Australian Government

Department of Agriculture, Fisheries and Forestry

# Draft review of policy: Alternative risk management measures to import *Lilium* spp. cut flowers from Taiwan

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Cover image: *Lilium spp* flower production in Taiwan, photographed by DAFF officers, Taiwan field visit, April 2011.

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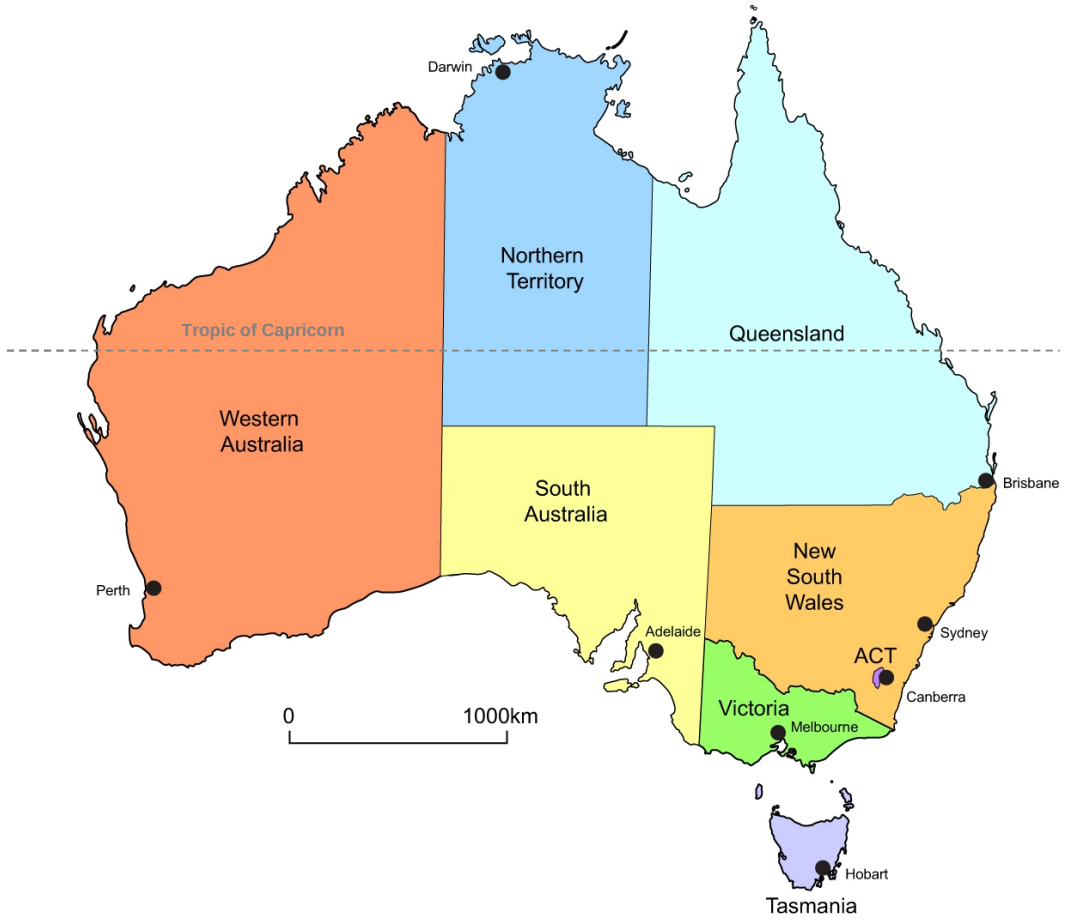


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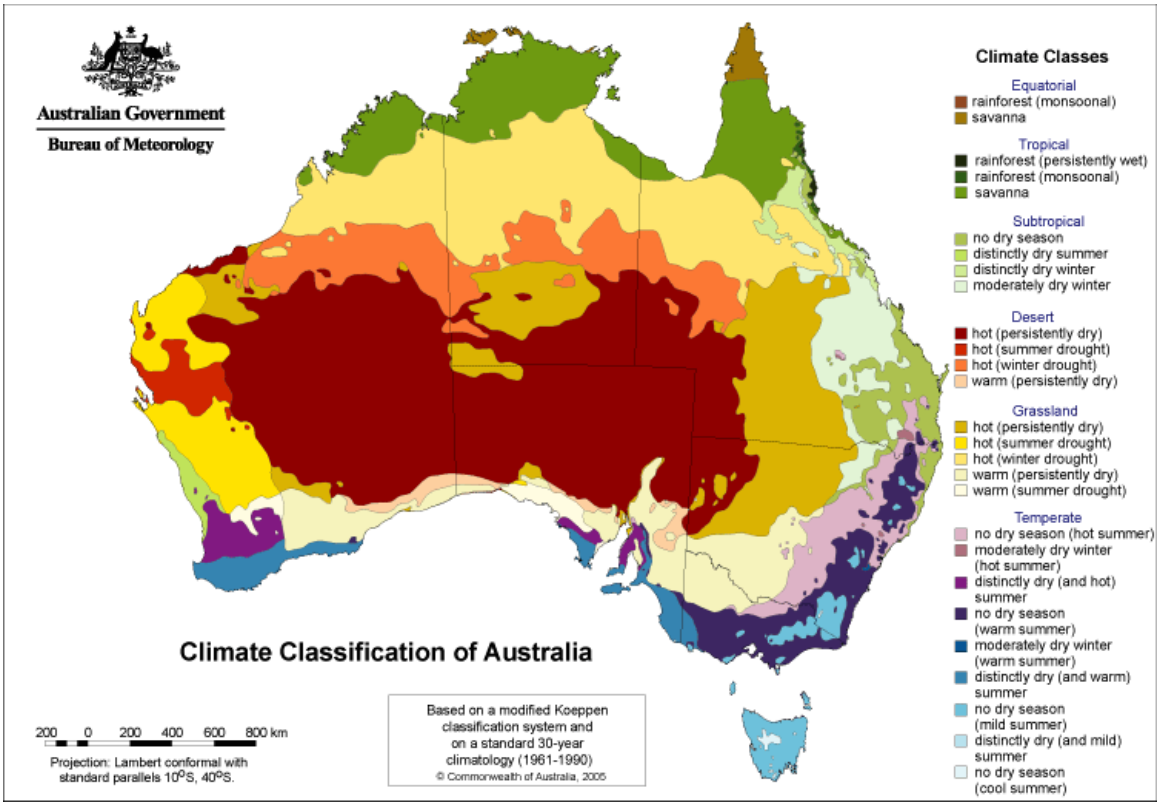


# Acronyms and abbreviations

| Term or abbreviation | Definition |
|---|---|
| ALOP | Appropriate level of protection |
| APPD | Australian Plant Pest Database (Plant Health Australia) |
| AQIS | Australian Quarantine and Inspection Service |
| BAPHIQ | Bureau of Animal and Plant Health Inspection and Quarantine, Taiwan |
| CABI | CAB International, Wallingford, UK |
| CMI | Commonwealth Mycological Institute |
| DAFF | Australian Government Department of Agriculture, Fisheries and Forestry |
| FAO | Food and Agriculture Organization of the United Nations |
| IPC | International Phytosanitary Certificate |
| IPM | Integrated Pest Management |
| IPPC | International Plant Protection Convention |
| IRA | Import Risk Analysis |
| ISPM | International Standard for Phytosanitary Measures |
| NPPO | National Plant Protection Organization |
| NSW | New South Wales |
| NT | Northern Territory |
| PRA | Pest Risk Analysis |
| Qld | Queensland |
| Tas. | Tasmania |
| Vic. | Victoria |
| WA | Western Australia |
| WTO | World Trade Organisation |

# Abbreviations of units

| Term or abbreviation | Definition |
|---|---|
| °C | degree Celsius |
| °F | degree Fahrenheit |
| kg | kilogram |
| km | kilometre |
| m | metre |
| µm | micrometre (one millionth of a metre) |
| ml | millilitre |
| mm | millimetre |
| ppm | parts per million |
| s | second |

## Summary

The Department of Agriculture, Fisheries and Forestry (DAFF) has assessed the quarantine risks associated with the importation of lily (*Lilium* spp.) cut flowers from Taiwan. This draft review of policy proposes measures to manage the phytosanitary risks associated with *Lilium* spp. cut flowers from Taiwan.

A number of pests of quarantine concern associated with *Lilium* spp. cut flowers from Taiwan were identified, including several species of beetles, thrips, leafminers and moths, as well as several viruses.

Taiwan has requested exemption from mandatory fumigation of *Lilium* spp. with methyl bromide. A systems approach to manage the identified pests is recommended.

Plant Biosecurity considers that the risk management measures proposed in this draft review of policy including a systems approach administered by BAPHIQ and phytosanitary inspection will adequately mitigate the identified biosecurity risks posed by arthropod pests.

Consistent with the existing policy for the importation of cut flowers, the identified viruses will be managed through freedom from bulbils, rendering the cut flowers non-propagable. These mitigation measures minimise the risk of pests entering the importation pathway, or of them establishing in Australia.

Additionally, DAFF will undertake a documentation compliance examination for consignment verification purposes, at the port of entry in Australia, prior to inspection and discharge of the imported *Lilium* spp. cut flowers. All *Lilium* spp. cut flowers will be subject to on-arrival inspection by DAFF officers. The detection of live insects, disease symptoms or regulated articles will result in failure of the consignment. Remedial actions for failed consignments include methyl bromide fumigation if live insects are detected, germicidal dips, or re-export as required.

DAFF invites comments on the technical aspects of the proposed risk management measures for *Lilium* spp. cut flowers from Taiwan. In particular, comments are sought on their appropriateness and any other measures stakeholders consider would provide equivalent risk management outcomes.

This draft policy review is being issued for 30 days consultation. DAFF will provide a final review of policy, including any changes, after any issues arising from the consultation process have been addressed.

# 1 Introduction

## 1.1 Australia's biosecurity policy framework

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

The pest risk analysis (PRA) process is an important part of Australia's biosecurity policies. It enables the Australian Government to formally consider the risks that could be associated with proposals to import products into Australia. If the risks are found to exceed Australia's appropriate level of protection (ALOP), risk management measures are proposed to reduce the risks to an acceptable level. But, if it is not possible to reduce the risks to an acceptable level, then no trade will be allowed.

Successive Australian Governments have maintained a conservative, but not a zero risk, approach to the management of biosecurity risks. This approach is expressed in terms of Australia's ALOP, which reflects community expectations through government policy and is currently described as providing a high level of protection aimed at reducing risk to a very low level, but not to zero.

Australia's PRAs are undertaken by the Department of Agriculture, Fisheries and Forestry, hereafter referred to as DAFF, using teams of technical and scientific experts in relevant fields, and involves consultation with stakeholders at various stages during the process. DAFF provides recommendations for animal and plant quarantine policy to Australia's Director of Animal and Plant Quarantine (the Secretary of the Australian Department of Agriculture, Fisheries and Forestry). The Director or delegate is responsible for determining whether or not an importation can be permitted under the *Quarantine Act 1908*, and if so, under what conditions.

More information about Australia's biosecurity framework is provided in the *Import Risk Analysis Handbook 2007* (update 2009) located on the DAFF website www.daff.gov.au/ba.

## 1.2 This review of policy

Australia has established policy for the import of many species of cut flowers. Imported cut flowers require mandatory on-arrival fumigation. While *Lilium* spp. cut flowers are not currently permitted, Australia does permit the importation of *Lilium* bulbs from the Netherlands, and other countries, for production in open quarantine at a Quarantine Approved Premises (QAP) prior to release as cut flowers.

The purpose of this policy review is to examine a market access request from Taiwan for *Lilium* spp. cut flowers. This proposal includes a request for exemption of *Lilium* spp. from mandatory fumigation with methyl bromide.

[1] A pest is any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2012).

### 1.2.1 Background

In 2009, the Bureau of Animal and Plant Health Inspection and Quarantine (BAPHIQ) requested market access for *Lilium* spp. cut flowers from Taiwan to Australia, and submitted technical information. BAPHIQ advised in September 2010 that lily cut flowers were their highest priority.

DAFF advised Taiwan that their request was an "A" priority on the Import Market Access Advisory Group list of October 2010.

Taiwan's plant quarantine authority (BAPHIQ) provided supplementary information on their market access request for lily cut flowers to Australia in March 2011 and proposed a field visit by DAFF during the lily harvest season in April 2011.

Following the official request, officers from Plant Biosecurity visited a number of *Lilium* production areas and packing houses near Houli township in April 2011. The visit was an opportunity to discuss the Taiwan proposal and to collect information and observe pest and disease prevalence first hand, as well as seek clarification from growers and BAPHIQ experts on pest and disease status and management. This assisted DAFF in undertaking the pest risk analysis of *Lilium* cut flowers.

In September 2011, at the 8th Agricultural Working Group meeting in Canberra, Australia confirmed that the PRA for lily cut flowers was being undertaken on the basis that Taiwan wishes to export without methyl bromide fumigation. Both countries agreed to look at the possibility of a systems approach and other equivalent measures, retaining fumigation as a back-up treatment option.

In June 2012, BAPHIQ proposed equivalent management measures for the treatment of cut flowers and disinfestations from arthropod pests. These include in-field sanitary measures during production involving bulb treatment with systemic pesticide at planting, application of pesticide at flower bud formation, and two weeks prior to harvest under supervision by a BAPHIQ inspector. These measures are also to be recorded and available for audit by BAPHIQ.

### 1.2.2 Scope

This review covers market access for *Lilium* spp. of commercial varieties intended for cut flower end use. Taiwan proposes to export Oriental and Longiflorum hybrids. This review of policy has been extended to include all non-propagable non-bulbil forming commercial varieties/hybrids. This excludes *L.* × *elegans* (Asiatic lily) and its hybrids, and *L. longiflorum* × Oriental lilies (LO hybrids) some of which are known to form axil bulbils (Roh 1992, Roh *et al.* 1996, Roh 2011). This review excludes bulbil forming species of *Lilium lancifolium* (or *L. tigrinum*), *L. sargentiae*, *L. sulphureum* (or *L. myriophyllum*) and *L. bulbiferum* (*L. croceum*, *L. chaixii*) and their hybrids (McRae 1998, Jefferson-Brown and Howland 2002, GRIN 2012).

Taiwan also requested the removal of methyl bromide fumigation as a treatment for lily cut flowers originating from Taiwan for export to Australia. Taiwan has proposed to only send varieties which are free of bulbils, and thus are non-propagable.

The scope of this review is limited to:

- identification of biosecurity risks associated with *Lilium* spp. cut flowers from Taiwan

- non-propagable non-bulbil forming commercial varieties/hybrids only
- evaluation of alternative measures to methyl bromide fumigation that may be equally effective in meeting Australia's ALOP.

## 1.3 Existing policy

### 1.3.1 Current import policy for *Lilium* spp. bulbs as nursery stock

Currently, import conditions exist for many species of *Lilium* as bulbs imported from the Netherlands and from 'all countries' as nursery stock for cut flower production in open quarantine or for potted colour plant production. In 2007, more than 75 million bulbs were imported into Australia, the bulk of which were *Lilium* bulbs (72.5 million) (AQIS 2008). Existing import conditions for lily bulbs as nursery stock, for potted colour or cut flower production, can be accessed at http://www.daff.gov.au/aqis/import/icon-icd

Standard bulb import conditions for permitted *Lilium* species bulbs, as nursery stock for potted colour or cut flower production, are subject to:

- an import permit
- phytosanitary certification for freedom from black wart and potato cyst nematode (and freedom from rust and smut fungi if from the Netherlands)
- inspection prior to mandatory methyl bromide fumigation or hot water immersion for invertebrate pests
- growth in open quarantine (field planting or tunnel house) at a QAP, and
- two crop inspections following a period of sufficient growth for symptoms of quarantine pathogens, prior to release as cut flowers or potted colour.

Bulbs imported from the Netherlands and certified under Bloembollenkeuringsdienst (BKD) scheme, are subject to one disease inspection during growth in quarantine. Additional conditions apply to bulbs packaged in peat moss imported from FMD countries (ICON 2012).

Contaminated consignments (soils, plant debris, disease or quarantinable matter) are subject to cleaning, nematicide treatment, destruction or re-export (determined by the risk associated with the contaminating material).

**Table 1 Specific quarantine/biosecurity measures for *Lilium* spp. bulbs as nursery stock (potted colour or cut flower production)**

| Reference number | Condition title |
|---|---|
| **Condition C14922 (Netherlands) / C14921 (other countries)** | Lists of permitted *Lilium* spp. and hybrids as nursery stock including American, Asiatic, Candidum, Dauricum, Martagon, Oriental and Trumpet hybrids. |
| **Condition C7416** | BKD Scheme (the Netherlands)- requirements for import and growth in QAP for approved species and hybrids exported and certified under the scheme |
| **Condition C7418** | Conditions for non-certified bulbs (i.e. non-BKD generated bulbs from the Netherlands). |

### 1.3.2 Past policies for lily cut flowers

In 1978 trade in *Lilium* spp. cut flowers was halted due to concerns of propagability mainly from bulbils on the leaf axis, that is, from *Lilium* spp. known as bulbil-forming species. *Lilium* was then placed on the list of prohibited cut flower species. In 1981, the prohibition was modified to allow entry of flowers of species which did not form bulbils. The species of most concern was *Lilium tigrinum* (Tiger lily) (Evans *et al.* 1998).

The prohibition was extended in 1982 to other species able to propagate by axil bulbils (*L. tigrinum, L. bulbiferum, L. sargentiae* and *L. sulphureum*) (AQIS 1983, Evans *et al.* 1998). This is because of the capacity for propagation into full plantlets from stem bulbils and the increased likelihood of distribution and spread of pathogens that they may carry.

However, the importation of all *Lilium* species as cut flowers was stopped in 1983 due to operational difficulties in identifying species/hybrids at inspection and the delays this was causing at the border (AQIS 1983).

### 1.3.3 Current import policy for cut flowers

There are no import conditions for *Lilium* spp. cut flowers as these are not currently permitted entry into Australia. Conditions for permitted cut flower species can be found at: http://www.aqis.gov.au/icon32/asp/ex_querycontent.asp.

Standard cut flower import conditions for permitted species are subject to mandatory devitalisation for propagable species and mandatory methyl bromide fumigation.

Some cut flowers/foliage consignments can be exempt from mandatory fumigation on arrival through one of the following three options:

- Overseas Accreditation Schemes for flower suppliers (currently operating in Singapore and Malaysia)
- Offshore fumigation monitored by National Plant Protection Organisation (NPPO) in the country of origin (Currently, only China has arrangements in place with DAFF)
- Importer Initiated Pathway Fumigation Exemption (IIPFE) based on proven clean pathways - exemption from mandatory fumigation is considered for individual importer applications for specific pathway exemptions, from importers who can demonstrate that their existing import pathways have maintained substantial compliance to DAFF requirements (*i.e.* freedom from live pests) over the preceding twelve month period based on historical data.

**Table 2 Specific quarantine/biosecurity measures for cut flowers**

| Reference number | Condition title |
|---|---|
| **Condition C6519** | General guide for commercial consignments of cut flowers |
| **Condition C6511** | Nil tolerance for live quarantine pests and treatment to be used for infested flowers that are exempt from mandatory fumigation |
| **Condition C6518** | Treatment to be used for cut flowers infested with snails and slugs |
| **Condition C8739** | Devitalisation treatment and list of overseas accredited facilities |
| **Condition C9658** | Overseas Accreditation Scheme (Singapore and Malaysia)- requirements for exemption from fumigation for species exported and certified under the scheme |

The existing policy for the importation of cut flowers is based on minimising the risk of accidental introduction of any associated pathogen and arthropod pest. The risk management measures proposed in this document provide equivalence under a systems approach as an alternative measure which may be equally effective in meeting Australia's quarantine requirements.

# 2 *Lilium* spp. propagation, commercial cultivation and Taiwan's commercial production practices

This chapter provides general information on varieties of *Lilium spp.* of commercial floricultural importance, and on lily propagation. It also provides specific information on the commercial production practices for *Lilium* spp. cut flowers in Taiwan and considers pre-harvest, harvest and post-harvest practices. The export capacity of Taiwan is also outlined.

## 2.1 *Lilium* spp. varieties, propagation and commercial cultivation

This review will cover varieties of *Lilium* of commercial floricultural importance. Lilies comprise more than 80 species belonging to several sections or divisions (Lim *et al.* 2008). The divisions have no botanical significance but are for the convenience of gardeners (Mikolajski 2004). Lilies have been divided to 10 divisions of closely related hybrids and taxa for horticultural use. These include Asiatic, Martagon, Candidum, American, Longiflorum hybrids (mostly *L. longiflorum* × Asiatic), Trumpet and Aurelian hybrids, Oriental, Orienpet (Trumpet Aurelian × Oriental) hybrids, as well as true species and miscellaneous (not included in other divisions) (Mc Rae 1998).Within the divisions cultivars bred from *Lilium longiflorum* (Leucolirion) hybrids, Asiatic (Sinomartagon) and Oriental (Archelirion) hybrids are the most important in the commercial market (Lim *et al.* 2008). These important hybrid groups for cut flowers have distinctive characteristics. Longiflorum hybrids have trumpet-shaped, outward-facing white flowers, a distinctive fragrance with the ability for forcing year-round (Lim and Van Tuyl 2007). Asiatic hybrids have a large range of colours and with upright-facing flowers and have early to late flowering types; Oriental hybrids also have early to late flowering types, a strong fragrance with pink or white flowers, sturdy stems with wide dark green leaves (Lim and Van Tuyl 2007). Many new hybrids have been introduced in recent years, interspecific hybrids of *L. longiflorum* × *L.* × *elegans* (LA hybrids), *L. longiflorum* × Oriental lilies (LO hybrids), and Oriental × Trumpet lilies (Orienpet or OT hybrids) (Roh 2011).

Lilies are propagated through seeds (providing genetic diversity and freedom from viral and other pathogens) or vegetatively (exact copies of the mother plant) predominantly through bulbs, bulb scales, bulblets, and bulbils (McRae 1998, Jefferson-Brown and Howland 2002). Bulblets are daughter bulbs that develop on the underground portion of the stem in close proximity to the mother bulb. Bulbils are adventitious bulbs formed on the stem or inflorescence above ground of some species of *Lilium*, and have a demonstrated capacity to regenerate new plant material (McRae 1998, Jefferson-Brown and Howland 2002).

Propagation from underground parts such as basal plate scales, stem bulblets (juvenile bulbs that are produced below soil level above the top of the bulb) are all vegetative methods of lily propagation that are not of concern in cut flowers. However, lily plant tissues of some species (and their cultivars) have a high generation potential and may also be propagable by bulbils or by leaf and stem cuttings (Luo and Liu 1993, Anon. 1993, Ruffoni *et al.* 2011). Kim *et al.* (2007) induced bulbil formation by growing bulbs (of *L. longiflorum* 'Nellie White') at different temperature and photoperiod regimes, though this is undesirable as it is presumed to be detrimental to bulb production since bulbils are a competitive sink for carbohydrates from the main plant. Ruffoni *et al.* (2011) state that lilies are one of the most important bulbous crops produced in tissue culture and on an industrial scale nowadays. Commercial hybrid floricultural varieties are usually bred to maximise flower beauty and attractive cut flower

features (e.g. scent). These are not known to form bulbils like the original mother species used to generate commercially viable crosses, and thus are not propagable via bulbils.

A few species of *Lilium*, such as *Lilium lancifolium* (or *L. tigrinum*), *L. sargentiae, L. sulphureum* (or *L. myriophyllum*) and *L. bulbiferum* (*L. croceum, L. chaixii*), as well as *L.* × *elegans* (an Asiatic lily) are known for producing stem or leaf axis bulbils in abundance, so are their cultivars and hybrids (Roh 1992, McRae 1998, Jefferson-Brown and Howland 2002, GRIN 2012). For instance, LA hybrids (LAIH) of *L. longiflorum* and *L.* × *elegans* Asiatic hybrid lilies may carry axil bulbils derived from *L.* × *elegans* in interspecific crosses (Roh *et al.* 1996). Later research by the same author describes bulbils only from *L.* × *elegans* (Asiatic hybrid) and the use of tissue culture for propagation of interhybrid crosses of Asiatics with Longiflorum (LAIH) (Roh *et al.* 2008, Roh 2011). Roh (2011) also identified some *L. longiflorum* × Oriental lilies (LO hybrids) as able to form axil bulbils.

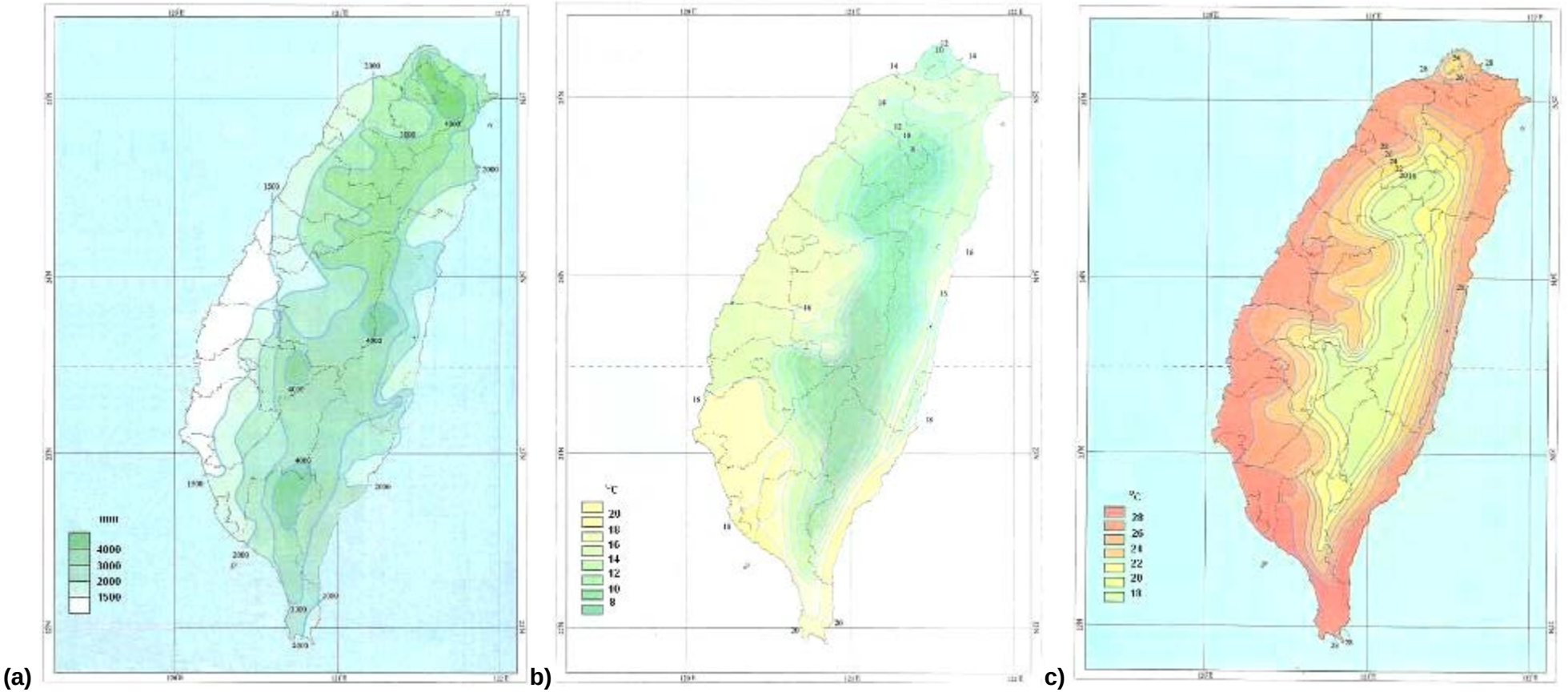
Bulbils develop early in the season and can be harvested shortly before they would drop naturally, that is when the parent plant flowers. Ryczkowski (2012) states that not all *Lilium* species form bulbils but can be forced to do so by removing flower bulbs and cutting off the upper half of stems (Ryczkowski 2012), while other sources state bulbils can only be forced from the species listed above that are naturally bulbil-forming (Herbs 2000). Thus, commercially grown non-bulbil forming lilies that have reached flowering stage in flower bud or in bloom cannot be forced to produce bulbils. Furthermore, upon visual inspection the presence of bulbils will be evident on the stem of commercial hybrids.

Most bulbs used for cut-flower production and sold to cut flower growers are grown in the Netherlands, Chile, France, New Zealand, South Africa, and north-western USA as commercial production of bulbs requires a cool environment (Gill *et al.* 2006). Lilies can be grown in the field in raised beds, in high tunnels, or in greenhouses (some in crates). Best conditions combine a loamy soil with good drainage, pH of 6.3–6.8, 6–8 hours of daily sun, and frequent watering. Cut flower stems are harvested when flowers are in the bud stage, when the lower-most buds show colour to allow the flowers to open after purchase by consumers. Prior to shipping, cut flowers are pulsed in sucrose solution and germicides, and stored with floral preservatives (silver thiosulphate or STS) to prolong their vase life (up to 9–14 days depending on the cultivar and the environment it is kept in), then transported in water (Balge *et al.* undated, Gill *et al.* 2006).

## 2.2 Climate in Taiwan's production areas

The island of Taiwan has a climate characterised by tropical monsoon conditions. Annual rainfall is generally above 2000 mm in the lowlands and increases with altitude (Figure 3a). Rainfall occurs throughout the year, but may increase from July to September due to the typhoon season (BBC 2011). Winter in the north of the island is marked by more cloud and rain than the south of the island (BBC 2011). At lower elevations humidity increases during the summer months (BBC 2011). Lily production is concentrated, but not limited to, the middle and mid-west of the island; a number of producers grow in the mountainous interior and other parts of the island. The island shares the tropical monsoon climate experienced by the regions surrounding the South China Sea.

**Figure 3 Climate in Taiwan: a) annual rainfall; b) January average temperatures; and c) July average temperatures (NICT 2009)**




## 2.3

## 2.4 Taiwan's commercial production practices

### 2.4.1 Pre-harvest production practices

Taiwan is proposing to export mainly Longiflorum (hybrids derived from *L. longiflorum* crossed with Asiatic hybrids) and Oriental hybrid lilies which are the main commercially cultured varieties in Taiwan, due to temperature limits. Growers also planted Orienpet hybrids derived from Oriental and Trumpet varieties, as observed during a field trip to Taiwan in 2011. *Lilium* spp. cut flowers for export are hybrid species bred for their ornamental value and specific flower colour and patterns.

Export-quality lilies are produced from bulbs imported yearly to Taiwan mainly from the Netherlands and Chile, some from France and New Zealand, and are accompanied by phytosanitary certificate, stating that the bulbs are free from *Ditylenchus dipsaci* and *Rhizoglyphus echinopus* (bulb mite) during production in the field. New quarantine requirements for lily bulbs exported to Taiwan will soon require lily bulbs to be tested for Arabis mosaic virus (ArMV) and Plantago asiatica mosaic virus (PlAMV).

The bulbs are inspected on-arrival by BAPHIQ for freedom from regulated pests. Some bulb samples are sent to approved virus-testing laboratories. According to the virus test reports, few viruses are rarely found on the imported bulbs, and these include Lily mottle virus (LMoV) and Lily symptomless virus (LSV).

Plants are visually inspected in the field for freedom from disease symptoms and only disease free plants should be further selected for export.

### 2.4.2 Cultivation practices

Growth of lily bulbs occurs in open fields under nets or in net-houses, and sometimes in glasshouses. These are not insect proof but allow for protection from direct sunlight. Lilies are grown in raised beds to prevent common rots and allow proper drainage. Watering, feeding and spraying treatments of plants are generally performed manually.

Pest management and general surveillance programs are applied for the production of *Lilium* species. Growers apply pest management measures in field as required in case a pest occurs in the field, and use chemical control or soil sterilisation for fungi and discard infected plants in case of viral infection. Growers use flooding and rotations with rice to manage soil borne diseases associated with lily bulbs. Other flowers are also grown at times in rotation with lilies (and can include *Anthurium*, *Amaryllis*, *Liatris* and other species).

BAPHIQ inspectors inspect the plants during their growth and supervise the packing of the plants for export. Exported plants are covered by BAPHIQ phytosanitary certification. BAPHIQ advised that they would not certify any plants that showed disease-like symptoms. However, no records are kept of these processes and generally rely on the grower's experience and their knowledge of the crop.

The overall procedures in the packing house (which do not follow a one-way flow of the product) entail the following; harvesting (monitoring for diseased or stunted flowers), movement to packing houses, washing of the cut flowers, de-leafing, sorting and grading, cutting to length, bunching and sleeving, placing in cool room (in preservative solution), or packing then storing in cool room for movement to market or export. After harvest, flowers

are pulsed and held at low temperature to extend vase life, by applying silver thiosulphate (STS) solution (BAPHIQ 2011a). This usually occurs usually within 12 hours if the cut flowers are destined for export, and following phytosanitary certification and inspection by BAPHIQ.

## 2.5 Taiwan's export capability

### 2.5.1 Production and exports

The total area of planted lilies in Taiwan is about 340 hectares with a total production volume of 5.8 million dozens in 2003 (CoA 2011).

Cultivation of lilies in Taiwan occurs in the cold areas of Nantou and Chiayi (1000 metres above sea level) in summer to supply local demand. During winter, lilies are produced in lowlands, primarily in Houli and Puli (CoA 2011). Taiwan's market access proposal states that lilies in 2008 were grown over 331 hectares in Taichung county (220 ha), Nantou county (66 ha), and Changhua county (18 ha) (BAPHIQ 2009).

Taiwan's export trade in lilies is well established (pers. comm.). Taiwan's leading export market for *Lilium* spp. cut flowers is Japan followed by Hong Kong, Singapore and other regional markets (Malaysia, Guam, and the Philippines). The export value of lilies is expected to continue to increase.

There are no specific export protocol requirements for Taiwan's current exports to regional Asian markets other than inspection, and generally include a BAPHIQ-issued phytosanitary certificate.

Production facilities are currently able to demonstrate full trace back of exported plants to the original packing house (though some are used by more than one grower); however, flower cartons are identifiable to the packing house, allowing traceability of the pathway should any non-compliance issues be detected on arrival in Australia.

### 2.5.2 Export season

*Lilium* spp. cut flowers are produced year round (as above). Exporting season includes November through April the next year (TFEA 1997).

# 3 Pest risk analysis

Plant Biosecurity has conducted this pest risk analysis (PRA) in accordance with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for pest risk analysis* (FAO 2007) and ISPM 11: *Pest risk analysis for quarantine pests, including analysis of environmental risks and living modified organisms* (FAO 2004). The standards provide a broad rationale for the analysis of the scientific evidence to be taken into consideration when identifying and assessing the risk posed by quarantine pests.

Following ISPM 11, this pest risk analysis process comprises of three discrete stages:

- Stage 1: Initiation of the PRA
- Stage 2: Pest Risk Assessment
- Stage 3: Pest Risk Management

Phytosanitary terms used in this PRA are defined in ISPM 5 (FAO 2012).

## 3.1 Stage 1: Initiation of the PRA

The *initiation* of a risk analysis involves identifying the reason for the PRA and the identification of the pest(s) and pathway(s) that should be considered for risk analysis in relation to the identified PRA area.

This commodity-based pest risk assessment was initiated by Plant Biosecurity as a basis for a review of the existing phytosanitary regulations to import *Lilium* spp. cut flowers material into Australia.

In the context of this PRA, *Lilium* spp. cut flowers are a potential import 'pathway' by which a pest can enter Australia.

The pests associated with *Lilium* spp. cut flowers from Taiwan were tabulated from published scientific literature, such as reference books, journals and database searches. This information is set out in Appendix A and forms the basis of the pest categorisation.

For this PRA, the 'PRA area' is defined as Australia for pests that are absent from Australia or of limited distribution and under official control in Australia.

## 3.2 Stage 2: Pest Risk Assessment

A pest risk assessment is the 'evaluation of the probability of the introduction and spread of a pest and of the magnitude of the associated potential economic consequences' (FAO 2012). The pest risk assessment provides technical justification for identifying quarantine pests and for establishing phytosanitary import requirements.

This is a commodity-initiated pest risk analysis and risk is estimated through a standard set of factors that contribute to introduction, establishment, spread or economic impact potential of pests. This pest risk assessment was conducted using three consecutive steps: pest categorisation; assessment of the probability of entry, establishment and spread; and assessment of potential consequences.

### 3.2.1 Pest categorisation

Pest categorisation is a process to examine, for each pest identified in Stage 1 (Initiation of the PRA process), whether the criteria for a quarantine pest is satisfied. In the context of cut flowers, pest categorisation includes all the main elements of a full pest risk assessment but is done in less detail and is essentially a quick assessment to identify pests of quarantine concern. The process of pest categorisation is summarised by ISPM 11 (FAO 2004) as a screening procedure based on the following criteria:

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

Pests are categorised according to their association with the pathway, their presence or absence or regulatory status, their potential to establish or spread, and their potential for economic consequences. Pests associated with *Lilium* spp. cut flowers listed in Appendix A were used to develop a pathway-specific pest list for *Lilium* spp. cut flowers from Taiwan. This list identifies the pathway association of pests recorded on *Lilium* spp. cut flowers and their status in Australia, their potential to establish or spread, and their potential for economic consequences. Pests likely to be associated with cut flowers, and are absent or under official control in Australia, may be capable of establishment or spread within Australia if suitable ecological and climatic conditions exist.

### 3.2.2 Quarantine pests associated with *Lilium* spp. from Taiwan

Quarantine pests associated *Lilium* spp. cut flowers from Taiwan are identified in Appendix A. The quarantine pests of *Lilium* spp. from all sources identified in the pest categorisation are listed in Table 3. These pathogens fulfil the International Plant Protection Convention (IPPC) criteria for a quarantine pest. Specifically:

- these pests are economically important (as they cause a variety of direct and indirect economic impacts, such as reduced yield, reduced commodity value, loss of foreign or domestic markets); and
- these pests are not present in Australia or have a limited distribution and are under official control.

Association with the host commodity provides the opportunity for pathogens and pests to enter Australia. Arthropod pests have a direct pathway on cut flowers. Viral pathogens may be transmissible in the presence of arthropod pests that act as vectors. However, cut flowers have a lower pest risk than nursery stock and material for planting given the chance of establishing a disease in a new environment is significantly enhanced if the diseases can develop within a living plant, and this plant is grown in the proximity of other hosts. The *Lilium* spp. cut flower species assessed are not propagable.

**Table 3 Quarantine pests for *Lilium* spp. cut flowers from Taiwan**

| Pest | Common name |
|---|---|
| **ARTHROPODS** | |
| **COLEOPTERA (beetles, weevils)** | |
| *Harmonia axyridis* (Pallas) [Coccinellidae] | Harlequin ladybird |
| *Lilioceris formosana* Heinze [Chrysomelidae] | Leaf beetle |
| *Lilioceris merdigera* (Linnaeus) [Chrysomelidae] | Leaf beetle |
| *Sangariola punctatostriata* (Motschulsky) [Chrysomelidae] | Lily leaf flea beetle |
| **DIPTERA (flies, gnats, midges)** | |
| *Liriomyza huidobrensis* (Blanchard) [Agromyzidae] | Leafminer |
| *Liriomyza trifolii* (Burgess) [Agromyzidae] | Leafminer |
| *Chromatomyia horticola* Goureau [Agromyzidae] | Leafminer |
| **HEMIPTERA (aphids, leafhoppers, mealybugs, psyllids, scales, true bugs, whiteflies)** | |
| *Pseudococcus comstocki* (Kuwana) [Pseudococcidae] | Comstock's mealybug |
| **LEPIDOPTERA (moths, butterflies)** | |
| *Agrotis segetum* Denis & Schiffermüller [Noctuidae] | Cutworm, dark moth |
| *Euproctis taiwana* (Shiraki) [Lymantriidae] | Tussock moth |
| *Kaniska canace* Linnaeus [Nymphalidae] | Blue admiral |
| *Orgyia postica* Walker [Lymantidae] | Tussock moth |
| *Xylena formosa* (Butler) [Noctuidae] | Cutworm |
| **THYSANOPTERA (thrips)** | |
| *Haplothrips chinensis* Priesner [Phlaeothripidae] | Chinese thrips |
| *Frankliniella intonsa* (Trybom) [Thripidae] | Flower thrips |
| *Megalurothrips distalis (Karny) [Thripidae]* | Bean blossom thrips |
| **VIRUSES** | |
| Lily mottle virus LMoV [Potyviridae: Potyvirus] | |
| Lily virus X LVX [Flexiviridae : Potexvirus] (synonym *Lily X potexvirus*) | |
| Plantago asiatica mosaic virus PlAMV [Alphaflexiviridae : Potexvirus] | |
| Strawberry latent ringspot virus SLRSV [Secoviridae : Genus Unassigned] | |
| Tobacco ringspot nepovirus TRSV [Secoviridae : Nepovirus] | |

### 3.2.3 Entry, establishment and spread

Details of how to assess the 'probability of entry', 'probability of establishment' and 'probability of spread' of a pest are given in ISPM 11 (FAO 2004).

#### Probability of entry

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

- *Lilium* spp. flowers are assumed to come from areas where the above pests occur and are, therefore, likely to enter on imported lily cut flowers.
- The pests' ability to survive on host cut flowers which are maintained in healthy condition during transport acts to assist their viability en route to, and during distribution across, Australia.

- Viruses, as a rule, systemically infect all parts of host plants. Therefore, cut flowers provide a pathway for viruses.
- The bulk of Taiwan's imports of certified bulbs for planting are from the Netherlands. Planting stock is of high health status and certified for freedom from viruses of quarantine concern for Taiwan by the Netherlands. Therefore, the probability of infected mother plants in Taiwan will be reduced and the entry of infected cut flowers into Australia through cut flower importations will be similarly reduced.
- Due to their short shelf life, *Lilium* spp. cut flowers will be transported in cool conditions, which are unlikely to adversely affect survival of arthropod pests and viruses.
- Cut flowers may contain arthropod pests which may be hidden in stem sheaths or closed flowers. These pests may not be detected by inspection.
- Due to the nature of packaging arthropod pests are likely to remain associated with the commodity.
- Upon arrival in Australia, arthropod pests may readily be distributed to susceptible hosts. Identified pest such as thrips and coleopterans are quite mobile with wide host ranges and are likely to readily find a suitable host species. *Lilium* spp. cut flowers are likely to be widely distributed through florists and other points of sale. Due to the short shelf life of lily cut flowers, their distribution is likely to occur soon after importation, which will assist the probability of arthropods being distributed in a viable state.

**Probability of establishment**

Establishment is defined as the 'perpetuation for the foreseeable future, of a pest within an area after entry' (FAO 2012).

- The categorisation process has not highlighted any fungal or stramenopile pests that are associated with *Lilium* spp. cut flower imports from Taiwan. The pests of concern are viruses and arthropods.
- Due to the systemic nature of viruses, propagative material is a major pathway for dispersal. However, the scope of *Lilium* spp. cut flowers from Taiwan is limited to varieties which are free of bulbils. These varieties are non-propagable. Therefore, systemic viruses are highly unlikely to establish.
- *Lilium* spp. cut flowers are likely to be disposed of in backyard compost heaps or as green waste in backyards, roadsides and other public locations, as well as in municipal waste disposal. The disposal of lily cut flowers in municipal waste is likely to reduce the probability of establishment of arthropod pests. However, disposal in other locations will provide the opportunity for establishment.
- Once arthropod pests have been distributed to a susceptible host, the likelihood of establishment is considered high.

**Probability of spread**

Spread is defined as 'the expansion of the geographical distribution of a pest within an area' (FAO 2012). The probability of spread considers the factors relevant to the movement of the pest, after establishment on a host plant or plants, to other susceptible host plants of the same or different species in other areas.

- The ability of arthropod pests to be introduced and distributed throughout Australia on cut flowers through human mediated spread (distribution to florists and other points of sale) is

a high risk for continued spread post-border in Australia. Pest related factors which would aid the spread of the pest once it has established in Australia (such as wind or mechanical transmission) will increase the pest's ability to spread.

- The systemic nature of some of the pests associated with propagative material (*i.e.* viruses) is a major pathway for dispersal. However, the scope of *Lilium* spp. cut flowers from Taiwan is limited to varieties which are free of bulbils. These varieties are non-propagable. Therefore, systemic pests are unlikely to establish and spread via propagation.

### 3.2.4 Consequences

The purpose of assessment of potential consequences in the pest risk assessment process is to identify and quantify, as much as possible, the potential impacts that could be expected to result from a pest's introduction and spread.

The basic requirements for the assessment of consequences are described in the SPS Agreement, in particular Article 5.3 and Annex A. Further detail on assessing consequences is given in the 'potential economic consequences' section of ISPM 11. This ISPM separates the consequences into 'direct' and 'indirect' and provides examples of factors to consider within each.

The introduction of pests which meet the criteria of a quarantine pest will have unacceptable economic consequences in Australia as these pests will cause a variety of direct and indirect economic impacts. The identified pests are of economic concern and do not occur in Australia. A summary and justification is provided below:

- Direct impacts of the introduction and spread of multi-host pests in Australia will not only affect the imported host but also other hosts. Introduction and establishment of quarantine pests in Australia would not only result in phytosanitary regulations imposed by foreign or domestic trading partners, but also in increased costs of production including control costs.
- Quarantine pest introduction and establishment would also be likely to result in industry adjustment. The potential economic impact for cut flowers is high. Without controls these pests have the potential to spread further in the trade network and could potentially expand their host range.
- Arthropod pests such as flower thrips can cause damage to ornamental flower buds, and to flowers of many leguminous plants or fruit crops which will not only require control if they establish and spread. They will affect cut flower trade as phytosanitary restrictions can apply.
- Most viruses of quarantine concern on lilies affect ornamentals and can cause deformation, asymmetrical opening of flowers, or necrosis and discolouration leading to decreased flower value and potential loss of markets locally and internationally. Others such as Tobacco ringspot nepovirus and Strawberry latent ringspot virus have a wide host range and can affect different crop species and ornamentals.
- Viruses are considered important as they cause a variety of direct and indirect economic impacts, such as reduced yield, reduced commodity value and loss of foreign or domestic markets. Therefore, these pests have a potential for economic consequences in the PRA area. Cut flowers do not present a direct pathway for viruses, which need to be vectored into suitable hosts. However, the presence of these pathogens in Australia would impact upon Australia's ability to access overseas markets.

### 3.2.5 Unrestricted risk estimate

As a result of these pathway specific factors, the overall likelihood for the probability of entry, establishment and spread is considered to be above the ALOP for arthropod quarantine pests entering on *Lilium* spp. cut flowers in the absence of management measures.

Arthropods and viruses listed in Table 3 are of economic significance and are either absent from Australia, or if present, are under official control. Therefore, arthropod pests of *Lilium* spp. cut flowers meet the IPPC criteria for a quarantine pest and phytosanitary measures are justified to manage these pests.

## 3.3 Stage 3: Pest Risk Management

ISPM 11 (FAO 2004) provides details on the identification and selection of appropriate risk management options. Pest risk management describes the process of identifying and implementing phytosanitary measures to manage risks posed by identified quarantine pests, while ensuring that any negative effects on trade are minimised.

Pest risk management evaluates and selects risk management options to reduce the risk of entry, establishment and spread of identified pests for the identified import pathways. To effectively prevent the introduction of pests associated with an identified pathway, a series of important safeguards, conditions or phytosanitary measures must be in place. Cut flowers represent a direct pathway for arthropod pests identified by the pest categorisation, which may also act as vectors for viral pathogens.

### 3.3.1 Identification and selection of appropriate risk management options

Phytosanitary measures to prevent the establishment and spread of quarantine pests may include any combination of measures; including pre- or post-harvest treatments, inspection at various points between production and final distribution, surveillance, official control, documentation, or certification. A measure or combination of measures may be applied at any one or more points along the continuum between the point of origin and the final destination. Pest risk management explores options that can be implemented

(i) in the exporting country,
(ii) at the point of entry or
(iii) within the importing country.

The ultimate goal is to protect plants and prevent the introduction of identified quarantine pests.

Measures can range from total prohibition to permitting import subject to visual inspection. In some cases, more than one phytosanitary measure may be required in order to reduce the pest risk to an acceptable level.

# 4 Pest risk management

This chapter describes the phytosanitary procedures associated with the importation of *Lilium* spp. cut flowers from Taiwan, and provides information on the management of quarantine pests identified with an unrestricted risk exceeding Australia's appropriate level of protection (ALOP). The proposed phytosanitary measures are described below.

## 4.1 Pest risk management measures and phytosanitary procedures

Pest risk management evaluates and selects options for measures to reduce the risk of entry, establishment or spread of quarantine pests for Australia where they have been assessed to have an unrestricted risk above Australia's ALOP. In examining the unrestricted risk, existing commercial production practices in Taiwan have been considered, as have postharvest procedures and the packing of *Lilium* spp. cut flowers.

In addition to Taiwan's existing commercial production practices for the production of *Lilium* spp. cut flowers and minimum border procedures in Australia, specific pest risk management measures are proposed to achieve Australia's ALOP. Finalisation of the quarantine conditions may be undertaken with input from DAFF and the Australian states and territories as appropriate.

### 4.1.1 Management for arthropod quarantine pests

Arthropod pests of concerns to Australia associated with *Lilium* spp. cut flowers from Taiwan have been assessed as requiring phytosanitary measures.

The existing conditions for cut flower imports stipulate mandatory methyl bromide treatment, or the alternatives detailed in section 1.3.3. Taiwan has requested alternative measures to methyl bromide.

The proposed risk management measures are:

1. Methyl bromide fumigation offshore or onshore, OR
2. A systems approach administered by BAPHIQ, including pre-export phytosanitary inspection and certification, to ensure that *Lilium* spp. cut flowers are free of arthropod pests of concern (Table 3).

Consignments will be subject to onshore inspection and verification. These risk management measures are consistent with Australia's quarantine policy for arthropod pests on other cut flower imported commodities.

Any measures equivalent with the above will be considered.

### 4.1.2 Management for virus quarantine pests

The standard import conditions for cut flowers include mandatory devitalisation for propagable species. The purpose of this measure is to render the risk from certain viruses and obligate fungi as equivalent to non-propagable species from the perspective of the propagation pathway for establishment.

As the varieties/hybrids proposed for import from Taiwan do not produce stem bulbils they are non-propagable. Thus, the risk for virus transmission is similar to other cut flower pathways currently permitted.

In addition, *Lilium* spp. bulbs are currently permitted from all countries for production in open quarantine. Open quarantine is subject to monitoring and inspection for pests and disease.

Therefore no additional phytosanitary measures are recommended to manage the risk of quarantine virus pests.

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

A system of operational procedures is necessary to maintain and verify the phytosanitary status of *Lilium* spp. cut flowers from Taiwan.

**Recognition of the competent authority**

BAPHIQ is the designated NPPO for Taiwan under the IPPC.

The objectives of the NPPO are to ensure that:

- recommended service and certification standards are met by all relevant agencies participating in this program
- recommended administrative processes are established to provide assurance that the recommended requirements of the program are being met.

**Audit and verification**

Where a systems approach is adopted for the management of arthropod pests, as an alternative to methyl bromide fumigation, or when fumigation is performed prior to export, the pathway will be subject to audit and verification.

BAPHIQ is responsible for establishing a system for *Lilium* spp. production that meets the phytosanitary requirements of Australia and for the audit of their system. DAFF may undertake an audit of the BAPHIQ system.

The objectives of the recommended requirement for audit and verification are to ensure that:

- an effective approved documented system for the net houses, the packing houses and during transport is in operation.

**Provisions for traceability**

All consignments must have adequate labelling or other means of identification so that they can be traced to critical points of the pathway.

**Packaging and labelling**

The objective of the requirement for packaging and labelling are to ensure that secure packaging that meets Australia’s import conditions is used.

### Specific conditions for storage and transport

The objective of the requirement for storage and transport are to ensure that:

- product for export to Australia is secure to prevent mixing or cross-contamination with produce destined elsewhere
- maintain the quarantine integrity of the commodity during storage and movement.

### Pre-export phytosanitary inspection and certification

The objectives of phytosanitary certification are to ensure that:

- an International Phytosanitary Certificate (IPC) is issued for each consignment, consistent with ISPM No. 12 Phytosanitary Certificates (FAO 2011), to provide formal documentation to DAFF verifying the relevant measures have been undertaken offshore
- ensure the goods have been inspected for quarantine pests and other regulated articles by the NPPO
- each IPC includes a description of the consignment (including grower number and packing house details).

### Additional Phytosanitary Certificate declaration

Each consignment must be accompanied by an original IPC endorsed with the following additional declarations:

> *Produce sourced from an accredited supplier under the agreement between DAFF and BAPHIQ for lily cut flowers.*
>
> *The* Lilium *spp. cut flowers are commercial hybrid varieties and are free of stem bulbils.*

### On-arrival DAFF inspection

DAFF officers will undertake an inspection of all *Lilium* spp. cut flowers consignments covered by separate phytosanitary certificates issued by the NPPO on arrival of the consignment in Australia. The inspection will be conducted using the standard inspection regime for the type of commodity and may involve specific techniques or use of optical enhancement where necessary.

The detection of live quarantine pests or regulated articles during an inspection will result in the failure of the inspection lot.

The objective of this procedure is to ensure that each consignment, as defined by a single phytosanitary certificate, is verified at the first port of entry to confirm that the consignment meets Australia's import requirements.

If no live quarantine pests, disease symptoms or other regulated articles are detected in the inspection lot, the consignment will be released from quarantine.

Consignments will fail if quarantine pests and/or regulated articles are detected during on-arrival inspections. Remedial action is to be taken when this occurs.

DAFF will advise BAPHIQ about non-compliance so that BAPHIQ can apply appropriate corrective action with suppliers.

## 4.2 Uncategorised pests

If an organism that has not been categorised is detected on *Lilium* spp. cut flowers during inspection, it will require assessment by DAFF 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 remedial action, as appropriate.

## 4.3 Review of policy

DAFF may audit the phytosanitary procedures prior to trade commencing.

Australia reserves the right to review and amend the import policy if circumstances change. Australia is prepared to review the policy after a substantial volume of trade has occurred. DAFF may review the import policy after the first year of trade.

# 5 Conclusion

The findings of this draft policy review are based on a comprehensive analysis of relevant scientific literature. DAFF considers that the risk management measures and operational system for the maintenance and verification of phytosanitary status proposed in this draft policy review will provide an appropriate level of protection against the pests identified in this risk analysis.

# Appendices

# Appendix A: Initiation and categorisation of pests associated with *Lilium* spp. cut flowers from Taiwan

Initiation identifies the pests which occur on *Lilium* spp. cut flowers, their status in Taiwan and Australia and their pathway association. In this assessment **pathway** is defined as commercially grown non-bulbil forming *Lilium* spp. cut flowers.

Pest categorisation identifies the potential for pests to enter, establish, spread and cause economic consequences in Australia to determine if they qualify as quarantine pests.

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| **MOLLUSCA (slugs, snails)** | | | | | | |
| *Bradybaena similaris* (Ferussac) [Eupulmonata : Bradybaenidae] | Yes (Wang and Lin 1997) | Yes (ABRS 2009) | Assessment not required | | | |
| **ARTHROPODS** | | | | | | |
| **ACARI (mites)** | | | | | | |
| *Rhizoglyphus echinopus* (Fumouze & Robin) [Sarcoptiformes] [synonym *R. hyacinthi* (Diaz *et al.* 2000, ABRS 2009), *R. callae* Oudemans, *R. zachvatkini* (Volgin) (Diaz *et al.* 2000, Klimov and Tolstikov 2011)] bulb mite | No (Wang and Lin 1997, BAPHIQ 2011b, BAPHIQ 2012)[2] | Unresolved presence (ABRS 2009)[3] | **Yes:** Bulb mites attack roots and subterranean plant parts, they tunnel the stems at the ground level, causing them to lean or break (Diaz *et al.* 2000). They are occasionally collected on leaves and stems of infested Liliaceae (Latta 1939, Diaz *et al.* 2000). | **Yes:** Host plants are present in Australia. Should infested flowers be occasionally selected, cut flower refuse is likely to end up in municipal waste where it is buried, or in household compost, where it could be spread locally in infested plant debris. | **No:** Economic consequences for the introduction of this pest from cut flowers are minor. The most likely pathway for introduction of live mites that will induce economic loss is through importation of bulbs for planting or nursery stock of the many host species including onions, carrots and garlic, and ornamental bulbs including lilies, gladiolus and hyacinths (Diaz *et al.* 2000). | No |

[1] In this pest categorisation the potential for economic consequences is assessed in relation to the pest's likelihood to meet the ISPM 5 definition of a quarantine pest. Namely, that the pest is potentially economically important. Consequently, any pest which is considered a minor pest or is not known to be economically important and which is not considered to be an emerging pest problem does not meet the definition of a quarantine pest.
[2] Taiwan's NPPO, BAPHIQ, has indicated this pest does not occur in Taiwan (BAPHIQ 2011b, 2012). Other references state it is present in Taiwan (Fan and Zhang 2003, 2004, Fan *et al.* 2010, Klimov and Tolstikov 2011).
[3] The following references indicate this species is present in Australia (Fan and Zhang 2003, 2004).

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Rhizoglyphus robini* Claparede [Sarcoptiformes] bulb mite | Yes (Wang and Lin 1997, Ho and Chen 2000, Liu 1998, Fan *et al.* 2010, Klimov and Tolstikov 2011) | Yes (Fan and Zhang 2003, ABRS 2009, APPD 2011) | Assessment not required | | | |
| *Rhizoglyphus setosus* Manson [Sarcoptiformes] bulb mite | Yes (Wang and Lin 1997, Ho and Chen 2000, Chen *et al.* 2002, Capinera 2008, Klimov and Tolstikov 2011) | Yes (Fan and Zhang 2004) | Assessment not required | | | |
| *Rhizoglyphus tsutienensis* Ho & Chen [Sarcoptiformes] (synonym *Rhizoglyphus singularis* Manson ) bulb mite | Yes (Ho and Chen 2000, Capinera 2008, Fan *et al.* 2010, Klimov and Tolstikov 2011, TaiBNET 2012)[4] | No (ABRS 2009) | **No:** Recorded as a pest of *Lilium* spp. bulb (Capinera 2008). First described by Ho and Chen (2000) from Tsutien in Taiwan. | Assessment not required | | |
| *Schwiebea cuncta* Ho [Sarcoptiformes] | Yes (Ho 1993, Wang and Lin 1997, Fan *et al.* 2010, Klimov and Tolstikov 2011) | No (ABRS 2009) | **No:** recorded as pest of *Lilium* spp. bulb (Ho 1993). Also a common inhabitant of decaying wood (Wurst and Frank 1999). | Assessment not required | | |
| *Schwiebea taiwanensis* Ho [Sarcoptiformes] | Yes (Ho 1993, Wang and Lin 1997, Fan *et al.* 2010, Klimov and Tolstikov 2011) | No (ABRS 2009) | **No:** recorded as pest of *Lilium* spp. bulb (Ho 1993). Also a common inhabitant of decaying wood (Wurst and Frank 1999). | Assessment not required | | |
| *Tetranychus cinnabarinus* (Boisduval) [Trombidiformes] carmine spider mite | Yes (Wang and Lin 1997, TaiBNET 2012) | Yes (ABRS 2009) | Assessment not required | | | |

[4] Taiwan's NPPO, BAPHIQ, has indicated this pest does not occur in Taiwan (BAPHIQ 2012). Other references state it is present.

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Tetranychus urticae* Koch [Trombidiformes] two-spotted spider mite | Yes (Wang and Lin 1997, TaiBNET 2012) | Yes (ABRS 2009) | Assessment not required | | | |
| **COLEOPTERA (beetles, weevils)** | | | | | | |
| *Harmonia axyridis* (Pallas) [Coccinellidae] harlequin ladybird | Yes (TaiBNET 2012) | No (ABRS 2009) | **Yes:** *H. axyridis* is known as a predator of aphids and other soft-bodied insects as well as pollen and nectar (Koch 2003), and can be imported and moved over long distances on cut flowers as well as other traded commodities including fruit (Koch 2003). | **Yes:** This species has demonstrated its ability to spread rapidly in Europe, Africa and the Americas (Brown *et al.* 2011, Nedvěd *et al.* 2011). | **Yes:** *H. axyridis* causes 'ladybug taint' in wines after processing if found on grapes (Brown *et al.* 2011), which may limit or restrict access of such goods into overseas markets and require additional measures to be undertaken. Can also infest buildings (Huelsman *et al.* 2010). | **Yes** |
| *Lasioderma serricorne* (Fabricius) [Anobiidae] tobacco beetle | Yes (TaiBNET 2012, BAPHIQ 2012) | Yes (ABRS 2009) | Assessment not required | | | |
| *Lilioceris formosana* Heinze [Chrysomelidae] (synonym *Lilioceris neptis* subsp. *formosana* Heinze, *Lilioceris impressa* subsp. *loochooana* Nakane, *formosana* = bona species: Kimoto et Takizawa, *loochooana* = *formosana*: Kimoto et Takizawa) leaf beetle | Yes (Wang and Lin 1997, Warchalowski 2011) | No (AICN 2008, ABRS 2009) | **Yes:** This species is native to Taiwan. *Lilioceris* spp. beetles feed on lilies and other hosts (Kroon 2009). Both adult and larval stages cause foliar damage to host plants (Salisbury 2008). It is likely to be on the pathway and transported internationally. | **Yes:** Some *Lilioceris* spp. have established in many countries where accidentally introduced, indicating potential as an invasive species (Kenis *et al.* 2003). *Lilium* bulbs are popular in backyards, and grown by local industry. The Australian climate is likely to be conducive for the spread of this pest. | **Yes:** Adults and larvae of *Lilioceris* spp. cause economic damage by attacking foliage and flowers of many cultivated and native *Lilium* plant species and other hosts (Salisbury 2008, Casagrande and Kenis 2004). *Lilioceris formosana* are herbivores but their host plant association is not fully elucidated. | **Yes** |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Lilioceris merdigera* (Linnaeus) [Chrysomelidae] (synonym *Crioceris brunnea* Fabricius, *Chrysomela merdigena* Linnaeus) leaf beetle | Yes (Wang and Lin 1997) | No (AICN 2008, ABRS 2009) | **Yes:** This beetle feeds on lilies (Salisbury 2008). Both adult and larval stages cause foliar damage to host plants (Salisbury 2008). It is likely to be on the pathway and transported internationally. | **Yes:** Some *Lilioceris* spp. have established in many countries where accidentally introduced, indicating potential as an invasive species (Kenis *et al.* 2003). *Lilium* bulbs are popular in backyards, and grown by local industry. The Australian climate is likely to be conducive for the spread of this pest. | **Yes:** Adults and larvae of *Lilioceris* spp. cause economic damage by attacking foliage and flowers of many cultivated and native *Lilium* plant species (Salisbury 2008, Casagrande and Kenis 2004).Other hosts include *Convallaria, Allium* and *Polygonatum* (Schmitt 1988, Haye and Kenis 2004). | **Yes** |
| *Sitophilus oryzae* (Linnaeus) [Curculionidae] rice weevil | Yes (Lo 1986, Lyal 2011) | Yes (ABRS 2009) | Assessment not required | | | |
| *Sangariola punctatostriata* (Motschulsky) [Chrysomelidae] lily leaf flea beetle | Yes (Wang and Lin 1997, TaiBNET 2012) | No (AICN 2008, ABRS 2009) | **Yes:** Associated with *Lilium* spp. (Wang and Lin 1997). Larvae eat *Lilium* spp. leaves (Maddison 1993). | **Yes:** This species has a limited distribution internationally though it has established in areas with a wide range of climatic conditions. Hosts of this species, including *Smilax* spp. are widespread in Australia (APNI 2012). | **Yes:** This species could cause economic damage by attacking foliage and flowers of many cultivated and native plant species, including *Smilax* spp. and *Lilium* spp. (APNI 2012). | **Yes** |
| *Sitophilus zeamais* Motschulsky [Curculionidae] maize weevil | Yes (Lo 1986) | Yes (ABRS 2009) | Assessment not required | | | |
| *Tenebroides mauritanicus* (Linnaeus) [Trogossitidae] cadelle beetle | Yes (Lo 1986) | Yes (ABRS 2009) | Assessment not required | | | |
| **DIPTERA (flies, gnats, midges)** | | | | | | |
| *Liriomyza huidobrensis* (Blanchard) [Agromyzidae] leafminer | Yes (CABI 2012, TaiBNET 2012) | No (ABRS 2009, CABI 2012) | **Yes:** Highly polyphagous leafminers (Malipatil and Ridland 2008). Different hosts include aster, begonia, dahlia, impatiens, lily, marigold, petunia, and verbena (UC IPM 2008). Liliaceae are hosts (Spencer 1973). | **Yes:** This species has demonstrated its ability to spread rapidly in tropical and sub-tropical areas in Asia and Africa, as well as Europe and nearctic regions (Minkenberg 1988, Wei *et al.* 2000). Host plants are present in Australia, as are similar climatic regions. | **Yes:** Leafminers cause economic loss to many crops as they reduce yield, leaf photosynthetic areas, aesthetic value of ornamentals, and are pesticide resistant (Minkenberg 1988, Wei *et al.* 2000, Shiao 2004). | **Yes** |
| *Liriomyza* trifolii (Burgess) [Agromyzidae] leafminer | Yes (CABI 2012, TaiBNET 2012) | No (ABRS 2009, CABI 2012) | | | | **Yes** |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Chromatomyia horticola* Goureau (synonym *Phytomiza horticola*) [Agromyzidae] leafminer | Yes (CABI 2012, TaiBNET 2012) | No (ABRS 2009, CABI 2012) | **Yes:** Highly polyphagous (Malipatil and Ridland 2008). Liliaceae are hosts (Spencer 1973). | **Yes:** This pest has established and spread in areas with a wide range of climatic conditions. It is found throughout Africa, Asia, and Europe (CABI 2012) and is polyphagous, thus, has the potential for establishment and spread in Australia. | **Yes:** Leafminers cause economic loss to many crops as they reduce yield, leaf photosynthetic areas, aesthetic value of ornamentals, and are pesticide resistant (Minkenberg 1988, Wei *et al.* 2000, Shiao 2004). | **Yes** |
| *Eumerus okinawaensis* Shiraki [Syrphidae] hover fly | Yes (Maddison 1993, Wang and Lin 1997, TaiBNET 2012) | No (Maddison 1993, ABRS 2009, ALA 2011) | **No:** Larvae of this genus bore into *Lilium* spp. bulbs (Maddison 1993). Not known to be associated with flowers and foliage. | Assessment not required | | |
| *Eumerus strigatus* (Fallen) [Syrphidae] onion bulb fly | Yes (CABI 2012)/Unconfirmed | No (CABI 2012)/ Unconfirmed (AICN 2008, APPD 2011) | **No:** Larvae bore in *Lilium* spp. bulbs (Maddison 1993). Not known to be associated with flowers and foliage. | Assessment not required | | |
| *Eumerus figurans Walker* (synonym *E. marginatus* Grimshaw) [Syrphidae] bulb fly | Yes (Thompson and Vockeroth 1989) | Yes (Thompson and Vockeroth 1989) | **No:** Larvae of this genus bore into bulbs (Maddison 1993, Mau and Kessing 1992). Not known to be associated with flowers and foliage. | Assessment not required | | |
| **HEMIPTERA (aphids, leafhoppers, mealybugs, psyllids, scales, true bugs, whiteflies)** | | | | | | |
| *Abgrallaspis cyanophylli* (Signoret) [Diaspididae] cyanophyllum scale | Yes (Lee 1988, Takagi 1969, Ben-Dov *et al.* 2012) | Yes (ABRS 2009) | Assessment not required | | | |
| *Aonidiella orientalis* (Newstead) [Diaspididae] oriental scale | Yes (Miller and Davidson 2005, BAPHIQ 2012) | Yes (ABRS 2009) | Assessment not required | | | |
| *Aulacorthum circumflexum* (Buckton) [Aphididae] (synonym *Neomyzus circumflexum*) lily aphid | Yes (TaiBNET 2012, BAPHIQ 2012) | Yes (ABRS 2009) | Assessment not required | | | |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Aulacorthum solani* (Kaltenbach) [Aphididae] foxglove aphid | Yes (Wang and Lin 1997, TaiBNET 2012) | Yes (Berlandier 1997, APPD 2011) | Assessment not required | | | |
| *Aphis gosspyii* Glover [Aphididae] cotton aphid | Yes (Wang and Lin 1997, BAPHIQ 2009) | Yes (ABRS 2009, CABI 2010) | Assessment not required | | | |
| *Chrysomphalus aonidum* (Linnaeus) [Diaspididae] Florida red scale, circular black scale | Yes (Lee 1988, EPPO 2007, Ben-Dov *et al.* 2012) | Yes (ABRS 2009, Ben-Dov *et al.* 2012) | Assessment not required | | | |
| *Coccus hesperidum* Linnaeus [Coccidae] brown soft scale | Yes (Lee 1988, Wang and Lin 1997, Ben-Dov *et al.* 2012) | Yes (Ben-Dov *et al.* 2012) | Assessment not required | | | |
| *Dysmicoccus brevipes* (Cockerell) [Pseudococcidae] pineapple mealy bug | Yes (Ben-Dov *et al.* 2012, BAPHIQ 2009) | Yes (Ben-Dov *et al.* 2012) | Assessment not required | | | |
| *Ferrisia virgata* (Cockerell) [Pseudococcidae] striped mealybug | Yes (Wang and Lin 1997, Ben-Dov *et al.* 2012) | Yes (Ben-Dov *et al.* 2012) | Assessment not required | | | |
| *Hemiberlesia lataniae* (Signoret) [Diaspididae] latania scale | Yes (Ben-Dov *et al.* 2012) | Yes (Ben-Dov *et al.* 2012) | Assessment not required | | | |
| *Myzus persicae* (Sulzer) [Aphididae] green peach aphid | Yes (BAPHIQ 2009, Wang and Lin 1997) | Yes (Berlandier 1997, APPD 2011) | Assessment not required | | | |
| *Parlatoria proteus* (Curtis) [Diaspididae] brown scale | Yes (Takagi 1969, Ben-Dov *et al.* 2012) | Yes (ABRS 2009, Ben-Dov *et al.* 2012) | Assessment not required | | | |
| *Pinnaspis aspidistrae aspidistrae (*Signoret) [Diaspididae] aspidistra scale | Yes (Takagi 1969, Wang and Lin 1997, Ben-Dov *et al.* 2012) | Yes (Ben-Dov *et al.* 2012) | Assessment not required | | | |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Planococcus citri* (Risso) [Pseudococcidae] citrus mealybug | Yes (Lee 1988, Wang and Lin 1997, Ben-Dov *et al.* 2012) | Yes (Ben-Dov *et al.* 2012) | Assessment not required | | | |
| *Pseudococcus comstocki* (Kuwana) [Pseudococcidae] Comstock's mealybug | Yes (Wang and Lin 1997, TaiBNET 2012) | No (ABRS 2009, Ben-Dov *et al.* 2012) | **Yes:** recorded as pest of *Lilium* spp. (Maddison 1993, Wang and Lin 1997). Occurs on the aerial parts of the host plant (Ben-Dov *et al*. 2012). | **Yes:** The Australian climate is likely to be conducive for the spread of this pest. It is polyphagous and has a wide host range including commercial fruit trees, ornamental shrubs and creepers, amenity trees and natives (CABI 2012). | **Yes:** This is an economically significant pest of many crops (Ben-Dov *et al.* 2012). The introduction of these pests in commercial production areas may limit access to overseas markets. | **Yes** |
| *Pseudococcus longispinus* (Targioni) [Pseudococcidae] longtail mealybug | Yes (Lee 1988, Wang and Lin 1997) | Yes (ABRS 2009, Ben-Dov *et al.* 2012) | Assessment not required | | | |
| *Saissetia coffeae* (Walker) [Coccidae] hemispherical scale | Yes (Lee 1988, Ben-Dov *et al.* 2012) | Yes (ABRS 2009, Ben-Dov *et al.* 2012) | Assessment not required | | | |
| **LEPIDOPTERA (moths, butterflies)** | | | | | | |
| *Acrolepiopsis incertella* (Chambers) [Acrolepiidae] carrionflower moth | Yes (BAPHIQ 2012) | No (Landry 2007, AICN 2008, ABRS 2009) | **No:** recorded as feeding on *Lilium* spp. by boring into the bulbs (Ellis 2004, Landry 2007). Not known to be associated with flowers and foliage. | Assessment not required | | |
| *Agrotis segetum* Denis & Schiffermüller [Noctuidae] cutworm, dark moth | Yes (Wang and Lin 1997, EPPO 2007, TaiBNET 2012) | No (ABRS 2009, CABI 2012) | **Yes:** *A. segetum* is a highly polyphagous pest that attacks a wide range of important crop plants and ornamentals including bulbaceous species (CABI 2012). | **Yes:** Association with the cut flower host provides opportunity for establishment and spread as this pest is polyphagous. It is established in areas with a wide range of climatic conditions (CABI 2012) and therefore has the potential to establish and spread in Australia. | **Yes:** Cutworms cause economic loss to many crops as they affects leaves, stems and roots of hosts (CABI 2012) including cotton, maize, potato, oilseeds, vegetable and root crops (CABI 2012). | **Yes** |
| *Brithys crini* Fabricius [Noctuidae] borer moth | Yes (BAPHIQ 2012) | Yes (Common 1990, Maddison 1993, ALA 2011) | Assessment not required | | | |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Chrysodeixis eriosoma* (Doubleday) [Noctuidae] green looper caterpillar | Yes (Wang and Lin 1997, TaiBNET 2012) | Yes (EPPO 2007, AICN 2008) | Assessment not required | | | |
| *Euproctis taiwana* (Shiraki) [Lymantriidae] (basionym *Porthesia taiwana* Shiraki) tussock moth | Yes (Lee 1988, Wang and Lin 1997, Liu 1998) | No (Nielsen *et al.* 1996) | **Yes:** This species feeds on the leaves of many flowers, including lilies (Liu 1998, Kuo 2005). | **Yes:** This species feeds on the leaves of gladiolus and lily plants (Liu 1998), the leaves of soybean (Talekar *et al.* 1988), grapevine (Chang 1988) and of rose in Taiwan (Biosecurity Australia 2006). The Australian climate is likely to be conducive for the spread of this pest. | **Yes:** This moth feeds on several hosts and can affect commercial crops through feeding on leaves, including flowers, fruit trees, vegetables and cereals. Larval hairs cause allergic reactions (Kuo 2005). | **Yes** |
| *Helicoverpa armigera* (Hübner) [Noctuidae] corn earworm | Yes (Wang and Lin 1997, CABI 2012, EPPO 2007) | Yes (ABRS 2009) | Assessment not required | | | |
| *Kaniska canace* Linnaeus [Nymphalidae] (synonym *Nymphalis canace* Linnaeus) blue admiral | Yes (Khramov *et al.* 2011, TaiBNET 2012) | No (Khramov *et al.* 2011) | **Yes:** Its distinctive larvae feed on hosts of the order Liliales including *Smilax*, *Tricyrtis*, *Streptopus* and *Lilium* spp. plants (Robinson *et al.* 2012). | **Yes:** Association with the host provides opportunity for establishment and spread of this species where cut flowers are sold and hosts are grown throughout Australia. Spreads in regions with similar climatic range as Australia. | **Yes:** The species is considered a minor pest of *Lilium* spp. However, *Smilax* spp. are widely spread in Australia (APNI 2012), and consequently its establishment and spread has potential for economic consequences in parts of Australia. | **Yes** |
| *Lampides boeticus* (Linnaeus) [Lycaenidae] longtailed pea-blue | Yes (TaiBNET 2012, Robinson *et al.* 2012) | Yes (ABRS 2009) | Assessment not required | | | |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Orgyia postica* (Walker) [Lymantidae] tussock moth | Yes (Lee 1988, Liu 1998, TaiBNET 2012) | No (CABI 2012) | **Yes:** This species has been recorded on *Lilium* species, larvae feed on leaves and flower buds (CoA undated - a). A pest of flowers in Taiwan (Liu 1998). | **Yes:** This species currently occurs from Japan to southern China (Nasu *et al.* 2004, Zhu and Zhang 2004). It established in areas with a wide range of climatic conditions and therefore has the potential to establish and spread in Australia. | **Yes:** This species is polyphagous (CABI 2012). It has been recorded as a pest of *Eucalyptus* plantations in Japan (Nasu *et al.* 2004). It is also considered to be one of the ten most important moths attacking tropical fruits in Southern China (Zhu and Zhang 2004). Hosts include durian, eucalypts, longan, lychee, mango, mangosteen, poplar, rambutan, roses, table grapes (CABI 2012), and soybean, cocoa, red beans and pear (Biosecurity Australia 2006). | **Yes** |
| *Spodoptera litura* (Fabricius) [Noctuidae] oriental leafworm moth | Yes (Lee 1988, TaiBNET 2012) | Yes (ABRS 2009) | Assessment not required | | | |
| *Xylena formosa* (Butler) [Noctuidae] (synonym *Xylena plumbeopaca* Hreblay & Ronkay) cutworm | Yes (Wang and Lin 1997, TaiBNET 2012) | No (Nielsen *et al.* 1996, ABRS 2009) | **Yes:** Recorded on lilies (Maddison 1993). This species is a generalist floral herbivore common in Japan, China, and Taiwan (Oguro and Sakai 2009). | **Yes:** The limited distribution of this species internationally suggests that it is not invasive; however, current reported distribution suggests that there are similar environments in parts of Australia that would be suitable for its establishment and spread. | **Yes:** This species is considered a minor pest of *Lilium* spp, though it has been recorded as feeding on sap of *Citrus* spp. and other fruit trees (Biosecurity Australia 2009). Therefore, this species has potential for economic consequences in parts of Australia and would impact upon overseas markets. | **Yes** |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| **ORTHOPTERA (grasshoppers, crickets, locusts)** | | | | | | |
| *Oxya intricata* (Stal)<br>[Acrididae]<br>[synonym *Oxya hyla intricata* (Stal)]<br>small rice grasshopper | Yes (BAPHIQ 2009) | No (ABRS 2009) | **Yes:** Recorded on *Lilium* spp. (BAPHIQ 2009, CoA undated - b). Generally, this is a rice pest that consumes foliage of grassy species (Heinrichs and Barrion 2004). On *Lilium* spp., it is likely a contaminant pest from nearby rice fields or previous crop rotations. | **No:** Adults are the most likely stage associated with minor hosts such as *Lilium* spp. *Oxya* lay their eggs behind rice leaves and stems, and when dry in the soil (Heinrichs and Barrion 2004). Its limited distribution internationally suggests that it is not an invasive species. | **Yes:** The species is not considered a major pest of *Lilium* spp. Adults and nymph damage and their feeding are easy to spot (Heinrichs and Barrion 2004). However, it is a pest of rice and consequently its establishment and spread has potential for economic consequences in parts of Australia. | **Yes** |
| **THYSANOPTERA (thrips)** | | | | | | |
| *Frankliniella intonsa* (Trybom)<br>[Thripidae]<br>flower thrips | Yes (Tang 1976, Wang and Lin 1997, BAPHIQ 2009) | No (Mound 2005, ABRS 2009)* | **Yes:** Thrips are sap-sucking insects that feed on foliage or flowers (Lewis 1997). *Frankliniella intonsa* is associated with the leaves and flowers of *Lilium* (Maddison 1993, BAPHIQ 2009). | **Yes:** This species is polyphagous and its current reported distribution suggests that there are similar environments in parts of Australia that would be suitable for its establishment and spread. | **Yes:** Flower thrips cause distortion of fruit and reductions in quality (Buxton and Easterbrook 1988); discolouration resulting in sales losses on ornamental and cut flower varieties (Sauer 1997). Flower thrips will affect cut flower trade as phytosanitary restrictions can apply. | **Yes** |
| *Haplothrips chinensis* Priesner<br>[Phlaeothripidae]<br>Chinese thrips | Yes (Liu 1998, TaiBNET 2012) | No (ABRS 2009) | **Yes:** This species has been recorded as a pest of rose, hibiscus, gladiolus and lily in Taiwan (Liu 1998, Kakimoto *et al.* 2006). | **Yes:** This species occurs on flowers but is also a predatory thrips (Kakimoto *et al.* 2006). It is recorded on several flower species in Japan (Kudo 1977), citrus (Biosecurity Australia 2009) and other fruit crops (GAAS 2012), and on vegetable crops in Korea and Taiwan (Woo 1988, Chang 1991). | **Yes:** This pest is listed as an invasive species by the USDA (Invasive.org 2010). It has a wide host range and can cause damage to several fruit and vegetable crops. Flower thrips will also affect cut flower trade and other commodities as phytosanitary restrictions can apply. | **Yes** |
| *Heliothrips haemorrhoidalis* (Bouché)<br>[Panchaetothripinae]<br>greenhouse thrips | Yes (Wang and Lin 1997, TaiBNET 2012) | Yes (ABRS 2009, Denmark and Fasulo 2010) | Assessment not required | | | |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Liothrips vaneeckei* (Priesner) [Phaleothripidae] lily bulb thrips | Yes (Wang and Lin 1997, TaiBNET 2012) | Yes (Malipatil *et al.* 2002) | Assessment not required | | | |
| *Megalurothrips distalis* (Karny) [Thripidae] bean blossom thrips | Yes (Wang and Lin 1997, TaiBNET 2012) | No (Maddison 1993, ABRS 2009) | **Yes:** Thrips are sap-sucking insects that feed on foliage or flowers (Lewis 1997). Found in *Lilium* spp. flowers in Asia and Pacific Islands (Maddison 1993). | **Yes:** The host range for this species includes legumes, groundnut and ornamentals (Reitz *et al.* 2011). It is likely to find environments in parts of Australia that would be suitable for its establishment and spread. | **Yes:** Flower thrips cause discolouration resulting in sales losses on ornamental and cut flower varieties (Sauer 1997). Damages buds of flowers of many leguminous plants (Ananthakrishnan 1993). Flower thrips will affect cut flower trade as phytosanitary restrictions can apply. | **Yes** |
| *Scirtothrips dorsalis* Hood [Thripidae] strawberry thrips | Yes (TaiBNET 2012) | Yes (ABRS 2009) | Assessment not required | | | |
| *Thrips hawaiiensis* (Morgan) [Thripidae] banana flower thrips | Yes (Lee 1988, Wang and Lin 1997) | Yes (ABRS 2009) | Assessment not required | | | |
| *Thrips palmi* Karny [Thripidae] melon thrips | Yes (Wang and Lin 1997, TaiBNET 2012) | Yes (ABRS 2009)[5] | Assessment not required | | | |
| *Thrips simplex* (Morison) [Thripidae] *Gladiolus* thrips | Yes (Wang and Lin 1997, TaiBNET 2012) | Yes (ABRS 2009) | Assessment not required | | | |
| *Thrips tabaci* Lindeman [Thripidae] onion thrips | Yes (Wang and Lin 1997, TaiBNET 2012) | Yes (ABRS 2009)[6] | Assessment not required | | | |

[5] These thrips species are virus vectors (Reitz *et al.* 2011).

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| **PATHOGENS** | | | | | | |
| **BACTERIA** | | | | | | |
| *Erwinia carotovora* (Jones) Bergey *et al.* [Enterobacteriales : Enterobacteriaceae] (synonym *Erwinia carotovora* subsp. *carotovora* (Jones) Bergey *et al.* *Pectobacterium carotovorum* subsp. *carotovorum* (Jones) Hauben *et al.* emend. Gardan *et al.*) bacterial soft rot | Yes (Hsu and Tzeng 1981, Hseu *et al.* 2004) | Yes (Bradbury 1977, Chandrashekar and Diriwaechter 1983, Toth *et al.* 2001) | Assessment not required | | | |
| *Pseudomonas gladioli* Severini [Pseudomonadales : Pseudomonadaceae] (synonym *P. antimicrobica* Attafuah & Bradbury, *P. cocovenenans* van Damme et al, *Burkholderia gladioli* (Severini) Yabuuchi *et al.*, *B. cocovenenans* (van Damme) Gillis) stem rot, bacterial leaf spot | Yes (Chiou and Wu 2001) | Yes (Tesoriero *et al.* 1982, Saddler 1994) | Assessment not required | | | |
| *Pseudomonas marginalis* (Brown) Stevens [Pseudomonadales : Pseudomonadaceae] (synonym *Pseudomonas marginalis* pv *marginalis* (Brown) Stevens) | Yes (Tzeng *et al.* 1994) | Yes (Wimalajeewa and Price 1985, CABI 1993, EPPO 2007, CABI 2012) | Assessment not required | | | |
| **FUNGI** | | | | | | |
| *Alternaria tenuissima* (Kunze) Wiltshire [Pleosporales : Pleosporaceae] (basionym *Helminthosporium tenuissimum* Kunze) (synonym *Clasterosporium tenuissimum* (Nees & T. Nees) Sacc.) | Yes (Farr and Rossman 2011, TaiBNET 2012) | Yes (APPD 2011, Farr and Rossman 2011) | Assessment not required | | | |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Athelia rolfsii* (Curzi) Tu & Kimbr. [Atheliales : Atheliaceae] (anamorph *Sclerotium rolfsii* Sacc.) (synonym, *S. rolfsii* var. *delphinii* (Welch) Boerema & Hamers, *S. delphinii* Welch, *Corticium rolfsii* Curzi, *C. centrifugum*, *Pellicularia rolfsii* (Curzi) E. West, *Botryobasidium rolfsii* (Curzi) Venkatar.)<br>blight, stem and root rot | Yes (Chen *et al.* 1998, CABI 2012) | Yes (Simmonds 1966, Sampson and Walker 1982, Shivas 1989, Lenné 1990) | Assessment not required | | | |
| *Aspergillus niger* Tiegh. [Eurotiales : Trichocomaceae] (synonym *Sterigmatocystis nigra* (Tiegh.) Tiegh., *Aspergillopsis nigra* (Tiegh.) Speg., *Rhopalocystis nigra* (Tiegh.) Grove)<br>black mould | Yes (CABI 2012, TaiBNET 2012) | Yes (Simmonds 1966, Cook and Dubé 1989, Shivas 1989, Walker 2001) | Assessment not required | | | |
| *Botrytis elliptica* (Berk.) Cooke [Helotiales : Sclerotiniaceae] (basionym *Ovularia elliptica* Berk.) (synonym *Botrytis liliorum* Fujikiro, *Polyactis cana* Corda , *Spicularia cana* (Corda) Bonord., *Botrytis canescens* Sacc., *Peronospora elliptica* (Berk.) W.G. Sm.)<br>grey mould, leaf blight | Yes (Lu and Chen 2005, BAPHIQ 2009) | Yes (Cunnington 2003, Sampson and Walker 1982, Shivas 1989) | Assessment not required | | | |
| *Botrytis tulipae* (Lib.) Lind [Helotiales : Sclerotiniaceae] (teleomorph *Sclerotium tulipae* Lib.) (synonym *Botrytis parasitica* Cavara, *Peronospora parasitica* (Pers.: Ft.) Fr., *Sclerotium entogenum* Westendorp)<br>blight, neck rot | Yes (Sawada 1959, TaiBNET 2012)<br>(as *P. parasitica, B. parasitica*) | Yes (Sampson and Walker 1982, Shivas 1989, Cook and Dubé 1989, Cunnington 2003) | Assessment not required | | | |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Colletotrichum dematium* (Pers. : Fr.) Grove [Glomerellaceae : Incertae sedis] (synonym *Exosporium dematium* (Pers.) Link, *Colletotrichum omnivorum* Halst., *Vermicularia dematium* (Pers.) Fr., *Lasiella dematium* (Pers.) Quél.) anthracnose, leaf spot | Yes (Hong *et al.* 2006) | Yes (Simmonds 1966, Sampson and Walker 1982, Shivas 1989, Cook and Dubé 1989) | Assessment not required | | | |
| *Epicoccum nigrum* Link [Ascomycetes : Incertae sedis] (synonym *Epicoccum purpurascens* Ehrenb., *E.asterinum* Pat., *Phoma epicoccina* Punith., Tulloch & J.G. Leach) | Yes (TaiBNET 2012, Farr and Rossman 2011) | Yes (APPD 2011, Farr and Rossman 2011) | Assessment not required | | | |
| *Fusarium oxysporum* Schltdl. [Hypocreales : Nectriaceae] (synonym *Fusarium angustum* Sherb.) blights, wilts, rots | Yes (TaiBNET 2012, Farr and Rossman 2011) | Yes (Simmonds 1966, Sampson and Walker 1982, Shivas 1989, Cook and Dubé 1989, Lenné 1990) | Assessment not required | | | |
| *Fusarium oxysporum* Schlecht. f. sp. *lilii* Imle. [Hypocreales : Nectriaceae] vascular wilt | Yes (BAPHIQ 2009) | No (Brake *et al.* 2002, APPD 2011, Farr and Rossman 2011) | **Yes:** This species causes brown basal rot of *Lilium* spp. bulbs. Affected stem and lower leaves become yellow and die. Plants become stunted and of poor quality (UC IPM 2009). | **No:** This fungus is disseminated by mycelia, conidia and/or chlamydospores carried in soil, on bulbs, dust, equipment, shoes, packing crates, by surface drainage water, and rarely by seed (Burgess 1981, Linderman 1981, Smith *et al.* 1988). The likelihood it will be distributed from cut flowers in a viable state to a susceptible host is low. | **Yes:** *F. oxysporum* f. sp. *lilii* host range extends to *Lilium*, *Freesia*, *Crocus* and *Cereus* spp. (Horst 2008). | No |
| *Fusarium proliferatum* (Matsush.) Nirenberg [Hypocreales : Nectriaceae] basal rot | Yes (Huang *et al.* 1992, Wu *et al.* 1998) | Yes (Summerell *et al.* 1993, Elmer *et al.* 1999) | Assessment not required | | | |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Fusarium solani (*Mart.) Sacc [Hypocreales : Nectriaceae] (teleomorph *Haematonectria haematococca* (Berk. & Broome) Samuels & Rossman) (synonym *Nectria haematococca* Berk. & Broome)<br>root and stem rot, wilt | Yes (BAPHIQ 2009, TaiBNET 2012) | Yes (Simmonds 1966, Sampson and Walker 1982, Shivas 1989, Cook and Dubé 1989) | Assessment not required | | | |
| *Helicobasidium mompa* Tanaka [Helicobasidiales : Helicobasidiaceae] (synonym *Septobasidium mompa* (Tanaka) Racib.)<br>root rot | Yes (BAPHIQ 2012) | No (Farr and Rossman 2011) | **No:** This species causes root rot and is associated with the bulbous part of *Lilium* spp. (Farr and Rossman 2011). Not known to be associated with flowers and foliage. | Assessment not required | Assessment not required | No |
| *Macrophomina phaseolina* (Tassi) Goid. [Ascomycota : Incertae sedis] (basionym *Macrophoma phaseolina* Tassi) (synonym *Macrophoma phaseoli* Maubl., *Sclerotium bataticola* Taubenh., *Rhizoctonia bataticola* (Taubenh.) E.J. Butler)<br>charcoal rot, ashy stem blight, damping-off | Yes (Wu 1985) | Yes (Simmonds 1966, Cook and Dubé 1989, Shivas 1989, Lenné 1990, Khangura and Aberra 2009). | Assessment not required | | | |
| *Magnaporthe grisea* (Hebert) Barr [Magnaporthaceae : Incertae sedis] (synonym *Pyricularia grisea* Sacc., *Ceratosphaeria grisea* Hebert)<br>grey leaf spot | Yes (EPPO 2007) | Yes (Simmonds 1966, Lenné 1990) | Assessment not required | | | |
| *Penicillium aurantiogriseum* Dierckx [Eurotiales : Trichocomaceae] (synonym *P. cyclopium* Westling, *P. martensii* Biourge*, P. solitum* Westling)<br>bulb rot | Yes (Tzean *et al.* 2009, TaiBNET 2012) | Yes (Pitt *et al.* 1991) | Assessment not required | | | |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Penicillium hirsutum* Dierckx [Eurotiales : Trichocomaceae] (synonym *P. hirsutum* var. *hirsutum* Dierckx*, P. verrucosum* var. *corymbiferum* (Westling), *P. corymbiferum* Westling) bulb rot | Yes (Tzean *et al.* 2009, TaiBNET 2012) | Yes (APPD 2011, Herb IMI 2012) | Assessment not required | | | |
| *Rhizoctonia solani* Kuhn [Cantharellales : Ceratobasidiaceae] (teleomorph *Thanatephorus cucumeris (*Frank) Donk) (synonym *Pellicularia filamentosa* (Pat.) Rogers, *Hypochnus cucumeris* Frank, *Corticium solani* (Prill. & Delacr.) Bourdot & Galzin, *Moniliopsis solani* (Kfihn) R.T.Moore) *Rhizoctonia* blight, stem rot, stem canker | Yes (BAPHIQ 2009) | Yes (Simmonds 1966, Sampson and Walker 1982, Shivas 1989) | Assessment not required | | | |
| *Sclerotinia sclerotiorum* (Lib.) de Bary [Helotiales : Sclerotiniaceae] (basionym *Peziza sclerotiorum* Lib.) (synonym *Hymenoscyphus sclerotiorum* (Lib.) W. Phillips, *Sclerotinia libertiana* Fuckel, *Sclerotium varium* Pers., *Whetzelinia sclerotiorum* (Lib.) Korf & Dumont) stem blight, head rot | Yes (Sawada 1959) | Yes (Shivas 1989, Lenné 1990) | Assessment not required | | | |
| **STRAMINOPILA** | | | | | | |
| *Phytophthora cactorum* (L. &L.) Schroeter [Peronosporales : Peronosporaceae] (synonym *Phytophthora omnivora* de Bary, *Peronospora cactorum* Lebert & Cohn) leaf, stem and root rot | Yes (Ho 1990, BAPHIQ 2009) | Yes (Sampson and Walker 1982, Shivas 1989) | Assessment not required | | | |
| *Phytophthora capsici* Leonian [Peronosporales : Peronosporaceae] (synonym *P. parasitica* var. *capsici* (Leonian) Sarej., *P. hydrophila* Curzi) stem and fruit rot | Yes (Ho 1990, Hartman 1993) | Yes (Shivas 1989) (NSW, Qld) (APPD 2011) | Assessment not required | | | |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Phytophthora cinnamomi* Rands [Peronosporales : Peronosporaceae] Phytophthora root rot | Yes (BAPHIQ 2009) | Yes (Simmonds 1966, Sampson and Walker 1982, Cook and Dubé 1989, Shivas 1989) | Assessment not required | | | |
| *Phytophthora nicotiana*e Breda de Haan [Peronosporales : Peronosporaceae] (synonym *P. parasitica* Dastur, *P. parasitica* var. *nicotianae* (Breda de Haan) Tucker, *P. melongenae* var. *ananaphthoros* Sideris , *P. manoana* Sideris , *P. melongenae* Sawada, *P. nicotianae* var. *parasitica* (Dastur) Waterh, *P. parasitica* var. *rhei* Godfrey, *P. tabaci* Sawada, P. terrestris Sherb.) black shank | Yes (Ho 1990, TaiBNET 2012) | Yes (Simmonds 1966, Sampson and Walker 1982, Shivas 1989) | Assessment not required | | | |
| *Pythium irregulare* Buisman [Pythiales : Pythiaceae] (synonym *Globisporangium irregulare* (Buisman) Uzuhashi, Tojo & Kakish, *P. fabae* Cheney, *P. irregulare var. hawaiiense Sideris, P. polymorphon* Sideris) downy mildew, blight, damping off, root and other rots | Yes (Ho 2009, TaiBNET 2012) | Yes (APPD 2011, Farr and Rossman 2011) | Assessment not required | | | |
| *Pythium ultimum* Trow [Pythiales : Pythiaceae] (synonym *Globisporangium ultimum* (Trow) Uzuhashi, Tojo & Kakish, *Pythium haplomitri* Lilienfeld) black-leg of seedlings | Yes (BAPHIQ 2006, Ho 2009, TaiBNET 2012) | Yes (Simmonds 1966, Sampson and Walker 1982, Shivas 1989, Lenné 1990) | Assessment not required | | | |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| **VIRUSES** | | | | | | |
| Apple stem grooving virus ASGV [Flexiviridae : Capillovirus] [synonym Citrus tatter leaf virus CTLV - CTLV isolates are now recognised as strains of Apple stem grooving virus (Lovisolo *et al*. 2003)] | Yes (CABI/EPPO 2000, EPPO 2007, Wu *et al.* 2010) | Yes (CABI/EPPO 2000, APPD 2011) | Assessment not required | | | |
| Broad bean wilt virus BBWV [Comoviridae : Fabavirus] | Yes (BAPHIQ 2012) | Yes (Shukla and Gough 1983, CABI 2012) | Assessment not required | | | |
| Cucumber mosaic virus CMV [Bromoviridae: Cucumovirus] | Yes (BAPHIQ 2009, TaiBNET 2012) | Yes (Brunt *et al.* 1996, CABI 2012) | Assessment not required | | | |
| Lily mottle virus LMoV [Potyviridae: Potyvirus] (synonym Tulip breaking virus - lily strain) | Yes (BAPHIQ 2009, TaiBNET 2012) | No. Although there are records of TBV in Australia (ICTVdB 2006, CABI 2012) there are no records of LMoV, now characterised as a distinct species rather than a synonym of TBV (Dekker *et al*. 1993; Derks *et al*. 1994). | **Yes:** LMoV is transmitted in a non-persistent manner by aphids (Asjes and Blom-Barnhoorn 2002). It may cause a mosaic pattern on leaves and flowers; flowers may also be malformed depending on the cultivar (EPPO 2002). | **Yes:** LMoV can be detected in the leaves of infected *Lilium* plants (Chinestra and Facchinette 2010). Aphids which become viruleferous after feeding on *Lilium* leaves may transmit the virus to susceptible host plants. The virus can also be transmitted mechanically (Navalinskienė and Samuitienė 2001). | **Yes:** Lily plants infected with LMoV are stunted and may die prematurely. Flower quality is reduced, with shorter vase life, and flowers may be malformed or exhibit colour-breaking (Pearson *et al.* 2009). | **Yes** |
| Lily symptomless virus LSV [Flexiviridae : Carlavirus] (synonym lily rosette virus, lily curl stripe virus, lily yellow flat virus, virus and marmor mite) (Asjes 2000) (synonym lily curl stripe virus, lily streak virus) (Brunt *et al.* 1996) | Yes (BAPHIQ 2009, TaiBNET 2012) | Yes (Brunt *et al.* 1996, Blake and Wilson 1996, CABI 2012) | Assessment not required | | | |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| Lily virus X LVX<br>[Flexiviridae : Potexvirus]<br>(synomyn *Lily X potexvirus*) | Uncertain/No (Brunt *et al*. 1996). However, lily bulbs are sourced from The Netherlands where this virus is known to occur. | No (Brunt *et al.* 1996) | **Yes:** Recorded on *Lilium* spp. in the UK (Stone 1980), the Netherlands (Memelink *et al*. 1990) and Lithuania (Dapkūniene *et al.* 2004). | **Yes:** No vector is known for LVX (Adams *et al*. 2004), although spread of LVX was reduced by insecticides but not by mineral-oil spraying. The mode of transmission is possibly by an insect in a persistent or semi-persistent manner (Asjes 1991). | **Yes:** LVX has not been shown to cause symptom expression in *Lilium* (EPPO 2002), although it causes symptoms of necrosis in edible lily when associated with TBV (Takashi *et al*. 2000). | **Yes** |
| Plantago asiatica mosaic virus PlAMV [Alphaflexiviridae : Potexvirus] (synonym Nandina mosaic virus) (Hughes *et al.* 2005). | No (PPSN 2010)/ Uncertain. However, lily bulbs are sourced from The Netherlands where this virus is known to occur. | No (PPSN 2010) Australian records are PEQ interceptions on bulbs grown in open quarantine | **Yes:** The virus was first detected in lily flower production facilities (indoor) then in production fields. Recorded in Japan, Russia, US, and possibly Chile, New Zealand and South Korea (Komatsu *et al*. 2008; PPSN 2010). | **Yes:** PlAMV is able to infect a wider host range than other Potexvirus species, and induce various symptoms such as necrosis (Ozeki *et al.* 2006, Komatsu *et al*. 2008). Like other Potexvirus species, the virus may be spread mechanically (PPSN 2010). | **Yes:** The leaves develop severe symptoms of necrosis and discolouration, which may result in the loss of flower value of up to 80% (PPSN 2010). | **Yes** |
| Strawberry latent ringspot virus SLRSV [Secoviridae : Genus Unassigned] | Yes (Chang *et al.* 2001) | No. One record from SA, with no evidence of establishment or spread (CABI/EPPO undated-a, CABI 2012) | **Yes:** although more likely to arrive on infected bulbs, or contaminating nematodes or soil (CABI/EPPO undated – a). | **Yes:** SLRSV is transmitted by the nematode *Xiphinema diversicaudatum*, which has been recorded on roses in Australia (APPD 2011), but may be eradicated (CABI/EPPO 2001), and *X. coxi* (Tzanetakis *et al.* 2006). It is also mechanically transmissible (CABI/EPPO undated – a). However, most cut flowers will eventually be disposed of in waste, or compost. The virus is not likely to survive and be transmitted to a suitable host by a nematode vector. | **Yes:** Has a wide host range including many different crop species such as ornamentals (*Delphinium*, *Gladiolus*, *Narcissus, Rosa*) and apricot, asparagus, celery, peach, cherry, currants , grapevine, hop, raspberry, strawberry, rhubarb, oleander, olive, parsley, and parsnip (CABI/EPPO undated – a, CABI 2012). In Israel SLRSV is associated with asymmetrical opening of flowers (Cohen *et al.* 1995). | **Yes** |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| Tobacco ringspot nepovirus TRSV [Secoviridae : Nepovirus] | Yes (EPPO 2007, CABI 2012) | Yes (EPPO 2007, CABI 2012) - isolated records from Qld, SA and WA (Randles and Francki 1965; CABI/EPPO undated - b). However, there are several biologically distinct strains of TRSV; and it is uncertain which are present in Australia. | **Yes**: TRSV may be transmitted in cuttings, pollen and seed (CABI/EPPO undated – b; Card *et al*. 2007). | **Yes:** TRSV is spread by the nematodes *Xiphinema americanum, X. rivesi and X. californicum* (Brown *et al.* 1995). It can also be spread non-specifically by aphids, thrips and the beetle *Epilachna varivestis*; and by dodder (*Cuscuta gronovii*) in cuttings, by pollen and seed, and by mechanical inoculation (Field *et al*., 1994; Card *et al.* 2007; CABI/EPPO undated – b). | **Yes:** TRSV has a very wide host range, and there are several biologically distinct strains (Stace-Smith 1985). There is potential for further spread in important crops for novel strains. TRSV causes symptoms in flowers, leaves, roots and seeds. TRSV has varying economic impact on different crops, with the most severely affected being soybeans, grapevine and some ornamentals (CABI/EPPO undated –b). | **Yes** |
| Tomato aspermy cucumovirus TAV [Bromoviridae : Cucumovirus] | Yes (TaiBNET 2012, BAPHIQ 2012) | Yes (Hill *et al.* 1996) | Assessment not required | | | |
| Tomato spotted wilt tospovirus TSWV [Bunyaviridae : Tospovirus] (synonym *Impatiens necrotic spot virus* (INSV), Tomato spotted wilt tospovirus, impatiens strain) | Yes (EPPO 2007, TaiBNET 2012, CABI 2012) | Yes (Latham and Jones 1997, APPD 2011, CABI 2012) | Assessment not required | | | |
| Tulip breaking potyvirus TBV [Potivyridae: Potyvirus] (synonym brown ring virus) (Derks 1976) | Yes (TaiBNET 2012, CABI 2012) | Yes (ICTVdB 2006, CABI 2012) | Assessment not required | | | |

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| **NEMATODES** | | | | | | |
| *Helicotylenchus dihystera* (Cobb) Sher. [Tylenchida : Hoplolaimidae] spiral nematode | Yes (CABI/EPPO 2010)[6] | Yes (McLeod *et al*. 1994, CABI/EPPO 2010) | Assessment not required | | | |
| *Heterodera* spp. Schmidt [Telenchida : Heteroderidae] cyst nematode | Yes (BAPHIQ 2012) | Yes (McLeod *et al.* 1994) | Assessment not required | | | |
| *Meloidogyne hapla* Chitwood [Tylenchida : Meloidogynidae] root knot nematode | Yes (Chen and Tsay 2006) | Yes (McLeod *et al.* 1994) | Assessment not required | | | |
| *Meloidogyne incognita* (Kofoid and White) Chitwood [Tylenchida : Meloidogynidae] root knot nematode | Yes (Chen and Tsay 2006) | Yes (McLeod *et al.* 1994, Stirling and Stanton 1997) | Assessment not required | | | |
| *Paratrichodorus* spp. Siddiqi [Triplonchida : Trichodoridae] stubby-root nematode | Yes (BAPHIQ 2012) | Yes (McLeod *et al.* 1994) | Assessment not required | | | |
| *Pratylenchus coffeae* Goodey [Tylenchida : Pratylenchidae] lesion nematode | Yes (Chen and Tsay 2006, EPPO 2007) | Yes (ABRS 2009, APPD 2011) | Assessment not required | | | |
| *Pratylenchus penetrans* Cobb [Tylenchida : Pratylenchidae] root lesion nematode | Yes (Chen and Tsay 2006, EPPO 2007) | Yes (ABRS 2009, APPD 2011) | Assessment not required | | | |
| *Pratylenchus pratensis* (de Man) Filipjev [Tylenchida : Pratylenchidae] meadow nematode | Yes (BAPHIQ 2012) | Yes (ABRS 2009, APPD 2011) | Assessment not required | | | |
| *Rotylenchulus reniformis* Linford and Oliveira [Tylenchida : Hoplolaimidae] reniform nematode | Yes (EPPO 2007) | Yes (McLeod *et al.* 1994) | Assessment not required | | | |

[6] Taiwan's NPPO, BAPHIQ, has indicated this pest does not occur in Taiwan (BAPHIQ 2012). Other references state it is present.

| Pest | Present in Taiwan | Present within Australia | Potential to be on pathway | Potential for establishment and spread | Potential for economic consequences[1] | Quarantine pest (Yes/No) |
|---|---|---|---|---|---|---|
| *Rotylenchus robustus* de Man [Tylenchoidea : Hoplolaimidae] (synonym *Tylenchus robustus, Hoplolaimus uniformis, Rotylenchus uniformis, Anguillulina robusta, Rotylenchus goodeyi, Rotylenchus fallorobustus*) | Yes (BAPHIQ 2012) | Yes (McLeod *et al.* 1994) | Assessment not required | | | |
| *Trichodorus* spp. [Triplonchida: Trichodoridae] stubby root nematodes | Yes (CABI 2012) | Yes (APPD 2011, CABI 2012) | Assessment not required | | | |
| *Xiphinema insigne* Loos [Dorylaimida : Longidoridae] (synonym *X. indicum* Siddiqi) dagger nematode | Yes (Ni *et al.* 2003, Chen *et al.* 2004) | Yes (McLeod *et al.* 1994) | Assessment not required | | | |

# Appendix B Additional quarantine pest data

| **COLEOPTERA (beetles, weevils)** | |
|---|---|
| **Quarantine pest** | ***Harmonia axyridis* (Pallas)** |
| **Synonyms** | None |
| **Common name(s)** | Harlequin ladybird, Multicoloured Asian lady beetle |
| **Main hosts** | Predator of soft bodied insects (e.g. aphids, scales) (Koch 2003, Brown *et al*. 2008) in a wide range of habitats (arboreal, herbaceous, and crop systems) (Brown *et al*. 2008). Hosts include *Cucurbita moschata* (pumpkin), *Malus domestica* (apple), *Pyrus communis* (pear), *Prunus domestica* (plum), *Prunus persica* (peach), *Rubus* (raspberry) and *Vitis vinifera* (grape) (EPPO 2009, CABI 2012). |
| **Distribution** | Argentina, Austria, Belarus, Belgium, Brazil, Canada, Chile, China, Czech Republic, Denmark, France, Germany, Greece, Hungary, Italy, Japan, Jersey, Korea, Latvia, Liechtenstein, Luxemburg, Mexico, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Spain, Sweden, Switzerland, Ukraine, United Kingdom and USA (CABI 2012). |
| **Quarantine pest** | ***Lilioceris formosana* Heinze** |
| **Synonyms** | *Lilioceris neptis* subsp. *formosana* Heinze (Wrocław)<br>*Lilioceris impressa* subsp. *loochooana* Nakane (Wrocław) |
| **Common name(s)** | Leaf beetle |
| **Main hosts** | herbivorous, no details found |
| **Distribution** | Taiwan, Tokara Is., Ryukyu Isl., Japan (Wrocław 2011) |
| **Quarantine pest** | ***Lilioceris merdigera* (Linnaeus)** |
| **Synonyms** | *Chrysomela merdigera* Linnaeus<br>*Crioceris wagneri* Jacobson<br>*Crioceris laticollis* Reitter<br>*Crioceris latior* Pic, |
| **Common name(s)** | Leaf beetle |
| **Main hosts** | *Allium ampeloprasum* (leek), *Allium cepa* (onion)*, A. schoenoprasum* (chive), *Asparagus officinalis* (Asparagus), *Convallaria majalis* (Lily of the Valley), *Fritillaria* spp. (fritillaries), *Lilium martagon* (Martagon lily), *L. longiflorum* var. *giganticum* (Easter lily), *Polygonatum multiflorum* (Solomon's-seal), *P. verticillatum* (Whorled Solomon's-seal)*, Smilacina* spp. (false solomon's seal), Exceptionally on *Salix* (willows) (Schmitt 1988, Maddison 1993). |
| **Distribution** | Asia, Central and South America, Europe, Japan (Maddison 1993) |
| **Quarantine pest** | ***Sangariola punctatostriata* (Motschulsky)** |
| **Synonyms** | *Galeruca? punctato-striata* Motschulsky<br>*Sangariola punctato-striata* subsp, *aequicostata* Chujo |
| **Common name(s)** | Lily leaf flea beetle |
| **Main hosts** | *Cardiocrinum cordatum* (giant lily), *Cardiocrinum glehni*, *Erythronium dens-canis* (dog's-tooth violet), *Erythronium japonicum*, *Lilium cordatum*, *Lilium leichtlinii* var. *tigrinum* (Leichtlins' lily), *Smilax china* (Chujo and Kimoto 1961; Maddison 1993) |
| **Distribution** | Asia, Russia, Japan (Hokkaido, Honshu, Shikoku, Kyushu, Okinawa), Korean Peninsula, Taiwan (Chujo and Kimoto 1961, Maddison 1993) |
| **DIPTERA (flies, gnats, midges)** | |
| **Quarantine pest** | ***Liriomyza huidobrensis* (Blanchard)** |
| **Synonyms** | *Agromyza huidobrensis* Blanchard<br>*Liriomyza cucumifoliae* Blanchard<br>*Liriomyza decora* Blanchard<br>*Liriomyza dianthi* Frick<br>*Liriomyza langei* Frick |
| **Common name(s)** | Serpentine leafminer, pea leafminer, South American leafminer |
| **Main hosts** | *Allium cepa* (onion), *Allium sativum* (garlic), *Amaranthus* (grain amaranth), *Amaranthus retroflexus* (redroot pigweed), *Apium graveolens* (celery), *Beta vulgaris* (beetroot), *Bidens pilosa* (blackjack), |

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|---|---|
| | *Brassica rapa*, *Calendula* (marigolds), *Capsicum annuum* (bell pepper), *Chenopodium quinoa* (quinoa), *Chrysanthemum morifolium* (chrysanthemum (florists')), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita pepo* (ornamental gourd), *Datura* (thorn-apple), *Emilia sonchifolia* (red tasselflower), *Galinsoga parviflora* (gallant soldier), *Gerbera* (Barbeton daisy), *Gypsophila paniculata* (babysbreath), *Lactuca sativa* (lettuce), *Lathyrus* (Vetchling), Liliaceae, *Linum* (flax), *Medicago sativa* (lucerne), *Melilotus* (melilots), *Oxalis* (wood sorrels), *Petunia*, *Phaseolus vulgaris* (common bean), *Pisum sativum* (pea), *Portulaca oleracea* (purslane), *Solanum lycopersicum* (tomato), *Solanum melongena* (aubergine), *Solanum tuberosum* (potato), *Sonchus* (Sowthistle) (Spencer 1973, CABI 2012). |
| **Distribution** | Argentina, Austria, Belgium, Belize, Brazil, Bulgaria, Canada, Chile, China, Colombia, Comoros, Costa Rica, Croatia, Cyprus, Czech Republic, Dominican Republic, Ecuador, El Salvador, Finland, France, French Guiana, Germany, Greece, Guadeloupe, Guam, Guatemala, Honduras, Hungary, India, Indonesia, Israel, Italy, Japan, Jordan, Korea DPR, Lebanon, Malaysia, Malta, Mauritius, Montenegro, Morocco, Netherlands, Nicaragua, Norway, Panama, Peru, Philippines, Poland, Portugal, Réunion, Saudi Arabia, Serbia, Seychelles, Singapore, South Africa, Spain, Sri Lanka, Switzerland, Syria, Taiwan, Thailand, Turkey, Uruguay, USA (California, Hawaii), Venezuela, Vietnam (CABI 2012). |
| **Quarantine pest** | ***Liriomyza trifolii* (Burgess)** |
| **Synonyms** | *Agromyza phaseolunata* Frost<br>*Liriomyza alliivora* Frick<br>*Liriomyza alliovora* Frick<br>*Liriomyza phaseolunata* (Frost)<br>*Oscinis trifolii* Burgess |
| **Common name(s)** | American serpentine leafminer, chrysanthemum leaf miner |
| **Main hosts** | *Abelmoschus esculentus* (okra), *Ageratum* (whiteweed), *Allium cepa* (onion), *Allium sativum* (garlic), *Allium schoenoprasum* (chives), *Alstroemeria* (Inca lily), *Ambrosia* (Ragweed), *Antirrhinum* (snapdragon), *Apium graveolens* var. *dulce* (celery), *Arachis hypogaea* (groundnut), *Artemisia* (wormwoods), *Aster*, *Avena sativa* (oats), *Baccharis*, *Basella*, *Bellis*, *Beta vulgaris* var. *saccharifera* (sugarbeet), *Bidens* (Burmarigold), *Brassica rapa*, *Brassica rapa* subsp. *chinensis* (Chinese cabbage), *Callistephus chinensis* (China Aster), *Capsicum annuum* (bell pepper), *Carthamus*, *Cassia* (sennas), *Centaurea* (Knapweed), *Cestrum* (jessamine), *Chenopodium* (Goosefoot), *Chrysanthemum indicum* (chrysanthemum), *Chrysanthemum morifolium* (chrysanthemum (florists')), *Citrullus lanatus* (watermelon), *Crataegus* (hawthorns), *Crotalaria*, *Cucumis melo* (melon),*Cucumis sativus* (cucumber), *Cucurbita maxima* (giant pumpkin), *Cucurbita moschata* (pumpkin), *Cucurbita pepo* (ornamental gourd), Cucurbitaceae (cucurbits), *Dahlia*, *Daucus carota* (carrot), *Dianthus* (carnation), *Erigeron* (Fleabane), *Eupatorium*, *Gaillardia*, *Gazania* (treasure-flower), *Gerbera* (Barbeton daisy), *Gladiolus* hybrids (sword lily), *Glycine max* (soyabean), *Gossypium* (cotton), *Gypsophila* (baby's breath), *Helianthus* (sunflower), *Hordeum* (barleys), *Ipomoea* (morning glory), *Lactuca sativa* (lettuce), *Lagenaria siceraria* (bottle gourd), *Lathyrus* (Vetchling), Liliaceae, *Linaria* (Toadflax), *Luffa acutangula* (angled luffa), *Luffa aegyptiaca* (loofah), *Lycopersicon*, *Macrotyloma*, *Malva* (mallow), *Medicago* (medic), *Medicago sativa* (lucerne), *Melilotus* (melilots), *Mollucella*, *Ocimum*, *Phaseolus* (beans), *Phaseolus lunatus* (lima bean), *Phaseolus vulgaris* (common bean), *Phlox*, *Physalis* (Groundcherry), *Pisum sativum* (pea), *Polyphagous* (polyphagous), *Primula* (Primrose), *Ricinus communis* (castor bean), *Salvia* (sage), *Senecio* (Groundsel), *Solanum lycopersicum* (tomato), *Solanum melongena* (aubergine), *Solanum tuberosum* (potato), *Sonchus* (Sowthistle), *Spinacia oleracea* (spinach), *Tagetes* (marigold), *Taraxacum* (dandelion), *Tithonia*, *Tragopogon* (goat's-beard),*Tribulus* (caltrop), *Trifolium* (clovers), *Trifolium repens* (white clover), *Trigonella*, *Tropaeolum*, *Typha* (reedmace), *Verbena* (vervain), *Vicia* (vetch), *Vigna unguiculata* (cowpea), *Xanthium* (Cocklebur), *Zinnia* (Spencer 1973, CABI 2012). |
| **Distribution** | This species is found throughout Africa, Asia, Europe, North America and South America (CABI 2012). |
| **Quarantine pest** | ***Chromatomyia horticola* Goureau** |
| **Synonyms** | *Agromyza atricornis*<br>*Chromatomyia atricornis*<br>*Phytomyza atricornis* (partim.) Meigen<br>*Phytomyza bidensivora* Séguy<br>*Phytomyza fediae* Kaltenbach<br>*Phytomyza horticola* Goureau<br>*Phytomyza lactucae* Vimmer<br>*Phytomyza linariae* Kaltenbach<br>*Phytomyza nainiensis* Garg<br>*Phytomyza pisi* Kaltenbach<br>*Phytomyza subaffinis* Malloch<br>*Phytomyza tropaeoli* Dufour |

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|---|---|
| **Common name(s)** | Pea leaf miner |
| **Main hosts** | Alliaceae, *Allium* (onions, garlic, leek, etc.), *Allium cepa* (onion), Amaranthaceae, Anacardiaceae, Asteraceae, *Brassica*, *Brassica campestris*, *Brassica oleracea* var. *gongylodes* (kohlrabi), *Brassica oleracea* var. *viridis* (collards), Brassicaceae (cruciferous crops), Caryophyllaceae, Chenopodiaceae, *Chrysanthemum* (daisy), *Cicer*, Convolvulaceae, *Cucurbita* (pumpkin), Cucurbitaceae (cucurbits), Euphorbiaceae, Fabaceae, *Lactuca sativa* (lettuce), Liliaceae, Malvaceae, *Mentha* (mints), Onagraceae, *Phaseolus* (beans), *Pisum* (pea), *Pisum sativum* (pea), Ranunculaceae, *Raphanus sativus* (radish), Rutaceae, Solanaceae, *Solanum lycopersicum* (tomato), Umbelliferae, *Vicia* (vetch) (Spencer 1973, CABI 2012). |
| **Distribution** | This species is found throughout Africa, Asia, and Europe (CABI 2012). |
| **HEMIPTERA (aphids, leafhoppers, mealybugs, psyllids, scales, true bugs, whiteflies)** | |
| **Quarantine pest** | ***Pseudococcus comstocki* (Kuwana)** |
| **Synonyms** | *Dactylopius comstocki* Kuwana |
| **Common name(s)** | Comstock‘s mealybug |
| **Main hosts** | *Acer, Aesculus* spp. (horse chestnut), *Aglaia odorata* (Chinese perfume tree), *Alnus japonica* (Japanese alder), *Amaryllis vittata*, *Artemisia*, *Buxus microphylla* (littleleaf boxwood), *Camellia japonica* (camellia), *Castanea* (chestnut), *Catalpa* (northern catalpa), *Celtis willdenowiana* (enoki), *Cinnamomum camphorae* (camphor tree), *Citrus* (citrus), *Crassula tetragona* (miniature pine tree), *Cydonia oblonga* (quince), *Cydonia sinensis* (Chinese quince), *Deutzia parviflora typical* (gaura), *Dieffenbachia picta* (dumb cane), *Erythrina indica* (rainbow eucalyptus), *Euonymus alatus* (winged euonymus), *Fatsia japonica* (Japanese aralia), *Ficus carica* (fig), *Fiwa japonica*, *Forsythia koreana* (forsythia), *Gardenia jasminoides* (gardenia), *Ginkgo biloba* (ginkgo), *Hydrangea* (hydrangea), *Ilex cornuta* (Chinese holly), *Ilex crenata microphylla* (Korean gem), *Kraunhia*, *Lagerstroemia indica* (crepe myrtle), *Ligustrum ibota angustifolium*, *Lilium* spp. (lily), *Lonicera* (honeysuckle), *Loranthus* (mistletoe), *Malus pumila* (paradise apple), *Malus sylvestris* (crab apple), *Masakia japonica* (Japanese euonymus), *Monstera deliciosa* (monstera), *Morus alba* (white mulberry), *Morus kagayamae* (mulberry), *Musa* (bananas), *Nephelium lappaceum* (rambutan), *Opuntia dillenii* (prickly pear), *Orixa japonica* (Japanese orixa), *Pandanus* (screwpines), *Persica vulgaris* (peach), *Pinus thunbergiana* (Japanese black pine), *Populus* (poplar), *Prunus mume* (Japanese apricot), *Punica granatum* (pomegranate), *Pyrus communis* (European pear), *Pyrus serotina culta* (black cherry), *Rhamnus* (buckthorn), *Rhododendron mucronulatum* (Korean Rhododendron), *Sasamorpha* (bamboo), *Taxus* (yew), *Torreya nucifera* (Japanese torreya), *Trema orientalis* (nalita), *Viburnum awabucki* (acacia confuse), *Zinnia elegans* (zinnia) (Maddison 1993, Ben-Dov 2012). |
| **Distribution** | Afghanistan, Argentina, Armenia, Azerbaijan, Brazil, Canada, Canary Islands, China, Columbia, Federated States of Micronesia, Indonesia, Iran, Italy, Japan, Kampuchea, Kazakhstan, Kyrgyzstan, Madeira Islands, Malaysia, Mexico, Moldova, Northern Mariana Islands, Russia, Saint Helena, South Korea, Sri Lanka, Taiwan, Tajikistan, Turkmenistan, USA, Uzbekistan, Vietnam (Wang and Lin 1997, Ben-Dov 2012). |
| **LEPIDOPTERA (moths, butterflies)** | |
| **Quarantine pest** | ***Agrotis segetum* Denis & Schiffermüller** |
| **Synonyms** | *Agrotis fucosa* Butler<br>*Agrotis segetis* Hübner<br>*Euxoa segetis*<br>*Euxoa segetum* Denis & Schiffermüller<br>*Euxoa segetum* form *albiptera* Turati<br>*Feltia segetum* Denis & Schiffermüller<br>*Noctua segetum* Denis & Schiffermüller<br>*Scotia segetum* Denis & Schiffermüller |
| **Common name(s)** | Turnip moth, black cutworm, common cutworm, cutworm, dark moth, dart moth, tobacco cutworm, turnip dart moth. |
| **Main hosts** | *Abelmoschus esculentus* (okra), *Allium porrum* (leek), *Allium sphaerocephalon* (Roundhead garlic), *Amaranthus* (grain amaranth), *Anethum graveolens* (dill), *Apium graveolens* var. *dulce* (celery), *Arachis hypogaea* (groundnut), *Asparagus officinalis* (asparagus), *Aster*, *Atropa belladonna* (deadly nightshade), *Avena sativa* (oats), *Beta vulgaris* var. *saccharifera* (sugarbeet), *Boehmeria nivea* (ramie), *Brassica juncea* var. *juncea* (Indian mustard), *Brassica napus* var. *napobrassica* (swede), *Brassica napus* var. *napus* (rape), *Brassica oleracea* (cabbages, cauliflowers), *Brassica oleracea* var. *botrytis* (cauliflower), *Brassica oleracea* var. *capitata* (cabbage), *Brassica rapa* subsp. *chinensis* (Chinese cabbage), *Brassica rapa* subsp. *oleifera* (turnip rape), *Camellia sinensis* (tea), *Cannabis sativa* (hemp), *Capsicum annuum* (bell pepper), *Carum carvi* (caraway), *Chrysanthemum* (daisy), *Cicer arietinum* (chickpea), *Cichorium endivia* (endives), *Coffea arabica* (arabica coffee), *Cucumis melo* (melon), *Cucurbita pepo* (ornamental gourd), *Cyperus esculentus* (yellow nutsedge), *Daucus carota* (carrot), *Dianthus caryophyllus* (carnation), *Foeniculum vulgare* (fennel), *Fragaria vesca* (wild strawberry), *Freesia refracta* (common freesia), *Gladiolus* hybrids (sword lily), *Glycine max* |

| | |
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| | (soyabean), *Gossypium* (cotton), *Gossypium hirsutum* (Bourbon cotton), *Guizotia abyssinica* (niger), *Helianthus annuus* (sunflower), *Hevea brasiliensis* (rubber), *Hibiscus cannabinus* (kenaf), *Hordeum vulgare* (barley), *Ipomoea batatas* (sweet potato), *Lactuca sativa* (lettuce), *Lilium* spp. (lily), *Linum* (flax), *Lupinus luteus* (yellow lupin), *Malus sylvestris* (crab-apple tree), *Medicago sativa* (lucerne), *Mentha* (mints), *Nicotiana rustica* (wild tobacco), *Nicotiana tabacum* (tobacco), *Oryza sativa* (rice), *Paeonia officinalis* (common paeony), *Papaver somniferum* (Opium poppy), *Petroselinum crispum* (parsley), *Picea sitchensis* (Sitka spruce), *Pinus sylvestris* (Scots pine), *Raphanus sativus* (radish), *Ribes nigrum* (blackcurrant), *Ricinus communis* (castor bean), *Secale cereale* (rye), *Sesamum indicum* (sesame), *Solanum laciniatum* (kangaroo apple), *Solanum lycopersicum* (tomato), *Solanum tuberosum* (potato), *Spinacia oleracea* (spinach), *Trifolium* (clovers), *Trifolium incarnatum* (Crimson clover), *Triticum aestivum* (wheat), *Vitis vinifera* (grapevine), *Zea mays* (maize) (CABI 2012). |
| **Distribution** | This species is distributed across Africa, Asia, and Europe (Wang and Lin 1997, CABI 2012). |
| **Quarantine pest** | ***Euproctis taiwana* (Shiraki)** |
| **Synonyms** | *Lymantria taiwana*<br>*Porthesia taiwana* Shiraki |
| **Common name(s)** | Yellow tailed moth, tussock moth |
| **Main hosts** | *Gladiolus, Glycine max* (soyabean), *Lilium* spp. (lily), *Mangifera indica* (mango), *Rosa* spp. (rose), *Vigna radiata* (mung bean), *Vitis vinifera* (grape), *Ziziphus mauritiana* (jujube) as well as many fruit trees, flowers, vegetable and cereal crops (Liu 1998, Chang 1988, Kuo 2005, Biosecurity Australia 2006, CABI 2012). |
| **Distribution** | Japan (Honshu, Ryukyu Archipelago), Taiwan (CABI 2012). |
| **Quarantine pest** | ***Kaniska canace* (Linnaeus)** |
| **Synonyms** | *Nymphalis canace* Linnaeus<br>*Papilio canace* Linnaeus<br>*Vanessa canace* Fruhstorfer |
| **Common name(s)** | Blue admiral |
| **Main hosts** | *Heterosmilax japonica*, Liliales, *Lilium* (lily), *Lilium lancifolium* (tiger lily), *Smilax china*, *Streptopus amplexifolius* (clasping twisted-stalk), *Tricyrtis hirta* (toad lily) (Iwase 1954, Robinson *et al.* 2012). |
| **Distribution** | Burma, China, India, Japan, Korea, Malaysia, Russia, Sri Lanka, Taiwan (Iwase 1954, Khramov *et al.* 2011, TaiBNET 2012). |
| **Quarantine pest** | ***Orgyia postica* Walker** |
| **Synonyms** | *Lacida postica* (Walker)<br>*Notolophus australis posticus* (Walker)<br>*Notolophus postica* (Walker)<br>*Notolophus posticus* (Walker)<br>*Orgyia australis postica* (Walker)<br>*Orgyia ceylanica* Nietner<br>*Orgyia ocularis* Moore<br>*Orgyia posticus* (Walker) |
| **Common name(s)** | Cocoa tussock moth, tussock moth, small tussock moth |
| **Main hosts** | *Amherstia nobilis*, *Camellia sinensis* (tea), *Cinchona*, *Cinnamomum*, *Coffea* (coffee), *Durio zibethinus* (durian), *Erythrina* spp., *Euphorbia longana* (longan), *Garcinia mangostana* (mangosteen), *Glycine max* (soyabean), *Hevea brasiliensis* (rubber), *Lablab purpureus* (hyacinth bean), *Leucaena leucocephala* (leucaena), *Lilium* spp. (lily), *Litchi chinensis* (lichi), *Malpighia glabra* (acerola), *Mangifera indica* (mango), *Nephelium lappaceum* (rambutan), Orchidaceae (orchids), *Populus deltoides* (poplar), *Pyrus communis* (European pear), *Ricinus communis* (castor bean), *Rosa* (roses), *Syzygium cumini* (black plum), *Theobroma cacao* (cocoa), *Vigna radiata* (mung bean), *Vitis vinifera* (grapevine), *Ziziphus jujuba* (common jujube) (CABI 2012, CoA undated - a). |
| **Distribution** | Bangladesh, Brunei Darussalam, China, India, Indonesia, Japan, Laos, Malaysia, Myanmar, Papua New Guinea, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam (CABI 2012). |
| **Quarantine pest** | ***Xylena formosa* (Butler)** |
| **Synonyms** | *Calocampa formosa* Butler |
| **Common name(s)** | Cutworm |
| **Main hosts** | *Lilium* spp. (lily), *Prunus mume* (Chinese plum), *Quercus acutissima, Quercus cerris, Quercus serrata, Quercus variabilis,* (Ikeda and Fukuyo 1985, Maddison 1993, HOSTS 2012). |
| **Distribution** | Japan, Taiwan |

| **THYSANOPTERA (thrips)** | |
|---|---|
| **Quarantine pest** | ***Frankliniella intonsa* Trybom** |
| **Synonyms** | *Frankliniella intonsa* f. *norashensis* Yakhontov and Jurbanov<br>*Thrips intonsa* Trybom<br>*Frankliniella formosae* Moulton |
| **Common name(s)** | Flower thrips |
| **Main hosts** | *Abelmoschus esculentus* (okra), *Arachis hypogaea* (groundnut), *Asparagus officinalis* (asparagus), *Capsicum annuum* (capsicum), *Chrysanthemum indicum* (chrysanthemum), *Fragaria* (strawberry), *Glycine max* (soyabean), *Gossypium* (cotton), *Lilium* spp. (lily), *Lycopersicon esculentum* (tomato), *Medicago sativa* (lucerne), *Oryza sativa* (rice), *Phaseolus vulgaris* (common bean), *Pisum sativum* (pea), *Prunus persica* (peach), *Rosa* (roses), *Solanum lycopersicum* (tomato), *Vigna angularis* (adzuki bean) (Maddison 1993, CABI 2012). |
| **Distribution** | This species is distributed across Asia, Europe and North America (CABI 2012). |
| **Quarantine pest** | ***Haplothrips chinensis* Priesner** |
| **Synonyms** | None |
| **Common name(s)** | Chinese thrips |
| **Main hosts** | Buckwheat (*Fagopyrum esculentum*), *Capsicum* sp. Carrot (*Daucus carota*), Chinese cabbage (*Brassica rapa*, var. *chinensis*), Chrysanthemum (*Chrysanthemum morifolium*), *Convolvulus* spp., Corn(*Zea mays*), Cotton (*Gossypium hirsutum*), *Cupressus* spp., Dandelion (*Taraxacum officinale*), Hyacinth bean (*Lablab purpureus*), Kiwi (*Actinidia deliciosa*), Lily (*Lilium* spp.), *Lobelia* spp., *Lysimachia* spp., Mandarin Orange (*Citrus reticulata*), Mango (*Mangifera indica*), Onion (*Allium cepa*), Peach (*Prunus persica*), Plum (*Prunus* spp.), Pomegranate (*Punica granatum*), Potato (*Solanum tuberosum*), Red Clover (*Trifolium pratense*), Rose (*Rosa chinensis*), *Solidago* sp., Spinach (*Spinacia oleracea*), Tea (*Camellia sinensis*), Wheat (*Triticum aestivum*), White Clover (*Trifolium repens*), Willow (*Salix* spp.), Wolfberry (*Lycium chinense*) (Chang 1991, Hua *et al.* 1997 , Huang 2010, Liu *et al.* 2010, Qin *et al.* 2010, GAAS 2012). |
| **Distribution** | China, Korea, Japan, Taiwan (Chang 1991, GAAS 2012) |
| **Quarantine pest** | ***Megalurothrips distalis* (Karny)** |
| **Synonyms** | *Megalurothrips morosus* Bhatti<br>*Physothrips brunneicarnis* Bagnall<br>*Taeniothrips brunneicornis* Hood<br>*Taeniothrips distalis* Karny<br>*Taeniothrips ditissimus* Anantha. & Jagd.<br>*Taeniothrips infernalis* Priesner<br>*Taeniothrips morosus* Priesner<br>*Taeniothrips nigricornis* Priesner |
| **Common name(s)** | Bean blossom thrips |
| **Main hosts** | *Acacia nilotica* (gum arabic tree), *Anacardium occidentale* (cashew nut), *Arachis hypogaea* (groundnut), *Areca catechu* (betelnut palm), *Azadirachta indica* (neem tree), *Bauhinia racemosa* (bidi leaf tree), *Butea monosperma* (flame of the forest), *Cajanus cajan* (pigeon pea), *Camellia sinensis* (tea) *Canavalia ensiformis* (gotani bean) *Canavalia gladiata* (horse bean), *Coffea arabica* (arabica coffee), *Crotalaria juncea* (sunn hemp), *Cyamopsis tetragonoloba* (guar), *Flemingia macrophylla* (large leaf flemingia), *Gladiolus* hybrids (sword lily), *Gliricidia maculata*, *Glycine max* (soyabean), *Gomphrena globosa* (Globe amaranth), *Hibiscus rosa-sinensis* (China-rose), *Lablab purpureus* (hyacinth bean), *Lathyrus odoratus* (sweet pea), *Lathyrus sativus* (grasspea), *Lens culinaris* ssp. *culinaris* (lentil), *Lilium* spp. (lily), *Litchi chinensis* (lichi), *Macrotyloma uniflorum* (horsegram), *Mangifera indica* (mango), *Medicago sativa* (lucerne), *Mimosa pudica* (sensitive plant), *Moringa oleifera* (horse-radish tree), *Morus alba* (mora), *Morus nigra* (black mulberry), *Papaver somniferum* (Opium poppy), *Phaseolus vulgaris* (common bean), *Pisum sativum* (pea), *Pongamia pinnata* (Indian beech), *Punica granatum* (pomegranate), *Rosa chinensis* (China rose), *Santalum album* (Indian sandalwood), *Sesbania cannabina* (corkwood tree), *Sesbania grandiflora* (agati), *Sesbania sesban* (sesban), *Tephrosia purpurea* (purple tephrosia), *Vigna mungo* (black gram), *Vigna radiata* (mung bean), *Vigna umbellata* (Rice- bean), *Vigna unguiculata* (cowpea) (Maddison 1993, CABI 2012). |
| **Distribution** | Bangladesh, Bhutan, China, India, Indonesia, Japan, Korea, Mongolia, Myanmar, Nepal, Oman, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand (CABI 2012). |

| **VIRUSES** | |
|---|---|
| **Quarantine pest** | **Lily mottle virus LMoV** |
| **Synonyms** | Lily mosaic virus<br>Lily mottle potyvirus<br>Tulip breaking virus |
| **Common name(s)** | Lily mottle virus |
| **Main hosts** | *Alstroemeria brasiliensis* (Peruvian lily), *Lilium* spp. (lily), *Narcissus pseudonarcissus* (wild lent lily), *Tulipa* (tulip) (CABI 2012). |
| **Distribution** | China, Israel, Japan, Korea, USA, Italy, Netherlands, Poland (CABI 2012). |
| **Quarantine pest** | **Lily virus X LVX** |
| **Synonyms** | Lily potexvirus |
| **Common name(s)** | Lily virus X |
| **Main hosts** | *Lilium formosanum, Tetragonia expansa*, *Tricyrtis formosana* (Brunt *et al.* 1996, Jordan *et al.* 2008). |
| **Distribution** | Netherlands, United Kingdom, USA (Chen *et al.* 2005, Brunt *et al.* 1996, Jordan *et al.* 2008). |
| **Quarantine pest** | **Plantago asiatica mosaic virus PlAMV** |
| **Synonyms** | None found |
| **Common name(s)** | Plantago asiatica mosaic virus |
| **Main hosts** | *Lilium* spp. (lily), *Nandina domestica* (nandina, bamboo), *Plantago asiatica* (plantago), *Primula* spp. (primula), *Vigna sinensis* (cow pea) (Komatsu *et al.* 2008, PPSN 2010). |
| **Distribution** | Japan, Netherlands, Russia, USA (Komatsu *et al.* 2008, PPSN 2010). |
| **Quarantine pest** | **Strawberry latent ringspot virus SLRSV** |
| **Synonyms** | Rhubarb virus 5<br>*Aesculus* line pattern virus |
| **Common name(s)** | Latent ringspot of strawberry |
| **Main hosts** | *Aesculus* (buckeye) , *Apium graveolens* (celery), *Asparagus officinalis* (asparagus), *Capsella bursa-pastoris* (shepherd's purse), *Fragaria ananassa* (strawberry), *Fragaria vesca* (wild strawberry), *Humulus lupulus* (hop), *Lamium amplexicaule* (henbit deadnettle), *Lilium* spp. (lily), *Narcissus* (daffodil), *Pastinaca sativa* (parsnip), *Prunus armeniaca* (apricot), *Prunus avium* (sweet cherry), *Prunus domestica* (plum), *Prunus persica* (peach), *Prunus salicina* (Japanese plum), *Rheum hybridum* (rhubarb), *Ribes nigrum* (blackcurrant), *Ribes rubrum* (red currant), *Rosa* (roses) , *Rubus fruticosus* (blackberry), *Stellaria media* (common chickweed), *Trifolium repens* (white clover), *Urtica dioica* (stinging nettle), *Vitis vinifera* (grapevine) (CABI 2012). |
| **Distribution** | India, Lebanon, Syria, Turkey, Canada, USA, Albania, Austria, Belarus, Belgium, Croatia, Czech Republic, Finland, France, Germany, Hungary, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Romania, Serbia, Spain, Switzerland, Taiwan, United Kingdom, Yugoslavia (Serbia and Montenegro), Australia (South Australia- few occurrences), New Zealand (CABI/EPPO undated-a, EPPO 2009, Chang *et al.* 2001, CABI 2012). |
| **Quarantine pest** | **Tobacco ringspot nepovirus TRSV** |
| **Synonyms** | Anemone necrosis virus,<br>Blueberry necrotic ringspot virus,<br>Tobacco ringspot virus 1,<br>Tulip veinal streak virus. |
| **Common name(s)** | Tobacco ringspot nepovirus |
| **Main hosts** | *Amaranthus caudatus* (tassel flower), *Amaranthus hybridus* (smooth amaranth), *Anemone coronaria* (poppy anemone), *Armoracia rusticana* (horseradish), *Astilbe chinensis, Impatiens hostie* (Impatiens), *Ilex crenata* (holly), *Begonia semperflorens* (begonia), *Brassica campestris* (turnip), *Beta vulgaris* (beetroot), *Brassica spp., Calendula officinalis* (pot marigold), *Cornus racemosa* (dogwood), *Cornus stolonifera* (dogwood), *Coronopus didymus* (Lesser swine-cress), *Capsicum* (peppers), *Capsicum annuum* (bell pepper), *Carica papaya* (paw paw), *Caryopteris spp.* (bluebeard), *Crataegus spp., Crocus spp., Cucumis melo* (melon), *Citrullus lanatus* (watermelon), *Cornus florida* (dogwood), *Cucumis sativus* (cucumber), *Cucurbita pepo* (ornamental gourd), *Cucurbita spp., Cyamopsis tetragonoloba* (cluster bean), *Cymbidium* (orchid), *Daucus carota* (corrot), *Eupatorium purpureum* (trumpet weed), *Gladiolus hybrids* (sword lily), *Glycine max* (soyabean), *Hyacinthus orientalis* (Hyacinth), *Hydrangea* spp., *Daphne* spp., *Iris hollandica* (Iris), *Lablab purpureus* (Hyacinth bean), *Lactuca sativa* (lettuce), *Lilium longiflorum* (lily), *Lycopersicon* |

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| | *esculentum* (tomato), *Malus domestica* (apple), *Medicago sativa* (alfalfa), *Melilotus alba* (sweet clover), *Nicotiana tabacum* (tobacco), *Osmunda cinnamomea* (cinnamon fern), *Pastinaca sativa* (parsnip), *Pelargonium spp., Petunia × hybrida, Phaseolus lunatus* (lima bean), *Phaseolus vulgaris* (common bean), *Phlox drummondii* (annual Phlox), *Phlox subulata* (creeping Phlox), *Plantago lanceolata* (ribwort), *Populus tremuloides* (aspen), *Potentilla spp., Prunus* (stone fruit), *Rubus* (blackberry, raspberry), *Rumex spp.* (sorrel), *Solanum lycopersicum* (tomato), *Solanum melongena* (aubergine), *Solanum nigrum* (black nightshade), *Solanum tuberosum* (potato), *Sophora microphylla* (Kowhai), *Spinacia oleracea* (spinach), *Taraxacum officinale* (common dandelion), *Tulipa spp., Vaccinium* (blueberries), *Vicia* spp., *Vitis vinifera (grapevine) Viola cornuta* (horned violet), *Zea mays* (corn), *Zinnia elegans* (zinnia) (Gibbs and Gibbs 2002, CABI 2012). |
| **Distribution** | Distribution probably worldwide. Found in Africa, Central Asia, East and South-East Asia, Eurasia, the Mediterranean, the Middle East, North America, Australasia and Oceania, South and Central America; Australia, Brazil, Bulgaria, Canada, China, Denmark, France, Hungary, India, Indonesia, Iran, Italy, Japan, Korea Republic, Lithuania, Nigeria, Oman, Peru, Poland, Saudi Arabia, Sri Lanka, Taiwan, Turkey, United States of America. Found, but with no evidence of spread, in Australia, the U.K., Germany and New Zealand (Gibbs and Gibbs 2002). |

# Glossary

| Term or abbreviation | Definition |
|---|---|
| Additional declaration | A statement that is required by an importing country to be entered on a phytosanitary certificate and which provides specific additional information on a consignment in relation to regulated pests (FAO 2012). |
| Appropriate level of protection (ALOP) | The level of protection deemed appropriate by the Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory (WTO 1995). |
| Area | An officially defined country, part of a country or all or parts of several countries (FAO 2012). |
| Area of low pest prevalence | An area, whether all of a country, part of a country, or all parts of several countries, as identified by the competent authorities, in which a specific pest occurs at low levels and which is subject to effective surveillance, control or eradication measures (FAO 2012). |
| Consignment | A quantity of plants, plant products or other articles being moved from one country to another and covered, when required, by a single phytosanitary certificate (a consignment may be composed of one or more commodities or lots) (FAO 2012). |
| Control (of a pest) | Suppression, containment or eradication of a pest population (FAO 2012). |
| DAFF | Australian Government Department of Agriculture, Fisheries and Forestry |
| ELISA | Enzyme-linked immuno-sorbent assay. |
| Endangered area | An area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss (FAO 2012). |
| Entry (of a pest) | Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO 2012). |
| Establishment | Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2012). |
| Equivalence (of phytosanitary terms) | The situation where, for a specified pest, different phytosanitary measures achieve a contracting party's appropriate level of protection (FAO 2012). |
| Host range | Species capable, under natural conditions, of sustaining a specific pest or other organism (FAO 2012). |
| Import permit | Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2012). |
| Import risk analysis | An administrative process through which quarantine policy is developed or reviewed, incorporating risk assessment, risk management and risk communication. |
| Infestation (of a commodity) | Presence in a commodity of a living pest of the plant or plant product concerned. Infestation includes infection (FAO 2012). |
| Inspection | Official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (FAO 2012). |
| Intended use | Declared purpose for which plants, plant products, or other regulated articles are imported, produced, or used (FAO 2012). |
| Interception (of a pest) | The detection of a pest during inspection or testing of an imported consignment (FAO 2012). |
| International Standard for Phytosanitary Measures (ISPM) | An international standard adopted by the Conference of the Food and Agriculture Organization, the Interim Commission on phytosanitary measures or the Commission on phytosanitary measures, established under the IPPC (FAO 2012). |
| Introduction | The entry of a pest resulting in its establishment (FAO 2012). |
| National Plant Protection Organization (NPPO) | Official service established by a government to discharge the functions specified by the IPPC (FAO 2012). |
| Official control | The active enforcement of mandatory phytosanitary regulations and the application of mandatory phytosanitary procedures with the objective of eradication or containment of quarantine pests or for the management of regulated non-quarantine pests (FAO 2012). |
| Pathway | Any means that allows the entry or spread of a pest (FAO 2012). |
| Pest | Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2012). |

| Term or abbreviation | Definition |
|---|---|
| Pest categorisation | The process for determining whether a pest has or has not the characteristics of a quarantine pest or those of a regulated non-quarantine pest (FAO 2012). |
| Pest free area (PFA) | An area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained (FAO 2012). |
| Pest free place of production | Place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period (FAO 2010). |
| Pest free production site | A defined portion of a place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period and that is managed as a separate unit in the same way as a pest free place of production (FAO 2012). |
| Pest risk analysis (PRA) | The process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any phytosanitary measures to be taken against it (FAO 2012). |
| Pest risk assessment (for quarantine pests) | Evaluation of the probability of the introduction and spread of a pest and of the associated potential economic consequences (FAO 2012). |
| Pest risk management (for quarantine pests) | Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2012). |
| Phytosanitary certificate | An official paper document or its official electronic equivalent, consistent with the model certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (FAO 2012). |
| Phytosanitary measure | Any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO 2012). |
| Phytosanitary regulation | Official rule to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests, including establishment of procedures for phytosanitary certification (FAO 2012). |
| Polyphagous | Feeding on a relatively large number of hosts from different genera. |
| PRA area | Area in relation to which a pest risk analysis is conducted (FAO 2012). |
| Quarantine pest | A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO 2012). |
| Regulated article | Any plant, plant product, storage place, packing, conveyance, container, soil and any other organism, object or material capable of harbouring or spreading pests, deemed to require phytosanitary measures, particularly where international transportation is involved (FAO 2012). |
| Restricted risk | Risk estimate with phytosanitary measure(s) applied. |
| Spread | Expansion of the geographical distribution of a pest within an area (FAO 2012). |
| SPS Agreement | WTO Agreement on the Application of Sanitary and Phytosanitary Measures (WTO 1995). |
| Stakeholders | Government agencies, individuals, community or industry groups or organisations, whether in Australia or overseas, including the proponent/applicant for a specific proposal, who have an interest in the policy issues. |
| Systems approach(es) | The integration of different risk management measures, at least two of which act independently, and which cumulatively achieve the appropriate level of protection against regulated pests (FAO 2012). |
| Unrestricted risk | Unrestricted risk estimates apply in the absence of risk mitigation measures. |

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