may not totally remove these pests from around the calyx. This is particularly true of those adult females or nymphs that have found protective spaces around the calyx or are protected by waxy cocoons.

Interceptions of these species have been made on produce imported into New Zealand from the Pacific area (Downs, pers. comm., 1999; Williams & Watson, 1988).

Probability of distribution

The likelihood that mealybugs will be distributed to the endangered area as a result of the processing, sale or disposal of fresh Tahitian lime fruit from New Caledonia: **Moderate**.

Adults or immature forms may remain on the surface of the fruit during distribution via wholesale or retail trade. The pests are likely to survive storage and transportation because mealybugs generally tolerate cold temperatures and overwinter at various stages of growth. Hoy & Whiting (1997) showed that it took 42 days storage at 0°C for a complete mortality of *Pseudococcus affinis*.

The commodity may be distributed throughout Australia for retail sale. The intended use of the commodity is human consumption but waste material would be generated.

Unassisted movement of the immature and adult life stages of mealybugs is predominantly within a host plant. Adult females are wingless and would need to be carried onto hosts by vectors such as people or other insects. Adult males are weak fliers and only persist for a few days.

Short-range dispersal of juveniles could occur through the movement of crawlers in wind currents or as contaminants on biological or mechanical vectors (Williams, 1996). All stages of mealybugs survive in the environment for some time and because they are polyphagous, they could be transferred to a susceptible host.

Probability of entry

The likelihood that mealybugs will arrive in Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, and be distributed to the endangered area: **Moderate**.

The overall probability of entry is determined by combining the likelihoods of importation and of distribution using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Probability of establishment

The likelihood that mealybugs will establish based on a comparative assessment of factors in the source and destination areas considered pertinent to the ability of the pest to survive and propagate: **High**.

Mealybugs are highly polyphagous and host plants are common in Australia. Lemon/lime trees are commonly grown in urban areas of Australia.

Existing control programs may be effective for some hosts (e.g. broad spectrum pesticide applications) but not hosts where specific integrated pest management programs are used.

This group of pests has a high reproductive rate. Reproduction is bisexual (production of fertilised eggs) with two to eight generations per year. Females lay between 90-600 eggs during their lifetime. The eggs hatch in 6-14 days and the first instars or 'crawlers' disperse to suitable feeding sites on their new host plants. Nymphs are active during the first instar stage and may travel some distance to a new plant where they become sessile for the remaining nymphal (larval) instars. Crawlers can survive only about a day without feeding. Most mealybugs overwinter at various juvenile stages. The complete life cycle for *Nipaeccocus* spp. takes between 3 and 8 weeks (Smith *et al*., 1997a).

The probability of establishment of these species is considered high due to their high reproductive rate and adaptability, even though a number of natural enemies known to attack mealy bugs are present in Australia.

Ferrisia virgata is already established in the Northern Territory and Queensland in Australia (AICN, 2004).

Probability of spread

The likelihood that mealybugs will spread based on a comparative assessment of those factors in the area of origin and in Australia considered pertinent to the expansion of the geographical distribution of the pest: **High**.

Australia has a wide climate range and many areas are suitable for the establishment and spread of mealybugs. Tropical or sub-tropical environments of Australia would be suitable for the spread of these pests because both species are recorded from those environments.

Adults and nymphs may be moved within and between orchards with the movement of equipment, personnel and infested plant material, and juveniles may be dispersed by wind (Ben Dov, 1994). Adult males are winged but are weak flyers. The long-range dispersal of mealybugs requires the movement of adults and nymphs with vegetative material CABI, 2004).

Probability of entry, establishment or spread

The overall likelihood that mealybugs will enter Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, be distributed in a viable state to suitable hosts, establish in that area or subsequently spread within Australia: **Moderate**.

The probability of entry, establishment or spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of ‘rules’ for combining descriptive likelihoods (Table 3).

Consequences

The impact scores for these mealybugs are based on those for *N. filamentosus* at the national level, as these are the higher estimates.

Consequences (direct and indirect) of mealybugs: **Low**.

Criterion	Estimate
Direct consequences	
Plant life or health	C — Mealybugs can cause direct harm to a wide range of plant hosts and have also been reported as disease vectors. Fruit quality can be reduced by the presence of secondary sooty moulds. It is estimated that the consequences are unlikely to be discernible at the national level and of minor significance at the regional level.
Any other aspects of the environment	A — There are no known consequences of these pests on other aspects of the environment.
Indirect consequences	
Eradication, control	C — Programs to minimise the impact of these pests on host plants are likely

etc.	to be costly and include pesticide applications and crop monitoring. Mealybugs are estimated to have consequences that are unlikely to be discernible at the national level and significant at the district level.
Domestic trade	C — The presence of these pests in commercial production areas may have a highly significant effect at the local level due to any resulting interstate trade restrictions on a wide range of commodities. These restrictions may lead to a loss of markets, which in turn would be likely to require industry adjustment.
International trade	C — The presence of these pests in commercial production areas of a range of commodities (e.g. *Citrus* spp., *Vitis vinifera*, *Carica papaya*) may have a significant effect at the district level due to any limitations to access to overseas markets where these pests are absent.
Environment	A — Pesticides required to control mealybugs are estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the local level.

Note: Refer to Table 5 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the approach taken to consequence assessment.

Unrestricted risk estimate

The unrestricted risk estimate is determined by combining the overall 'probability of entry, establishment or spread' with the 'consequences' using the risk estimation matrix (Table 1): **Low**.

LITTLE FIRE ANT

Wasmannia auropunctata (Roger) (little fire ant)

Introduction and spread probability

Probability of importation

The likelihood that the little fire ant will arrive in Australia with the importation of fresh Tahitian lime fruit from New Caledonia: **High**.

Little fire ant is widely known as a "tramp" ant due to its ability to hitch-hike and establish itself throughout the world. It was originally found in Cuba and has spread widely throughout the warmer regions of the world (Brooks & Nickerson, 2000).

Little fire ant populations multiply rapidly and invade citrus orchards and coffee plantations in New Caledonia. They have also been recorded as invading coffee plantations in Cuba and cocoa plantations in Brazil (Fabres & Brown, 1978; Castineiras *et al.*, 1987). At high populations, the ants forage over branches and foliage of trees.

The species may be found within lime consignments because they invade citrus plantations in New Caledonia. However, the treatment schedule for New Caledonian lime production includes a treatment effective against little fire ant, which will reduce the numbers potentially associated with lime fruit. Some ants may also be removed during post-harvest processing. Little fire ant may also travel in packaging material associated with lime exports from New Caledonia.

AQIS inspectors have intercepted little fire ants on produce imported into Australia from Bolivia, New Caledonia, Singapore, Solomon Islands, USA, Vanuatu and Vietnam, including both queens and workers (PDI, 2003)

Probability of distribution

The likelihood that the little fire ant will be distributed to the endangered area as a result of the processing, sale or disposal of Tahitian lime fruit from New Caledonia: **Moderate**.

Although the ants are unlikely to be cold hardy (Ayre, 1977), they are highly adaptive (Nickerson, 1983) and may survive during cold storage and transportation. They are minute in size (1-2 mm), so they may be difficult to detect. Upon arrival, the pest may remain on the fruit or packaging or find an alternate habitat.

Little fire ant can easily disperse by crawling. This species is highly adaptable and doesn't require any specific plant host to survive.

Probability of entry

The likelihood that the little fire ant will arrive in Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, and be distributed to the endangered area: **Moderate**.

The overall probability of entry is determined by combining the likelihoods of importation and of distribution using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Probability of establishment

The likelihood that the little fire ant will establish based on a comparative assessment of factors in the source and destination areas considered pertinent to the ability of the pest to survive and propagate: **Moderate.**

This species is highly adaptable as the ants can nest in both open and shaded situations under moist or dry conditions (Nickerson, 1983).

It is likely that the tropical and sub-tropical areas of Australia would be suitable for the pest to establish.

A fertilised queen and workers may need to be introduced to establish a colony, as the little fire ant is a unicolonial species that spreads by inseminated queens accompanied on foot by workers (Romanski, 2001).

Probability of spread

The likelihood that the little fire ant will spread based on a comparative assessment of those factors in the area of origin and in Australia considered pertinent to the expansion of the geographical distribution of the pest: **High**.

If this ant becomes established in Australia, it is likely to spread to various parts of Australia. Nests of this ant usually have more than one laying queen. The queens have a high fecundity which, when coupled with a rapid development of workers, can lead to a rapid increase in the population in a short period.

Probability of entry, establishment or spread

The overall likelihood that the little fire ant will enter Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, be distributed in a viable state to suitable hosts, establish in that area or subsequently spread within Australia: **Low**.

The probability of entry, establishment or spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Consequences

Consequences (direct and indirect) of the little fire ant: **Moderate**.

Criterion	Estimate
Direct consequences	
Plant life or health	B— Little fire ants do not directly affect the health of the plant. They may however stimulate outbreaks of citrus pests by reducing the impact of beneficial insects. It is estimated that little fire ant has consequences that are unlikely to be discernible at the national level and a significant effect at the local level.
Any other aspects of the environment	D— Introduction of little fire ants into a new environment may be significant. The invasive characteristics of *W. auropunctata,* such as high adaptive ability, food searching and competitive ability, would have impacts on native fauna and flora, particularly in tropical rainforests. The low number of natural parasitic or predator species in Australia would contribute to a lower mortality rate of little fire ant populations. The changes in balance they provoke among the communities of phytophagous insects often lead to rapid increases of pest populations such as scale insects, aleurodids and psyllids (Fabres & Brown, 1978). Little fire ant is estimated to have consequences of minor significance at the national level and a significant effect at the regional level.
Indirect consequences	
Eradication, control etc.	D— Little fire ants can reduce the productivity of farm workers and increase the cost of pest control. This species has a potent sting that is annoying to agricultural workers during cultivation and harvest of fruit. It has been reported that premium wages have to be paid to harvest fruit in some groves (Brooks & Nickerson, 2000). Where the ant is present, the production of land is seriously affected, as their mounds make it difficult to cultivate the land and their presence deters animals and humans from the infested area. Little fire ant is estimated to have consequences of minor significance at the national level and a significant effect at the regional level.
Domestic trade	D— The presence of these pests in commercial production areas is estimated to have highly significant consequences at the district level due to any resulting interstate trade restrictions on a wide range of commodities. These restrictions may lead to a loss of markets.
International trade	C— The presence of these pests in commercial production areas of a wide range of commodities (e.g. citrus) is estimated to have significant consequences at the district level due to any limitations to access to overseas markets where these pests are absent.
Environment	C— Pesticides required to control little fire ant are estimated to have consequences that are unlikely to be discernible at the national level and of

	high significance at the local level.

Note: Refer to Table 5 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the approach taken to consequence assessment.

Unrestricted risk estimate

The unrestricted risk estimate is determined by combining the overall 'probability of entry, establishment or spread' with the 'consequences' using the risk estimation matrix (Table 1): **Low**.

CITRUS SCAB

Sphaceloma fawcettii Jenkins (citrus scab)

Introduction and spread probability

Probability of importation

The likelihood that citrus scab will arrive in Australia with the importation of fresh Tahitian lime fruit from New Caledonia: **High**.

Sphaceloma fawcettii causes warty scab pustules on the surface of fruit of susceptible varieties of citrus (Timmer, 2000).

Most cultivars of *C. latifolia* were recorded to be moderately tolerant to citrus scab (Smith *et al.*, 1997b).

Fruit with scabs may escape detection during commercial grading operations and be exported to Australia.

Probability of distribution

The likelihood that citrus scab will be distributed to the endangered area as a result of the processing, sale or disposal of fresh Tahitian lime fruit from New Caledonia: **Low**.

Scab pustules consist of a mixture of fungal and host tissues (Timmer, 2000) and the fungus is likely to survive cool storage during transport and distribution.

The commodity may be distributed throughout Australia for retail sale. The intended use of the commodity is human consumption but waste material would also be generated.

Sphaceloma fawcettii, the anamorph, produces two types of conidia on the surface of scab pustules. Hyaline conidia are elliptical and are spread primarily by rain splash. Coloured, spindle-shaped conidia are also produced on scab lesions and can be airborne for short distances (Timmer, 2000).

Discarded waste containing this fungus would be rapidly colonised by other saprophytic microorganisms, reducing the likelihood that conidia would be produced on the waste.

It is likely that only a small number of imported fruit or fruit residues would be discarded in sufficiently close proximity to a host to enable the movement of conidia to the host by rain splash or wind.

While hosts of citrus scab are widespread in home gardens and commercial orchards in Australia, most pathotypes of *S. fawcettii* have a narrow host range (Timmer, 2000), reducing the likelihood that conidia would spread to a susceptible species. The Florida Broad Host Range pathotype, which attacks grapefruit, lemon, rough lemon, satsuma and cleopatra mandarins, sour orange, Temple and Murcott tangors, and sweet orange fruit, is known only from Florida and Korea (Timmer, 2000; Hyun *et al*., 2001).

The probability of distribution was reduced from moderate to low in the final IRA report, based on reconsideration of the factors necessary for the production and transfer of conidia from discarded fruit or fruit waste to a susceptible host.

Probability of entry

The likelihood that citrus scab will arrive in Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, and be distributed to the endangered area: **Low**.

The overall probability of entry is determined by combining the likelihoods of importation and of distribution using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Probability of establishment

The likelihood that citrus scab will establish based on a comparative assessment of factors in the source and destination areas considered pertinent to the ability of the pest to survive and propagate: **Moderate**.

The hyaline conidia of *S. fawcettii* die quickly when exposed to dry conditions or direct sunlight. The coloured, spindle-shaped conidia germinate to produce hyaline conidia (Timmer, 2000).

The degree of varietal susceptibility of *Citrus* species to infection (Hyun *et al*., 2001) may reduce the likelihood of infection by an introduced pathotype of *S. fawcettii*.

Only young leaves and fruit are susceptible to infection. Leaves are most susceptible just after emergence and are tolerant to infection by the time they are half expanded. Fruit is susceptible to infection for 6-8 weeks after petal fall (Timmer, 2000).

While the optimum temperature for the development of citrus scab is 24-27°C, infection occurs at lower and higher temperatures but requires longer periods of wetness (Timmer, 2000).

Only 2-3 hours of wetness are needed for infection (Timmer, 2000).

In Australia, two pathotypes of *S. fawcettii* are established in coastal New South Wales, Queensland and the Northern Territory (Timmer *et al*., 1996; APDD, 2005), indicating that other pathotypes could also establish in these areas.

Probability of spread

The likelihood that citrus scab will spread based on a comparative assessment of those factors in the area of origin and in Australia considered pertinent to the expansion of the geographical distribution of the pest: **Moderate**.

Spread of the pathogen is mostly by conidia in wind-carried water droplets (Whiteside, 1975), during rain or irrigation (Gottwald, 1995). When dispersed by dry wind, conidia remain viable at least until the following night and then germinate if high moisture conditions occur (Whiteside, 1975).

Although spores can be spread by various means, conditions for infection require high moisture conditions for 2.5-3.5 hours and temperatures between 14-25°C.

Insects may also contribute to the spread of this pathogen (Whiteside, 1975).

Most long distance dispersal occurs with infested nursery stock (Timmer, 2000).

Known hosts are restricted to the Rutaceae, and are largely *Citrus* spp. (Timmer *et al*., 1996; Hyun *et al*., 2001; CABI, 2005). The narrow host range of *S. fawcettii* may limit its natural dispersal.

Probability of entry, establishment or spread

The overall likelihood that citrus scab will enter Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, be distributed in a viable state to suitable hosts, establish in that area or subsequently spread within Australia: **Low**.

The probability of entry, establishment or spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Consequences

Consequences (direct and indirect) of citrus scab: **Moderate**.

Criterion	**Estimate**
Direct consequences	
Plant life or health	D — The host range of *S. fawcettii* is restricted to *Citrus* spp. (including some native Australian *Citrus* spp.) and *Fortunella* spp. *Sphaceloma fawcettii* attacks the young fruit causing 66-72% fruit drop during autumn if the temperature and humidity are favourable (Huang & Huang, 1999). Each year, the disease can cause the loss of millions of dollars due to the poor marketability of deformed fruit, although it may not generally affect yields of *Citrus* spp. (Barkley *et al*., 1995; Dede & Varma, 1987). Citrus scab is estimated to have consequences of minor significance at the national level.
Any other aspects of the environment	B— There may be significant direct consequences at a local level of this pathogen on native C*itrus* spp. The consequences are unlikely to be discernible at a national level.
Indirect consequences	
Eradication, control etc.	C— Once established, the pathogen can be persistent and is unlikely to be eradicated. Citrus scab is estimated to have consequences that are unlikely to be discernible at the national level and significant at the district level.

Domestic trade	C — The presence of this pathogen in commercial production areas is estimated to have significant consequences at the district level due to any resulting interstate trade restrictions on citrus.
International trade	C — The presence of this pathogen in commercial production areas of citrus is estimated to have significant consequences at the district level due to limitations of access to overseas markets while suitable phytosanitary management measures are developed.
Environment	B — Fungicides required to control citrus scab and indirect effects on native plants are estimated to have consequences that are unlikely to be discernible at the national level and significant at the local level.

Note: Refer to Table 5 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the approach taken to consequence assessment.

Unrestricted risk estimate

The unrestricted risk estimate is determined by combining the overall 'probability of entry, establishment or spread' with the 'consequences' using the risk estimation matrix (Table 1): **Low**.

BLACK MILDEW

Meliola citricola Syd. & P. Syd. (black mildew)

Introduction and spread probability

Probability of importation

The likelihood that black mildew will arrive in Australia with the importation of fresh Tahitian lime fruit from New Caledonia: **Low**.

Meliola citricola occurs in some countries in the south Pacific and is widespread throughout Southeast Asia, particularly in the wet season (Beattie pers. comm.., 2003).

The fungus is found on leaves and fruit and appears as dense, black, velvety, circular patches of mycelial growth, up to about 5mm in diameter. With respect to leaves, the fungus is more commonly found on the lower surface (Ecoport, 1999).

When infected, the cosmetic quality of the fruit is reduced, and therefore would be likely to be visually detected and rejected during sorting and grading prior to packing.

Probability of distribution

The likelihood that black mildew will be distributed to the endangered area as a result of the processing, sale or disposal of fresh Tahitian lime fruit from New Caledonia: **Moderate**.

Little is known about the ability of this species to survive commercial distribution methods. Dormant mycelium or spores on fruit may survive during distribution.

If infected fruit is not detected at inspection, infection rates are likely to be low and may not be detected by commercial operations. In this instance, distribution may occur.

Transfer to a host would be possible via the movement of ascospores from infected fruit. This could be either by splash dispersal, air movement or direct contact.

Probability of entry

The likelihood that black mildew will arrive in Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, and be distributed to the endangered area: **Low**.

The overall probability of entry is determined by combining the likelihoods of importation and of distribution using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Probability of establishment

The likelihood that black mildew will establish based on a comparative assessment of factors in the source and destination areas considered pertinent to the ability of the pest to survive and propagate: **Low**.

Meliola citricola appears to be limited to tropical countries and is favoured by long wet seasons and heavy dews at night in the dry season (Saenz & Taylor, 1999).

Tahitian limes are mainly grown in tropical and subtropical regions of Australia (DAFF, 2002). However, the main market for imported limes will be in large cities in temperate areas.

While *M. citricola* is recorded on many citrus species, most records of this fungus are on a smooth skinned cultivar of *Citrus reticulata* (Whittle, 1992).

Probability of spread

The likelihood that black mildew will spread based on a comparative assessment of those factors in the area of origin and in Australia considered pertinent to the expansion of the geographical distribution of the pest: **Moderate**.

The fungus produces ascospores (Ecoport, 1999) that are spread by wind and air currents. Ascospores of *M. citricola* require young leaves or fruits for penetration and infection (Ecoport, 1999).

Probability of entry, establishment or spread

The overall likelihood that black mildew will enter Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, be distributed in a viable state to suitable hosts, establish in that area or subsequently spread within Australia: **Very low**.

The probability of entry, establishment or spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Consequences

Consequences (direct and indirect) of black mildew: **Very low**.

Criterion	Estimate
Direct consequences	
Plant life or health	A — The host range of *Meliola citricola* appears to be restricted to *Citrus* spp. There are no known direct consequences on animal or plant life, health or welfare.
Any other aspects of the environment	A— There are no known direct consequences of this pathogen on any other aspects of the environment.
Indirect consequences	
Eradication, control etc.	B— *Meliola citricola* is easily controlled with mineral oil sprays. In some cases, bleaching in a weak solution may be required to improve the cosmetic quality of the fruit. *Meliola citricola* is estimated to have consequences that are unlikely to be discernible at the national level and significant at the local level.
Domestic trade	A— The presence of this pathogen in commercial production areas of citrus is estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the local level. It is doubtful that there would be any resulting interstate trade restrictions on citrus.
International trade	A — The presence of this pathogen in commercial production areas of citrus is estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the local level. It is doubtful that there would be any limitations in access to overseas markets where this pathogen is absent.
Environment	A— Mineral oil sprays required to control black mildew are estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the local level.

Note: Refer to Table 5 (The assessment of local, district, regional and national consequences) and text under the ‘Method for assessing consequences’ section for details on the approach taken to consequence assessment.

Unrestricted risk estimate

The unrestricted risk estimate is determined by combining the overall ‘probability of entry, establishment or spread’ with the ‘consequences’ using the risk estimation matrix (Table 1): **Negligible**.

CONCLUSIONS: RISK ASSESSMENTS

Table 7 summarises the detailed risk assessments and provides unrestricted risk estimates for the quarantine pests considered to be associated with Tahitian lime fruit from New Caledonia.

Fruit flies, mealybugs, fire ants and citrus scab were assessed to have an unrestricted risk of moderate or low. The unrestricted risk estimates for these pests exceed Australia's appropriate level of protection.

Scales and black mildew were assessed to have an unrestricted risk of very low or negligible and therefore do not require the application of any specific phytosanitary measures in order to maintain Australia's appropriate level of protection.

Risk management measures are therefore required to be applied to import Tahitian lime fruits from New Caledonia into Australia to adequately address the potential quarantine risks.

Table 7: Unrestricted risk summary

Scientific name	Probability of					Overall probability of entry, establishment or spread	Consequences	Unrestricted Risk
	Entry			Establishment	Spread			
	Importation	Distribution	Overall probability of entry					
ARTHOPODS								
Fruit flies (*Bactrocera curvipennis, B. psidii. B. tryoni* and *B. umbrosa*)	moderate	moderate	low	high	moderate	low	high	moderate
Mealybugs (*Ferrisia virgata* and *Nipaecoccus filamentosus)*	high	moderate	moderate	high	high	moderate	low	low
Little fire ant (*Wasmannia auropunctata)*	high	moderate	moderate	moderate	high	low	moderate	low
Scales (*Lepidosaphes gloverii, Lopholeucaspis cockerelli, Morganella longispina, Parlatoria cinerea, Pinnaspis aspidistrae, Pseudaonidia trilobitiformis* and *Unaspis citri*)	high	low	low	high	moderate	low	low	very low
PATHOGENS								
Citrus scab *(Sphaceloma fawcettii)*	high	low	low	moderate	moderate	low	moderate	low
Black mildew (*Meliola citricota)*	low	moderate	low	low	moderate	very low	very low	negligible

Table 8 provides the final list of quarantine pests for Tahitian lime from New Caledonia that have been assessed to have an unrestricted risk estimate above Australia's ALOP. These pests require the use of risk management measures in addition to standard practices used in the production of commercial limes in New Caledonia to meet Australia's ALOP. The risk management measures are described in the following section.

Table 8: Quarantine pests of Tahitian lime from New Caledonia assessed to have unrestricted risk estimates above Australia's ALOP

Scientific name	Common name
ARTHROPODS	
Diptera (flies)	
Bactrocera curvipennis (Froggatt) [Diptera: Tephritidae]	banana fruit fly
Bactrocera psidii (Froggatt) [Diptera: Tephritidae]	South Sea guava fruit fly
Bactrocera tryoni (Froggatt) [Diptera: Tephritidae]	Queensland fruit fly
Bactrocera umbrosa (Fabricius) [Diptera: Tephritidae]	breadfruit fly
Hemiptera (scales, mealybugs)	
**Ferrisia virgata* (Cockerell) [Hemiptera: Pseudococcidae]	striped mealybug
Nipaecoccus filamentosus (Cockerell) [Hemiptera: Pseudococcidae]	mealybug
Hymenoptera (ants)	
Wasmannia auropunctata (Roger) [Hymenoptera: Formicidae]	little fire ant
PATHOGENS	
Fungi	
Sphaceloma fawcettii Jenkins	citrus scab

*WA only – this species is a quarantine pest for the State of Western Australia due to its absence from this State

PEST RISK MANAGEMENT

Pest risk management evaluates and selects options for measures to reduce the risk of entry, establishment or spread of quarantine pests assessed to have an unrestricted risk estimate above Australia's ALOP, via the importation of commercially produced Tahitian lime from New Caledonia, i.e. fruit sourced from commercial production sites subjected to standard cultivation, harvesting and packing activities.

It is important to note that it is only appropriate for the unrestricted risk estimates to take into account the minimum border procedures used by relevant government agencies and not those measures approved by such agencies that are intended to mitigate risks associated with the commodity itself. The minimum procedures include verifying that the commodity is as described in the shipping documents and identifying external and internal contaminations of containers and packaging. In order to have least trade restrictive measures, evaluation of restricted risk management options started with consideration of the use of a 600-unit inspection in detecting quarantine pests requiring risk management, and the subsequent remedial actions or treatments that might be applied if a pest is intercepted.

The standard AQIS sampling protocol requires inspection of 600 units, for quarantine pests in systematically selected random samples per homogeneous consignment or lot. The unit for Tahitian limes is defined as one fruit. Biometrically, if no pests are detected by the inspection, this size sample achieves a confidence level of 95% that not more than 0.5% of the units in the consignment are infested/infected. For 'consignments' of fruit of less than 1000 units, the sample size is either 450 units or 100% of consignment (whichever is smaller). For 'consignments' of fruit of greater than or equal to 1000 units, the sample size is 600 units. The level of confidence depends on each fruit in the consignment having about the same likelihood of being affected by a quarantine pest and the inspection technique being able to reliably detect all quarantine pests in the sample. If no live quarantine pests are detected in the sample, the consignment is considered to be free from quarantine pests and would be released from quarantine. Where a live quarantine pest is intercepted in a sample, the remedial actions or treatments may (depending on the location of the inspection) include:

- withdrawing the consignment from export to Australia;
- re-export of the consignment from Australia;
- destruction of the consignment; or
- treatment of the consignment and re-inspection to ensure that the pest is no longer viable.

It should be emphasised that inspection is not a measure that mitigates the risk of a pest. It is the remedial action or treatment that can be taken based on the results of the inspection that would reduce a pest risk.

Biosecurity Australia considers that the risk management measures described in this document will provide an appropriate level of protection against the pests identified in the risk assessment. Biosecurity Australia supports the 600 unit sampling protocol implemented by AQIS as a statistically valid method used to detect quarantine pests of concern.

Biosecurity Australia has considered stakeholders comments on the draft and revised draft IRA reports to develop the risk management measures. Biosecurity Australia considers that the risk management measures below are commensurate with the identified risks and the measures form the basis of final import conditions for Tahitian lime from New Caledonia.

RISK MANAGEMENT MEASURES

The measures described below form the basis of the final import conditions for Tahitian limes from New Caledonia. These measures are described in the section entitled Final Import Conditions.

The following risk management measures and phytosanitary procedures are recommended to mitigate the risks identified in the pest risk assessments:

1. systems approach for fruit flies;
2. visual inspection and remedial action for mealybugs and little fire ant;
3. orchard control of citrus scab; and
4. operational systems for the maintenance and verification of the phytosanitary status of Tahitian limes.

[1] Systems approach for fruit flies (*Bactrocera curvipennis, B. psidii, B. tryoni and B. umbrosa*)

Fruit flies have been assessed as having an unrestricted risk estimate of moderate and measures are therefore required to manage that risk.

Visual inspection alone is not considered to be an appropriate risk management option in view of the level of risk identified and because clear visual external signs of infestation (particularly in recently infested fruit) may not be present. If infested fruit was not detected at inspection, fruit flies may enter, establish or spread in Australia.

A systems approach will be used for the management of fruit flies. The objective of this measure is to ensure that no viable life stages of fruit flies are present in export consignments of Tahitian lime fruit from New Caledonia. This measure is considered to reduce the risk associated with fruit flies to an acceptable level. Components of the systems approach are as follows;

Harvesting and sorting fruit to meet mature green requirements

DAVAR-NC provided Biosecurity Australia with results of non-host status tests for the four species of quarantine fruit fly in this IRA. Host status tests indicated that Tahitian limes at the mature green stage of development were not a preferred host for economic fruit fly species in New Caledonia (Sales & Paulaud, 1995). Therefore, these fruit fly species can be managed by harvesting fruit at the mature green stage (defined in section "Australia's current quarantine policy for imports of fresh Tahitian limes").

Orchard sanitation

In tropical climates, uncontrolled breeding of fruit flies in poorly managed or abandoned orchards and in a variety of wild hosts results in high populations of adult flies. Orchard sanitation (e.g. collection and destruction of all unwanted fruit on the trees and on the ground) contributes significantly towards reducing damaging fruit fly populations (Vijaysegaran, 1985). The objective of this measure is to reduce the amount of fruit fly host material thus reducing fruit fly populations and the chance of fruit being infested in orchards.

[2] Visual inspection and remedial action for mealybugs and little fire ant

Two species of mealybugs and one species of little fire ant have been assessed to have an unrestricted risk estimate of low (see Table 8 for details of species names) and measures are therefore required to manage this risk.

Visual inspection will involve the examination of a sample of Tahitian limes to detect the presence of the mealybugs and little fire ants. Remedial action when pests are present is recommended as an appropriate risk management option for these pests, given that trained inspectors can readily detect these pests.

The objective of this measure is to ensure that consignments of Tahitian lime fruit from New Caledonia infested with these pests can be readily identified and subjected to appropriate remedial action. This measure is considered to reduce the risk associated with mealybugs and little fire ant to a very low level.

Particular care must be taken with inspection of packaging, as little fire ant is a well-known contaminant in plant packaging material.

[3] Orchard control of citrus scab (*Sphaceloma fawcettii)*

Sphaceloma fawcettii has been assessed to have an unrestricted risk estimate of low and measures are therefore required to manage that risk.

Visual inspection of fruit alone is not considered to be an appropriate risk management option as external signs of infection may not be visible. If infected fruit was not detected at inspection, citrus scab may enter, establish or spread in Australia.

DAVAR-NC has not proposed citrus export areas in New Caledonia as pest free areas for citrus scab. The risk posed by citrus scab will be managed by the inclusion of an effective fungicide in the pesticide spray program to prevent infection by *S. fawcettii*. The objective of this measure is to ensure that Tahitian lime fruit from New Caledonia is not infected by *S. fawcettii*. This measure is considered to reduce the risk associated with *S. fawcettii* to an acceptable level. This proposed measure is further discussed below;

Chemical control

DAVAR-NC approved effective fungicide applications must be integrated into the pesticide spray program to prevent infection by *S. fawcettii.* Fungicides must be applied at critical infection periods.

Information on the DAVAR-NC approved orchard control program for *S. fawcettii* must be made available to AQIS if requested.

Detection of citrus scab during pre-export or on-arrival inspections will result in removal of the source orchard from the export program for the remainder of the shipping season.

[4] Operational procedures and verification of phytosanitary status

Biosecurity Australia/AQIS will develop a Work Plan, in consultation with DAVAR-NC, following the finalisation of this IRA.

It is necessary to have a system of operational procedures in place to ensure that the phytosanitary status of Tahitian lime fruit imports from New Caledonia is maintained and verified during the process of production and export to Australia.

The system of operational procedures for the production and export of fresh Tahitian limes from New Caledonia to Australia will include:

- registration of export orchards;
- registration of packinghouses and auditing of procedures;
- specific packaging and labelling requirements;
- specific conditions for storage and movement of produce;
- phytosanitary inspection by DAVAR-NC;
- phytosanitary certification by DAVAR-NC; and
- on-arrival quarantine clearance by AQIS.

[4A] Registration of export orchards

All Tahitian lime exports from New Caledonia to Australia must be sourced from registered export orchards. Copies of the registration records must be made available to AQIS if requested. DAVAR-NC is required to register all export orchards prior to commencement of exports. Pre-harvest spray records must be made available to AQIS, if required.

All export orchards are expected to produce commercial Tahitian lime fruit under standard cultivation, harvesting and packing activities.

The objective of this procedure is to ensure that orchards from which Tahitian limes are sourced can be identified. This is to allow trace-back to individual orchards and growers in the event of non-compliance and for audit of control measures. For example, if live pests are regularly intercepted during on-arrival inspection, the ability to identify a specific orchard/grower allows investigation and corrective action to be targeted rather than applying to all contributing orchards/growers.

[4B] Registration of packinghouses and auditing of procedures

All packinghouses intending to export Tahitian lime fruit to Australia will be required to be registered with DAVAR-NC, for trace-back purposes.

Sorting of fruit to meet mature green requirements for freedom from fruit flies is to be completed within the registered packinghouses.

Packinghouses will be required to identify the individual orchards with a unique identifying system and identify fruit from individual orchards by marking boxes or pallets (i.e. one orchard per pallet) with a unique orchard number. The list of registered packinghouses must be kept by DAVAR-NC and provided to AQIS prior to exports commencing with updates provided if packinghouses are added or removed from the list.

Registration of orchards and packinghouses is to include an audit program by DAVAR-NC. An audit is to be conducted prior to registration and then carried out at least annually.

[4C] Specific packaging and labelling requirements

All Tahitian lime fruit for export must be free from trash and weed seeds of quarantine concern to Australia and meet Australia's general import conditions for fresh fruits and vegetables (C6000 General Requirements for All Fruit and Vegetables, available at http://www.aqis.gov.au/icon/). Trash refers to soil, splinters, twigs, leaves and other plant material. Inspected and treated fruits will be required to be packed in new boxes. Packing material will be synthetic or processed if of plant origin. No unprocessed packing material of plant origin, such as straw, will be allowed. All wood material used in packaging of Tahitian limes must comply with the AQIS conditions (e.g. those specified in the "Cargo containers: quarantine aspects and procedures" document, http://www.aqis.gov.au/cargoqap).

All boxes must be labelled with the orchard registration number and packinghouse registration number for the purposes of trace back in the event that this is necessary. The pallet will be securely strapped only after phytosanitary inspection has been carried out. Palletised product is to be identified by attaching a uniquely numbered pallet card to each pallet or part pallet to enable trace back to registered orchards.

The objectives of these requirements are to ensure that:

- The Tahitian limes exported to Australia are not contaminated by weeds or trash;
- Unprocessed packing material (which may carry pests identified as not on the pathway and pests not known to be associated with Tahitian limes) is not imported with the Tahitian limes; and
- The packaged Tahitian limes are labelled in such a way as to identify the orchard and packinghouse (see measures 4A,B).

[4D] Specific conditions for storage and movement of produce

Packed product and packaging is to be protected from pest contamination during and after packing, during storage and during movement between locations (e.g. packinghouse to cool storage/depot, to inspection point, to export point).

Product for export to Australia that has been inspected and certified by DAVAR-NC must be maintained in secure conditions that will prevent mixing with fruit for export to other destinations.

Security of the consignment is to be maintained until release from quarantine in Australia.

Arrangements for secure storage and movement of produce are to be developed by DAVAR-NC in consultation with Biosecurity Australia/AQIS.

The objective of this procedure is to ensure that the phytosanitary status of the product is maintained during storage and movement.

[4E] Pre-export phytosanitary inspection by DAVAR-NC

DAVAR-NC will inspect all consignments in accordance with official procedures for all visually detectable quarantine pests and trash. Sample rates must achieve a 95% confidence level that not more than 0.5% of the units (Tahitian lime fruits) in the consignment are infested. This equates to a level of zero units infested by quarantine pests in a random sample size of 600 units from the homogeneous fruits in the consignment. The 600-unit sample must be selected randomly from every inspection lot in the consignment. The detection of live quarantine pests and/or trash will result in the failure of all fruit in the inspection lot.

The objective of this procedure is to ensure that Tahitian lime fruit exported to Australia is free of quarantine pests and trash and complies with packing and labelling requirements.

Records of any interceptions made during these inspections (live or dead quarantine pests, and trash) are to be maintained by DAVAR-NC and made available to Biosecurity Australia as requested. This information will assist in future reviews of this import pathway and consideration of the appropriateness of the phytosanitary measures that have been applied.

Note: A consignment is the number of boxes of Tahitian limes for shipment from New Caledonia to Australia covered by one phytosanitary certificate. An inspection lot is the number of boxes presented for a single phytosanitary inspection.

[4F] Phytosanitary certification by DAVAR-NC

DAVAR-NC is required to issue a Phytosanitary Certificate for each consignment upon completion of the pre-export phytosanitary inspection. The objective of this procedure is to provide formal documentation to AQIS verifying that the relevant measures have been undertaken offshore. Each Phytosanitary Certificate is to contain the following information:

Additional declarations

> *"The Tahitian lime fruit in this consignment has been produced in New Caledonia in accordance with the conditions governing the entry of fresh Tahitian lime fruit to Australia and inspected and found to be free of quarantine pests".*

Distinguishing marks

The orchard registration number, packinghouse registration number, number of boxes per consignment, and container and seal numbers (as appropriate); (to ensure trace back to the orchard in the event that this is necessary).

Note: A consignment is the quantity of Tahitian lime fruits from New Caledonia covered by one Phytosanitary Certificate that arrives at one port in one shipment. All consignments will need to be shipped directly from one port or city in New Caledonia to a designated port or city in Australia.

[4G] On-arrival quarantine clearance by AQIS

AQIS will undertake a documentation compliance examination for consignment verification purposes at the port of entry in Australia prior to inspection and release from quarantine. No land bridging of goods will be permitted unless goods have cleared quarantine.

Consignments will be inspected by AQIS using the standard AQIS inspection protocol. The detection of live quarantine pests and/or regulated articles will result in the failure of the inspection lot[3].

AQIS inspectors are trained to detect all life stages of arthropod pests, including eggs. On arrival inspections are conducted in accordance with AQIS work procedures, which include optical enhancement where necessary.

The objective of this procedure is to verify that the required measures have been undertaken.

3 An inspection lot is the number of boxes presented for a single phytosanitary inspection.

Action for non-complying lots

Where inspection lots are found to be non-compliant with requirements, then remedial action must be taken as outlined at the beginning of this section. If product continually fails inspection, Biosecurity Australia/AQIS reserves the right to suspend the export program and conduct an audit of the Tahitian lime risk management systems in New Caledonia. The program will recommence only after Biosecurity Australia/AQIS is satisfied that appropriate corrective action has been taken.

Uncategorised pests

If an organism is detected on Tahitian lime fruit from New Caledonia that has not been categorised, it will require assessment by Biosecurity Australia to determine its quarantine status and if phytosanitary action is required. The detection of any pests of quarantine concern not already identified in the analysis may result in the suspension of trade while a review is conducted, to ensure that the existing measures continue to provide the appropriate level of phytosanitary protection for Australia.

FINAL IMPORT CONDITIONS

The final import conditions described below are based on the conclusions of the pest risk analysis contained in this final IRA report. Specifically, they are based on the risk management measures described in the previous section.

The components of the final import conditions are summarised in alphabetical format below and the risk management measure that links with each component is given in brackets ( ).

a. Registration of export orchards (links with risk management measure 4A)

b. Packinghouse registration and auditing of procedures (4B)

c. In orchard pest and disease control programs (1; 3)

d. Harvest procedure and pre-sorting (1)

e. Pre-export inspection and remedial action (2; 4E)

f. Packing and labelling compliance (4C)

g. Phytosanitary certification (4F)

h. Security of fruit (4D)

i. On-arrival inspection, remedial action and clearance by AQIS (2; 4G)

j. Review of policy

k. Specific phytosanitary requirements for fruit flies – Certified mature green fruit (1)

a. Registration of export orchards

All Tahitian lime fruit for export must be sourced from orchards registered for export of Tahitian lime fruit to Australia. Copies of the registration records must be made available to AQIS if requested. DAVAR-NC is required to register all export orchards and growers prior to commencement of exports to enable trace-back in the event of non-conformance.

All export orchards are expected to produce commercial Tahitian lime fruit under standard cultivation, harvesting and packing activities.

All export orchards must maintain spray records to ensure agreed field control programs have been implemented.

b. Packinghouse registration and auditing of procedures

All packinghouses intending to export Tahitian lime fruit to Australia are to be registered with DAVAR-NC for trace back purposes.

Sorting of fruit to meet mature green requirements for freedom from fruit flies is to be completed within the registered packinghouses.

Packinghouses are required to identify individual orchards with a numbering system and identify fruit from individual orchards by marking boxes or pallets (i.e. one orchard per pallet) with a unique orchard number. The list of registered packinghouses must be kept by DAVAR-NC and provided to AQIS prior to exports commencing, with updates provided if packinghouses are added or removed from the list.

Registration of orchards and packinghouses is to include an audit program by DAVAR-NC. An audit is to be conducted prior to registration and then carried out at least annually.

c. Orchard control program

Registered growers will have an orchard control program developed by DAVAR-NC, incorporating appropriate fungicidal applications for citrus scab control and field sanitation for fruit fly control. Care will be taken to ensure that the chemicals used are approved for use on the produce exported to Australia and that any residues do not exceed Australian Maximum Residue Limits. Registered growers will keep records of control measures for auditing purposes and be given registration numbers. If required, the details of the orchard control program will need to be submitted to Biosecurity Australia/AQIS, through DAVAR-NC.

The orchard control program will include:

- Field sanitation with all fallen fruit to be removed from the orchards regularly (i.e. every 7 days) and destroyed or deep buried (for fruit fly control);
- Chemical control, using an appropriate and effective fungicide (for citrus scab control);
- Audit of grower compliance with the orchard control program by DAVAR-NC. Orchards found not to be complying with the program will have their export registration suspended until DAVAR-NC have re-inspected orchards and confirmed compliance with requirements; and
- DAVAR-NC grower audit records must be available for Biosecurity Australia/AQIS review as requested.

d. Harvest procedure and pre-sorting

Tahitian lime fruits for export to Australia will be required to be harvested when mature, firm and green, cleaned of adhering debris and free of other plant parts. Only clean mature green fruit is to be packed for export.

The exporter will implement sorting systems during the grading and packing process to ensure fruit certified as mature green meets the requirements specified in the section *"Specific phytosanitary requirements for fruit flies - certified mature green fruit"*. Any fruit that shows a yellow colour or pre-harvest cracks, punctures or other breaks of the skin that penetrate through to the flesh and have not healed with callus tissue will be excluded.

Any fruit that does not conform to the requirements specified in the above-mentioned section will be regarded as not conforming and will be rejected for certification under this protocol. Any fruit that does not conform to these specified requirements would need to be clearly identified and segregated to prevent mixing with product for export.

e. Pre-export inspection and remedial action

DAVAR-NC will inspect all consignments in accordance with official procedures for all visually detectable quarantine pests and trash. Sample rates must achieve a 95% confidence level that not more than 0.5% of the units (Tahitian lime fruits) in the consignment are infested. This equates to a level of zero units infested by quarantine pests in a random sample size of 600 units from the homogeneous fruits in the consignment. The 600-unit sample must be selected randomly from every inspection lot in the consignment. The detection of live quarantine pests and/or trash will result in the failure of all fruit in the inspection lot. Remedial action may then be taken. Action may include:

- withdrawing the consignment from export to Australia; or
- treatment of the consignment and re-inspection to ensure that the pest is no longer viable.

The inspection procedures are to ensure that Tahitian lime fruit is free from pests of quarantine concern to Australia, contaminating plant material/trash (leaves, twigs, seed, etc.) and soil.

During pre-export inspection, any consignment that is found to contain fruit that does not comply with the mature green requirement will subsequently be rejected, withdrawn and isolated and clearly distinguished from other lots or consignments.

Records of the interceptions made during these inspections (live or dead quarantine pests, and trash) are to be maintained by DAVAR-NC and made available to Biosecurity Australia/AQIS as requested. This information will assist in future reviews of this import pathway and consideration of the appropriateness of the phytosanitary measures that have been applied.

Detection of citrus scab (*Sphaceloma fawcettii*) during pre-export or on-arrival inspection will result in removal of the source orchard from the export program for the remainder of the shipping season.

f. Packing and labelling compliance

All packages of Tahitian limes for export must be found free from contaminated plant materials including trash and weed seeds and must meet Australia's general import conditions for fresh fruits and vegetables (C6000 General Requirements for All Fruit and Vegetables, available at http://www.aqis.gov.au/icon/). Trash refers to soil, splinters, twigs, leaves and other plant material.

Inspected and treated fruit will be required to be packed in new boxes. Packing material will be synthetic or processed if of plant origin. No unprocessed packing material of plant origin, such as straw, will be allowed. All wood material used in packaging of Tahitian limes must comply with the AQIS conditions [e.g. those in "Cargo containers: Quarantine aspects and procedures" document (AQIS, 2004) http://www.aqis.gov.au/cargoqap].

All boxes will be labelled with the orchard registration number and packinghouse registration number for the purposes of trace back in the event that this is necessary. The pallets must be securely strapped only after phytosanitary inspection has been carried out. Palletised product is to be identified by attaching a uniquely numbered pallet card to each pallet or part pallet to enable trace back to registered orchards.

g. Phytosanitary Certification

DAVAR-NC is required to issue a Phytosanitary Certificate for each consignment upon completion of pre-export inspection. Each Phytosanitary Certificate is to contain the following information:

Additional declarations

"The Tahitian lime fruit in this consignment has been produced in New Caledonia in accordance with the conditions governing the entry of fresh Tahitian lime fruit to Australia and inspected and found to be free of quarantine pests".

Distinguishing marks

The orchard registration number, packinghouse registration number, number of cartons per consignment, and container and seal numbers (as appropriate).

A consignment is the quantity of Tahitian lime fruit covered by one Phytosanitary Certificate that arrives at one port in one shipment. All consignments would need to be shipped directly from one port or city in New Caledonia to a designated port or city in Australia.

h. Security of fruit

All certified fruit and packaging is to be protected from pest contamination during and after packing, during storage and during movement between locations (e.g. packinghouse to cool storage/depot, to inspection point, to export point).

Product for export to Australia that has been inspected and certified by DAVAR-NC must be maintained in secure conditions that will prevent mixing with fruit for export to other destinations. This will be achieved through segregation of fruit for export to Australia in separate storage facilities, netting or shrink-wrapping pallets in plastic, or by placing sealed cartons in low temperature cold storage before loading into a shipping container. Alternatively, packed fruit will be directly transferred at the packinghouse into a shipping container, which will be sealed and not opened until the container reaches Australia.

Security of the consignment is to be maintained until release from quarantine in Australia.

i. On-arrival inspection, remedial action and clearance by AQIS

AQIS will undertake a documentation compliance examination for consignment verification purposes at the port of entry in Australia prior to inspection and release from quarantine. No land bridging of goods will be permitted unless goods have cleared quarantine.

Consignments will be inspected by AQIS using the standard AQIS inspection protocol. The detection of live quarantine pests and/or regulated articles will result in the failure of the inspection lot.

AQIS inspectors are trained to detect all life stages of arthropod pests, including eggs. On arrival inspections are conducted in accordance with AQIS work procedures, which include optical enhancement where necessary.

The sampling methodology in the AQIS inspection protocol provides 95% confidence that there is not more than 0.5% infestation in the consignment. The sample size for inspection of Tahitian limes is given below.

Consignment size (Units)	Sample size (Units)
For ‘consignments’ of fruit of less than 1000 units*	either 450 units or 100% of consignment (whichever is smaller)
For ‘consignments’ of fruit of greater than or equal to 1000 units	600 units

*Unit = one Tahitian lime fruit

AQIS inspection procedures for the on-arrival inspection of citrus fruit require the removal of at least 10% of the buttons (calyces) to allow inspection for any pests under the buttons.

If no live quarantine pests are detected in the sample, the consignment is considered to be free from quarantine pests and will be released from quarantine.

Remedial action

If live quarantine pests or regulated articles are found during an inspection, the importer will be given the option to treat (if a suitable treatment is available), re-export or destroy the consignment.

Methyl bromide fumigation is currently used by AQIS to control arthropod pests detected during on-arrival inspections. Methyl bromide is commonly used at a treatment rate of 32g/m3 for 2 hours at temperatures of 21°C or above, with an increase of 8g/m3 for each decrease of 5°C or less in temperature.

Documentation errors

Any ‘consignment’ with incomplete documentation, or where certification does not conform to specifications, or seals on the containers are damaged or missing, will be held pending clarification by DAVAR-NC and determination by AQIS, with the options of re-export or destruction. DAVAR-NC will be notified immediately by AQIS of any such problems.

Uncategorised pests

If an organism is detected on Tahitian limes from New Caledonia that has not been categorised, it will require assessment to determine its quarantine status and if phytosanitary action is required. The detection of any pests of quarantine concern not already identified in the analysis may result in the suspension of the trade while a review is conducted to ensure that the existing measures continue to provide the appropriate level of phytosanitary protection for Australia.

j. Audit of protocol

During the first season of trade, an officer from Biosecurity Australia and/or an officer from AQIS will visit areas in New Caledonia designated for export of Tahitian limes to Australia in order to audit the operation of the protocol including registration and operational procedures.

k. Review of policy

This policy will be reviewed at the end of the first year of export of Tahitian limes from New Caledonia to Australia and in the event of new outbreaks in New Caledonia of pests of quarantine concern to Australia.

l. Specific phytosanitary requirements for fruit flies - Certified mature green fruit

In accordance with ICA-15 (http://www.dpi.qld.gov.au/health/4145.html)* or an equivalent system, Tahitian limes will be harvested at the mature green stage. Fruit certified as mature green under this import policy will comply with the following two requirements:

Mature green	mature green fruit with skin free from yellow colouring.
Unbroken skin	the skin has no pre-harvest crack, puncture, pulled stem or other break that penetrates through to the flesh and has not healed with callus tissue.

The sampling system used to certify mature green status will be conducted during the general inspection for quarantine pests and comply with sampling regimes required under ICA-15 or an equivalent system. Each fruit in the sampling package shall be removed and examined for green colour and unbroken skin as described above.

If sample fruits do not comply with the mature green requirements detailed above, the consignment will be rejected or the importers will be offered the option of re-sorting, re-export or destruction. If sorting is to be performed and agreed by importers, the process must be undertaken in quarantine-approved premises under the supervision of AQIS inspectors. AQIS will re-inspect the consignments after re-sorting to confirm that remedial action has been effective.

* A full copy of ICA 15 is available from Plant Biosecurity on request. ICA 15 – Mature Green Condition of Passionfruit, Tahitian limes and Black Sapotes was provided courtesy of the Department of Primary Industries and Fisheries, Queensland.

CONCLUSIONS

The findings of this final IRA report are based on a comprehensive analysis of relevant scientific literature and existing import requirements for limes from Egypt, New Zealand, Spain and the USA (California, Arizona, Texas).

Biosecurity Australia considers that the risk management measures described in this final IRA report will provide an appropriate level of protection against the pests identified in the risk assessment.

In the course of preparing the final IRA report, Biosecurity Australia received and considered stakeholder comments on the revised draft IRA report. An overview of stakeholder comments and a list of those who commented are included in this final IRA report. Biosecurity Australia has considered all scientific issues raised in the submissions of stakeholders and material matters raised have been incorporated into, or addressed in, this final IRA report.

FURTHER STEPS IN THE IMPORT RISK ANALYSIS PROCESS[4]

The IRA process requires that the following steps be followed for the implementation of import policy:

- A thirty day appeal period commencing from the release date of the final IRA report (appeals will be considered if there was a significant deviation from the process as set out in the IRA Handbook or a significant body of scientific evidence relevant to the outcome of the IRA was not considered);
- Consideration of any appeals;
- If no appeals, or if appeals are rejected, the recommended policy will be submitted to the Director of Animal and Plant Quarantine who will make the final policy determination; and
- Biosecurity Australia will notify registered stakeholders, DAVAR-NC and the WTO of the final policy determination.

4 The process described here is the process as outlined in Biosecurity Australia's *Import Risk Analysis Handbook* 2003.

STAKEHOLDER COMMENTS ON THE REVISED DRAFT IRA REPORT

Biosecurity Australia has received comments on the revised draft IRA report for Tahitian limes from New Caledonia from five stakeholders, namely

	Organisation	Representative	Date received
1	Queensland Department of Primary Industries and Fisheries	Jim Varghese – Director General	13 April 2005
2	Australian Citrus Growers Inc	Leonie Burrows – Executive Director	14 April 2005
3	Department of Agriculture – Western Australia	Shashi Sharma – Program Manager, Plant Health	15 April 2005
4	New South Wales Department of Primary Industries	B. D. Buffier – Director General	3 June 2005
5	Direction des Affaires Vétérinaires Alimentaires et Rurales - New Caledonia	Ch. Desoutter - Director	21 November 2005

Comments were received relating to a number of pests and their categorisation, including regional freedom status, the methodology used in this IRA and the results of the risk ratings attributed to certain pests.

These comments have been carefully considered in the preparation of the final IRA report, and Biosecurity Australia would like to thank all those who provided comments, as these assist in ensuring that the risk assessment process is technically accurate and rigorous.

Detailed responses to these comments have been prepared and are available on the public file held by Biosecurity Australia.

Comments on the revised draft IRA report from DAVAR-NC, forwarded to the Australian High Commission in New Caledonia in a letter dated 11 April 2005, were received by Biosecurity Australia on 21 November 2005. These comments have been considered and responded to outside the formal consultation process.

APPENDICES

APPENDIX 1 PEST CATEGORISATION FOR TAHITIAN LIMES FROM NEW CALEDONIA (PRESENCE OR ABSENCE)

Pest[1]	Common name/s	Present in New Caledonia	Reference	Present in Australia[2]	Reference	Consider further[3]
ARTHROPODS						
Acari [mites]						
Brevipalpus phoenicis (Geijskes) [Acari: Tenuipalpidae]	red crevice mite	yes	Brun & Chazeau (1980)	yes	CABI (2004)	no
Phyllocoptruta oleivora (Ashmead) [Acari: Eriophyidae]	citrus rust mite	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a); Woods *et al*. (1996)	no
Polyphagotarsonemus latus (Banks) [Acari: Tarsonemidae]	broad mite	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a)	no
Tetranychus neocaledonicus André [Acari: Tetranychidae]	vegetable spider mite	yes	Brun & Chazeau (1980)	yes	UQIC (2004); Smith *et al.* (1997a)	no

Pest[1]	Common name/s	Present in New Caledonia	Reference	Present in Australia[2]	Reference	Consider further[3]
Coleoptera [beetles; weevils]						
Bradymerus amicorum Fairmaire [Coleoptera: Tenebrionidae]	beetle	yes	Brun & Chazeau (1980)	no	NA	yes
Ceresium flavipes (Fabricius) [Coleoptera: Cerambycidae]	longhorn beetle	yes	Brun & Chazeau (1980)	yes* (not in WA)	Storey (2002)	yes
Onidistus pacificus Lansberge [Coleoptera: Curculionidae]	weevil	yes	Brun & Chazeau (1980)	no	NA	yes
Helmoreus dufouri Montrouzier synonym *Plintheria dufouri* Montrouzier [Coleoptera: Anthribidae]	beetle	yes	Brun & Chazeau (1980)	no	NA	yes
Diptera [flies]						
Bactrocera curvipennis (Froggatt) [Diptera: Tephritidae]	banana fruit fly	yes	Amice & Sales (1997)	no	NA	yes
Bactrocera psidii (Froggatt) [Diptera: Tephritidae]	South Sea guava fruit fly	yes	Amice & Sales (1997)	no	NA	yes
Bactrocera tryoni (Froggatt) [Diptera: Tephritidae]	Queensland fruit fly	yes	Amice & Sales (1997)	yes (under official control in some regions)	Drew (1989)	yes
Bactrocera umbrosa (Fabricius)	breadfruit fly	yes	Amice & Sales	No (present in	NA	yes

Pest[1]	Common name/s	Present in New Caledonia	Reference	Present in Australia[2]	Reference	Consider further[3]
[Diptera: Tephritidae]			(1997)	Torres Strait Islands)		
Dirioxa pornia (Walker) [Diptera: Tephritidae]	South sea fly, Island fruit fly	yes	Brun & Chazeau (1980)	yes	White & Elson-Harris (1994)	no
Hemiptera [aphids; leafhoppers; mealybugs; psyllids; scales; true bugs; whiteflies]						
Aonidiella aurantii (Maskell) [Hemiptera: Diaspididae]	red scale	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a)	no
Aphis gossypii Glover [Hemiptera: Aphididae]	cotton aphid	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a)	yes[5]
Bemisia giffardi (Kotinski) synonym *Asterobemisia helyi* (Dumbleton) [Hemiptera: Aleyrodidae]	Giffardi white fly	yes	Brun & Chazeau (1980)	yes* (not in WA)	Carver & Reid (1996); Stuart (2000)	yes
Ceroplastes pseudoceriferus Green synonym *Ceroplastes ceriferus* (Fabricius) [Hemiptera: Coccidae]	wax scale	yes	Brun & Chazeau (1980)	yes	APPD (2004)	no
Ceroplastes rubens Maskell [Hemiptera: Coccidae]	pink waxy scale	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a)	no
Chrysomphalus aonidum (Linnaeus)	purple scale	yes	Brun & Chazeau	yes	Smith *et al.*	no

[5] This aphid is a known vector of citrus tristeza virus (CTV).

Pest[1]	**Common name/s**	**Present in New Caledonia**	**Reference**	**Present in Australia[2]**	**Reference**	**Consider further[3]**
synonym *Chrysomphalus ficus* Ashmead [Hemiptera: Diaspididae]			(1980)		(1997a); Woods (2001)	
Coccus hesperidum Linnaeus [Hemiptera: Coccidae]	soft scale	yes	Ben-Dov (1993); Williams & Watson (1990)	yes	Smith *et al.* (1997a)	no
Coccus longulus (Douglas) synonym *Coccus elongatus* (Sing.) [Hemiptera: Coccidae]	long brown scale	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a); Richards (1968)	no
Coccus viridis (Green) [Hemiptera: Coccidae]	soft green scale	yes	Brun & Chazeau (1980)	yes	Poole (2004); Smith *et al.* (1997a)	no
Euricania translucida Montrouzier [Hemiptera: Ricaniidae]	leafhopper	yes	Brun & Chazeau (1980)	no	NA	yes
Ferrisia virgata (Cockerell) [Hemiptera: Pseudococcidae]	striped mealybug	yes	Brun & Chazeau (1980)	yes* (not in WA)	CABI (2004); Stuart (2000); Williams (1985)	yes
Icerya purchasi Maskell [Hemiptera: Margarodidae]	cottony cushion scale	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a)	no
Icerya seychellarum (Westwood) [Hemiptera: Margarodidae]	Seychelles fluted scale	yes	Brun & Chazeau (1980)	yes* (not in WA)	Smith *et al.* (1997a)	yes
Lepidosaphes beckii (Newman) [Hemiptera: Diaspididae]	mussel scale	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a)	no

Pest[1]	**Common name/s**	**Present in New Caledonia**	**Reference**	**Present in Australia[2]**	**Reference**	**Consider further[3]**
Lepidosaphes gloverii (Packard) [Hemiptera: Diaspididae]	glover scale	yes	Brun & Chazeau (1980)	yes* (not in WA)	Smith *et al.* (1997a); Stuart (2000)	yes
Lopholeucaspis cockerelli (Grandpré & Charmoy) [Hemiptera: Diaspididae]	diaspine scale	yes	Brun & Chazeau (1980)	no	NA	yes
Mictis profana (Fabricius) [Hemiptera: Coreidae]	crusader bug	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a)	no
Morganella longispina (Morgan) [Hemiptera: Diaspididae]	plumose scale	yes	Brun & Chazeau (1980)	yes* (not in WA)	Naumann (1993)	yes
Nezara viridula (Linnaeus) [Hemiptera: Pentatomidae]	green vegetable bug	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a)	no
Nipaecoccus filamentosus (Cockerell) [Hemiptera: Pseudococcidae]	mealybug	yes	Brun & Chazeau (1980)	no	NA	yes
Nipaecoccus viridis (Newstead) synonym *Nipaecoccus vastator* Maskell [Hemiptera: Pseudococcidae]	spherical mealybug	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a); NAQS (1992)	no
Orchamoplatus caledonicus Dumbleton [Hemiptera: Aleyrodidae]	white fly	yes	Brun & Chazeau (1980)	no	NA	yes
Orchamoplatus dentatus Dumbleton [Hemiptera: Aleyrodidae]	white fly	yes	Brun & Chazeau (1980)	no	NA	yes

Pest[1]	Common name/s	Present in New Caledonia	Reference	Present in Australia[2]	Reference	Consider further[3]
Orchamoplatus dumbletoni (Cohic) [Hemiptera: Aleyrodidae]	white fly	yes	Brun & Chazeau (1980)	no	NA	yes
Orchamoplatus noumeae Russell [Hemiptera: Aleyrodidae]	white fly	yes	Brun & Chazeau (1980)	no	NA	yes
Parlatoria cinerea Deane & Hadden [Hemiptera: Diaspididae]	tropical grey chaff scale	yes	Brun & Chazeau (1980)	no	NA	yes
Pinnaspis aspidistrae (Signoret) [Hemiptera: Diaspididae]	fern scale	yes	Brun & Chazeau (1980)	yes* (not in WA)	CIE (1977)	yes
Planococcus citri (Risso) [Hemiptera: Pseudococcidae]	citrus mealybug	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a); Williams (1985)	no
Pseudaonidia trilobitiformis (Green) [Hemiptera: Diaspididae]	trilobite scale	yes	Brun & Chazeau (1980)	yes* (not in WA)	CIE (1981)	yes
Pulvinaria psidii (Maskell) synonym *Pulvinaria darwiniensis* Froggatt [Hemiptera: Coccidae]	soft scale	yes	Brun & Chazeau (1980)	yes* (not in WA)	Qin & Gullan (1992); Stuart (2000)	yes
Tectocoris diophthalmus (Thunberg) [Hemiptera: Scutelleridae]	cotton harlequin bug	yes	Amice (1996)	yes	Page (1970)	no
Toxoptera aurantii (Boyer de Fonscolombe) [Hemiptera: Aphididae]	black citrus aphid	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a)	no

Pest[1]	Common name/s	Present in New Caledonia	Reference	Present in Australia[2]	Reference	Consider further[3]
Unaspis citri Comstock [Hemiptera: Diaspididae]	citrus snow scale	yes	Brun & Chazeau (1980)	yes* (not in WA)	Smith *et al.* (1997a); Stuart (2000)	yes
Lepidoptera [butterflies; moths]						
Eudocima fullonia (Clerck) synonym *Othreis fullonia* Linnaeus [Lepidoptera: Noctuidae]	fruit piercing moth	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a)	no
Eudocima materna Linnaeus synonym *Othreis materna* (Linnaeus) [Lepidoptera: Noctuidae]	fruit piercing moth	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a)	no
Eudocima salaminia (Cramer) [Lepidoptera: Noctuidae]	fruit piercing moth	yes	Brun & Chazeau (1980)	yes* (not in WA)	Smith *et al.* (1997a); Stuart (2000)	yes
Ophiusa coronata (Fabricius) [Lepidoptera: Noctuidae]	fruit piercing moth	yes	Brun & Chazeau (1980)	yes	Herbison-Evans & Crossley (2002)	no
Papilio anactus W.S. Macleay [Lepidoptera: Papilionidae]	small citrus butterfly	yes	Brun & Chazeau (1980)	yes	Nielsen *et al.* (1996)	no
Papilio ilioneus amynthor Boisduval [Lepidoptera: Papilionidae]	citrus swallowtail	yes	Brun & Chazeau (1980)	no	NA	yes
Papilio montrouzieri Boisduval [Lepidoptera: Papilionidae]	citrus swallowtail	yes	Brun & Chazeau (1980)	no	NA	yes

Pest[1]	Common name/s	Present in New Caledonia	Reference	Present in Australia[2]	Reference	Consider further[3]
Phyllocnistis citrella Stainton [Lepidoptera: Gracillaridae]	Asian leafminer	yes	Brun & Chazeau (1980)	yes	Smith *et al.* (1997a)	no
Serrodes campana (Guenée) [Lepidoptera: Noctuidae]	fruit piercing moth	yes	Brun & Chazeau (1980)	yes* (not in WA)	Common (1990); Nielsen *et al.* (1996)	yes
Serrodes mediopallens A.E. Prout [Lepidoptera: Noctuidae]	fruit piercing moth	yes	Brun & Chazeau (1980)	yes* (not in WA)	Nielsen *et al.* (1996)	yes
CONTAMINATING PESTS						
Wasmannia auropunctata (Roger) [Hymenoptera: Formicidae]	little fire ant	yes	Fabres & Brown (1978)	no	NA	yes
ALGAE						
Cephaleuros virescens Künze [Trentepohliales: Trentepohliaceae]	algal disease	yes	Kohler (1985)	yes* (not in WA)	APPD (2004); Stuart (2000)	yes
FUNGI						
Lasiodiplodia theobromae (Pat.) Griffith & Maubl.	diplodia stem-end rot	yes	Kohler (1985)	yes	APPD (2004)	no
Cochliobolus geniculatus Nelson anamorph *Curvularia geniculata* (Tracy	root rot	yes	Kohler (1985)	yes	Shivas (1989)	no

Pest[1]	Common name/s	Present in New Caledonia	Reference	Present in Australia[2]	Reference	Consider further[3]
& Earle) Boedijn						
Corticium salmonicolor Berk. & Broome	pink disease	yes	Kohler (1985)	yes* (not in WA)	APPD (2004)	yes
Diaporthe citri F.A. Wolf anamorph *Phomopsis citri* H. Fawc. Non (Sacc.) Traverso & Spessa, hom. illeg.	melanose	yes	Kohler (1985)	yes	APPD (2005)	no
Fusarium stilboides Wollenw. teleomorph *Gibberella stilboides* W.L. Gordon ex C. Booth	bark disease	yes	Amice (1996)	yes	APPD (2004)	no
Ganoderma philippii (Bres. & Henn. ex Sacc.) Bres. synonym *Ganoderma pseudoferreum* (Wakef.) Overreem & Steinm.	red root rot	yes	Amice (1996)	no	IMI (1993)	yes
Geotrichum candidum Link	sour rot	yes	Kohler (1985)	yes	APPD (2004)	no
Glomerella cingulata (Stonem.) Spaulding & H. Schrenk	anthracnose, fruit rot	yes	Kohler (1985)	yes	APPD (2004)	no
Meliola citricola Syd. & P. Syd.	black mildew	yes	Kohler (1985)	no	NA	yes
Penicillium digitatum (Pers.:Fr.) Sacc.	green mould	yes	Kohler (1985)	yes	APPD (2004)	no
Penicillium italicum Wehmer	blue mould	yes	Kohler (1985)	yes	APPD (2004)	no
Phellinus noxius (Corner) G. Cunn.	brown root rot	yes	Kohler (1985)	yes* (not in WA)	CABI (2004); Stuart (2000)	yes

Pest[1]	**Common name/s**	**Present in New Caledonia**	**Reference**	**Present in Australia**[2]	**Reference**	**Consider further**[3]
Phytophthora nicotianae Breda de Haan synonym *Phytophthora parasitica* Dastur var. *nicotianae* (Breda de Haan) Tucker	root and collar rot	yes	Kohler (1985)	yes	APPD (2004); Shivas (1989)	no
Septobasidium crustaceum Couch	felty fungus	yes	Kohler (1985)	no	NA	yes
Sphaceloma fawcetti Jenkins teleomorph *Elsinoe fawcettii* Bitancourt & Jenkins	citrus scab	yes	Kohler (1985)	yes (possibly a different pathotype) * (not in WA)	APPD (2004); Barkley (1998)	yes
VIRUSES						
Citrus ringspot virus (CRSV)	citrus scaly bark, psorosis of citrus	yes	Kohler (1985)	yes* (not in WA)	Fraser & Broadbent (1979)	yes
Citrus tristeza closterovirus (CTV)	tristeza, quick decline, grapefruit stem pitting, lime dieback	yes	Kohler (1985)	yes* (under official control in WA)	CABI (2004)	yes

NA No known record of this species in Australia.
* Not recorded in Western Australia (Mark Stuart, personal communication), and will be considered further for imports into WA.
1 The initial list contains all pests known to be associated with Tahitian lime in New Caledonia.
2 As described in Pest Categorisation (see *Method for Stage 2: Risk assessment*).
3 Pest present in New Caledonia, but not in Australia or present but officially controlled, are considered further in the 'present on pathway' stage of pest categorisation.

APPENDIX 2 PEST CATEGORISATION FOR TAHITIAN LIMES FROM NEW CALEDONIA (PATHWAY ASSOCIATION)

Pest[1]	**Common name/s**	**Present on the pathway**[4]	**Reference**	**Consider pest further**
ARTHROPODS				
Coleoptera [beetles; weevils]				
Bradymerus amicorum Fairmaire [Coleoptera: Tenebrionidae]	beetle	no	Mademba-Sy (1999)	no
Ceresium flavipes (Fabricius) [Coleoptera: Cerambycidae]	longhorn beetle	no	Humble *et al.* (1996)	no
Onidistus pacificus Lansberge [Coleoptera: Curculionidae]	weevil	no	Lawrence & Britton (1991)	no
Helmoreus dufouri Montrouzier synonym *Plintheria dufouri* Montrouzier [Coleoptera: Anthribidae]	beetle	no	Kuschel (1998)	no
Diptera [flies]				
Bactrocera curvipennis (Froggatt) [Diptera: Tephritidae]	banana fruit fly	yes	Drew (1989); Drew *et al.* (1982)	yes

Pest[1]	**Common name/s**	**Present on the pathway**[4]	**Reference**	**Consider pest further**
Bactrocera psidii (Froggatt) [Diptera: Tephritidae]	South Sea guava fruit fly	yes	Drew (1989); Drew *et al.* (1982)	yes
Bactrocera tryoni (Froggatt) [Diptera: Tephritidae]	Queensland fruit fly	yes	Drew (1989); Drew *et al.* (1982)	yes
Bactrocera umbrosa (Fabricius) [Diptera: Tephritidae]	breadfruit fly	yes	Drew (1989); Drew *et al*. (1982)	yes
Hemiptera [aphids; leafhoppers; mealybugs;psyllids; scales; true bugs; whiteflies]				
Aphis gossypii Glover [Hemiptera: Aphididae]	cotton aphid	no	Capinera (2000)	no
Bemisia giffardi (Kotinski) synonym *Asterobemisia helyi* (Dumbleton) [Hemiptera: Aleyrodidae]	Giffardi white fly	no	Brun & Chazeau (1980)	no
Euricania translucida Montrouzier [Hemiptera: Ricaniidae]	planthopper	no	Chou *et al.* (1985); Logan *et al*. (2002)	no
Ferrisia virgata (Cockerell) [Hemiptera: Pseudococcidae]	striped mealybug	yes	CABI (2004)	yes
Icerya seychellarum (Westwood) [Hemiptera: Margarodidae]	Seychelles fluted scale	no	CABI (2004)	no
Lepidosaphes gloverii (Packard) [Hemiptera: Diaspididae]	glover scale	yes	Smith *et al.* (1997a)	yes

Pest[1]	**Common name/s**	**Present on the pathway**[4]	**Reference**	**Consider pest further**
Lopholeucaspis cockerelli (Grandpré & Charmoy) [Hemiptera: Diaspididae]	diaspine scale	yes	Williams & Watson (1988)	yes
Morganella longispina (Morgan) [Hemiptera: Diaspididae]	plumose scale	yes	Hamon (1981)	yes
Nipaecoccus filamentosus (Cockerell) [Hemiptera: Pseudococcidae]	mealybug	yes	Smith *et al.* (1997a)	yes
Orchamoplatus caledonicus Dumbleton [Hemiptera: Aleyrodidae]	white fly	no	Martin (1985); Nguyen *et al.* (1993)	no
Orchamoplatus dentatus Dumbleton [Hemiptera: Aleyrodidae]	white fly	no	Mound & Halsey (1978)	no
Orchamoplatus dumbletoni (Cohic) [Hemiptera: Aleyrodidae]	white fly	no	Mound & Halsey (1978)	no
Orchamoplatus noumeae Russell [Hemiptera: Aleyrodidae]	white fly	no	Mound & Halsey (1978)	no
Parlatoria cinerea Deane & Hadden [Hemiptera: Diaspididae]	tropical grey chaff scale	yes	Williams &Watson (1988)	yes
Pinnaspis aspidistrae (Signoret) [Hemiptera: Diaspididae]	fern scale	yes	Futch *et al*. (2001)	yes
Pseudaonidia trilobitiformis (Green)	trilobite scale	yes	Miller (1997)	yes

Pest[1]	**Common name/s**	**Present on the pathway**[4]	**Reference**	**Consider pest further**
[Hemiptera: Diaspididae]				
Pulvinaria psidii (Maskell) synonym *Pulvinaria darwiniensis* Froggatt [Hemiptera: Coccidae]	soft scale	no	Mau & Kessing (1992)	no
Unaspis citri Comstock [Hemiptera: Diaspididae]	citrus snow scale	yes	Smith *et al.* (1997a)	yes
Lepidoptera [butterflies; moths]				
Eudocima salaminia (Cramer) [Lepidoptera: Noctuidae]	fruit piercing moth	no	Fay (2000); Smith *et al*. (1997a)	no
Papilio ilioneus amynthor Boisduval [Lepidoptera: Papilionidae]	citrus swallowtail	no	Holloway & Peters (1976)	no
Papilio montrouzieri Boisduval [Lepidoptera: Papilionidae]	citrus swallowtail	no	Holloway & Peters (1976)	no
Serrodes campana (Guenée) [Lepidoptera: Noctuidae]	fruit piercing moth	no	Common (1990)	no
Serrodes mediopallens A.E. Prout [Lepidoptera: Noctuidae]	fruit piercing moth	no	Nielsen *et al.* (1996)	no

Pest[1]	**Common name/s**	**Present on the pathway**[4]	**Reference**	**Consider pest further**
CONTAMINATING PESTS				
Wasmannia auropunctata (Roger) [Hymenoptera: Formicidae]	little fire ant	yes	Fabres & Brown (1978)	yes
ALGAE				
Cephaleuros virescens Kunze [Trentepohliales: Trentepohliaceae]	algal disease	no	Timmer *et al*. (2000)	no
FUNGI				
Corticium salmonicolor Berk. & Broome	pink disease	no	Timmer *et al*. (2000)	no
Ganoderma philippii (Bres. & Henn. ex Sacc.) Bres. synonym *Ganoderma pseudoferreum* (Wakef.) Overreem & Steinm.	red root rot	no	CABI (2004)	no
Meliola citricola Syd. & P. Syd.	black mildew	yes	Beattie (2003)	yes
Phellinus noxius (Corner) G. Cunn.	brown root rot	no	CABI (2004)	no
Septobasidium crustaceum Couch	felty fungus	no	Timmer *et al*. (2000)	no
Sphaceloma fawcetti Jenkins teleomorph *Elsinoe fawcettii* Bitancourt & Jenkins	citrus scab	yes	Kohler (1985); Timmer *et al*. (2000)	yes

Pest[1]	**Common name/s**	**Present on the pathway[4]**	**Reference**	**Consider pest further**
VIRUSES				
Citrus ringspot virus (CRSV)	citrus scaly bark, psorosis of citrus	no	Timmer *et al*. (2000)	no
Citrus tristeza closterovirus (CTV)	tristeza, quick decline, grapefruit stem pitting, lime dieback	no	Timmer *et al*. (2000)	no

[4] Describes whether the pest is associated with fresh individual limes and therefore if it is on the pathway. Pests that are known to be associated with individual fruit and either not present in Australia or present but officially controlled, are considered further in the second stage of pest categorisation.

APPENDIX 3 POTENTIAL FOR ESTABLISHMENT OR SPREAD AND ASSOCIATED CONSEQUENCES FOR PESTS OF TAHITIAN LIMES FROM NEW CALEDONIA

Scientific name	Common name	Potential for establishment and spread in the PRA area	Reference	Potential for economic consequences	Reference	Pest to be considered further?
ARTHROPODS						
Diptera [flies]						
Bactrocera curvipennis (Froggatt)	banana fruit fly	feasible	Drew *et al*. (1982)	significant	Drew *et al*. (1982)	yes
Bactrocera psidii (Froggatt)	South Sea guava fruit fly	feasible	Drew *et al*. (1982)	significant	Drew *et al*. (1982)	yes
Bactrocera tryoni (Froggatt)	Queensland fruit fly	feasible	Drew *et al*. (1982)	significant	Drew *et al*. (1982)	yes
Bactrocera umbrosa (Fabricius)	breadfruit fly	feasible	Drew *et al*. (1982)	significant	Drew *et al*. (1982)	yes
Hemiptera [aphids; leafhoppers; mealybugs;psyllids; scales; true bugs; whiteflies]						
Ferrisia virgata (Cockerell)	striped mealybug	feasible	CABI (2004)	significant	Schreiner (2000)	yes
Lepidosaphes gloveri (Packard)	glover scale	feasible	Smith *et al*. (1997a)	significant	Smith *et al*. (1997a)	yes
Lopholeucaspis cockerelli (Grandpré & Charmoy)	diaspine scale	feasible	Anon. (1976); Williams & Watson (1988)	significant	Anon. (1976); Williams & Watson (1988)	yes
Morganella longispina	plumose scale	feasible	Fasulo & Brooks (2001) (note: this reference does not give specific information on this	significant	Pena & Johnson (2001)	yes

Scientific name	Common name	Potential for establishment and spread in the PRA area	Reference	Potential for economic consequences	Reference	Pest to be considered further?
(Morgan)			species, but gives general information about the Diaspididae family and other diaspid scales. Little information is available on this species)			
Nipaecoccus filamentosus (Cockerell)	mealybug	feasible	APPPC (1987); Williams & de Willink (1992)	significant	APPPC (1987); Williams & de Willink (1992)	yes
Parlatoria cinerea Deane & Hadden	tropical grey chaff scale	feasible	Williams & Watson (1988)	significant	Gravena *et al*. (1993); Williams & Watson (1988)	yes
Pinnaspis aspidistrae (Signoret)	fern scale	feasible	Tenbrink & Hara (1992)	significant	Tenbrink & Hara (1992)	yes
Pseudaonidia trilobitiformis (Green)	trilobite scale	feasible	Fasulo & Brooks (2001) (note: this reference does not give specific information on this species, but gives general information about the Diaspididae family and other diaspid scales. Little information is available on this species)	significant	Morton (1987)	yes
Unaspis citri Comstock	citrus snow scale	feasible	Smith *et al*. (1997a)	significant	Smith *et al*. (1997a)	yes
CONTAMINATING PESTS						
Wasmannia auropunctata (Roger)	little fire ant	feasible	Anon. (1999)	significant	Williams (1994)	yes

Scientific name	Common name	Potential for establishment and spread in the PRA area	Reference	Potential for economic consequences	Reference	Pest to be considered further?
FUNGI						
Meliola citricola Syd. & P. Syd.	black mildew	feasible	Dingley *et al.* (1981)	significant	Beattie (2003)	yes
Sphaceloma fawcetti Jenkins teleomorph *Elsinoe fawcettii* Bitancourt & Jenkins	citrus scab	feasible	Timmer *et al.* (2000)	significant	Tan *et al.* (1999)	yes

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APPENDIX 4 DATASHEETS

ARTHROPODS

Bactrocera (*Bactrocera*) *curvipennis* (Froggatt, 1909) [Diptera: Tephritidae]

Synonyms and changes in combination: *Dacus curvipennis* Froggatt, 1909; *Strumeta curvipennis* Perkins, 1939; *Dacus* (*Strumeta*) *curvipennis* Drew, 1974.

Common name(s): Banana fruit fly.

Hosts: *Anacardium occidentale* (cashew); *Annona reticulata* (custard apple); *Annona squamosa* (sugar apple); *Calophyllum inophyllum* (Alexandrian laurel); *Capsicum annuum* (bell pepper, capsicum); *Carica papaya* (pawpaw); *Citrus* spp.; *Citrus latifolia* (Tahitian limes: ripe fruit); *Citrus maxima* (pummelo); *Citrus* x *paradisi* (grapefruit); *Citrus reticulata* (mandarin); *Citrus sinensis* (sweet orange); *Diospyros macrocarpa* (ebony); *Eugenia uniflora* (Surinam cherry); *Guettarda speciosa*; *Lycopersicon esculentum* (tomato); *Malpighia glabra* (Barbados cherry); *Mangifera indica* (mango); *Prunus persica* (nectarine, peach); *Psidium cattleianum* (cherry guava); *Psidium guajava* (guava); *Syzygium jambos* (rose apple); *Terminalia catappa* (tropical almond, wild almond) (Anon., 1996).

Plant part affected: Fruit, pod.

Distribution: New Caledonia; Vanuatu.

Biology

Life history: Adults of this species are smaller than the average fruit fly and have a predominantly dark thorax and orange brown abdomen with a characteristic wing pattern. The adults have a habit of holding their wings at an angle to the body and slowly raising and lowering them. Adults have very small, pale brown facial spots. The scutum is predominately black with lateral yellow stripes. The wings have a broad brown costal band, which extends along the cross veins and forms an anal streak. The outer corner of the costal cells is pale brown. The orange-brown abdomen has a narrow, brown, transverse band that merges into broad lateral black margins toward the base (Drew, 1989).

The female fly has a very conspicuous ovipositor, which is greatly extended when eggs are being laid. Females lay eggs just below the surface of the rind of fruits that are within a few weeks of maturity. Eggs are cream-coloured and are 1 mm long and 0.2 mm wide. The eggs are laid in batches and after two to three days the larvae hatch and feed within fruit. The number of larvae per fruit varies from 1 to 12 or more. The larvae go through three instars and vary in length from 7–9 mm. The larvae are yellowish in colour, broad at the anal end and tapering to a point in front. When mature, the larvae pupate in the soil, under debris, in fruit cases, etc. The pupa, or resting stage, is enclosed in a brown, cylindrical puparium, consisting of the hardened cast skin of the larvae (O’Conor, 1969). Adults emerge after approximately 7-10 days, but do not become sexually mature for a further 7-10 days. Adult females can live for some months and can lay hundreds of eggs (Drew, 1989). Adult flies cannot survive more than a few days without feeding.

The ‘stings’ or punctures made in the rind of citrus fruit by the ovipositor of the female can allow the entry of pathogens, which can cause rapid decay of the fruit. The ‘sting’ may show as a circular, brown spot. Infested fruit often falls to the ground prematurely. *Bactrocera curvipennis* may infest Tahitian lime fruits when they are overripe. This species of fruit fly is attracted to Cue lure.

Control

Mature green condition

This measure will reduce the chance of quarantine fruit flies being introduced with Tahitian limes by excluding fruit that shows yellowing (entering the final stage of maturity), pre-harvest cracks, stings or punctures or other breaks in the skin (indicating a potential wound site through which the fruit flies may have deposited eggs within the fruit). Sorting and rejection of fruit for these reasons may occur during the harvesting, grading and packing of export fruit (quality control stage). Pre-export inspection and on-arrival inspection (details in Section 5: Proposed Phytosanitary Import Requirements) will verify the mature green status of Tahitian limes in the consignment in accordance with the requirements of ICA-15.

Orchard sanitation

Some authors have reported that overripe fruit of *Citrus* spp., including Tahitian limes, can be hosts for economic fruit fly species in New Caledonia (Anon., 1996; Drew *et al*., 1982; Sales & Paulaud, 1995). The chance of fruit fly infestation during field production would be reduced by implementing orchard sanitation involving the removal of ripe and fallen Tahitian lime fruits from the orchard regularly, and then, deeply burying or spraying these fruit with insecticides.

In China, infested fruits were handpicked, buried in the soil to about one metre in depth and the soil surface sprayed with insecticide. If infested fruit had dropped and decayed on the ground, insecticide was sprayed around the fruit to kill newly emerged larvae and pupae. By implementing orchard sanitation in this manner, fruit fly infestations were reduced (Yang, 1991).

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Bactrocera (*Bactrocera*) *psidii* (Froggatt, 1899) [Diptera: Tephritidae]

Synonyms and changes in combination: *Dacus ornatissimus* Froggatt, 1909; *Dacus psidii* Froggatt, 1909; *Dacus* (*Strumeta*) *psidii* Drew, 1974; *Dacus virgatus* Coquillett, 1910; *Strumeta psidii* Perkins, 1939; *Tephrititis psidii* Froggatt, 1899.

Common name(s): South Sea guava fruit fly.

Hosts: *Anacardium occidentale* (cashew); *Annona reticulata* (custard apple); *Annona squamosa* (sugar apple); *Citrus* spp.; *Citrus maxima* (pummelo); *Diospyros macrocarpa* (ebony); *Eugenia uniflora* (Surinam cherry); *Ficus sp*. (fig); *Inocarpus fagifer* (Polynesian chestnut, Tahiti chestnut); *Mangifera indica* (mango); *Passiflora quadrangularis* (giant granadilla); *Prunus persica* (nectarine, peach); *Psidium cattleianum* (cherry guava); *Psidium guajava* (guava); *Syzygium jambos* (rose apple); *Syzygium malaccense* (Malay apple); *Terminalia catappa* (tropical almond, wild almond); *Vitis vinifera* (wine grape) (Anon., 1996).

Some species such as *Nephelium sp*. (rambutan, pulasan and formerly lychee) were not recorded from New Caledonia and were probably based on misidentifications of another species.

Plant part affected: Fruit, pod.

Distribution: New Caledonia (Drew *et al*., 1982; White & Elson-Harris, 1994).

Biology

Life history: The life history of this species has not been thoroughly studied. Adults are medium-sized and are predominantly dark orange-brown to black in colour, with small facial spots. The thorax is orange-brown to black with short lateral yellow stripes and broad triangular dorsal markings. The abdomen is entirely glossy black. The wings have a narrow tint of extremely pale brown colouration around the costal margin, a narrow red-brown anal streak and a narrow tint of brown colouration around the cross veins. The species is attracted to Cue lure and Willison's lure (Drew, 1989).

This species has only been recorded from New Caledonia. It has the capacity to become a serious pest of horticultural crops in regions where host crops are produced (Drew, 1989). Compared with *B. tryoni*, (Queensland fruit fly), this species will probably be less economically important in New Caledonia due to its narrower host range (Drew *et al*., 1982).

When a fruit fly oviposits in green citrus fruit, tissue around the oviposited puncture grows as a protuberance, or a sting would turn brown after few days or the rind around a sting may turn yellow making it easy to identify the attacked fruits (Yang, 1991).

Control

Mature green condition

This measure will reduce the chance of quarantine fruit flies being introduced with Tahitian limes by excluding fruit that shows yellowing (entering the final stage of maturity), pre-harvest cracks, stings or punctures or other breaks in the skin (indicating a potential wound site through which the fruit flies may have deposited eggs within the fruit). Sorting and rejection of fruit for these reasons may occur during the harvesting, grading and packing of export fruit (quality control stage). Pre-export inspection and on-arrival inspection (details in Section 5: Proposed Phytosanitary Import Requirements) will verify the mature green status of Tahitian limes in the consignment in accordance with the requirements of ICA-15.

Orchard sanitation

Some authors have reported that overripe fruit of *Citrus* spp., including Tahitian limes, can be hosts for economic fruit fly species in New Caledonia (Anon., 1996; Drew *et al*., 1982; Sales & Paulaud, 1995). The chance of fruit fly infestation during field production would be reduced by implementing orchard sanitation involving the removal of ripe and fallen Tahitian lime fruits from the orchard regularly, and then, deeply burying or spraying these fruit with insecticides.

In China, infested fruits were handpicked, buried in the soil to about one metre in depth and the soil surface sprayed with insecticide. If infested fruit had dropped and decayed on the ground, insecticide was sprayed around the fruit to kill newly emerged larvae and pupae. By implementing orchard sanitation in this manner, fruit fly infestations were reduced (Yang, 1991).

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Bactrocera (*Bactrocera*) *tryoni* (Froggatt, 1899) [Diptera: Tephritidae]

Synonyms and changes in combination: *Dacus (Bactrocera) tryoni* Drew, 1982; *Strumeta tryoni* May, 1963; *Dacus (Strumeta) tryoni* Hardy, 1951; *Chaetodacus tryoni* Tryon, 1927; *Chaetodacus tryoni* var. *juglandis* Tryon, 1927; *Chaetodacus tryoni* var. *sarcocephali* Tryon, 1927; *Dacus tryoni* Froggatt, 1909; *Tephritis tryoni* Froggatt, 1897.

Common name(s): Queensland fruit fly.

Hosts: Commercial hosts - *Anacardium occidentale* (cashew); *Annona reticulata* (custard apple); *Annona squamosa* (sugar apple, sweetsop); *Artocarpus heterophyllus* (jackfruit); *Averrhoa carambola* (carambola); *Cananga odorata* (ylang-ylang); *Capsicum annuum* (bell pepper, capsicum); *Capsicum frutescens* (chilli pepper, tabasco pepper); *Carica papaya* (pawpaw); *Casimiroa edulis* (white sapote); *Citrus* spp. (Lemontey & Mademba-Sy, 1994); *Citrus aurantium* (sour orange); *Citrus latifolia* (Tahitian limes); *Citrus limon* (lemon); *Citrus maxima* (pummelo); *Citrus medica* (citron); *Citrus x paradisi* (grapefruit); *Citrus reticulata* (mandarin); *Citrus sinensis* (sweet orange); *Coffea arabica* (arabica coffee); *Cydonia oblonga* (quince); *Diospyros kaki* (Chinese persimmon); *Dovyalis caffra* (kei apple); *Eremocitrus glauca* (Australian desert lime); *Eriobotrya japonica* (loquat); *Eugenia uniflora* (Surinam cherry); *Ficus benjamini* (weeping fig); *Ficus carica* (fig); *Ficus racemosa* (cluster fig); *Flacourtia jangomas* (Indian plum); *Fortunella japonica* (round kumquat); *Juglans regia* (English walnut); *Hernandia cordigera*; *Lycopersicon esculentum* (tomato); *Malpighia glabra* (Barbados cherry); *Malus domestica* (apple); *Mangifera indica* (mango); *Mimusops elengi* (Spanish cherry); *Morus alba* (white mulberry); *Morus nigra* (black mulberry); *Musa acuminata* (dwarf banana); *Olea europaea* (olive); *Opuntia ficus-indica* (Indian prickly pear); *Passiflora edulis* (passionfruit); *Passiflora quadrangularis* (giant granadilla); *Persea americana* (avocado); *Phoenix dactylifera* (date palm); *Physalis peruviana* (Cape gooseberry); *Pometia pinnata*; *Prunus armeniaca* (apricot); *Prunus avium* (sweet cherry); *Prunus cerasifera* (cherry plum, myrobalan); *Prunus domestica* (plum, prune); *Prunus persica* (nectarine, peach); *Psidium cattleianum* (cherry guava); *Psidium guajava* (guava); *Psidium littorale* (strawberry guava); *Punica granatum* (pomegranate); *Pyrus communis* (pear); *Rubus fruticosa* (blackberry); *Rubus ursinus* (loganberry); *Solanum laciniatum* (kangaroo apple); *Solanum seaforthianum* (Brazilian nightshade); *Spondias cytherea* (Jew plum); *Syzygium aqueum* (watery rose apple); *Syzygium jambos* (rose apple); *Terminalia catappa* (Pacific almond, tropical almond); *Vitis labrusca* (fox grape); *Vitis vinifera* (wine grape); *Ziziphus mauritiana* (Indian jujube). Unconfirmed reports include *Musa x paradisiaca* (banana) (CABI, 2004).

Wild hosts - Recorded from 60 wild hosts by Drew (1989), belonging to the families Anacardiaceae; Annonaceae; Apocynaceae; Capparidaceae; Celastraceae; Combretaceae; Cunoniaceae; Davidsoniaceae; Ebenaceae; Euphorbiaceae; Lauraceae; Meliaceae; Moraceae; Myrtaceae; Naucleaceae; Oleaceae; Passifloraceae; Rhamnaceae; Rutaceae; Sapindaceae; Sapotaceae; Siphonodontaceae; Smilacaceae; Solanaceae and Vitaceae (CABI, 2004).

Plant part affected: Fruit, pod.

Distribution: Australia* – (East coast from Cape York, Queensland to east Gippsland, Victoria); Chile (Easter Island (eradicated in 1974)); French Polynesia (Austral Islands, Society Islands); New Caledonia; Papua New Guinea; Torres Strait Islands (O'Conor, 1969) (CABI, 2004).

* An extensive outbreak of Queensland fruit fly was discovered in Perth, Western Australia in 1989, leading to a very expensive eradication program (Yeates, 1990).

Biology

Life history: Adult flies are about 7 mm in length, reddish brown with yellow lateral markings or stripes on the thorax. The pointed ovipositor is clearly visible at the end of the female's abdomen (Smith *et al*., 1997). The male fly is distinguished by a row of spines on either side of the abdomen (Smith *et al*., 1997). The wings have a narrow, brown costal band, a broad brown fuscous anal streak and brown costal cells.

Adult females can lay several hundred eggs when they are two to three weeks old (Anon., 1983). Females lay eggs below the surface of the fruit skin which are within a few weeks of maturity. The eggs are laid in batches of 10-12. Eggs are white in colour, banana-shaped and about 0.9-1 mm in length. The eggs hatch in two to three days and the larvae burrow into the fruit pulp to feed. The number of larvae per fruit can vary from one to 12 or more (Smith *et al*., 1997). If the fruit is green, the eggs remain dormant until the fruit begins to ripen. There is high mortality of eggs and young larvae of fruit flies, particularly in immature fruit, caused by oil released from oil cells in the rind ruptured during egg laying (Smith *et al*., 1997).

Larvae vary in length from about 3-15 mm in length, are yellow or white in colour, broad at the rear end and tapering to a point at the head end. Mature larvae are about 9 mm long and can move up to 15 cm at a time by skipping or flicking themselves into the air. In summer, larvae can complete their development in about 10 days (Smith *et al*., 1997). Mature larvae drop to the ground to find a suitable place to pupate. Pupation occurs in the soil and during summer the emergence of adult flies can take as little as nine days. Normally pupation takes about two weeks. Pupae are brown, barrel-shaped and about four to five mm in length (Anon., 1983; Smith *et al*., 1997). The life cycle takes about four to five weeks. There are at least six generations per year in northern Queensland and the Northern Territory, with the number of generations determined by temperature.

Fruit damage results from puncturing of the rind during egg laying and larvae feeding on the fruit pulp. The rind puncture is not visible at first, but later a circular yellow or brown area develops around the ‘sting’ site. The ‘stings’ or punctures made in the fruit rind can allow the entry of fungi and bacteria that cause decay. Stung fruit eventually drop to the ground where mature larvae can leave the fruit and pupate in the soil or under debris.

Adult females must feed on protein (e.g. bacteria growing on fruit and plant surfaces and on sugars in honeydew or nectar) for up to a week before they can mature and lay their eggs. Adult flies cannot survive more than a few days without feeding. Mating occurs when the females reach maturity and once hosts have been located. Movements of adult flies become localised and egg laying alternates with periods of feeding. Once suitable hosts become diminished, the females disperse in search of other hosts. The host searching ability of Queensland fruit fly is very effective, particularly when there is no suitable host nearby (Fletcher, 1973; 1989). Adults may travel over many kilometres.

B. tryoni is the most destructive insect pest of fruit and vegetable crops in Australia. It infests many commercial fruit crops, costing between $200-900 per ha depending on the variety of fruit produced and the time of harvest (Anon., 1991). Many wild plant fruits contribute to the development of extremely large fly populations in forest areas. Males are attracted to Cue lure (Drew *et al*., 1982; Drew, 1989). This species is highly competitive in comparison to other fruit flies in the South Pacific (Amice & Sales, 1997).

B. tryoni may survive the cold storage temperature of 1±0.5ºC for up to 16 days (Hill *et al*., 1988).

Control

Mature green condition

Australia has conducted host status tests for Queensland fruit fly and the results confirmed that Tahitian lime fruits at mature green stage were not a preferred host of Queensland fruit fly as reported at a Tri–State Fruit Fly Meeting (Anon., 2000). As discussed earlier in this document, States and Territories within Australia have accepted Interstate Certification Assurance (ICA) arrangements for domestic trade of horticultural commodities that are susceptible hosts to

Queensland fruit fly infestations. ICA-15 allows interstate movement of Tahitian limes based on the ‘mature green condition’. Given that ICA 15 provides an appropriate level of protection and is currently in place, the definition used in ICA 15 can also be applied for Tahitian limes from New Caledonia (i.e. mature green).

This measure will reduce the chance of quarantine fruit flies being introduced with Tahitian limes by excluding fruit that shows yellowing (entering the final stage of maturity), pre-harvest cracks, stings or punctures or other breaks in the skin (indicating a potential wound site through which the fruit flies may have deposited eggs within the fruit). Sorting and rejection of fruit for these reasons may occur during the harvesting, grading and packing of export fruit (quality control stage). Pre-export inspection and on-arrival inspection (details in Section 5: Proposed Phytosanitary Import Requirements) will verify the mature green status of Tahitian limes in the consignment.

Orchard sanitation

Some authors have reported that overripe fruit of *Citrus* spp., including Tahitian limes, can be hosts for economic fruit flies species in New Caledonia (Anon., 1996; Drew *et al*., 1982; Sales & Paulaud, 1995). The chance of fruit fly infestation during field production would be reduced by implementing orchard sanitation involving the removal of ripe and fallen Tahitian lime fruits from the orchard regularly, and then, deeply burying or spraying these fruit with insecticides.

In China, infested fruits were handpicked, buried in the soil to about one metre in depth and the soil surface sprayed with insecticide. If infested fruit had dropped and decayed on the ground, insecticide was sprayed around the fruit to kill newly emerged larvae and pupae. By implementing orchard sanitation in this manner, fruit fly infestations were reduced (Yang, 1991).

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Bactrocera (*Bactrocera*) *umbrosa* (Fabricius, 1805) [Diptera: Tephritidae]

Synonyms and changes in combination: *Bactrocera fasciatipennis* Doleschall, 1856; *Dacus conformis* Walker, 1857; *Dacus diffusus* Walker, 1860; *Dacus fascipennis* Wiedemann, 1819; *Dacus frenchi* Froggatt, 1909; *Dacus umbrosus* Fabricius, 1805; *Dacus* (*Bactrocera*) *umbrosus* Malloch, 1939; *Dacus* (*Strumeta*) *umbrosus* Hardy & Adachi, 1954; *Strumeta frenchi* Perkins, 1939; *Strumeta umbrosa* Perkins, 1939.

Common name(s): Breadfruit fly.

Hosts: This species generally attacks *Artocarpus* spp. (breadfruit), including *Artocarpus altilis* (breadfruit); *Artocarpus balncoi* (Antipolo), *Artocarpus camansi*, *Artocarpus champeden*, *Artocarpus heterophyllus* (jackfruit), *Artocarpus integer* (chempedak), *Artocarpus odoratissima*, *Artocarpus rigida* and *Momordica charantia* (balsam pear, bitter gourd). Unconfirmed reports include *Citrus* spp.; *Citrus aurantium* (sour orange); *Citrus maxima* (pummelo) and *Passiflora quadrangularis* (giant granadilla) (Drew *et al.*, 1982; Lemontey & Mademba-Sy, 1994).

Plant part affected: Fruit, pod.

Distribution: Widespread in south east Asia and the Pacific: Malaysia; New Caledonia (lowlands, especially disturbed areas); Papua New Guinea (Bismarck Archipelago, Bougainville Island); The Philippines; Solomon Islands; Vanuatu.

Biology

Life history: Adults are medium-sized and have black facial spots. The thorax is predominately black with yellow lateral stripes. The abdomen is orange-brown with variable orange markings that are sometimes broadly black laterally. Females lay eggs beneath the skin of the host fruit. The eggs hatch within one to two days and the hatching larvae feed on the host fruit for about one week. Mature larvae pupate in the soil beneath the host plant for a week or more, depending on environmental conditions. Adults occur throughout the year and commence mating within two weeks of hatching. Adult flies cannot survive more than a few days without feeding. Male flies are attracted to methyl eugenol (White & Elson-Harris, 1994).

This species is widespread and occurs throughout Southeast Asia where it attacks jackfruit, breadfruit and custard apple. In the Pacific, it has been found to attack breadfruit, jackfruit and *Citrus* spp. Yukawa (1984) reported that it is a serious pest of breadfruit and jackfruit in Indonesia.

When a fruit fly oviposits in green citrus fruit, tissue around the oviposited puncture grows as a protuberance, or a sting would turn brown after few days or the rind around a sting may turn yellow making it easy to identify the attacked fruits (Yang, 1991).

Control

Mature green condition

This measure will reduce the chance of quarantine fruit flies being introduced with Tahitian limes by excluding fruit that shows yellowing (entering the final stage of maturity), pre-harvest cracks, stings or punctures or other breaks in the skin (indicating a potential wound site through which the fruit flies may have deposited eggs within the fruit). Sorting and rejection of fruit for these reasons may occur during the harvesting, grading and packing of export fruit (quality control stage). Pre-export inspection and on-arrival inspection (details in Section 5: Proposed Phytosanitary Import Requirements) will verify the mature green status of Tahitian limes in the consignment.

Orchard sanitation

Some authors have reported that overripe fruit of *Citrus* spp., including Tahitian limes, can be hosts for economic fruit flies species in New Caledonia (Anon., 1996; Drew *et al.*, 1982; Sales & Paulaud, 1995). The chance of fruit fly infestation during field production would be reduced by implementing orchard sanitation involving the removal of ripe and fallen Tahitian lime fruits from the orchard regularly, and then, deeply burying or spraying these fruit with insecticides.

In China, infested fruits were handpicked, buried in the soil to about one metre in depth and the soil surface sprayed with insecticide. If infested fruit had dropped and decayed on the ground, insecticide was sprayed around the fruit to kill newly emerged larvae and pupae. By implementing orchard sanitation in this manner, fruit fly infestations were reduced (Yang, 1991).

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Scales

Lepidosaphes gloverii (Packard, 1869)

Lopholeucaspis cockerelli (Grandpré & Charmoy, 1899)

Morganella longispina (Morgan)

Parlatoria cinerea Deane & Hadden, 1909

Pinnaspis aspidistrae (Signoret)

Pseudaonidia trilobitiformis (Green)

Unaspis citri Comstock, 1883

Synonyms and changes in combination:

Lepidosaphes gloverii: *Aspidiotus gloverii* Packard, 1869; *Insulaspis gloverii* (Packard); *Mytilaspis gloverii* (Packard); *Myrtilaspis gloveri* (Packard); *Myrtilococcus gloveri* (Packard); *Myrtilococcus gloverii* (Packard).

Lopholeucaspis cockerelli: *Fiorinia cockerelli* Grandpré & Charmoy, 1899; *Leucaspis cockerelli* (Grandpré & Charmoy).

Morganella longispina: *Aspidiotus longispina; Aspidiotus maskelli; Hemiberlesea longispina; Morganella maskelli; Hemiberlesia longispina; Hemiberlesia maskelli.*

Parlatoria cinerea: None known.

Pinnaspis aspidistrae: *Chionaspis aspidistrae*; *Hemichionaspis aspidistrae*.

Pseudaonidia trilobitiformis: *Aspidiotus trilobitiformis.*

Unaspis citri: *Chionaspis annae* Malenotti; *Chionaspis citri* Comstock, 1883; *Dinaspis annae* Malenotti; *Dinaspis veitchi* Green & Laing, 1923; *Prontaspis citri* (Comstock) MacGillivray, 1921; *Unaspis annae* Malenotti.

Common name(s):

Lepidosaphes gloverii: Citrus scale, Glover scale, Glover's scale, long scale, long mussel scale

Lopholeucaspis cockerelli: Diaspine scale

Morganella longispina: Plumose scale, Maskell scale

Parlatoria cinerea: Chaff scale

Pinnaspis aspidistrae: Fern scale

Pseudaonidia trilobitiformis: Trilobite scale, armoured scale

Unaspis citri: Citrus snow scale

Hosts:

Lepidosaphes gloverii: Attacks all *Citrus* cultivars. *Alocasia macrorrhiza* (giant taro); *Carissa*; *Citrus*; *Codiaeum variegatum* (croton); *Erythrina* spp.; *Euonymus* (spindle trees), *Fortunella* (kumquat), *Mangifera indica* (mango); *Poncirus*.

Lopholeucaspis cockerelli: Aleurites moluccana (candlenut tree); *Barringtonia* sp.; *Barringtonia racemosa*; *Calophyllum inophyllum* (Alexandrian laurel); *Citrus* spp.; *Citrus aurantifolia* (lime); *Citrus limon* (lemon); *Citrus maxima* (pummelo); *Heliconia sp*. (false bird-of-paradise, lobster claw); *Inocarpus fagifer* (Polynesian chestnut, Tahiti chestnut); *Passiflora edulis* (passionfruit); *Persea americana* (avocado); *Pinus caribaea* var. *caribaea* (Caribbean pine); *Pinus caribaea* var. *hondurensis* (Nicaraguan pine); *Piper aduncum* (spiked pepper); *Schefflera sp*.; *Theobroma cacao* (cocoa).

Morganella longispina: Carica papaya (papaw); *Citrus*.

Parlatoria cinerea: Annona muricata (soursop); *Citrus* spp.; *Citrus aurantifolia* (lime); *Citrus latifolia* (Tahitian limes); *Citrus limon* (lemon); *Citrus maxima* (pummelo); *Citrus reticulata* (mandarin); *Citrus sinensis* (sweet orange); *Malus sylvestris* (crabapple); *Vitis vinifera* (wine grape).

Pinnaspis aspidistrae: *Adiantum* spp. (maidenhair fern); *Asparagus setaceus* (lace fern); *Asparagus sprengeri* (asparagus fern); *Asplenium* spp. (bird's nest fern); *Citrus*; *Cocos nucifera* (coconut palm); *Codiaeum variegatum* (croton); *Cycas revoluta* (cycad); *Davallia trichomanoides* (rabbit foot fern); *Dracaena* spp. (dracaena); *Dryopteris* spp. (wood fern); *Hibiscus* spp. (hibiscus); *Howeia* spp. (sentry palm); *Mangifera indica* (mango); *Nephrolepis exaltata* (boston fern); *Pelargonium* spp. (geranium); *Piper nigrum* (black pepper); *Platycerium* spp. (elkhorn); *Pleopeltis polypodioides* (resurrection fern); *Polypodium* spp. (polypody fern); *Rhapis excelsas* (rhapis palm); *Rumohra adiantiformis* (leatherleaf fern); *Saintpaulia* spp. (African violet); *Solanum melongena* (aubergine); *Syagrus romanzoffiana* (queen palm); *Tectaria* spp. (halberd fern) (CABI, 2004; Tenbrink & Hara, 1992).

Pseudaonidia trilobitiformis: Anacardium occidentale (cashew nut); *Anthurium andreanum*; *Citrus*; *Cocos nucifera* (coconut); *Coffea* (coffee); *Mangifera indica* (mango); *Persea americana* (avocado); *Theobroma cacao* (cocoa); *Zingiber officinale* (ginger).

Unaspis citri: Polyphagous on a wide range of hosts, *Citrus* being the main host of economic importance. *Ananas comosus* (pineapple); *Annona muricate* (soursop); *Artocarpus heterophyllus* (jackfruit); *Capsicum* (peppers); *Citrus*; *Citrus aurantiifolia* (lime); *Citrus aurantium* (sour orange); *Citrus limon* (lemon); *Citrus maxima* (pummelo); *Citrus reticulata* (mandarin); *Citrus sinensis* (navel orange); *Citrus x paradisi* (grapefruit); *Cocos nucifera* (coconut); *Fortunella* (kumquat); *Hibiscus* (rosemallows); *Musa* (banana); *Poncirus trifoliata* (Trifoliate orange); *Psidium guajava* (common guava); *Tillandsia usneoides* (Spanish moss).

Plant part affected: Bark, twig, branch, fruit, leaf, stem.

Distribution:

Lepidosaphes gloverii: Algeria; Argentina; Australia (no record in Western Australia); Belarus; Bolivia; Cameroon; China (Hong Kong, Taiwan); Cook Islands; Costa Rica; Cuba; Dominican Republic; Ecuador; Egypt; Federated States of Micronesia; Fiji; France; French Polynesia; Gambia; Greece; Guinea; Honduras; India; Indonesia; Israel; Italy; Jamaica; Japan; Korea, DPR; Korea, Republic of; Lebanon; Madagascar; Malaysia; Mauritius; Mexico; Morocco; Mozambique; Myanmar; Nigeria; Niue; Northern Mariana Islands; Pakistan; Papua New Guinea; Philippines; Puerto Rico; Réunion; Russian Federation; Samoa; Senegal; Sierra Leone; South Africa; Spain; Sri Lanka; Suriname; Thailand; Tonga; Trinidad and Tobago; Turkey; Uganda; USA (Alabama, California, Florida, Hawaii, Louisiana, Texas); Venezuela (CABI, 2004).

Lopholeucaspis cockerelli: Cook Islands; Fiji; Kiribati; New Caledonia; Niue; Tonga; Samoa; Vanuatu. This species has a wide distribution, although it has still not been reported from some tropical countries (Williams & Watson, 1988).

Morganella longispina: Australia (AICN, 2004) (no record in Western Australia); Barbados; Bermuda; India (unconfirmed record); New Caledonia; USA (Florida, Hawaii) (CABI, 2004).

Parlatoria cinerea: Cook Islands; French Polynesia; New Caledonia; Niue; Pitcairn; Samoa; Vanuatu. This species is found on numerous host plants (Williams & Watson, 1988).

Pinnaspis aspidistrae: Australia (no record in Western Australia); Argentina; Bermuda; Brazil; India; Indonesia; Malaysia; New Caledonia; Peru; Philippines; Suriname, USA (Florida, Hawaii) (Brun & Chazeau, 1980; CABI, 2004; CIE, 1977; Futch *et al*., 2001; Tenbrink & Hara, 1992).

Pseudaonidia trilobitiformis: Australia (CIE, 1981) (no record in Western Australia); Barbados; Dominican Republic; Grenada; Jamaica; New Caledonia (Amice, 1996); Réunion; Saint Vincent and the Grenadines; Tanzania (CABI, 2004).

Unaspis citri: Antigua and Barbuda; Argentina; Australia (New South Wales, Queensland, South Australia, Victoria, no record in Western Australia); Barbados; Benin; Bermuda; Bolivia; Brazil; British Virgin Islands; Cameroon; Chile; China; Colombia; Congo; Congo Democratic Republic; Cook Islands; Côte d'Ivoire; Cuba; Dominica; Dominican Republic; Ecuador; El Salvador; Federated States of Micronesia; Fiji; Gabon; Grenada; Guadeloupe; Guinea; Guyana; Haiti; Honduras; Jamaica; Java; Kiribati; Malaysia; Malta; Mauritius; Mexico; Montserrat; New Caledonia; New Zealand; Niger; Nigeria; Niue; Panama; Papua New Guinea; Paraguay; Peru; Portugal; Puerto Rico; Saint Kitts and Nevis; Saint Lucia; Saint Vincent and the Grenadines; Samoa; Senegal; Sierra Leone; Singapore; Solomon Islands; Togo; Tonga; Trinidad and Tobago; United States Virgin Islands; Uruguay; USA (California, Florida, Georgia, Louisiana); Vanuatu; Venezuela; Vietnam; Wallis and Futuna; West Indies; Yemen (CABI, 2004).

Biology:

Most armoured scales are very small (2-4 mm long) and the body is covered with a hard, waxy 'armour'. The cover may be separate or attached to the body (Smith *et al*., 1997). The armour covers adult females and immature males.

Adult scale females are immobile, being wingless and often without legs. Adult males are tiny, fragile, usually with one pair of wings and well-developed legs. They lack mouthparts as they do not feed. The female pupillarial (cast exuvium of the second instar) is elongate, ridged and triangular in cross section, brown in colour and covered with a thin secretion of white wax. Male scales are similar to females but are narrower in length and much smaller. Adult females are elongate-oval. (Williams & Watson, 1988).

Nymphs are active only during the first instar (or crawler) stage and may travel some distance to a new plant; they become sessile for the remaining nymphal (larval) instars. The crawlers settle down and feed upon plant juices by inserting their piercing-sucking mouthparts into the host plant. First instars (crawlers) are able to disperse by active wandering and by wind.

Armoured scales do not produce honeydew, but their feeding can damage fruit or cause leaf drop. They inject toxins into plant tissues and high populations can cause the death of the trees. This species is polyphagous and is often found in large numbers on the leaves.

In cooler regions during winter, development of all scales progresses very slowly up to the adult stage for females and up to pupal stage for males. At this stage, development stops until the onset of warmer weather. Once the warmer weather starts, adult males emerge and mating begins. Females then start reproducing within one to two months. Crawlers hatch and move onto young, new season fruit after petal fall and continue moving for several weeks. From this time until summer, the population tends to be at the same stage of development. Scale insects develop well during summer, even at low humidity.

Brun and Chazeau (1980) recorded *Lopholeucaspis cockerelli* species from New Caledonia on *Citrus* spp. *Lopholeucaspis cockerelli* was first recorded attacking *Pinus caribaea* var. *caribaea* and *P. caribaea* var. *hondurensis* in Fiji in 1974 (Anon., 1976). Little is published about *Lopholeucaspis cockerelli*, which may imply that it is of minor importance.

The spread of *Parlatoria* spp. depends on relative humidity and temperature (Gerson, 1980). They cannot spread well under low relative humidity and high temperatures. Chaff scales establish their population on limbs and trunks, but it can be widely distributed on the tree. Adults and nymphs feed on leaves, stems and fruit, which sometimes lead to fruit abscission. Chaff scales are often associated with gumming, flaking and splitting of the bark, causing dieback of branches and sometimes killing the tree. This species has been found to cover nearly 100% of bark and 70% of twigs of *Citrus sinensis* (sweet orange) in the Cook Islands (Walker & Deitz, 1979).

Parlatoria cinerea and *P. citri* McKenzie are similar species, which are found on citrus in some parts of the world (Gill, 1997). *Parlatoria cinerea* has been recorded on *Citrus* spp. in New Caledonia where it is common but difficult to find underneath colonies of *Lepidosaphes beckii* (citrus mussel scale) and *Unaspis citri* (citrus snow scale) (Williams & Watson, 1988). *Parlatoria cinerea* is usually associated with citrus and is probably one of the commonest scale insects on citrus in the South Pacific area.

Pinnaspis aspidistrae is usually found on leaves and fruit of citrus and not on the trunk or large limbs of the tree. Large colonies of males are found with only one to two females (Futch *et al*., 2001). *Pinnaspis* scales can be a quarantine problem on exports of nursery stock and cut foliage (Tenbirnk & Hara, 1992).

Unaspis citri is one of the main pests of citrus in regions where citrus is grown throughout the world. This species is usually found on the trunk and main limbs of the tree, during heavy infestations they spread to twigs, leaves and fruit. A small number of scales can cause serious damage (CABI, 2004).

Lepidosaphes gloverii is a minor pest of citrus. This species is polyphagous in tropical countries, however it is unable to survive hot, dry summers (Gill, 1997).

In general, scale insects are major citrus pests and, being small, are difficult to detect in quarantine inspections, especially at low population levels. They generally live around the sepal or under the calyx of the fruit from flowering onwards. Damage is usually caused by removal of plant sap and results in senescence of the branch or leaf drop.

Control

Field insecticide treatments

Insecticide application has been shown to give effective control against scale insects and resulted in the harvest of 95-99% export quality fruit while the unsprayed control had only 50% export quality fruit (Frankel *et al.,* 1976). The application of oil soap and/or insecticide reduced the number of scale insects and mealybugs in citrus by 93-100% (Baker & Shearin, 1992; Beattie & Ribbon, 1980; Lindquist, 1981); and with the same efficacy (93-100%) for grapevine (Su and Wang, 1988).

In Australian citrus production areas, trees are inspected regularly for scale insects, when pest levels reach 20-30% a spray is used. Monitoring is effective in determining when the pest is at its most vulnerable (the young crawler stage), as timing is vital with oil sprays (Moulds and Tugwell, 1999).

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Mealybugs

***Ferrisia virgata* (Cockerell, 1893) [Hemiptera: Pseudococcidae]**

***Nipaecoccus filamentosus* (Cockerell, 1893) [Hemiptera: Pseudococcidae]**

Synonyms and changes in combination:

Ferrisia virgata: Dactylopius ceriferus Newstead, 1894; *Dactylopius dasylirii* Cockerell; *Dactylopius magnolicida* King, 1902; *Dactylopius segregatus* Cockerell, 1893; *Dactylopius setosus* Hempel, 1900; *Dactylopius talini* Green, 1896; *Dactylopius virgatus* Cockerell, 1893; *Dactylopius virgatus* var. *farinosus* Cockerell, 1893; *Dactylopius virgatus* var. *humilis* Cockerell, 1893; *Dactylopius virgatus* var. *madagascariensis* Newstead, 1908; *Ferrisiana setosus* (Hempel); *Heliococcus malvastras* McDaniel, 1962; *Pseudococcus bicaudatus* Keuchenius, 1915; *Pseudococcus ceriferus* Newstead; *Pseudococcus dasylirii* (Cockerell); *Pseudococcus magnolicida* (King); *Pseudococcus marchali* Vayssière, 1912; *Pseudococcus segregatus* (Cockerell); *Pseudococcus setosus* Hempel; *Pseudococcus talina* Green; *Pseudococcus virgatus* (Cockerell); *Pseudococcus virgatus farinosus* (Cockerell); *Pseudococcus virgatus humilis* (Cockerell); *Pseudococcus virgatus madagascariensis* (Newstead).

Nipaecoccus filamentosus: Dactylopius filamentosus Cockerell, 1893; *Pseudococcus filamentosus* (Cockerell); *Ceroputo filamentosus* (Cockerell).

Common name(s):

Ferrisia virgata: striped mealybug, cotton scale, grey mealybug, guava mealybug, spotted mealybug, tailed coffee mealybug, tailed mealybug, white-tailed mealybug.

Nipaecoccus filamentosus: mealybug

Hosts:

Ferrisia virgata: Highly polyphagous. *Abelmoschus esculentus* (okra); *Acalypha* (Copperleaf); *Anacardium occidentale* (cashew nut); *Ananas comosus* (pineapple); *Annona*; *Arachis hypogaea* (groundnut); *Cajanus cajan* (pigeon pea); *Carica papaya* (papaw); *Citrus*; *Coccoloba uvifera* (Jamaican kino); *Cocos nucifera* (coconut); *Codiaeum variegatum* (croton); *Coffea* (coffee); *Colocasia esculenta* (taro); *Corchorus* (jutes); *Cucurbita maxima* (banana squash); *Cucurbita pepo* (ornamental gourd); *Dracaena*; *Elaeis guineensis* (African oil palm); *Ficus*; *Gossypium* (cotton); *Hibiscus* (rosemallows); *Ipomoea batatas* (sweet potato); *Leucaena leucocephala* (horse tamarind); *Litchi chinensis* (lychee); *Lycopersicon esculentum* (tomato); *Malpighia punicifolia* (Barbados cherry tree); *Mangifera indica* (mango); *Manihot esculenta* (cassava); *Manilkara*; *Musa* (banana); *Nicotiana tabacum* (tobacco); *Persea americana* (avocado); *Phaseolus* (beans); *Phoenix dactylifera* (date-palm); *Piper betle* (betel pepper); *Piper nigrum* (black pepper); *Psidium guajava* (common guava); *Punica granatum* (pomegranate); *Saccharum officinarum* (sugercane); *Solanum melongena* (aubergine); *Solanum nigrum* (black nightshade); *Theobroma cacao* (cocoa); *Vigna unguiculata* (cowpea); *Vitis vinifera* (grapevine); *Zea mays* (maize); *Zingiber officinale* (ginger) (CABI, 2004).

Nipaecoccus filamentosus: Annona reticulata (custard apple); *Asparagus sp*.; *Citrus* spp.; *Citrus aurantifolia* (lime); *Citrus aurantium* (sour orange); *Citrus deliciosa* (Mediterranean mandarin); *Citrus reticulata* (mandarin); *Clerodendrum heterophyllum*; *Euphorbia hirta* (asthma plant); *Ficus carica* (fig); *Gossypium sp*. (cotton); *Hibiscus manihot*; *Leucaena leucocephala* (leucaena); *Lysiloma sp*.; *Mangifera indica* (mango); *Punica granatum* (pomegranate); *Tamarindus indica* (tamarind); *Tamarix sp*. (tamarisk); *Vernonia glabra*; *Ximenia americana* (tallow-wood) (CABI, 2004; Williams & Watson, 1988).

Plant part affected: Flower, fruit, leaf, trunk, twig.

Distribution:

Ferrisia virgata: Angola; Argentina; Australia (Northern Territory, Queensland) (no record in Western Australia); Bahamas; Bangladesh; Barbados; Belau; Belize; Bermuda; Bolivia; Brazil; Brunei; Cambodia; Cameroon; Cayman Islands; Chagos Archipelago; China; Cook Islands; Colombia; Comoros; Congo; Congo Democratic Republic; Costa Rica; Côte d'Ivoire; Cuba; Dominica; Ecuador; Egypt; Ethiopia; Federated states of Micronesia; Fiji; French Polynesia; Ghana; Guatemala; Guinea; Guyana; Haiti; Honduras; India; Indonesia; Jamaica; Japan; Kenya; Kiribati; Laos; Madagascar; Malawi; Malaysia; Marshall Islands; Martinique; Mauritius; Mexico; Mozambique; Myanmar; Netherlands Antilles; New Caledonia; Nicaragua; Nigeria; Northern Mariana Islands; Pakistan; Panama; Papua New Guinea; Paraguay; Peru; Philippines; Puerto Rico; Saint Kitts and Nevis; Samoa; Sao Tome and Principe; Saudi Arabia; Senegal; Seychelles; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; Sri Lanka; Sudan; Suriname; Tanzania; Thailand; Togo; Tonga; Trinidad and Tobago; Tuvalu; Uganda; United Arab Emirates; USA (Alabama, California, Florida, Hawaii, Louisiana, Maryland, Mississippi, New Mexico, New York, Pennsylvania, Texas); United States Virgin Islands; Vanuatu; Venezuela; Vietnam; Wallis and Futuna; Yemen; Zambia; Zimbabwe (CABI, 2004).

Nipaecoccus filamentosus: Afghanistan; China (Taiwan); Haiti; India; Iran; Jamaica; Kiribati; Madagascar; Mexico; New Caledonia; Papua New Guinea; Philippines; Solomon Islands; South Africa, Thailand; Zimbabwe.

Biology

Life history: Adults are generally 3–4 mm in length and covered with a thin coating of white, mealy wax, which extends into filaments around the edge of the body. Adult females are covered in copious secretions, usually white or yellow, or enclosed in compact or felted wax. The body is often blue-green or purplish in colour. Females are broadly oval in body, wingless and quite sedentary, with well-developed legs. Females produce (spin) loose cottony ovisacs that contain and enclose the egg masses. The ovisac in this species completely covers the body. Following completion of the ovisac, females produce eggs until their death. Females lay between 90 and 600 eggs during their lifetime.

Nymphs are active only during the first instar (or crawler) stage, becoming sessile for the remaining nymphal (larval) instars. The first instar is the primary dispersal phase in the life cycle. The crawlers migrate and settle mainly in protected areas, under the sepals of the fruitlets when they are 0.5 cm or larger (CABI, 2004). They often settle in cryptic places on lime fruit such as around the calyx. Female *Nipaecoccus viridis* (a closely related species to *Nipaecoccus filamentosus*) pass through three moults before reaching adulthood and males pass through four moults before emerging as a fragile-winged adult. Most mealybugs overwinter as various juvenile stages. The complete life cycle takes between 3 and 8 weeks (Smith *et al*., 1997).

Ferrisia virgata is a highly polyphagous species of mealybug. Annecke and Moran (1982) list this species as a minor pest of citrus. It secretes honeydew, attracting ants and causing problems with sooty mould growth. This species has been known to produce several overlapping generations per year (CABI, 2004).

Adults and larvae damage the host plant by sucking sap and excreting honeydew onto the fruit and leaves, leading to sooty mould growth that interferes with photosynthesis. Mealybugs often form dense colonies on plants, making it difficult to distinguish individual insects. Heavy infestations by these species may severely stunt the growth of young trees. Infestations on young fruit result in the fruit turning yellow and eventually dropping off the tree. Late infestations on larger fruit can result in yellow spots at feeding areas or in fruit distortion (Cilliers and Bedford, 1978).

Control

Field insecticide treatments

The application of oil soap and/or insecticide reduced the number of scale insects and mealybugs in citrus by 93-100% (Baker & Shearin, 1992; Beattie & Ribbon, 1980; Lindquist, 1981); and with the same efficacy (93-100%) for grapevine (Su and Wang, 1988).

Post-harvest insecticide treatments

A 30-second dip in oil (Ampol) during post harvest processing was found to be effective in eliminating live mealybugs, mites and thrips from Citrus (Bailey & Brown, 1999). The efficacy of a post-harvest oil dip to control arthropod pests (e.g. mealybugs, light brown apple moth and mites) was found to be 95-100%, depending on the oil concentration used (Bailey & Brown, 1999; Taverner & Bailey, 1995). When mealybug infestation was less than 6%, a combination of insecticidal soap and insecticide can kill all the mealybug survivors remaining after harvest (Hata *et al*., 1992).

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Wasmannia auropunctata (Roger, 1863) [Hymenoptera: Formicidae]

Synonyms and changes in combination: *Hercynia panamana* Enzmann, 1947; *Ochetomyrmex auropunctata* Roger, 1963; *Tetramorium auropunctatum* (Roger).

Common name(s): Cocoa tree-ant, little fire ant, small fire ant, tramp ant.

Hosts: Many species including *Citrus* spp. and *Coffea* spp. (coffee).

Plant part affected: Fruit, leaf, trunk, whole plant.

Distribution: Argentina; Bolivia; Brazil; Cameroon; Colombia; Cuba; Dominican Republic; Ecuador (Galapagos Islands); New Caledonia; Solomon Islands (Santa Cruz Islands); Vanuatu; West Africa; United States (Florida).

Biology

Life history: Ants are golden-brown to yellow-brown in colour and 1–2 mm in length. The head is covered with grooves and it can inflict a painful sting that is annoying to agricultural workers in plantations and gardens. This species of ant is unusual in having no definite nests (Spencer, 1941). Ant colonies are found in soil, under logs, stones and leaf debris and in the ground either between dead leaves or in rotten wood. In the dry season the ants nest in soil at the base of trees and occasionally in dead wood on trees. The species is highly adaptable as the ants can nest in both open and shaded situations under moist or dry conditions (Nickerson, 1983). Although the ants are unlikely to be cold hardy (Ayre, 1977), they are highly adaptive (Nickerson, 1983) and may survive during cold storage and transportation.

Little fire ant is widely known as a “tramp” ant due to its ability to hitch-hike and establish itself throughout the world. It was originally found in Cuba and has spread widely throughout the warmer regions of the world (Brooks & Nickerson, 2000).

Polygyny (multiple-queen colonies) is common in this species. Multiple-queen colonies have many egg-laying queens (usually 20–60), with 100,000–500,000 workers. Multiple-queen colonies generally do not fight with other multiple-queen colonies. Consequently, mounds are close together and can reach densities of 200–800 mounds per acre. Multiple-queen mounds may also be inconspicuous, often being clusters of small, flattened excavations, in contrast to the distinct dome-shaped mounds of single-queen colonies. Multiple-queen colonies can establish new colonies by budding, where a portion of the queens and workers split off from a colony.

Fire ants are omnivorous, feeding on carbohydrates (e.g. honeydew, plant exudates, sugars and syrups), proteins (e.g. insects, meat) and lipids (e.g. grease, lard, oils from seeds). Adult ants require carbohydrates and/or lipids to sustain themselves throughout the year. Workers of this species are extremely voracious predators of arthropods, including some pest species. In capturing prey, this ant uses its sting and venom and it can quickly subdue most prey insects, even those much larger than itself. The ants forage all over the branches and foliage of nearby trees as well as on the ground. This species also tends honeydew-producing insects such as aphids and scale insects (Nickerson, 1983; Spencer, 1941) and the ants’ presence favours increased populations of these pests. The excess honeydew on plants promotes sooty mould growth on leaves, which can affect photosynthesis.

This species is an insect pest that invades coffee and citrus plantations in New Caledonia. The rapid multiplication of the ant has become a hindrance to the culture and harvesting of coffee and citrus fruits in countries where it is present (Castineiras & Noyra, 1993; Fabres & Brown, 1978). This species is considered a pest because of the damage it does to the environment and the danger it poses to human health.

Control

Field insecticide treatments

Excellent control of ants was achieved using various insecticides, with records of 90-97% efficacy (Klotz *et a*l., 1996; Shorey *et al*., 1996).

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FUNGI

Sphaceloma fawcettii Jenkins [Coelomycetes]

Synonyms and changes in combination: *Sphaceloma citri* Jenkins; *Sphaceloma fawcettii* var. *fawcettii* Jenkins; *Sphaceloma fawcettii* var. *scabiosa* Jenkins; *Sporotrichum citri* Butler; *Ramularia scabiosa*; *Elsinoe fawcetti* Bitancourt & Jenkins [teleomorph]; (CABI, 2004).

Throughout this report, Biosecurity Australia has followed the convention for fungal pathogens of using the name of the stage that causes the disease in the countries in question, which for this disease is the anamorph. The teleomorph of the citrus scab pathogen is *Elsinoe fawcettii* and is known only from Brazil. Four known strains are differentiated primarily by host range, tissues attacked and molecular markers (Tan *et al*., 1996; Timmer *et al*., 1996).

Common name(s): Citrus scab, common scab of orange, sour orange scab (CABI, 2004).

Hosts: Members of the family Rutaceae particularly: *Citrus aurantium* (sour orange); *C. hystrix* (papeda lime); *C. jambhiri* (rough lemon); *C. latifolia* (Tahitian limes); *C. limon* (lemon); *C. limonia* (lemandarin, Mandarin lime); *C. madurensis* (calamondin); *C.* x *nobilis* (tangor); *C.* x *paradisi* (grapefruit); *C. reticulata* (mandarin); *C. sinensis* (some cultivars of sweet orange); *C. unshiu* (Satsuma orange) and *Poncirus trifoliata* (trifoliate orange) (CABI, 2004; CABI/EPPO, 1997).

Most cultivars of *C. latifolia* (Tahitian limes), *Fortunella margarita* (oval kumquat), *C. sinensis* (sweet orange) and *C. maxima* (pummelo) are more resistant. *C. aurantium* (sour orange) is attacked by only the Florida Broad Host Range pathotype that is also capable of infecting *C. sinensis* (sweet orange) fruit. *C.* x *paradisi* (grapefruit) is affected by the Florida Broad and Narrow Host Range pathotypes but not by Tryon's or the lemon pathotypes. All pathotypes affect *C. jambhiri* (rough lemon) and *C. limon* (lemon). Tryon's pathotype attacks certain *C. reticulata* (mandarin) cultivars whereas the lemon pathotype does not (Timmer *et al*., 1996).

Plant part affected: Fruit, inflorescence, leaf, root, stem (CABI, 2004; Sivanesan & Critchett, 1974).

Distribution: American Samoa; Argentina; Australia (Tryon's and lemon pathotypes only - New South Wales, Northern Territory, Queensland and Victoria); Bangladesh; Barbados; Belize; Bermuda; Bolivia; Brazil (Bahia, Ceara, Espirito Santo, Minas Gerais, Rio de Janeiro, São Paulo); Brunei Darussalam; Cambodia; Cayman Islands; China (Fujian, Guangdong, Guangxi, Guizhou, Hong Kong (restricted), Hubei, Hunan, Jiangxi, Sichuan, Taiwan (restricted), Yunnan, Zhejiang); Colombia; Cook Islands; Costa Rica; Cuba; Dominica; Dominican Republic; Ecuador; El Salvador; Ethiopia; Fiji; French Guiana; French Polynesia; Gabon; Ghana; Georgia; Grenada; Guadeloupe; Guam; Guatemala; Guyana; Haiti; Honduras; India (Assam, Karanataka, Madhya Pradesh, Maharashtra, Sikkim, Tamil Nadu, Uttar Pradesh, West Bengal); Indonesia (Irian Jaya, Java, Kalimantan); Jamaica; Japan (Honshu, Ryukyu Archipelago); Kenya; Korea, Democratic People's Republic of; Korea, Republic of; Laos; Madagascar; Malawi; Malaysia (Peninsular Malaysia, Sabah, Sarawak); Maldives; Martinique; Mexico; Micronesia, Federated States of (dubious record); Mozambique; Myanmar; Nepal; New Caledonia; New Zealand; Nicaragua; Nigeria; Pakistan; Panama; Papua New Guinea; Paraguay; Peru; Philippines; Puerto Rico; Saint Lucia; Samoa; Sierra Leone; Solomon Islands; Somalia; South Africa; Spain (Canary Islands); Sri Lanka; Suriname; Tanzania; Thailand; Trinidad and Tobago; Uganda; United States (Alabama, Florida, Georgia, Hawaii, Louisiana, Mississippi, Texas); Uruguay (restricted); Vanuatu; Venezuela; Vietnam; Zaire; Zambia; Zimbabwe (restricted) (CABI, 2004; CABI/EPPO, 1997).

Biology

Life history: This fungus infects young leaves, young twigs, tender shoots and stems of nursery plants, blossom pedicels and fruits in their early stages of development (Whiteside, 1975; Timmer, 2000; Sivanesan & Critchett, 1974). Leaves, shoots and fruits are infected when young (e.g. when leaves are up to 15 mm wide and fruits are not more than 20 mm across). Infected tissues form scabby lesions with corky eruptions (CABI, 2004). The pathogen survives from one season to the next in scab pustules on fruit remaining on the tree and other plant organs. Even in resistant cultivars, the fungus can survive on diseased shoots from susceptible rootstocks (Whiteside, 1975; Whiteside, 1988).

The pathogen reproduces by forming conidia in the scabs on leaves, twigs and fruits of infected trees. Conidia are produced copiously in wet scabs in a near saturated atmosphere at temperatures between 20°C and 28°C. Germination of conidia can occur in dew or under high moisture conditions. However, a wet period of 2.5 to 3.5 hours is required for infection by conidia to occur. Germination occurs at temperatures between 13° and 32°C, while infection will only occur between 14° and 25°C. Incubation period is approximately three to five days with a temperature of 20° to 25°C, relative humidity at 75-80% being optimal for disease development (Gonzalez & Cachon, 1993).

In general, if temperature and humidity are favourable, disease incidence was recorded at 77-80% for *Citrus jambhiri*, 11-20% for *C. sinensis* (Daljeet *et al*., 1997) and 10% in *C. aurantifolia* (Persian lime) (Gonzalez, 1980). Most cultivars of *C. latifolia* were recorded to be moderately tolerant to citrus scab (Smith *et al*., 1997).

Dissemination of the pathogen is mostly by rain (or irrigation water), although insects and, to a certain extent, wind-carried water droplets containing spores, may contribute to the spread of the pathogen. The pathogen can be carried on infected nursery stock, ornamental citrus plants and fruits in international trade.

Sphaceloma fawcettii is widespread in areas where suitable conditions of temperature and rainfall or high humidity prevail (wet subtropics and cooler tropics). Elsewhere, it occurs when a new growth flush and fruit setting coincides with spells of relatively warm, humid weather. The disease does not present a serious problem in areas where the annual rainfall is limited to less than 1300 mm and long periods of hot weather (mean monthly temperature above 24°C) or dry summers occur (Timmer, 2000).

Two scab diseases are currently recognised on citrus (Tan *et al*., 1996; Tan *et al*., 1999; Hyun *et al*., 2001): (i) citrus scab caused by *S. fawcettii* Jenkins; and (ii) sweet orange scab caused by S. *australis* Bitancourt & Jenkins. Tryon’s scab, previously recognised as being caused by *S. fawcettii* var. *scabiosa*, is now regarded as a pathotype rather than a subspecies (Timmer *et al*., 1996).

Timmer *et al.* (1996) recognised four pathotypes of *S. fawcettii* based on host range: Florida broad host range (FBHR); Florida narrow host range (FNHR); Tryon’s; and lemon. In Australia, the Tryon’s and lemon pathotypes of *S. fawcettii* were identified (Tan *et al*., 1996; Timmer *et al*., 1996). Tryons’ pathotype infects rough lemon and Cleo mandarin. The lemon pathotype infects rough lemon and close relatives. In Florida, Whiteside (1975) was able to differentiate two different pathotypes based on host range. One pathotype (FBHR) has a broad host range infecting the leaves and fruits of *C. limon* (lemon), *C. jambhiri* (rough lemon), *C.* x *paradisi* (grapefruit), *C. aurantium* (sour orange) and *C. sinensis* (Temple and Murcott tangors, sweet orange). The second pathotype (FNHR) infects all of the above except *C. aurantium* (sour orange) and *C. sinensis* (Temple tangor, sweet orange) fruits.

Tan *et al*. (1996, 1999) suggested that, because unidentified pathotypes may exist in localised areas, strict quarantine precautions should be taken to avoid moving the citrus scab fungi into Australia from other countries. Current AQIS import policy for *Citrus* spp. (from Egypt, New Zealand, Spain and the USA) identifies citrus scab as a regulated pest and prohibits the import of scab infested commodities into the country.

When fully formed, scab lesions are raised and range in colour from buff through pink to olive. Heavily infected fruit may drop shortly after being attacked. Infected fruit remaining on the tree may be scarred and distorted and become unmarketable as fresh fruit. Scab does not invade the flesh and lesions do not provide an site for secondary fungal infection (Knorr, 1973).

Scab incidence is a function of interacting factors including degree of varietal susceptibility, presence of host tissue in a juvenile stage, inoculum potential, available water for spore dispersal and germination, and temperature.

Citrus scab can be controlled using resistance cultivars and by fungicide applications both in the nursery and in the orchard. Systemic fungicides such as benomyl and carbendazim can be applied before flushing and after petal fall (Reddy *et al*., 1983). Benomyl-tolerant strains of the pathogen have been found (Whiteside, 1980).

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Meliola citricola Syd. & P. Syd., 1917 [Meliolales: Melioaceae]

Synonyms and changes in combination: None known.

Common name(s): Black mildew, black mould

Hosts: Members of the family Rutaceae; *Citrus aurantifolia* (West Indian lime, Mexican lime), *Citrus reticulata* (mandarin, tangerine), *Citrus sinensis* (L.) Osbeck (sweet orange), *Citrus paradisi* (grapefruit), *Citrus aurantium* L. (sour orange) (Dingley *et al*., 1981), *Citrus medica*, *Citrus grandis* (Whittle, 1992).

Plant part affected: Leaves, fruit (Whittle, 1992; McKenzie, 2003)

Distribution: Southeast Asia (widespread); Western Samoa; Fiji (Dingley *et al*., 1981); New Caledonia (Amice, 1996); Philippines; Indonesia (Java, Sumatra and Borneo/Kalimantan); New Guinea; Sri Lanka (Whittle, 1992).

Biology

Life history: *Meliola citricola* is a parasitic fungus, penetrating leaf cuticles and forming haustoria within individual epidermal cells. No asexual spores are produced. Ascospores germinate on the surface of young leaves and immediately penetrate the cuticle. Symptoms are seen on mature leaves, due to the slow growth rate of fungal colonies (Ecoport, 1999). *Meliola citricola* is not a strong parasite (Whittle, 1992)

The fungus is found on leaves and fruit and appears as dense, black, velvety, circular patches of mycelial growth, up to about 5 mm in diameter. With respect to leaves, the fungus is more commonly found on the lower surface (Ecoport, 1999).

This species is quite common in the wet season in Southeast Asia (Beattie pers. comm., 2003), and is commonly mistaken for sooty mould. However, the development of symptoms is not dependent on honeydew, as is the case with the sooty moulds (Whittle, 1992).

Meliolaceae are adapted to long wet seasons and heavy night dews during the dry season. They prefer warm low mountain areas and densely shaded areas (Saenz & Taylor, 1999).

Although little is known about the economic importance of *M. citricola*, it can reduce the cosmetic quality of fruit (Whittle, 1992) and may lead to a reduction in the vigour of the tree by direct loss of photosynthate from the epidermal cells (Ecoport, 1999).

Control

Colonies are essentially superficial, but are still difficult to remove manually (Whittle, 1992). *Meliola citricola* is easily controlled with mineral oil sprays, which have been trialled in Indonesia (Beattie pers. comm., 2003).

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