Biosecurity Australia

AUSTRALIA

Non-Routine Import Risk Analysis (IRA) on Ornamental Bulbs from The Netherlands, the United Kingdom, Israel and New Zealand

Draft IRA Report

November 2000

AGRICULTURE FISHERIES FORESTRY

AGRICULTURE, FISHERIES AND FORESTRY - AUSTRALIA

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EXECUTIVE SUMMARY

> In August 2000, there was a general restructure within the Department of Agriculture, Fisheries and Forestry - Australia (AFFA) to provide a sharper focus on the Department's major output areas. As a result of this restructuring, Plant Biosecurity, which is part of the recently established Biosecurity Australia, has taken over the functions of the former Plant Quarantine Policy Branch of AQIS.

This document sets out the key aspects of the Import Risk Analysis (IRA) on the importation into Australia of ornamental bulbs of the genera *Crocus, Freesia, Gladiolus, Hippeastrum, Hyacinthus, Iris, Lilium, Narcissus* and *Tulipa* from the Netherlands, the United Kingdom, Israel and New Zealand.

Resulting from this assessment, a total of 83 species or genera of quarantine pests were identified (Table 1). These include insects, mites, a flatworm, nematodes, fungi, bacteria, a phytoplasma and viruses. An additional 113 organisms associated with bulbs were identified as pests that are established in Australia and are not of quarantine concern.

In terms of their potential impact, the organisms identified as quarantine pests vary. Some are well-known specific pests of bulb production. Others are polyphagous and can attack a wide range of crops, and in some cases harm natural eco-systems. A number of diseases were identified that are symptomless or minor in bulbs, but are potentially serious diseases of other crops. Importation of the pathogens that cause these diseases, for which bulbs could be a carrier, poses a threat to a wide range of other horticultural and agricultural industries.

The following is a summary of suggested risk management options for bulbs produced under an AQIS-approved Quality Assurance System. These options are designed to manage the risks associated with quarantine pests. An important risk management strategy is to ensure that the bulbs have been produced under conditions of 'good horticultural practice', and this can be done either within a bulb certification scheme or within a production system of equivalent standard.

- Currently, most bulb species covered by this IRA are allowed entry. Species currently permitted into Australia will not be affected by the ongoing review of the AQIS 'permitted list' of plant imports. Each new species not on the revised AQIS 'permitted list' will need assessment for its weediness as per the AQIS Weed Risk Assessment process.
- A phytosanitary certificate issued by the National Plant Protection Organisation (NPPO) of the exporting country will be required by AQIS stating that bulbs presented for export have been produced according to Australian requirements. Each exporter must gain approval from AQIS to become an 'accredited' supplier of bulbs to Australia before they ship bulbs under this protocol.
- Inspection on arrival in Australia to check the phytosanitary certificate, to confirm the identity of bulbs and to check for presence of soil, seeds and visible pests and diseases.
- This draft IRA proposes an option to allow cold storage of bulbs in an AQIS-approved facility located in a metropolitan area. The cold storage would be allowed under an AQIS Compliance

Agreement for bulbs prior to disinfestation treatment. This will enable importers to delay warming and disinfestation treatment of bulbs until they are ready to plant.

- Virus testing (by ELISA or PCR technique) for quarantine viruses where required. Bulb consignments found infected with quarantine viruses will be destroyed or re-exported at the importer's expense.
- Disinfestation either by amended methyl bromide treatment **OR** hot water treatment by an AQIS- approved supplier under an AQIS Compliance Agreement.
- Bulbs that have tested negative for viruses and been hot water treated will be released for general use.
- Bulbs that have been fumigated will enter post-entry quarantine as per current protocols (subject to passing virus testing).

It is proposed that all bulbs from all countries specified in this IRA could be imported subject to the protocol developed here. Before additional bulb genera from the Netherlands, the UK, Israel or New Zealand, or any bulbs from other countries, are allowed into Australia under this protocol, AFFA would need to ensure that the management procedures identified here are appropriate for the pests in those genera and countries, including an assessment of weed risk. In particular, AFFA would need to ensure that appropriate tests are identified and undertaken for diseases of quarantine concern to Australia. This risk analysis sets out a risk management framework against which further importation requests of ornamental flower bulbs may be considered.

Bulbs from non AQIS-accredited sources, for which it is not possible to demonstrate production under 'good horticultural practice', may be imported subject to weed risk assessment, inspection, virus testing, disinfestation and post-entry quarantine requirements. Regardless of the method of disinfestation, such bulbs will be required to be grown in post-entry quarantine at an AQIS-approved facility for an entire growing season before being considered for release.

The main changes to the current bulb import conditions proposed in this draft IRA are:

- Removal of quotas for bulbs from non-accredited sources;
- Setting of standards and pest risk management options for all bulbs from all sources;
- Option of cool storage of bulbs under bond;
- Testing for quarantine viruses;
- Hot water treatment as an alternative to fumigation with methyl bromide at increased doses;
- Removal of requirement for planting in post-entry quarantine if bulbs are hot water treated and free of quarantine viruses.

At the conclusion of the IRA process, taking into account comments from stakeholders, importers will be consulted on a realistic timeframe for implemention of any significant changes to current quarantine requirements.

GLOSSARY OF TERMS AND ABBREVIATIONS

AQIS	Australian Quarantine and Inspection Service
AFFA	Agriculture, Forestry and Fisheries - Australia
Area	An officially defined country, part of a country or all or parts of several countries
Bulb scheme	A system, either government run or government recognised, that ensures that bulbs are produced under a set of standards to ensure consistent health and quality
BKD	Bloembollkeeuringsdienst – Bulb scheme in the Netherlands for all bulbs covered by this IRA except Freesias
Endangered area	An area where ecological factors favor the establishment of a pest whose presence in the area will result in economically important loss
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled
Entry potential	Likelihood of the entry of a pest
EPPO	European and Mediterranean Plant Protection Organization
Establishment	The perpetuation, for the foreseeable future, of a pest within an area after entry
Establishment potential	Likelihood of the establishment of a pest
'Good horticultural practice'	Production of bulbs under industry best practice, a detailed description is given in Table 14
Introduction	Entry of a pest resulting in its establishment
Introduction potential	Likelihood of the introduction of a pest
IPPC	International Plant Protection Convention, as deposited in 1951 with FAO in Rome and as subsequently amended
IRA	Import Risk Analysis
MAFF	Ministry of Agriculture, Fisheries and Food , United Kingdom
NAKB	Naktuinbouw Elite - bulb scheme in the Netherlands that covers Freesias
National Plant Protection Organization (NPPO)	Official service established by a government to discharge the functions specified by the IPPC
Official	Established, authorized or performed by a National Plant Protection Organization
OIE	Office International des Epizooties (world organisation for animal health)
Pest	Any species, strain or biotype of plant or animal, or any pathogenic agent, injurious to plants or plant products. (Definition subject to formal amendment of the IPPC.)
Pest free area	An area in which a specific pest does not occur as demonstrated

	by scientific evidence and in which, where appropriate, this condition is being officially maintained
Pest risk analysis (PRA)	Pest risk assessment and pest risk management
Pest risk assessment	Determination of whether a pest is a quarantine pest and evaluation of its introduction potential
Pest risk management	The decision-making process of reducing the risk of introduction of a quarantine pest
PHPS	Plant Health Propagation Scheme, voluntary bulb scheme run by UK Ministry of Agriculture Fisheries and Food (MAFF) and the National Assembly for Wales – Agriculture Department
Phytosanitary measure	Any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests
Phytosanitary regulation	Official rule to prevent the introduction and/or spread of quarantine pests, by regulating the production, movement or existence of commodities or other articles, or the normal activity of persons, and by establishing schemes for phytosanitary certification
PRA area	Area in relation to which a pest risk analysis is conducted
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. (Definition subject to formal amendment of the IPPC.)
RAP	Risk Analysis Panel
SOAEFD	Scottish Office Agriculture, Environment and Fisheries Department, United Kingdom
Spread	Expansion of the geographical distribution of a pest within an area
Spread potential	Likelihood of the spread of a pest
SPS	Sanitary and Phytosanitary
UK	United Kingdom
WTO	World Trade Organization

This document contains the following separate sections:

1. Introductory discussions of the background to this import risk analysis (IRA), including the history of access requests, the scope of the IRA and an outline of AFFA policy framework.

2. Identification of pests that potentially could be associated with bulbs of the genera concerned from the countries concerned.

3. Options available to manage risks posed by the identified quarantine pests. Following on from this, a risk management process is developed from the options available.

4. Additional information in the form of tables and pest datasheets are given in Appendix 1 and Appendix 2.

The document was compiled as a comprehensive reference base, and has been structured and written using appropriate scientific and technical terminology

BACKGROUND TO THE ANALYSIS

In September 1996, AQIS contracted consultants to review the import conditions for flower bulbs imported into Australia. The initiation of the consultants' review pre-dated the implementation of recommendations of the Nairn Committee Review of Quarantine (see *"Australian Quarantine - a shared responsibility: The Government Response*"), and the subsequent AFFA IRA process. Therefore, AFFA has endeavoured to integrate this prior work into the IRA framework that resulted from the implementation of the Nairn Review recommendations.

The consultants' report, "*Pest Risk Analysis of the Importation of Ornamental Bulbs from the Netherlands, the United Kingdom, New Zealand and Israel*", was completed in January 1998. This report was provided to registered stakeholders in March 1999, and further copies are available.

AQIS formally notified stakeholders of the IRA proposal on 21 May 1998. On 3 August 1998, AQIS proposed that the IRA should be subject to the non-routine IRA process outlined in *The AQIS Import Risk Analysis Process Handbook* (Anon, 1997). Stakeholders were invited to comment on the type of risk analysis proposed and all responded favourably. On 17 November 1998, AQIS notified stakeholders that the non-routine IRA process would be used.

On 15 January 1999, stakeholders were invited to comment on the scope and timing of the IRA and the membership of the Risk Analysis Panel (RAP), and on 30 March 1999 a copy of the Issues Paper and the previously compiled consultants' report was sent to all registered stakeholders for comments. A public meeting with stakeholders was held in Melbourne on 1 June 1999 to discuss the IRA process and the Issues Paper.

Stakeholders were advised by Plant Policy Memorandum on 9 May and 28 June 2000 of progress of the draft IRA and of changes of Chair of the RAP and a proposed stakeholder meeting. A Plant Policy Memorandum of 20 September 2000 advised stakeholders of a further change in the RAP membership, a revised release date for the draft IRA and details of the proposed stakeholder meeting.

In August 2000, the Department of Agriculture, Fisheries and Forestry - Australia (AFFA) underwent a restructure that moved the IRA function into a new Market Access and Biosecurity business group. Technical work on this IRA was substantially complete by this time.

Importation of bulbs and the Australian bulb industry

More than 40 million flower bulbs are imported into Australia annually, and over 99% of these come from the Netherlands. By volume, *Iris* bulbs comprise approximately 44%, *Lilium* 28%, *Tulipa* 15%, *Gladiolus* 6%, *Freesia* 3%, *Narcissus* 2% and *Hyacinthus* and *Crocus* both less than 1%.

Bulb importers and growers are mostly situated in Victoria, Tasmania and New South Wales. Currently bulbs are imported primarily for commercial production of cut flowers for the domestic market. However, a small quantity of *Lilium* and *Tulipa* blooms are exported as cut flowers. A small percentage of bulbs (mostly *Narcissus*) enter the retail trade after the flowers have been harvested. However, the vast majority of imported bulbs are destroyed once they have flowered, with new stock being imported for the next season.

Bulb schemes

Two countries (The Netherlands and the United Kingdom (UK)) covered by this IRA have government recognised or sponsored certification schemes to monitor all or some production of bulbs. Currently AFFA is unaware of similar schemes being in place in Israel or New Zealand, although some growers may have quality assurance systems that address many of the same issues. The vast majority of bulbs currently being imported into Australia are produced in the Netherlands under one of two schemes: Naktuinbouw Elite (NAKB) or Bloembollkeeuringsdienst (BKD). In the UK there are two schemes – one, the Plant Health Propagation Scheme (bulbs), operates in England and Wales. This is managed by the Ministry of Agriculture, Fisheries and Food (MAFF)/National Assembly for Wales Agriculture Department. Another scheme is operated in Scotland by the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD).

In 1998 the European and Mediterranean Plant Protection Organisation (EPPO) produced standards for certification schemes for adoption by member states. Of the countries covered in this IRA, three (the Netherlands, the UK and Israel) are members of EPPO. Bulb genera covered are *Crocus* (PM 4/14(1)), *Freesia* (PM 4/22(1)), *Hyacinthus* (PM 4/23(1)), bulbous *Iris* (PM 4/15(1)), *Narcissus* (PM 4/24(1)) and *Tulipa* (PM 4/13(1)). These standards are available via http://www.eppo.org.

These (schemes) standards appear to be similar to those currently in place in the Netherlands and the UK.

SCOPE OF THIS IMPORT RISK ANALYSIS

This IRA considers quarantine risks that may be associated with the importation into Australia of a number of genera of ornamental flower bulbs from certain countries. The ornamental bulb genera and countries of origin that are considered under this import risk analysis are as follows:

Genus	Countr(y)ies of Origin
Crocus	Netherlands
Freesia	Netherlands
Gladiolus	Netherlands
Hippeastrum	Netherlands
Hyacinthus	Netherlands
Iris (bulbaceous)	Israel, Netherlands, United Kingdom
Lilium	Israel, Netherlands, New Zealand, United Kingdom
Narcissus	Netherlands, United Kingdom
Tulipa	Netherlands, New Zealand

The above combinations of ornamental bulb genera and source countries are those that importers have expressed most interest in. In addition, interest has also been expressed in a number of *Allium* species. These are to be considered under a separate IRA devoted to this genus.

This IRA considers potential pests of bulbs that are of quarantine concern. These include arthropod pests (insects and mites), snails and nematodes as well as diseases (caused by fungi, bacteria, viruses, viroids and phytoplasmas). It does not cover parasites, parasitoids, hyperparasitoids and predators that may be associated with these pests nor does it cover all ‘hitch-hikers’ or otherwise accidental species including members of the soil biota. The identities of such species are impossible to predict, being a random sample of the fauna of the region that the bulbs come from. The package of management options put in place to manage risk from quarantine pests and diseases should control these ‘hitch-hiker’ species.

The risk analysis has developed procedures and conditions to manage the identified quarantine risks. It is intended that this risk analysis will set out a risk management framework against which further importation requests of ornamental flower bulbs may be considered.

Weed risks have also be considered, including the potential weed risks posed by the bulb species themselves as well as the risks of weeds being introduced in association with the bulbs.

INTERNATIONAL FRAMEWORK

World Trade Organization

As a member of the World Trade Organization (WTO), Australia has certain rights and obligations under the WTO Agreement, including the Agreement on the Application of Sanitary and Phytosanitary Measures - the so-called 'SPS Agreement'. The SPS Agreement recognises the standards, guidelines and recommendations for plant health developed by the International Plant Protection Convention (IPPC), as the relevant international benchmark.

Under the SPS Agreement, measures put in place by a country must be based either on an international standard or upon a scientific risk analysis. A risk analysis must:

- Identify the pests whose entry, establishment or spread within its territory a WTO member wants to prevent, as well as the potential biological and economic consequences associated with the entry, establishment or spread of these pests
- Evaluate the likelihood of entry, establishment or spread of these pests, as well as the associated potential biological and economic consequences
- Evaluate the likelihood of entry, establishment or spread of these pests according to the SPS measures that might be applied.

The SPS Agreement defines 'appropriate level of sanitary or phytosanitary protection' as the level of protection deemed appropriate by the member country establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory. This is termed *appropriate level of protection* (ALOP) in Australia. Further information on Australia's rights and obligations arising from the SPS Agreement may be found in the report National Risk Management and the SPS Agreement (Wilson and Gascoine, *in press*).

International Plant Protection Convention

Australia is a member of the IPPC and actively contributes to the development of the series of International Standards for Phytosanitary Measures (IPSM), as developed by the Secretariat of the IPPC. Of particular relevance to this document is *ISPM No. 2: Guidelines for Pest Risk Analysis*, abbreviated henceforth as 'IPPC Guidelines'. The technical component of this PRA fulfils the requirements of the IPPC Guidelines.

AFFA POLICY FRAMEWORK

Legislation and conceptual framework

AFFA's objective is to adopt quarantine policies that are, wherever appropriate, based on international standards and that provide the health safeguards required by government policy in the least trade-restrictive way. In developing quarantine policies, the pest risks associated with importations are analysed using PRA, a structured, transparent and science-based process.

The Quarantine Act 1908 and subordinate legislation, including Quarantine Proclamation 1998 (QP 1998), are the legislative basis of human, animal and plant quarantine in Australia. Section 4 of the Act defines the scope of quarantine as follows:

In this Act, Quarantine has relation to measures for the inspection, exclusion, detention, observation, segregation, isolation, protection, treatment, sanitary regulation, and disinfection of vessels, installations, persons, goods, things, animals, or plants, and having as their object the prevention of the introduction, establishment or spread of diseases or pests affecting human beings, animals, or plants.

Subsection 13(1) of the Act provides, among other things, that the Governor-General in Executive Council may, by proclamation, prohibit the importation into Australia of any articles likely to introduce any infectious or contagious disease, or disease or pest affecting persons, animals or plants. The Governor-General may apply this power of prohibition generally or subject to any specified conditions or restrictions.

For articles prohibited by proclamation, the Director of Animal and Plant Quarantine may permit entry of products on an unrestricted basis or subject to compliance with conditions, which are normally specified on a permit. A PRA provides the scientific and technical basis for quarantine policies that determine whether an import may be permitted and, if so, the conditions to be applied.

The matters to be considered when deciding whether to issue a permit are set out in section 70 of QP 1998 and include the quarantine risk, whether the imposition of conditions would be necessary to limit the quarantine risk to a level that would be acceptably low, and anything else that is considered relevant. ‘Quarantine risk’ means the likelihood of the importation leading to the introduction, establishment or spread of a disease or a pest in Australia, the likelihood that harm will result (to humans, animals, plants, the environment or economic activities) and the likely extent of any such harm.

This IRA provides the basis for future consideration of applications for import permits outlined in QP 1998 in relation to the importation of ornamental bulbs. In keeping with the scope of the Quarantine Act, only the factors relevant to the evaluation of quarantine risk (ie. the risk associated with the entry, establishment and spread of unwanted pests and diseases) are considered in the PRA. Questions related to the potential economic consequences of importation (other than the economic impact of a pest) are not part of AFFA's process of evaluation.

The actions of the Director of Animal and Plant Quarantine or his/her delegate in reaching a decision under the Quarantine Act must take into account relevant provisions of other Commonwealth legislation, including the Endangered Species Protection Act 1992 and the Environment Protection (Impact of Proposals) Act 1974. The Environment Protection (Impact of Proposals) Act 1974 and the administrative procedures under that Act require consideration of whether Commonwealth action (such as the granting of an import permit) is an action that will, or is likely to, affect the environment to a significant extent or that will have the effect of permitting or facilitating an action by another person that will result, or is likely to result, in such an effect.

Decisions made by AFFA to permit the entry of plants or plant products, made under the Quarantine Act and consistent with Australia's conservative approach to risk, are unlikely to lead to significant adverse effects on the environment. Nevertheless, AFFA would inform the Environment Minister of any intention to make a decision that is likely to result in a significant risk of harm to the environment. Furthermore, Environment Australia is given the opportunity to comment on proposals to develop new quarantine policies. In consultation with Environment Australia, AFFA is also developing guidelines to assist quarantine officers when making decisions to ensure that the likely effects on the environment are taken into account.

Domestic policy environment

In 1996, a committee chaired by Professor Malcom E. Nairn conducted a detailed independent review of Australian quarantine (Nairn *et al.*, 1996). Noting that the risk analysis process underpins Australia's quarantine policies and procedures, the Nairn committee identified six principles that should apply. The committee recommended that PRA should be:

- Conducted in a consultative framework
- A scientific process and therefore politically independent
- A transparent and open process
- Consistent with both government policy and Australia's international obligations (under the SPS Agreement)
- Harmonised, by taking account of international standards and guidelines
- Subject to appeal on the process.

In its response (DPIE 1997), the Australian Government accepted all recommendations of the Nairn report relevant to the risk analysis process. The AQIS publication titled, *The AQIS Import Risk Analysis Process Handbook* sets out AFFA's approach to PRA, which is consistent with Australia's obligations under the SPS Agreement and with relevant recommendations of the OIE. Copies of the handbook can be obtained from AFFA or viewed on the Internet.

AFFA FRAMEWORK FOR PEST RISK ANALYSIS

In order to achieve a consistently objective method, import risk analyses carried out by AFFA follow the principles laid out in the IPPC Guidelines. According to these guidelines, pest risk analysis should be based on the following steps:

- Stage 1: Initiation of the pest risk analysis (PRA)
- Stage 2: Risk assessment
- Stage 3: Risk management

STAGE 1. INITIATION OF THE PEST RISK ANALYSIS

Over recent years, concern has been raised by AQIS and industry regarding the adequacy and appropriateness of certain import conditions for imported flower bulbs. In addition, there has been increased interest in importing larger quantities of ornamental bulbs from countries other than the Netherlands. Under the present import conditions, this is not possible.

In September 1996, AQIS contracted consultants to review the import conditions for ornamental flower bulbs. Following the adoption of the 1996 Australian Quarantine Review recommendations of the Nairn committee, AQIS developed the AQIS Import Risk Analysis process and implemented it in 1998. AQIS decided to continue the ornamental bulbs review using the new non-routine IRA process. The consultants' report, completed in 1998, has been distributed to stakeholders and used as background information for the current IRA.

The interest in importation of bulbs from additional countries and changes to international law in regard to quarantine measures, form the basis for AQIS initiating the IRA process in order to review the quarantine risks and requirements for imported flower bulbs.

In accordance with the non-routine IRA process, AQIS appointed a Risk Analysis Panel in late 1998 after consultation with stakeholders. The membership of the Panel comprised:

Dr Adrian Harris (Chair), AFFA
Dr Bob Ikin, (Former Chair, retired October 1999), AQIS
Ms Lois Ransom, (Former Chair, resigned from RAP May 2000), AQIS
Mr Gordon Berg, Department of Natural Resources and Environment, Victoria
Mr Terry Lockyer, Department of Primary Industries, Water and Environment, Tasmania
Mr Rob Schwarz, AQIS
Mr Ian Atkinson, horticulture industry, resigned from RAP August 2000.

The Risk Analysis Panel appointed a Technical Working Group in 1999 that comprised:

Dr Adrian Harris (Chair), AFFA
Ms Penny Greenslade (entomology), AQIS, resigned from TWG October 1999
Ms Alison Roach (entomology), AFFA
Dr Vani Srungaram (virology, pathology), AFFA
Mr Mark Whattam (plant pathology), Department of Natural Resources and Environment, Victoria
Mr Keith Bodman (mycology), Queensland Horticulture Institute, resigned from TWG February 2000
Ms Eve Steinke (weeds and Technical Secretary), AFFA
Mr Nick Small (horticulture), AFFA.

The Technical Working group commenced the Pest Risk Assessment stage in 1999. The scope of the IRA covers nine genera of ornamental flower bulbs imported from The Netherlands, the United Kingdom, Israel and New Zealand, which are those in which importers and the industry have expressed most interest. However, mindful that there may be interest in importing these bulb genera from other countries, the IRA sets out standards that may be applied for importations from countries other than those four listed above.

STAGE 2. RISK ASSESSMENT

PEST CATEGORISATION

A total of 83 species or genera of organisms of quarantine concern were identified (Table 1). These are insects, mites, a flatworm, nematodes, fungi, bacteria, a phytoplasma and viruses. An additional 113 organisms were identified as pests and diseases of bulbs that are established in Australia and are not of quarantine concern. Many of the pests reported in Table 1 are based on single records with limited information available. Given the lack of data on the distribution of these pests, they were retained on the list of potential quarantine pests for further consideration.

In terms of potential impact on bulbs and other plant life, the organisms identified as quarantine pests are:

- specific pests and diseases of bulbiferous plants;
- pests and diseases that can attack, in addition to bulbiferous plants, a wide range of plants including many economically important crops.

Tables 16 to 24 in Appendix 1 present for each genus of bulbs a list of quarantine pests associated with it in one or more of the countries covered by this IRA. Also included is information on distribution, economic importance and quarantine significance of each quarantine pest. In addition to these tables, information on each quarantine pest is given in the data sheets in Appendix 2. Pests of bulbs identified as not of quarantine concern are listed in Table 25 in Appendix 1.

Insects and mites

A total of 26 genera and species were identified as of quarantine concern, of which about half are specific to bulbiferous plants. These have the potential to become important pests of bulb production but are probably of minor importance elsewhere, except on closely related plant species such as *Allium* spp. (onion, garlic, etc.). Included in this category are bulb flies of the genera *Eumerus* and *Meredon,* and the mite *Steneotarsonemus laticeps*.

Other species identified as of quarantine concern are polyphagous and feed on a wide range of crops including bulbs. These include indiscriminate root-feeders, such as wireworms (*Agriotes* spp.), swift moths (*Hepialus* spp.) and sucking pests such as mealy bugs, thrips, aphids, leaf miners and leafhoppers. Many of these sucking pests are virus vectors. In addition, several polyphagous moths (*Agrotis segetum* and *Spodoptera littoralis*) are well known pest species of a wide range of crops including important crops such as cotton. Many of these polyphagous pests are difficult to control as they are capable of rapidly developing resistance to pesticides. Another moth, *Opogona sacchari***,** is of particular concern. This species is a known pest of bananas and has potential to be a pest of a wide range of other plant species in sub-tropical and tropical environments.

Flatworms and nematodes

A total of nine species or genera are included in this category. The New Zealand flatworm *Arthurdendyus triangulatus* is not a pest of plant material, but a predator of beneficial earthworms. It was introduced on apparently contaminated nursery stock into the UK where it is of major concern. Preying on earthworms, it has a deleterious impact on the rate of soil conditioning and nutrient recycling. Beneficial earthworms in Australian agricultural land are mostly introduced European species that are susceptible to this predator. If introduced here, the flatworm may have a similar impact to that in the UK, especially in cool areas such as Tasmania and southern Victoria.

Globodera spp. are very important nematode pests of potatoes. Bulbs could act as a carrier for nematode cysts if they have been grown on land previously used for susceptible crops such as potatoes. *Ditylenchus destructor,* is a pest of potatoes and a wide range of other plants including bulbs. *Meloidogyne chitwoodi* is the most important pest of potatoes in the Pacific Northwest of the USA. Recently it has become established in the Netherlands and is therefore of concern. Bulbiferous plants can act as a host for this species, but it poses a greater threat to potatoes.

Nematodes of the genera *Longidorus* and *Xiphinema,* in addition to being root feeders, are vectors of a number of viruses of quarantine concern. If introduced and established, some species (eg. *X. diversicaudatum*) may promote the spread of viruses, such as *Arabis mosaic virus,* that are currently present in Australia without their natural vector. Quarantine viruses such as *Raspberry ringspot virus, Strawberry latent ringspot virus* and *Tomato black ring virus* can be vectored by these nematodes, or be introduced in nematodes carried on bulbs or in soil contaminating them.

Other invertebrates

No specific references were found relating to the association of slugs and snails with the bulb genera covered in this IRA. It is possible, however, for members of the local slug and snail fauna from the region concerned to 'hitch-hike' on bulbs, particularly as eggs.

Fungi

A total of 28 species of fungi are considered as quarantine pests. These mostly belong to the genera *Botrytis, Fusarium, Ramularia, Sclerotium, Urocystis* and *Uromyces* and are considered to be of medium to high economic importance. The economic importance of some of the identified fungal genera, such as *Puccinia, Embellisia, Mycosphaerella* and *Septocylindrium,* is unknown.

Some of these species cause diseases of leaves and flowers rather than specifically of bulbs. However, other plant parts including bulbs could become contaminated with their wind-borne spores (eg. *Puccinia* spp.), or they could be carried in bulbs as latent mycelium (eg. *Botrytis* spp.). Fungi such as *Fusarium* spp. directly infect bulbs causing a destructive rot that results in stunted plants, leaf tip damage, deformed flowers and limited root development. Although *Fusarium oxysporum* is recorded in Australia on bulbs, the exact identity of the *formae speciales* present in Australia is unclear. The quarantine status of these fungi will be maintained until thorough tests are undertaken to determine the identity of those already in Australia.

Bacteria

Two species of bacteria were identified as of quarantine concern. *Corynebacterium fascians* occurs on a wide range of plants in addition to bulbs. *Curtobacterium flaccumfaciens* pv. *oortii* causes a disease specifically of tulips.

Phytoplasmas

The only phytoplasma of quarantine concern that was identified is Aster yellows. It has a very wide host range.

Viruses

A total of 17 viruses of quarantine concern were identified, most of these specific to one or more genera of bulbs. Several of these have a wide host range (*Raspberry ringspot virus*, *Strawberry latent ringspot virus* and *Tomato black ring virus*). These viruses are spread either by nematodes or by the propagation of infected plant material. While they are rare and symptomless on bulbs, they are important pathogens to other horticultural crops.

No viroids of quarantine concern to Australia were identified in this IRA.

Table 1: List of pests of ornamental bulbs of quarantine concern to Australia from the Netherlands, the United Kingdom, Israel and New Zealand.

The following pest list represents our present state of knowledge and is subject to change as a result of reclassification of organisms and new scientific evidence.

Species	Common name	Host in countries of origin									
		Crocus	*Freesia*	*Gladiolus*	*Hipp.*	*Hyac.*	*Iris*	*Lilium*	*Narcissus*	*Tulipa*	Other plants including other bulbs
Arthropods											
Aceria tulipae (Keifer, 1938) [Acari : Eriophyidae]	dry bulb mite									Y	
Agriotes spp. [Coleoptera : Elateridae]	wireworms	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Agrotis segetum Denis & Schiffermüller [Lepidoptera : Noctuidae]	cutworm	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Aphis fabae Scopoli, 1763 [Hemiptera : Aphididae]	black bean aphid	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Eumerus amoenus Loew, 1848 [Diptera : Syrphidae]	lesser bulb fly								Y		
Eumerus strigatus (Fallén, 1817) [Diptera: Syrphidae]	lesser bulb fly			Y	Y	Y	Y	Y	Y	Y	
Eumerus tuberculatus (Rondani, 1857) [Diptera : Syrphidae]	lesser bulb fly			Y	Y	Y	Y	Y	Y	Y	
Eumerus spp. [Diptera : Syrphidae]	lesser bulb fly			Y	Y	Y	Y	Y	Y	Y	
Frankliniella fusca (Hinds, 1902) [Thysanoptera : Thripidae]	tobacco thrips	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Frankliniella occidentalis (Pergande, 1895) [Thripidae : Thysanoptera]	western flower thrips	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hepialus humuli (Linnaeus, 1758) [Lepidoptera : Hepialidae]	ghost swift	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hepialus lupulinus Linnaeus, 1758 [Lepidoptera : Hepialidae]	common swift	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Lilioceris spp. [Coleoptera : Chrysomelidae]	lily beetles							Y			
Liothrips vaneeckei Priesner, 1920 [Thysanoptera : Phaleothripidae]	lily thrips							Y			
Liriomyza trifolii (Burgess, 1880) [Diptera : Agromyzidae]	serpentine leaf miner	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Macrosteles sexnotatus (Fallén, 1806) [Hemiptera: Cicadellidae]	aster leafhopper			Y		Y					Y
Merodon eques (Fabricius, 1805) [Diptera : Syrphidae]	large narcissus bulb fly				Y			Y		Y	
Merodon equestris (Fabricius, 1794) [Diptera : Syrphidae]	large narcissus bulb fly				Y	Y	Y	Y	Y	Y	
Merodon spp. (other than *M. eques* and *M. equestris*) [Diptera : Syrphidae]	large narcissus bulb fly				Y	Y	Y	Y	Y	Y	
Norellia spinipes (Meigen) [Diptera : Scathophagidae]	scathophagid fly								Y		Y
Opogona sacchari Bojer [Lepidoptera : Tineidae]	banana moth			Y	Y						Y
Phenacoccus avenae Borchsenius, 1949 [Hemiptera : Pseudococcidae]	iris mealybug	Y	Y		Y	Y	Y	Y	Y	Y	Y
Phenacoccus emansor Williams & Kozarzhevskaya, 1988 [Hemiptera : Pseudococcidae]	mealybug						Y	Y			Y
Rhizoglyphus spp. [Acari : Acaridae]	bulb mite		Y	Y		Y	Y	Y	Y	Y	Y
Spodoptera littoralis (Boisduval) [Lepidoptera : Noctuidae]	Egyptian cotton leafworm	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Species	Common name	Host in countries of origin									
		Crocus	*Freesia*	*Gladiolus*	*Hipp.*	*Hyac.*	*Iris*	*Lilium*	*Narcissus*	*Tulipa*	Other plants including other bulbs
Steneotarsonemus laticeps (Halbert) [Acari : Tarsonemidae]	bulb scale mite				Y				Y		
Flatworm and nematodes											
Arthurdendyus triangulatus (Dendy) [Tricladida : Terricola]	New Zealand flatworm	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ditylenchus destructor Thorne, 1945 [Tylenchida : Anguinidae]	potato rot nematode	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ditylenchus dipsaci (Kuhn) Filipjev, 1936 [Tylenchida : Anguinidae]	stem nematode	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Globodera pallida Behrens, 1975 [Tylenchida : Heteroderinae]	pale potato cyst nematode	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Globodera rostochiensis Behrens, 1975 [Tylenchida : Tylenchoidinae]	potato cyst nematode	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Meloidogyne chitwoodi Golden, O'Bannon, Santo & Finley, 1980 [Tylenchida : Meloidogynidae]	Columbia root-knot nematode	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Longidorus attenuatus (Filipjev, 1934) [Dorylamida : Longidoridae]	needle nematode	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Longidorus macrosoma (Filipjev, 1934) [Dorylamida : Longidoridae]	needle nematode	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Xiphinema spp. [Nematoda : Longidoridae]	dagger nematodes	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fungi											
Aecidium narcissi Liou [Uredinales : Pucciniaceae]	narcissus rust						Y		Y		Y
Botrytis hyacinthi Westerd. & v. Beyma Theo Kingma. [Leotiales : Sclerotinaceae]	hyacinth fire					Y	Y	Y			Y
Botrytis polyblastis Dowson [Leotiales : Sclerotinaceae]	narcissus fire								Y		
Cercospora amaryllidis Ellis & Everh.[mitosporic fungi : Hyphomycetes]	leaf spot				Y						Y
Coleosporium narcissi Grove [Uredinales : Melampsoraceae]	narcissus rust								Y		
Embellisia hyacinthi de Hoog & P J Muller [mitosporic fungi : Hyphomycetes]	skin spot of hyacinths		Y			Y					Y
Fusarium oxysporum f. sp. *gladioli* (Massey) Snyder & Hansen [mitosporic fungi : Hyphomycetes]	basal rot	Y	Y	Y			Y				Y
Fusarium oxysporum f. sp. *lilii* Imle.[mitosporic fungi : Hyphomycetes]	basal rot	Y	Y					Y			
Fusarium oxysporum f. sp. *narcissi* Snyder & Hansen [mitosporic fungi : Hyphomycetes]	basal rot								Y		
Fusarium oxysporum Schl. f. sp. *tulipae* Apt. [mitosporic fungi : Hyphomycetes]	basal rot									Y	
Hendersonia ucrainica Petr. [mitosporic fungi : Coelomycetes]							Y				
Mycosphaerella cinxia [Dothidiales : Mycosphaerellaceae]	leaf spot of liliums							Y			
Mycosphaerella martagonas Arx [Dothidiales : Mycosphaerellaceae]	leaf spot of liliums							Y			
Phyllosticta liliicola Cejp [Sphaeropsidales: Sphaerioidaceae]								Y			
Puccinia gladioli (Duby) Cast. [Uredinales : Pucciniaceae]	gladioli rust			Y							
Puccinia narcissi Laundon [Uredinales : Pucciniaceae]	narcissus rust								Y		

Species	Common name	Host in countries of origin									
		Crocus	*Freesia*	*Gladiolus*	*Hipp.*	*Hyac.*	*Iris*	*Lilium*	*Narcissus*	*Tulipa*	Other plants including other bulbs
Puccinia prostii Moug. [Uredinales: Pucciniaceae]	rust									Y	
Puccinia schroeteri Pass. [Uredinales: Pucciniaceae]	rust								Y		
Ramularia vallisumbrosae Cavara [Moniliales: Moniliaceae]	white mould of narcissus								Y		
Sclerotium perniciosum van Slogt & Thomas [Stereales: Corticiaceae]	smoulder of tulip									Y	
Sclerotium wakkeri Boerema & Posthumus [Stereales: Corticiaceae]	smoulder			Y			Y	Y		Y	
Stromatinia narcissi Drayton & Groves [Helotiales: Sclerotiniaceae]	dry rot of narcissus								Y		Y
Septocylindrium spp. [Ascomycota : Hyphomycetes]								Y		Y	
Urocystis colchici f. sp. *narcissi* (Schlech.) Rabenh.G. Frag. [Ustilaginales : Tilletiaceae]	leaf smut of narcissus								Y	Y	Y
Uromyces aecidiiformis [Str.] Rees [Uredinales: Pucciniaceae].	lily rust							Y			Y
Uromyces croci Passerini. [Uredinales : Pucciniaceae]	crocus rust	Y									
Uromyces erythronii [Uredinales : Pucciniaceae]	rust									Y	Y
Uromyces holwayi Lagerh. [Uredinales: Pucciniaceae]	lily rust							Y			
Bacteria											
Corynebacterium fascians (Tilford 1936) Dowson 1942 [Actinomycetales : Nocardiaceae]	fasciation			Y		Y		Y			Y
Curtobacterium flaccumfaciens pv. *oortii* (Saal. & Maas Gee.) Coll. & Jones 1983 [Actinomycetales : Microbacteriacea]	tulip canker									Y	Y
Phytoplasma											
Aster yellows [Mollicutes: Acholeplasmatales] serotypes that attack bulbs				Y		Y					Y
Viruses											
Freesia leaf necrosis virus Van Dorst, (1973) [Varicosavirus]			Y								
Hippeastrum mosaic virus Kunkel (1922); Brants & van den Heuvel (1965) [Potyvirus]					Y						Y
Iris yellow spot virus [Tospovirus]							Y	Y			Y
Lily mottle virus Brierley & Smith (1944) [Potyvirus]								Y		Y	
Lily X virus Stone (1976) [Potexvirus]								Y			
Narcissus late season yellows virus Brunt (1977) [Potyvirus (?)]									Y		
Narcissus tip necrosis virus Asjes (1972) [Carmovirus (?)]									Y		
Nerine latent virus Brunt *et al.* (1970) [Carlavirus]					Y						Y
Raspberry ringspot virus Cadman (1956) [Nepovirus]									Y		Y
Rembrandt tulip-breaking virus [Potyvirus]								Y		Y	
Strawberry latent ringspot virus Lister (1964)				Y				Y			Y

Species	Common name	Host in countries of origin									
		Crocus	*Freesia*	*Gladiolus*	*Hipp.*	*Hyac.*	*Iris*	*Lilium*	*Narcissus*	*Tulipa*	Other plants including other bulbs
Tomato black ring virus Smith (1946) [Nepovirus]				Y					Y	Y	Y
Tulip band-breaking virus Asjes & Segers (1985) [Potyvirus]										Y	
Tulip severe mosaic virus [Closterovirus (?)]										Y	
Tulip top breaking virus [Potyvirus]										Y	
Tulip X virus, Mowat (1982) [Potexvirus]									Y	Y	Y
Vallota mosaic virus, Inouye & Hakkaart (1980) [Potyvirus]			Y								Y

WEED RISK ASSESSMENT

An assessment was made of the potential weed risk associated with importation of bulbs of the genera covered by this IRA. Two aspects were considered as follows:

- The risk posed by the imported plant species itself;
- The risk posed by weed contamination of imported bulbs.

Weed risk assessment of bulbs themselves

AQIS introduced a ‘permitted list’ approach to new plant imports in the Quarantine Proclamation 1998. Plants must now be on the permitted list before they are permitted entry into Australia. Currently the list includes *Crocus, Freesia*, *Hippeastrum*, *Lilium, Narcissus and Tulipa* as permitted genera. The genus *Gladiolus* is also permitted with the exception of one species, *G. segetum.* In this document the term 'permitted plant' is used in a general sense. It indicates that the species or genus is permitted as seed, although this may be subject to post-entry quarantine conditions depending on any pest risk associated with the seed. Whether a species or genus is also permitted as a foliage plant, tissue culture or bulb varies with the species/genus. AQIS importation conditions for individual species and genera can be found in the AQIS Import Conditions Database (ICON) on the AQIS web site at http://www.aqis.gov.au/icon

As part of a program to improve the screening of new plant imports to prevent new weeds entering Australia, a review of the permitted plant list is being undertaken, which will result in the removal of genus level permissions, replacing them with permissions for species known to be in Australia and not under official control as weeds and species assessed as not being a weed risk to Australia. New plants will be added to the list when an importer requests assessment and the species is found not to pose a weed risk, or if information is provided demonstrating that the plant is already in Australia and not under official control as a weed. Details of the weed risk assessment process are available via the AQIS web site at http://www.aqis.gov.au/docs/plpolicy/weeds1.htm.

The review of the existing permitted list is expected to be completed in 2001. To minimise disruption to existing trade a consultation phase will be undertaken before changes are implemented, and advance notice provided of when the changes will take place. Requests to industry for information regarding bulb species of interest to stakeholders in this IRA have been made on three occasions as part of this IRA process, but no response has been received. As a further part of this consultation a list has been compiled of species known by AFFA to be established or widely available in Australia, and is included in this document (see below). Stakeholders are requested to examine this list and notify AFFA of species which they believe should be included due to there being an existing trade in the species, or the species being established in Australia. Evidence of existing trade or establishment in Australia must be provided.

In addition to the national permitted lists, State governments may maintain their own permitted lists, and importers should check with the State into which they wish to import a plant to ensure that importation is permitted.

List of bulb species and varieties currently understood by AFFA to be widely available for sale and/or naturalised in Australia

Crocus
Crocus chrysanthus Herb.
Crocus flavus (syn. *C. maesiacus* Ker-Gawl., *C. aureus* Sibth. & Sm.)
Crocus tomasinianus Herb.
Crocus vernus (L.) Hill
Dutch hybrids – Yellow mammoth, Pickwick, Jeanne d'Arc, Flower Record

Freesia
Freesia alba (G.L. Mey.) Gumbl. (syn. *F. lactea*, *F. refracta* var. *alba* G.L. Mey.)
Freesia liechtlinii Klatt
Freesia liechtlinii x *refracta*
Freesia refracta (Jacq.) Klatt
Freesia hybrids – Royal Crown, White Angel, Himalaya, Vulcano, Rose Pascal, Amadeus, Tequila sunrise

Gladiolus
Gladiolus alatus L.
Gladiolus angustus L.
Gladiolus byzantinus Mill. (syn *G. communis* ssp. *byzantinus* (P.Mill.) A. Hamilton
Gladiolus calianthus Marais, nom. illeg. (syn *G. murielae* Kelway & Langport ex anon., *Acidanthera bicolor* var. *murielae*)
Gladiolus cardinalis Curtis
Gladiolus carneus Delaroche (syn. *G. blandus* Aiton)
Gladilous caryophyllaceus
Gladiolus x *colvillei* Sweet (*G. cardinalis* x *G. tristis*)
Gladiolus floribundus Jacq.
Gladiolus x *gandavensis* Van Houtte
Gladiolus gueinzii Kunze
Gladiolus tristis L.
Gladiolus undulatus Jacq.
Gladiolus hybrids – dwarf hybrids, Nymph, Salmoneus; large flowered hybrids, Grandiflorus group; Butterfly hybrids, Nanus group

Hippeastrum
Hippeastrum advenum (Ker Gawl.) Herb.
Hippeastrum 'Apple Blossom'
Hippeastrum 'Red Lion'

Hyacinthus
Hyacinthus orientalis L.
Hyacinthus amethystinus L. (syn. *Brimeura amethystina* (L.) Chourd)
Hyacinthus hybrids – Anna Lisa, City of Haarlem, Delfts blue, Gypsy Queen, Jan Bos, Lady Derby, L'Innocence

Iris
Iris bucharica Foster
Iris foetidissima L.
Iris germanica L.
Iris junonia Schott & Kotschy ex Schott (syn. *Iris pallida* Lam.)
Iris latifolia (Mill.) Voss
Iris orientalis Mill.
Iris pseudacorus L.
Iris reticulata M. Bieb.
Iris spuria L.
Iris tingitana Boiss & Reut.
Iris unguicularis Poiret
Iris xiphium L.
Iris hybrids – Dutch

Lilium
Lilium auratum Lindl.
Lilium candidum L.
Lilium formosanum Wallace
Lilium henryi Baker
Lilium lancifolium Thunb. (syn. *Lilium tigrinum* Ker Gawl.)
Lilium longiflorum Thunb.
Lilium martagon L.
Lilium regale E.H. Wilson
Lilium speciosum Thunb.
Lilium hybrids – Asiatic, Trumpet, Aurelian, Oriental

Narcissus
Narcissus bulbococium L.
Narcissus cyclamineus DC.
Narcissus jonquilla L.
Narcissus x *medioluteus* Mill.
Narcissus x *odorus* L.
Narcissus papyraceus Ker Gawl.
Narcissus poeticus L.
Narcissus pseudonarcissus L.
Narcissus tazetta L.
Narcissus hybrids – Trumpet (Division 1), Large-cupped daffodils (Division 2), Small-cupped daffodils (Division 3), Double flowered daffodils (Division 4), Silver-Chimes, Tete-a-Tete

Tulipa
Tulilpa gesneriana L.
Tulip hybrids – Single Early Tulips, Double Early Tulips, Single Late Tulips, Darwin tulips, Cottage tulips, Parrot tulips

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Weed contaminants of ornamental bulbs

The following plants (Table 2) are recorded as weeds of bulb cultivation and it may be possible for one or more of these plants to be transported in association with bulbs. A number of the genera listed include serious weeds that are not currently present in Australia. Requests for information on weeds of bulb cultivation and their management were sent to countries covered by this IRA. A verbal response has been received from New Zealand, and a written one from the United Kingdom. Both replies were inconclusive, providing at best genus level identification, and general information on herbicide application.

A small trial was undertaken in Tasmania to assess probability of importation of weeds being imported with bulbs under current import protocols. Some 50+ bulbs each of *Iris reticulata*, *Iri*s (Dutch), *Lilium* and *Tulipa* were randomly selected from bulbs imported from the BKD certification scheme in the Netherlands for the 1999/2000 bulb season. These bulbs, with any packing material, were planted into sterilised pine bark-based potting mix in clean new polystyrene boxes. Boxes were placed in an enclosed screen-house at the Kingston Quarantine Station in Tasmania. The growing period was Dec. 1999 to Feb. 2000. During this period only two weed plants were observed in growth, and both were identified as *Chenopodium quinoa*. *C. quinoa* is a species already present in Australia. In spite of the small sample used in this study, it was demonstrated that weed propagules can be imported with bulbs, even if in this case the species found was one that already occurs in Australia.

Table 2: Weeds found in bulb cultivation

Country	Weed	Under quarantine control in Australia or importation subject to quarantine control in Australia	Ref.
Netherlands and United Kingdom	potato ground keepers *(Solanum tuberosum)*	Yes	1
	Persicaria spp.	Status unclear	1
	Veronica spp. (speedwell)	Status unclear	1
	Polygonum sp. (knotgrass - probably *P. aviculare*, herbicide resistant in the Netherlands	Strains/species in Australia not herbicide resistant	1,5
	cereals	Yes	1
	Matricaria sp.	Status unclear	3
	barley	Yes	2
	oats	Yes	2
	wheat	Yes	2
	rye	Yes	2
	broadleaved weeds	Status unclear	2
Israel	*Amaranthus* spp.	Status unclear	4
	Malva spp.	Status unclear	4
	Heliotropium spp.	Status unclear	4
	Convolvulus spp.	Status unclear	4
	Sonchus spp.	Status unclear	4
New Zealand	No specific information		

References for Table 2

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Environmental Impact

Importation of a particular bulb species poses a number of potential risks to the environment, both by itself as a potential weed and/or as a result of pest and disease species associated with it.

A review of the permitted plant list is being undertaken in line with the Quarantine Proclamation 1998 which will result in a list of plants at the species rather than the genus level. There will be consultation before these changes are implemented. Species in addition to these will be permitted after a weed risk assessment (on application) or if evidence is provided that they are established or widely available in Australia and are not under official control.

Unlike many other horticultural products which are imported for consumption, bulbs are imported for the express purpose of planting in the ground. This greatly increases the chance that the plant may exhibit its weedy nature or that a pest introduced in a bulb could find itself placed in an environment in which it can establish and thrive. For example, a nematode in an imported bulb destined for planting has a much greater chance of survival than one in an onion that is cut up and fried in an urban fastfood establishment.

An additional factor directly related to the process of replanting is the risk associated with soil adhering to and associated with shipments of bulbs. Soil can also act as a vehicle for a wide range of pests.

Pests potentially associated with bulbs fall into two groups: those that are specific to one or more genera of bulbiferous plants and those that non-specific on plant hosts they attack. Prediction of the impact of the non-specific pests on the Australian cultivated and natural environment is more difficult to predict than say a pest that is physiologically and ecologically adapted to a specific host. Some pests that could be imported with bulbs have the potential to become important pests of Australian agriculture or horticulture.

In addition to the pests and diseases identified by this IRA, potential risks also exist from organisms that are accidental on bulbs, such as elements of the soil biota or accidental hitch-hikers that have nothing to do with bulbs. Measures put in place to manage identified pests, together with insistence on a high standard of freedom from soil, will minimise the risk from such organisms.

STAGE 3. PEST RISK MANAGEMENT

This IRA reviews specific conditions that need to be put in place to manage the pests of quarantine concern to Australia for *Crocus, Freesia, Gladiolus, Hippeastrum, Hyacinthus, Iris, Lilium, Narcissus* and *Tulipa* imported from the Netherlands, the United Kingdom, Israel and New Zealand.

Stage 2 identified the organisms that are considered to pose a risk and require management. AFFA has identified the following risk management options in order to manage the identified risks. AFFA has made an assessment of the effectiveness of these options and their likely impact on trade. The final risk management measures will be selected with regard to their capacity to both manage the risks to acceptably low levels and to fulfil the principle of minimum impact on trade.

Table 3 lists potential management options available for the control of groups of pests identified in this IRA, together with the genera of bulbs affected. It is intended that a combination of these will be selected and used to control each group of pests and diseases.

Table 3: Risk Management options for quarantine pests identified in this IRA

Quarantine pest	Potential management options	Bulb genera affected
Weeds (as a contaminant of bulbs) As per table 2	• ‘Good horticultural practice' during production • Area freedom • Selection of certified stock for import • Cleaning of bulbs prior to export • Storage and transportation • Inspection on arrival • Hot water treatment • Growth in post-entry quarantine	All genera
Arthropods As per table 1	• ‘Good horticultural practice' during production • Area freedom • Selection of certified stock for import • Cleaning of bulbs prior to export • Storage and transportation • Inspection on arrival • Fumigation on arrival^ • Hot water treatment • Insecticide dip^ • Nematicide dip^ • Growth in post-entry quarantine (PEQ) • Soil application of systemic insecticide before planting in PEQ^ • Soil application of nematicide prior to planting in PEQ^	All genera
Flatworms and nematodes As per table 1	• ‘Good horticultural practice' during production • Area freedom • Selection of certified stock for import • Cleaning of bulbs prior to export • Process of transportation • Inspection on arrival • Fumigation on arrival^ • Hot water treatment • Nematicide dip^ • Fungicide dip^ • Growth in post-entry quarantine (PEQ) • Soil application of systemic insecticide before planting in PEQ^ • Soil application of nematicide prior to planting in PEQ^	All genera

Quarantine pest	Potential management options	Bulb genera affected
Other invertebrates (eg. slugs and snails)	• 'Good horticultural practice' during production • Selection of certified stock for import • Cleaning of bulbs prior to export • Process of transportation • Inspection on arrival • Fumigation on arrival^ • Hot water treatment	All genera
Fungi As per table 1	• 'Good horticultural practice' during production • Area freedom • Selection of certified stock for import • Selection of resistant varieties • Cleaning of bulbs prior to export • Inspection on arrival • Hot water treatment • Nematicide dip^ • Fungicide dip^ • Growth in post-entry quarantine	*Freesia* *Gladiolus* *Hippeastrum* *Hyacinthus* *Iris* *Lilium* *Narcissus* *Tulipa*
Bacteria As per table 1	• 'Good horticultural practice' during production • Area freedom • Selection of certified stock for import • ? Selection of resistant varieties • Cleaning of bulbs prior to export • Inspection on arrival • Hot water treatment • Growth in post-entry quarantine	*Gladiolus* *Lilium* *Tulipa*
Phytoplasmas Aster yellows	• 'Good horticultural practice' during production • Area freedom • Selection of certified stock for import • ? Selection of resistant varieties • Inspection on arrival • Fumigation on arrival^ (for vectors) • Hot water treatment (for vectors) • Insecticide dip^ (for vectors) • Growth in post-entry quarantine (PEQ) • Soil application of systemic insecticide before planting in PEQ^ • Diagnostic testing (ELISA/PCR)	*Gladiolus* *Hyacinthus*
Viruses As per table 1	• Good horticultural practice' during production • Area freedom • Selection of certified stock for import • ? Selection of resistant varieties • Inspection on arrival • Fumigation on arrival^ (for vectors) • Hot water treatment (for vectors) • Insecticide dip^ (for vectors) • Nematicide dip^ (for vectors) • Fungicide dip^ (for vectors) • Growth in post-entry quarantine (PEQ) • Soil application of systemic insecticide before planting in PEQ^ • Soil application of nematicide prior to planting in PEQ^ • Diagnostic testing (ELISA/PCR)	*Freesia* *Gladiolus* *Hippeastrum* *Iris* *Lilium* *Narcissus* *Tulipa*

^ Use of any pesticide is subject to both state and federal regulation. It is assumed that users fully understand their obligations under these regulations, in particular the requirement to follow instructions on the product label or on extensions to these (eg. relevant 'off label' permits) granted by the relevant regulatory authority. Statements made in this document DO NOT constitute an authority to deviate from such instructions. Permission to do this must first be granted by the relevant regulatory authority.

DISCUSSION OF MANAGEMENT OPTIONS

Management options for pests of quarantine concern can be undertaken at a number of points during the process of production, exportation, importation and quarantine clearance. In the following discussion, control measures have been grouped roughly in the order in which they are likely to be undertaken:

- in country of origin
- on arrival
- after arrival
- at any time

The following discussion will examine the impact of each management option on the various pests as identified in the previous section.

Measures undertaken in country of origin

1. 'Good horticultural practice' during production

To control weeds, arthropods, flatworms and nematodes, other invertebrates, fungi, bacteria, phytoplasmas and viruses.

A definition of 'good horticultural practice' is given in Table 14.

The probability of weeds and pests contaminating bulbs depends to a large extent on the quality of management of the cultivation process. Bulbs from established, clean and well-managed production areas are less likely to be contaminated with organisms of quarantine concern than material from poorly managed production areas. In addition, increased risks may also be associated with bulbs grown on land recently turned to such use or grown in areas that have been fallow or used for a rotation of another crop, in particular potatoes or other root crops.

Assurances should be obtained from the relevant NPPO that bulbs have been produced under conditions of 'good horticultural practice' and that they have been grown in ground free of contaminant species of concern. This is to a large extent explicit in government-sponsored bulb certification schemes in place in the Netherlands and the UK (Table 4).

Advantages

- Management of risk undertaken offshore
- Implicit part of production of 'certified bulbs'
- Provides a useful reduction in pest and disease load to be handled by

Disadvantages

- Unlikely in itself to provide complete control of quarantine pests
- Reliance on overseas management, which may be difficult to audit

subsequent control measures
- Has beneficial impact across all classes of quarantine pests

2. Area freedom

To control weeds, arthropods, flatworms and nematodes, fungi, bacteria, phytoplasmas and viruses.

A number of quarantine pests identified in this IRA are absent from some countries and/or have restricted distributions within certain countries. Consequently, it may be possible to negotiate area freedom arrangements for specific pests with the NPPO concerned. It is highly unlikely, however, that a location exists from which all pests and diseases of quarantine concern are absent. In addition, 'area freedom' does not deal with 'hitch-hiking' or accidental pests that could contaminate imported material.

Area freedom arrangements are likely to work best for specific pests and diseases that can be easily identified, are not very mobile, and for which good information exists as to their distribution and status. Examples include certain nematodes (such as *Globodera* spp. and *Meloidogyne chitwoodi*), weeds and disease-causing organisms. For mobile pests, such as insects, it may be difficult to ensure 'area freedom' without considerable and consistent monitoring, although country freedom status may be possible.

Advantages
- Management of risk undertaken offshore
- May reduce/eliminate risk posed by certain pests

Disadvantages
- Unlikely to find area where bulbs can be produced free of all quarantine pests
- Reliance on overseas management, which may be difficult to audit

3. Selection of certified stock for import

To control weeds, arthropods, flatworms and nematodes, other invertebrates, fungi, bacteria, phytoplasmas and viruses.

As stated above, bulbs produced under a certification scheme have generally been grown under conditions of 'good horticultural practice' and are least likely to carry quarantine pests.

Table 4 details the information available to AFFA on management protocols used by government-sponsored bulb certification schemes currently in place in the Netherlands and the UK. This table clearly shows differences between schemes, in particular in the need for registration, testing/inspection protocols (ELISA/visual) and identity preservation of bulbs. In the Netherlands, membership of a certification scheme is required to be able to commercially produce bulbs for any use, but in the UK membership is voluntary. All schemes provide some measure of protection against the importation of potato cyst nematode and potato wart disease, either by testing or by restriction as to where bulbs can be grown.

An examination was made of the extent to which quarantine pests (as identified by this IRA- Tables A-I in Appendix 1) are controlled or regulated by bulb certification standards in current use. The outcome of this comparison is given in Table 4.

The bulb schemes examined here address many issues of quarantine concern to Australia but they do not address all such concerns. This also applies to the schemes recently approved by EPPO which appear to be broadly in line with current Dutch and UK practice.

Many pests identified as being of quarantine concern to Australia are not listed by these schemes, eg. for several genera of bulbs, the BKD scheme does not specify any requirements for bacteria, nematodes, insects and mites. As a result, it is impossible to say how effectively such schemes would regulate such pests, other than reducing their incidence by ‘good horticultural practice’.

In other cases where a pest of quarantine concern is listed, tolerances declared for it by the scheme (typically a maximum of 0.02 – 5% of infested bulbs) may or may not provide an ‘appropriate level of protection’ for Australia. In others (eg. Scottish scheme) the tolerances are vague, such as ‘reasonable freedom’, so as the make assessment of efficacy from a quarantine perspective difficult.

Importation of bulbs produced under a certification scheme over other commercial production will reduce the risk of a range of pests and diseases of quarantine concern being introduced into Australia. This may be as a result of directly addressing the particular problem, at least in part or by default as a result of application of ‘good horticultural practice’ and identity preservation of the consignment. However, the comparison undertaken here demonstrates that none of the reviewed schemes are currently able, in themselves, to ensure supply of bulbs that meet all issues of quarantine concern to Australia. To manage risks not covered by these schemes, additional phytosanitary measures are likely to be required.

Advantages

- Management of some pest and disease problems offshore
- Assurance that bulbs are of ‘good quality’
- Easy to administer on arrival
- Minimal disruption to trade

Disadvantages

- Purpose of such schemes is to provide stock of known health and quality to a commercial quality standard rather than a quarantine standard.
- Certification schemes in themselves do not address all issues of quarantine concern to Australia, so additional measures are likely to be needed.
- Risk of substitution of inferior product unless certification and management of certified product is undertaken rigorously.

Table 4: Management processes used by government-sponsored bulb certification schemes currently in the Netherlands and the United Kingdom

Action	Netherlands – BKD#	Netherlands - NAKB#	UK (England and Wales) - PHPS Scheme, Elite grade#	UK (Scotland) 'A' grade#
Membership of scheme is compulsory for commercial production	Yes	Yes	No	No
Site approval	Required to grow any flower bulb for trade	Required to grow any flower bulb for trade	Not required	Required to participate in scheme
Quarantine/ restricted pests	Potatoes not allowed in rotation. Areas used for bulb production must be free of potato cyst nematode, *Globodera* spp. Presence of *Ditylenchus dipsac*i and *D. destructo*r prevents certification of bulbs – hence they cannot be traded.	No information	Land under notice for *Globodera* spp. and potato wart disease may not be used for production of certified bulbs. Presence of *Ditylenchus dipsaci* on Narcissus and *D. destructo*r on Iris not allowed and must be reported to Plant Health Inspectorate	Certification not possible if bulbs grown on land infested with potato wart disease or *Globodera* spp.
Candidate material	Must be of 'tradeable quality' ie. graded by scheme (Class I, II, Algemeen, Standard)	Any suitable material (vigour, quality, trueness to type and absence of pest and disease symptoms) including material classified the previous year.	Any healthy material of at least 'Elite' grade. Micropropagated material permitted with certificate	Any commercial variety of *Narcissus* will be accepted
Hot water treatment before planting	Not required for stock destined for bulb production	Not required for stock destined for bulb production	Required - before planting	No information
Location of production	Under glass or open ground	Candidate material grown in aphid-proof house	Open ground	Open ground
Soil sampling	No information (presumed undertaken to confirm absence of nematodes of concern)	No information	Sampling not undertaken unless required by importer. Soil sampling for nematodes can be undertaken at request of importer.	No information
Pest and disease control	No information	Management of pests in accordance with 'good horticultural practice'	An effective program of pest control needs to be in place. Stock showing signs of bulb scale mite and/or large/small bulb fly exceeding published tolerances (Table 5) cannot be certified until they have received hot water treatment and completed two consecutive seasons free of symptoms. Adjacent stocks may be treated in similar way.	No information

Action	Netherlands – BKD#	Netherlands - NAKB#	UK (England and Wales) - PHPS Scheme, Elite grade#	UK (Scotland) 'A' grade#
Isolation	No information	No information	At least 2 m from stock not entered for certification	At least 1 m from other stocks of narcissus and a 'reasonable' distance from any other stocks that are obviously infested
Rotation	Potatoes not allowed in rotation	No information	Required – site must not have been used for bulb production for previous four years	No information
Roguing	Permitted - can be undertaken to improve grade obtained by inspection. Not permitted in the case of infestation with nematode *D. dipsaci*	Permitted –grower should remove any unhealthy plants.	Permitted – Records must be kept and reason for roguing recorded. Stocks will not be certified where adequate records are not kept.	No information
Inspection	Yes - for *Tulip*, *Gladiolus*, *Iris* and *Crocus vernus* – lots must be greenhouse tested and/or ELISA tested; for other bulbs such tests not needed. All bulbs subject to visual inspection 2-3 times during growth	Yes - visual inspection undertaken for pests and diseases at least twice during growing season. Before harvest, test by ELISA undertaken for Freesia mosaic virus and bean yellow mosaic virus	Yes - two visual inspections during growing season before bulb lifting, one at green bud and one at flowering. Dry bulb inspection required when bulbs are marketed and/or when they are moved to different management control.	Yes - visual inspection undertaken once during growing season
Identity preservation	Yes - lot number travels with consignment of bulbs	Certificate provided on a 'per lot' basis	Each variety must be clearly labelled or easily identified from growing plan. A certificate is issued by PHPS	No information
Soil contamination of bulbs	No information	No information	Substantial freedom	No information

\# - Information on schemes obtained from:

- BKD information supplied by Netherlands Plant Protection Service on 15 Dec. 1999
- NAKB information supplied by J. Roman, Netherlands Plant Protection Service on 6 March 2000
- PHPS Scheme, UK MAFF leaflet PHPS 41 (revised 9/99) obtained via Internet on 13 June 2000, http://www.maff.gov.uk/aboutmaf/regulat/phealth/phps41.pdf
- Scottish Scheme, No detailed information available from Scottish Office Website (13 June 2000), information presented here based on: Holland, S. (1992). A review of post entry quarantine procedures for bulbs. Technical Report Series (Vic. Dept. of Food and Agriculture) no. 206.

Table 5: The extent to which pests of quarantine concern to Australia are controlled or regulated by the bulb certification standards currently in use in the Netherlands and UK.

Species of bulb	Scheme#/ standard/ country	Pest	Organisms controlled by scheme – with tolerance level stated by scheme	Organisms identified by pest risk assessment as 'of quarantine concern' to Australia which have not been addressed or may have been inadequately addressed by scheme
Crocus spp.	BKD (Algemeen) Netherlands	Insects and mites	None specified	Insect and mite pests listed in Table 16

Species of bulb	Scheme#/ standard/ country	Pest	Organisms controlled by scheme – with tolerance level stated by scheme	Organisms identified by pest risk assessment as 'of quarantine concern' to Australia which have not been addressed or may have been inadequately addressed by scheme
		Nematodes	*Aphelenchoides subtenuis* 0%, *Ditylenchus destructor*, *Ditylenchus dipsaci* 0%	*Globodera* spp., *Meloidogyne chitwoodi*, *Longidorus* spp., *Xiphinema* spp.
		Fungi	*Fusarium* spp. 0.5%, *Penicillium* spp. 0.5%, *Fusarium oxysporum* 0.5%, *Uromyces croci* 0%, *Botrytis croci* 0.5%	*Fusarium oxysporum*, ?*Botrytis croci*
		Virus	Visible virus 1%, *Tobacco rattle virus* 1% - total virus 1.5%	None identified
Gladiolus spp.	BKD (Class 1) Netherlands	Insects and mites	None specified	Insects and mites listed in Table 18
		Nematodes	None specified	Nematodes listed in Table 18
		Fungi	*Urocystis gladiolicola* 0%, *Curvularia trifolii* 0.02%, *Stromatinia gladioli* 0.02%, *Fusarium oxysporum* 0% (for *G. nanus* and *G. colvilii* 0.1%), *Septoria gladioli* 0.2%	*Sclerotium wakkeri*
		Bacteria	None specified	*Corynebacterium fascians*
		Phytoplasma	0%	
		Virus*	*Tobacco rattle virus* 0.25%, *Gladiolus ringspot virus* 0.25%, *Cucumber mosaic virus* 0.25%, cork spot (unidentified) 0.25%. Total of all above 0.5%	*Strawberry latent ringspot virus*, *Tomato black ring nepovirus*
Hippeastrum spp.	BKD (Algemeen) Netherlands	Insects and mites	*Chorisococcus lounsburyi* 0.5%, *Opogona sacchari* 0%, *Spodoptera exigua* 0%, Tetranychidae 1%, *Steneotarsonemus laticeps* 0%, Thysanoptera 0.5%.	*Agriotes* spp., *Agrotis segetum, Aphis fabae, Eumerus* spp., *Frankliniella fusca, F. occidentalis, Hepialus* spp., *Liriomyza trifolii, Merodon* spp., *Planacoccus avenae, Spodoptera littoralis*
		Nematodes	*Pratylenchus* spp.	Nematodes listed in Table 19
		Fungi	*Fusarium* spp. 1%	*Armillaria mellea, Cerospora amaryllidis*
		Virus	*Hippeastrum mosaic virus* 0.5%, *Cucumber mosaic virus* 0.5%, *Tomato spotted wilt virus* 0%	*Nerine latent carlavirus*, ?*Hippeastrum mosaic virus*
Hyacinthus spp.	BKD (Algemeen) Netherlands	Insects and mites	None specified	Insects and mites listed in Table 20
		Nematodes	*Ditylenchus destructor & Ditylenchus dipsaci* 0%	*Globodera* spp., *Meloidogyne chitwoodi, Longidorus* spp., *Xiphinema* spp.
		Fungi	None specified	*Botrytis hyacinthi, Embellisia hyacinthi, Uromyces muscari*
		Bacteria	*Xanthomonas hyacinthi* 0%	*Corynebacterium fascians*
		Phytoplasma	0%	
Iris spp.	BKD (Class 1) Netherlands	Insects and mites	None specified	Insects and mites listed in Table 21
		Nematodes	None specified	Nematodes and flatworms listed in Table 21
		Fungi	None specified	Fungi listed in Table 21
		Bacteria	None specified	Bacteria listed in Table 21
		Virus*	*Iris severe mosaic virus* 0.25%, *Narcissus latent virus* 0.25%	*Iris yellow spot tospovirus*

Species of bulb	Scheme#/ standard/ country	Pest	Organisms controlled by scheme – with tolerance level stated by scheme	Organisms identified by pest risk assessment as 'of quarantine concern' to Australia which have not been addressed or may have been inadequately addressed by scheme
Lilium spp.	BKD (Algemeen) Netherlands	Insects and mites	None specified	Insects and mites listed in Table 22
		Nematodes	*Aphelenchoides fragariae, A.. ritzemabosi* 0%, *Rhizoglyphus* spp. 0%, *Pratylenchus penetrans* 0%, *Rotylenchus robustus* 0%	Nematodes listed in Table 22
		Fungi	*Fusarium oxysporum, Cylindrocarpon destructans, Nectria radicicola, Rhizoctonia tuliparum, Pythium* spp., *Sclerotium wakkeri* - in case of infection, reinspection of dry bulbs – limits not specified	*Botrytis hyacinthi,^ Mycosphaerella cinxia, M. martagonas, Phyllosticta liliicola*, ?*Sclerotium wakkeri*, *Septocylindrium* spp., *Uromyces aecidiiformis, U. holwayi.*
		Bacteria	*Corynebacterium fascians*	
		Virus	*Cucumber mosaic virus* 0.5%, *Arabis mosaic virus* 1%, *Tulip breaking virus* 0.5% (except *L. longiflorum* and *L. L.A.* hybrids - 5%), *Tobacco rattle virus* 1%	*Iris yellow spot tospovirus, Lily mottle potyvirus, Lily X potexvirus, Rembrandt tulip breaking potyvirus, Strawberry latent ringspot virus*
Narcissus spp.	BKD (Algemeen) Netherlands	Insects and mites	*Meredon (Lampetia) equestris* 0%, *Steneotarsonemus laticeps* 0%	Additional insects and mites listed in Table 23
		Nematodes	*Aphelenchoides subtenuis* 0%, *Ditylenchus dipsaci* 0%	*Globodera* spp., *Meloidogyne chitwoodi, Longidorus* spp., *Xiphinema* spp.
		Fungi	*Stagonosporopsis curtisii* 10%, *Fusarium oxysporum* 0.5%	Fungi listed in Table 23
		Virus	*Tobacco rattle virus* 1%, severe virus symptoms 1%	Viruses listed in Table 23
Tulipa spp.	BKD (Class 1) Netherlands	Insects and mites	*Aceria tulipae*	Additional insects and mites listed in Table 24
		Nematodes	*Ditylenchus destructor, Ditylenchus dipsaci* 0%	*Globodera* spp., *Meloidogyne chitwoodi, Longidorus* spp., *Xiphinema* spp.
		Fungi	None specified	All fungi listed in Table 24
		Bacteria	None specified	*Curtobacterium flaccumfaciens* pv. *oortii*
		Virus*	*Tulip breaking virus* 0.1%, *Tulip severe mosaic virus* 0.15%, *Cucumber mosaic virus* 0.1%, *Tobacco rattle virus* 0.1%, *Lily symptomless virus* 0.15%, *Tulip virus X* 0.1% - total for all above 0.2%, *Tobacco necrosis virus* 0.15%	*Lily mottle potyvirus, Rembrandt tulip breaking potyvirus, Tomato black ring nepovirus, Tulip band-breaking potyvirus, Tulip severe mosaic closterovirus, Tulip top breaking potyvirus, Tulip X potexvirus*
Freesia spp.	NAKB (Class EE) Netherlands	Insects and mites	Species other than aphids not specified - visual freedom	Insects and mites listed in Table 17
		Nematodes	Not specified	*Ditylenchus* spp., *Globodera* spp., *Meloidogyne chitwoodi*, *Longidorus* spp., *Xiphinema* spp.
		Fungi	*Fusarium* spp. 0%, others eg. *Botrytis* spp. *Erwinia carotovora* - visual freedom	*Embellisia hyacinthi*

Species of bulb	Scheme#/ standard/ country	Pest	Organisms controlled by scheme – with tolerance level stated by scheme	Organisms identified by pest risk assessment as 'of quarantine concern' to Australia which have not been addressed or may have been inadequately addressed by scheme
		Virus*	Visual freedom from leaf necrosis when growing. In bulbs - *Freesia mosaic virus* 0%, *Bean yellow mosaic virus* 0%	*Freesia leaf necrosis varicosavirus*
Iris spp.	UK PHPS - Elite stock	Insects and mites	Bulb aphid 0%, *Eumerus* spp. 2%, *Merodon* spp. 0%, *Steneotarsonemus laticeps* 4.5%	Insects and mites listed in Table 21
		Flatworm and nematodes	*Ditylenchus destructor* 0%, *Globodera* spp. 0%	*Arthurdendyus triangulatus*, *Ditylenchus dipsaci*, *Longidorus* spp., *Xiphinema* spp.
		Fungi	Potato wart disease 0%, basal rot/neck rot 2% (not more than 1.5% of either disease), penicillium rot 0.5%, ink disease 0.5%, smoulder 2%. Bulbs with 3 or more large sclerotia 4.5%	Fungi listed in Table 21
		Virus	Severe virus 2%	Viruses listed in Table 21
Narcissus spp.	UK PHPS - Elite stock	Insects and mites	Bulb aphid 0%, *Eumerus* spp. 2%, *Merodon* spp. 0%, *Steneotarsonemus laticeps* 4.5%	Insects and mites listed in Table 23
		Flatworm and nematodes	*Ditylenchus dispsaci* 0%, *Globodera* spp. 0%	*Arthurdendyus triangulatus*, *Ditylenchus dipsaci*, *Longidorus* spp., *Xiphinema* spp.
		Fungi	Potato wart disease 0%, basal rot/neck rot 2% (not more than 1.5% of either disease), penicillium rot 0.5%, smoulder 2%. Bulbs with 3 or more large sclerotia 4.5%	Fungi listed in Table 23
		Virus	Severe virus 2%	Viruses listed in Table 23
Narcissus spp.	UK - Scottish Narcissus Certification Scheme, 'A' grade	Insects and mites	Reasonable freedom	Insects and mites listed in Table 23
		Flatworm and nematodes	Free from visible symptoms of *Ditylenchus dipsaci*	*Arthurdendyus triangulatus*, *Ditylenchus dipsaci*, *Longidorus* spp., *Xiphinema* spp.
		Fungi	Reasonable freedom	Fungi listed in Table 23
		Virus	97% freedom from obvious viral symptoms	Viruses listed in Table 23

* - test to determine presence of viruses undertaken in whole or partly by ELISA.
? - before name of pest or disease – mentioned in certification scheme, tolerance may be too lax for quarantine purposes.

- Information on schemes obtained from:

- BKD information supplied from Netherlands Plant Protection Service on 15 Dec 1999
- NAKB information supplied from J. Roman, Netherlands Plant Protection Service on 6 March 2000
- PHPS Scheme, UK MAFF leaflet PHPS 41 (revised 9/99) obtained via Internet on 13 June 2000, http://www.maff.gov.uk/aboutmaf/regulat/phealth/phps41.pdf
- Scottish Scheme, No detailed information available from Scottish office Website (13 June 2000), information presented here based on: Holland, S. (1992). A review of post entry quarantine procedures for bulbs. Technical Report series (Vic. Dept. of Food and Agriculture) no. 206.

4. Selection of resistant varieties

To control fungi (possibly also other pathogenic organisms)

Bulb varieties are known to vary in terms of their susceptibility to a number of fungal diseases; some can be highly susceptible to a particular disease while others are resistant. Examples of resistant varieties include commercial narcissus varieties such as King Alfred, which is resistant to *F. oxysporum* infection. In contrast, narcissus varieties in the Tazetta group, such as Grand Soleil d'Or, are very susceptible to infection. Further, *F. oxysporum* is more serious in yellow iris varieties than in blue varieties (Moore, 1979).

Advantages

- Management of risk undertaken offshore
- Possibly no need for post-entry quarantine for specific disease

Disadvantages

- Few resistant varieties are commercially available, and many commercially desirable varieties may be susceptible
- Breakdown in resistance is possible
- Resistance may not be total
- Resistance likely to be specific; a variety may be resistant to one disease but susceptible to another
- Resistant varieties may mask disease symptoms, making detection harder
- Spores may still be present on the bulb

5. Cleaning of bulbs before export

To control weeds, arthropods, flatworms and nematodes and fungi.

Imported bulbs are currently required to be free of soil (a restricted import). Freedom from soil greatly reduces the risk of presence of weed seeds and other unwanted propagules (eg. propagable root fragments), and incidence of some arthropods, flatworms, nematodes and fungi. Cleaning also reduces the risks from 'hitch-hikers' and incidental pests (not covered by this IRA) being inadvertently transported, including organisms such as slugs and snails. Cleaning is unlikely to reduce incidence of phytoplasmas and viruses.

Clean bulbs free of soil and other unwanted material are both easier to inspect and to disinfest by fumigation or hot water treatment. For example, organisms that are normally susceptible to fumigation but present inside clods of soil, could escape sufficient exposure to the fumigant.

N.B. Some bulbs are more difficult to clean than others, eg. *Narcissus* species have long necks in which unwanted material may lodge.

Advantages

- Risk managed offshore

Disadvantages

- Will need regular inspection to ensure

- A simple measure that significantly reduces risk of importation of a number of quarantine pests

compliance

6. Process of storage and transportation

To control weeds, arthropods, flatworms, nematodes and other invertebrates.

Once bulbs are harvested, measures need to be put in place to ensure that they do not become infested in storage. This may include netting of storage areas to keep out flying insects, and keeping storage areas clean and free of debris, etc. from previous crops which may harbour pests such as mites.

The process of storage and transportation is likely to cause mortality of some weed propagules and pests through a combination of time, desiccation, physical disturbance and low temperatures. However, poor transportation conditions may allow some organisms (eg. fungi and some arthropods) to multiply and spread within a consignment.

Most bulb genera are transported in containers under ambient conditions. Irises may be transported at ambient temperatures or warm, *Lilium* bulbs are shipped frozen (a few degrees below freezing) or at ambient temperatures. Tulips are transported cold (to 2°C) or at ambient temperatures.

Cold storage/transportation could be used to kill many pests, especially insects and mites. Exposure to temperatures of -20ºC will kill arthropods rapidly, but may not be effective against many nematodes. Temperatures just either side of zero may only kill arthropods slowly or not at all. Freezing and successfully thawing commercial quantities of bulbs to and from insecticidal/miticidal temperatures may prove difficult and probably requires considerable research to develop a practical protocol.

Advantages

- An inherent part of the process of exporting bulbs to Australia
- Monitoring of transportation conditions now easy with electronic logging devices
- Some conditions (eg. sub-zero temperatures) may have significant effect on pests, esp. insects and mites

Disadvantages

- Has potential to control arthropods, but control of nematodes, fungi and bacteria may not be possible by this method
- Pests and some diseases such as fungi can thrive and spread on bulbs in transit if conditions allow.

<u>Measures undertaken on arrival</u>

7. Inspection on arrival

To control weeds, arthropods, flatworms and nematodes, other invertebrates, fungi, bacteria, phytoplasmas and viruses.

Inspection upon arrival can reduce risks in a number of ways. It can confirm the identity of the consignment and ensure that it is visibly free of soil, other unwanted material and symptoms of pests.

The ability to detect pests by visual inspection will vary, depending on the nature and habits of the organisms concerned. Weed propagules and most arthropods are likely to be easier to detect visually than nematodes. Disease organisms may or may not provide visual symptoms. Some fungi and bacteria may produce colour changes, rots, lesions and galls in dormant bulbs, which are easy to see but difficult to identify. Some diseases do not provide obvious symptoms and a general indication of bulb health may be the only clue provided. Visual inspection of bulbs is not a reliable way to detect contamination with fungal spores, even if the fungus itself produces obvious symptoms when growing or on growing plants.

Some viruses, potentially important in other crops (eg. *Raspberry ringspot virus*), are symptomless in bulbs. Such infestations would be impossible to detect visually.

The number of sampling units to collect for inspection will vary according to the degree of tolerance deemed acceptable for the presence of a particular organism. For example, inspection of 600 units (in this case bulbs) taken at random from a consignment will give a 95% certainty that a condition that affects 0.5% of bulbs will be detected (providing of course it exhibits visual symptoms). Larger sample sizes would be needed if a lower tolerance level is required.

Advantages

- Ensures compliance with importation protocols
- Will detect presence of many organisms, esp. arthropods and weed propagules

Disadvantages

- Visual inspection will not detect presence of all pests of quarantine concern (many disease-causing organisms do not provide visual symptoms when present in a dormant bulb)

8. Fumigation on arrival

To control arthropods, flatworms and nematodes, other invertebrates, fungi, vectors of phytoplasmas and viruses.

The quarantine risks associated with arthropod pests on ornamental bulbs are currently managed by fumigation with methyl bromide as per AQIS treatment T9064 (Import Conditions Database (ICON) at http://www.aqis.gov.au) (Table 6). A higher dose is used on bulbs (*Hippeastrum, Hyacinthus, Iris, Narcissus*) that are hosts of the narcissus fly (*Meredon* spp.) imported from a country where this pest is known to occur. Resulting from this IRA, it is suggested that two more genera (*Lilium* and *Tulipa*) should be added to the list of narcissus bulb fly hosts. While this pest is not of economic importance on these additional genera, there is sufficient evidence that, from a quarantine perspective, these species can be attacked by this pest (see data sheets in Appendix 2).

Available data on the efficacy of methyl bromide was reviewed, and is summarised in Table 6. Care must be taken to compare doses used by AQIS with those reported elsewhere that are undertaken at atmospheric pressure. Fumigations done under vacuum in some way generally require less fumigant. This data shows that at least for some mite species, eg. *Rhizoglyphus* spp. and *Steneotarsonemus laticeps*, current dosage schedules are likely to be inadequate. Also the current dosage recommendations for *Meredon* and *Eumerus* spp. are marginal.

Without comprehensive and detailed testing of a variety of life stages and strains of a species of interest, it is impossible to say what combination of dose and duration of fumigation is actually effective. Data available is limited. For example, for *Meredon* spp., all the data available applies to *M. equestris*. There is no data for the other *Meredon* species, which may be more or less susceptible to methyl bromide. Given that the dose currently recommended is marginal, any slight change in susceptibility may make a considerable difference to treatment efficacy. Eggs of many insects and especially mites are known to be more tolerant of fumigants than other life stages (Bond, 1984). Eggs of mites that attack bulbs are very likely to survive fumigations in the 100 g m^{-3} h range. Indeed EPPO, in its phytosanitary procedure PM 3/6(3), states that 100% kill of a range of pests cannot be guaranteed with such a dose. Repetition of such fumigations after 14 days has been recommended to kill mites by allowing eggs to hatch into larvae/nymphs that are more susceptible to the gas (Bond, 1984). The efficacy of methyl bromide as a fumigant generally increases with temperature. Care also needs to be taken to ensure that all the fumigated material is brought up to temperature (minimum 10°C). Failure to do so may limit the efficacy of the treatment, and if sufficiently cool (< 3.6°C), methyl bromide may condense on fumigated material causing surface burning. Methyl bromide at such temperatures will be hard to air-off, resulting in a significant Occupational Health and Safety issue.

If the objective of fumigation with methyl bromide is to disinfest bulbs of all quarantine arthropod pests, then doses currently used appear to be inadequate. In particular, current rates appear too low for mites of quarantine concern to Australia and are marginal for *Merodon* spp. For current rates to be effective against mites, bulbs would need to be fumigated twice with a gap of 14 days between treatments.

For a single fumigation to control *Merodon* and/or mites of the genus *Rhizoglyphus* and *Steneotarsonemus* (all bulb genera except *Crocus*) a <u>minimum</u> CT product (concentration X time) of at least 275 is needed (eg. 8.5 h at 32 g/m^3) (see Table 6). A <u>minimum</u> CT product of 128 (4 h at 32 g/m^3) is suggested for *Crocus* spp. These CT products assume that bulb core temperature is 21°C. At temperatures between 16-20°C, a concentration of 40 g/m^3 is required, increasing to 48 g/m^3 for temperatures from 10-15°C. Fumigation duration remains either 4 or 8.5 h. Fumigation of bulbs with a core temperature of below 10°C will not qualify as a quarantine treatment.

Fumigation at rates used to control insects and mites (above) are unlikely to control

nematodes of quarantine concern (Table 6). They will also not control snails species for which data exists, especially juvenile stages in diapause (Table 6). Alternative measures are required to control these pests. No data appears to be available on the efficacy of methyl bromide against slugs and New Zealand flatworm.

The current fumigation rates and those mentioned above differ from the label and may require permission for use. This may be provided either in the form of an ‘off-label’ permit from the National Registration Authority in Australia and/or approval from the state/territory authority in Australia responsible for control of pesticide use.

Concern has been expressed that fumigant dosages recommended here may be phytotoxic to bulbs. The rates recommended here are based on an assessment of what is required to kill target quarantine pests. From a phytosanitary perspective, it can be argued that it is unacceptable to fit the treatment to the commodity and not to the target pest. Some literature exists on the tolerance of bulbs to methyl bromide. Bulb genera vary in their response to the fumigant. Andison and Cram (1951) showed that *Narcissus* bulbs tolerated 58 g m^{-3} for 12 hours at 15ºC, being a CT product of 696 g m^{-3} h. Powell (1977) demonstrated that a CT product of 250 g m^{-3} h was non-toxic to *Narcissus* bulbs. Fumigation of *Lilium longiflorum* bulbs using methyl bromide at CT >120 g m^{-3} h, when compared with untreated controls, caused a reduction in number of buds and flowers, height of flowering stalks, and a reduction in weight increase of bulbs and stem bulblets (Breakey, 1941).

If carefully conducted fumigations at the amended rates are found to cause significant phytotoxicity to bulbs, then only one conclusion can be reached – that such treatments are unsuitable for this product and an alternative measure needs to be sought to meet phytosanitary requirements. One alternative to fumigation with methyl bromide is hot water treatment (see below).

After 31 December 2004, use of methyl bromide in Australia and other developed countries will be restricted to government-mandated emergency, quarantine and pre-shipment uses only. It is likely that such use will be increasingly restricted to situations where it is internationally accepted that there is no possible alternative. In addition, after this time it may become uneconomic for local suppliers to continue to supply and/or maintain registration of methyl bromide as a pesticide in Australia. Continuation of use of methyl bromide may be hard to justify in the case of bulbs, given that an alternative treatment (hot water) is already permitted by AQIS and is in widespread use overseas by major bulb producing countries.

Table 6: Quarantine fumigation schedules and CT products required to kill a selection of pests of bulbs.

Target pest	Reference	CT product (g m^{-3} h), dose & duration of fumigation, temperature*	Notes
All pests			

Target pest	Reference	CT product ($g\ m^{-3}\ h$), dose & duration of fumigation, temperature*	Notes
On bulbs not at risk from attack by *Meredon* spp.	AQIS T 9064	**96 $g\ m^{-3}$ h** - 3 h at 32 $g\ m^{-3}$ (21-25°C), also 3 h at 24 $g\ m^{-3}$ (26-30°C), 3 h at 40 $g\ m^{-3}$ (16-20°C), 3 h at 48 $g\ m^{-3}$ (11-15°C)	Current AQIS treatment, under atmospheric pressure
On bulbs at risk from attack by *Meredon* spp.	AQIS T 9064	**192 $g\ m^{-3}$ h**-6 h at 32 $g\ m^{-3}$, 4 h at 48 $g\ m^{-3}$, 3 h at 64 $g\ m^{-3}$ 2 h at 96 $g\ m^{-3}$ (21-25°C) also 4 h at 48 $g\ m^{-3}$, 3 h at 64 $g\ m^{-3}$ (at 16-20°C)	Current AQIS treatment, under atmospheric pressure
Arthropods			
Aphids	EPPO phytosanitary procedure PM 3/6(3)	**96 $g\ m^{-3}$ h,** 48 $g\ m^{-3}$ for 2 h at 20ºC	Under atmospheric pressure. Procedure notes than 100% kill cannot always be guaranteed
Aphids	FAO standard – Schedule N (Bond, 1984)	**120 $g\ m^{-3}$ h**, 48 g/m³ for 2.5 h, 15 to 21°C **98 $g\ m^{-3}$ h**, 48 g/m³ for 2 h, 21 to 27°C **80 $g\ m^{-3}$ h,** 40 g/m³ for 2 h >27°C	Under atmospheric pressure
Aphids	FAO standard – Schedule N (Bond, 1984)	**98 $g\ m^{-3}$ h**, 48 g/m³ for 2 h, 15 to 21°C **72 $g\ m^{-3}$ h**, 48 g/m for 1.5 h, 21 to 27°C **60 $g\ m^{-3}$ h**, 40 g/m³ for 1.5 h, >27°C	Under preliminary vacuum
Eumerus spp.	EPPO phytosanitary procedure PM 3/3(2)	**255 $g\ m^{-3}$ h,** 85 $g\ m^{-3}$ for 3h at 10-15ºC **215 $g\ m^{-3}$ h** 85 $g\ m^{-3}$ for 2.5 h, >15ºC	Under atmospheric pressure
Eumerus spp.	FAO standard – Schedule N (Bond, 1984)	**240 $g\ m^{-3}$ h**, 48 g/m³ for 5 h , 15 to 20°C **192 $g\ m^{-3}$ h,** 48 g/m³ for 4 h, >21°C	Under atmospheric pressure, fumigation not recommended below 15°C
Eumerus spp.	FAO standard – Schedule N (Bond, 1984)	**144 $g\ m^{-3}$ h,** 48 g/m³ for 3 h, 15 to 20°C **96 $g\ m^{-3}$ h,** 48 g/m³ for 2.5 h**,** >21°C	Under preliminary vacuum
Meredon equestris	Andison and Cram, 1952	**192 $g\ m^{-3}$ h,** 4 h at 48 $g\ m^{-3}$ at 21ºC **216 $g\ m^{-3}$ h**, 4.5 h at 48 $g\ m^{-3}$ at 15ºC	Under atmospheric pressure, minimum effective dose
Meredon equestris	EPPO Phytosanitary procedure PM 3/3(2)	**255 $g\ m^{-3}$ h,** 85 $g\ m^{-3}$ for 3 h, 10-15ºC **215 $g\ m^{-3}$ h,** 85 $g\ m^{-3}$ for 2.5 h**,** >15ºC	Under atmospheric pressure
Meredon equestris	EPPO Phytosanitary standards PM3/11(2)	**125 $g\ m^{-3}$ h,** 2.5 h at 50 $g\ m^{-3}$ at 16-20ºC **80 $g\ m^{-3}$ h,** 2 h at 40 $g\ m^{-3}$ at 21-25ºC	Under vacuum at 15kPa
Meredon equestris	FAO standard – Schedule N (Bond, 1984)	**240 $g\ m^{-3}$ h**, 48 g/m³ for 5 h, 15 to 20°C **192 $g\ m^{-3}$ h,** 48 g/m³ for 4 h, >21°C	Under atmospheric pressure, fumigation not recommended below 15°C
Meredon equestris	FAO standard – Schedule N (Bond, 1984)	**144 $g\ m^{-3}$ h,** 48 g/m³ for 3 h, 15 to 20°C **96 $g\ m^{-3}$ h,** 48 g/m³ for 2.5 h**,** >21°C	Under preliminary vacuum

Target pest	Reference	CT product (g m^{-3} h), dose & duration of fumigation, temperature*	Notes
Opogona sacchari	EPPO Phytosanitary procedure PM 3/14(2)	**100 g m^{-3} h,** 50g m^{-3} for 2 h at >15ºC	Undertaken under vacuum (88kPa) gradually returned to atmospheric pressure by end of fumigation
Phenacoccus spp.	EPPO phytosanitary procedure PM 3/6(3)	**96 g m^{-3} h,** 48g m^{-3} for 2 h at 20ºC	Under atmospheric pressure . Procedure notes than 100% kill cannot always be guaranteed
Rhizoglyphus spp.	Powell, 1977	**215 g m^{-3} h** at 15-20ºC	Under atmospheric pressure, some survivors seen on *Narcissus* bulbs following fumigations at up to this level
Rhizoglyphus spp.	EPPO phytosanitary procedure PM 3/6(3)	**96 g m^{-3} h,** 48g m^{-3} for 2 h at 20ºC	Under atmospheric pressure . Procedure notes than 100% kill cannot always be guaranteed
Rhizoglyphus spp.	FAO standard – Schedule N (Bond, 1984)	**120 g m^{-3} h,** 48 g/m³ for 2.5 h, 15 to 21°C **98 g m^{-3} h**, 48 g/m³ for 2 h, 21 to 27°C **80 g m^{-3} h,** 40 g/m³ for 2 h, >27°C	Under atmospheric pressure, 'treatment should be repeated after 10 to 14 days in order to kill eggs'
Rhizoglyphus spp.	FAO standard – Schedule N (Bond, 1984)	**98 g m^{-3} h**, 48 g/m³ for 2 h, 15 to 21°C **72 g m^{-3} h,** 48 g/m for 1.5 h, 21 to 27°C **60g m^{-3} h**, 40 g/m³ for 1.5 h, >27°C	Under preliminary vacuum, 'treatment should be repeated after 10 to 14 days in order to kill eggs'
Steneotarsonemus laticeps	Murdoch, 1975	**250 g m^{-3} h**	Under atmospheric pressure
Steneotarsonemus laticeps	Powell, 1977	**250 g m^{-3} h** 50 g m^{-3} for 5 h, 15-20ºC	Dose gave 'satisfactory' control of mites on bulbs. Dose probably inadequate at temperatures lower than 15ºC. However mites were noted again when bulbs were lifted after another growing season following fumigation at **200-340 g m^{-3} h** – indicating possible survival
Steneotarsonemus laticeps	EPPO Phytosanitary procedure PM 3/3(2)	**255 g m^{-3} h,** 85 g m^{-3} for 3 h, 10-15ºC **215 g m^{-3} h,** 85 g m^{-3} for 2.5 h**,** >15ºC	Under atmospheric pressure
Steneotarsonemus laticeps	FAO standard – Schedule N (Bond, 1984)	**120 g m^{-3} h,** 48 g/m³ for 2.5 h, 15 to 21°C **98 g m^{-3} h**, 48 g/m³ for 2 h, 21 to 27°C **80 g m^{-3} h,** 40 g/m³ for 2 h, >27°C	Under atmospheric pressure, 'treatment should be repeated after 10 to 14 days in order to kill eggs'
Steneotarsonemus laticeps	FAO standard – Schedule N (Bond, 1984)	**98 g m^{-3} h**, 48 g/m³ for 2 h, 15 to 21°C **72 g m^{-3} h,** 48 g/m for 1.5 h, 21 to 27°C **60g m^{-3} h**, 40 g/m³ for 1.5 h, >27°C	Under preliminary vacuum, 'treatment should be repeated after 10 to 14 days in order to kill eggs'

Target pest	Reference	CT product (g m^{-3} h), dose & duration of fumigation, temperature*	Notes
Taeniothrips simplex	EPPO phytosanitary procedure PM 3/6(3)	**96 g m^{-3} h** - 48g m^{-3} for 2 h at 20ºC	Under atmospheric pressure. Procedure notes than 100% kill cannot always be guaranteed
Taeniothrips simplex and *Liothrips vaneeckei*	FAO standard – Schedule N (Bond, 1984)	**144 g m^{-3} h,** 48 g/m³ for 3 h, 21 to 27°C **96 g m^{-3} h,** 48 g/m³ for 2 h, >27°C	Under atmospheric pressure. Temperature is an important factor in obtaining complete control of all stages, including eggs. It is advisable to fumigate at or above 20°C
Taeniothrips simplex and *Liothrips vaneeckei*	FAO standard – Schedule N (Bond, 1984)	**96 g m^{-3} h,** 48 g/m³ for 2 h, 21 to 27°C **80 g m^{-3} h,** 40 g/m³ for 2 h, >27°C	Under preliminary vacuum, temperature is an important factor in obtaining complete control of all stages, including eggs. It is advisable to fumigate at or above 20°C
Nematodes			
Globodera rostochiensis	Bond, 1984	**5888 g m^{-3} h** 368 g/m^3 for 16 h	Under atmospheric pressure
Ditylenchus dipsaci (data for fumigation of seeds)	Caubel *et al.*, 1985	**1280 g m^{-3} h** 80 g/m^3 for 16 h	Under atmospheric pressure
Ditylenchus dipsaci (data for fumigation of seeds)	EPPO Phytosanitary procedure PM 3/2(2)	**700 – 1300 g m^{-3} h** eg. 40 g m^{-3} for 24 h depending on temperatur**e** (10- 30°C) and seed moisture content.	Under atmospheric pressure
Snails#			
Cernuella virgata	Cassells *et al.*, 1994	**720 g m^{-3} h,** 30 g/m^3 for 24 h	Under atmospheric pressure
Cochlicella acuta	Cassells *et al.*, 1994	**720 g m^{-3} h,** 30 g/m^3 for 24 h	Under atmospheric pressure
Pomacea canaliculata	Sadoshima *et al.*, 1993	**8100 g m^{-3} h,** 300 g/m^3 for 27 h	Under atmospheric pressure

* Temperatures quoted are core temperatures of consignment
# species shown are those for which data is available, these species may or may not be associated with bulbs

Advantages

- Appears to have been effective at preventing entry of a wide range of arthropod pests.
- Relatively easy to apply to large quantities of bulbs (eg. full container loads).

Disadvantages

- Bulbs that enter in a frozen state must be brought up to temperature before fumigation. This may break the dormancy of the bulbs, meaning that the bulbs must be planted out sooner than would be the case if the dormancy had been maintained.
- Bulbs may be harmed by the fumigant
- The long-term availability of methyl bromide is uncertain. Its use is likely to be restricted to quarantine/pre-shipment, and only when there is no alternative. Hot water treatment is currently permitted by AQIS as an alternative.
- High standard of competency required to ensure fumigation is properly carried out

- Current fumigation schedule is not effective against all arthropod pests.
- Fumigation is not a practical measure to control nematodes or snails infesting bulbs

9. Hot water treatment (and other forms of heating/radiation treatment)

To control arthropods, flatworms and nematodes, other invertebrates, fungi, bacteria.

Immersion of bulbs into hot water can control arthropod and nematode pests as well as fungal and bacterial diseases. Some treatment regimes reported in the literature are summarised in Table 7. Phytoplasmas and viruses may not be directly affected by this treatment, although insect and nematode vectors will be controlled.

AQIS treatment T9064 (AQIS Import Conditions Database, ICON) permits a hot water treatment (immersion of bulbs into hot water so that the core temperature reaches and maintains a temperature of 44°C for one hour) as an alternative to methyl bromide fumigation for bulbs that are hosts of narcissus bulb fly and come from countries where this pest is present.

The bulb growing industry urgently needs to develop an alternative to disinfestation with methyl bromide, such as hot water treatment.

Hot water treatment is widely used by bulb industries in both the Netherlands and UK to control pests such as *Ditylenchus* nematodes, *Merodon* spp. and mites. References for the use of this method include Anon (1973), Rees and Turquand (1967) and Vigodsky (1970). The European and Mediterranean Plant Protection Organisation (EPPO) in its certification schemes for bulbs gives detailed protocols for the use of hot water treatment for the control of arthropods and nematodes. Extracts from these schemes pertaining to use of hot water are given in Table 8.

Hot water treatment will provide better control of nematodes (and some fungi and bacteria) than current fumigation protocols (see above). It will also help to clean bulbs and possibly dislodge some weed propagules. No data appears to be available on the efficacy of hot water treatment against slugs, snails and New Zealand flatworm.

From the information available, a hot water treatment that maintains bulb core temperatures at 43.5 to 47°C for 3 to 4 hours (as per EPPO recommendations – Table 8) will control insects, mites and nematodes of concern, as well as fungi and bacteria (Table 7). Where no EPPO recommendations are available, then a 'dose' of 44°C for 3 hours is recommended. Bulbs need to be pre-warmed before treatment (Table 8), and following treatment bulbs need to be cooled rapidly to minimise damage. Further work is needed to optimise the method in terms of efficacy, practicality and minimisation of phytotoxicity. There is potential to enhance the efficacy of this technique, especially for bacteria and fungi, with the addition of a registered sanitiser and/or a fungicide to the hot water. An 'off-label' permit may be required for use of such chemicals in this way.

Table 7: Summary of hot water treatments of bulbs against quarantine pests.

Pest	Time at required bulb core temperature
Insects and mites	
Eumerus spp. *Merodon* spp. *Rhizoglyphus* spp. *Steneotarsonemus laticeps*	'Standard treatment' of 3 hours at 43.3°C is fatal to fly larvae and mites. 100% mortality was obtained for dipping times of 40 mins. or more at 43.3°C. At temperatures of 45.6 – 48.9°C, 100% mortality occurs with dipping times of 30 mins. or more (Doucette, 1929).
Flatworms and nematodes	
Ditylenchus destructor (in iris bulbs) *Ditylenchus dipsaci* (in narcissus bulbs)	3 hours at 44.4°C (with 0.2% formaldehyde* and wetting agent) following storage for 1-2 weeks at 30ºC (Anon. 1973). Formaldehyde* can be replaced with 1% peroxyacetic acid (peracetic acid). 3 hours at 46.7ºC following pre-warming for 7 days at 35ºC and 75% relative humidity. In the absence of a pre-soaking period, hot water treatment at 46.7ºC for 4 hours was required (Anon., 1973).
Fungi	
F. oxysporum f. sp. *gladioli* (in *Gladioli)*	30 minutes at 57.2°C provides good control but drastically reduces viability of the corms (Hsieh 1985). The addition of formaldehyde* in hot water (44.4°C) at a dilution of 1:200 has been shown to effectively control infection in narcissus bulbs (Gregory 1932). Treatment for 3 hours at 44.4°C may provide control of this fungus.
Bacteria	
Corynebacterium fascians (on *Lilium* bulbs)	2 hours at 39°C (Kruyer and Boontjes, 1982).

- * Formaldehyde (formalin) no longer appears to be registered in Australia for use on plant material
- Times quoted exclude warm-up time. They are the times spent at the required core temperatures.

Table 8: Extracts from certification schemes for horticultural bulbs produced by the European and Mediterranean Plant Protection Organisation (EPPO) concerning use of hot water to control insects and nematodes

Bulb genera Phytosanitary measure	Extract from scheme concerning hot water treatment to control pests
CROCUS PM 4/14(1) (1998)	'In order to kill nematodes within bulbs, it is necessary to raise the temperature in the bulbs to 43.5°C and to maintain it for several hours. A pre-treatment storage for 1-2 weeks at 25°C can prevent damage to the bulbs. Bulbs are placed on mesh trays and immersed in water at room temperature (about 20°C) for 24 h. They are then transferred to a water bath at 43.5°C for 4 h. It is important that the temperature should be kept constant throughout the bath, and for this reason it is recommended to insulate the bath, to use forced water circulation and ensure that the bulbs are not touching each other so that the water can move between them. A small amount of wetter can aid penetration of hot water. After removal from the bath, the bulbs are allowed to dry for 30 min and are then dipped in 0.5% formalin*.'
FREESIA PM4/22 (1) (1998)	No recommendation given
HYACINTH PM4/23(1) (1998)	No recommendation given
BULBOUS IRIS PM4/15(1) (1998)	'In order to kill nematodes within bulbs, it is necessary to raise the temperature in the bulbs to 44.5°C and to maintain it for several hours. A pre-treatment storage for 1-2 weeks at 30°C can prevent damage to the bulbs. Bulbs are placed on mesh trays and immersed in water at room temperature (about 20°C) for 3 h. They are then transferred to a water bath at 44.5°C for 3 h (or 2 h if 1% formalin* is added to the water). It is important that the temperature should be kept constant throughout the bath, and for this reason it is recommended to insulate the bath, to use forced water

	circulation and ensure that the bulbs are not touching each other so that the water can move between them. A small amount of wetter can aid penetration of hot water.'
NARCISSUS PM4/24(1) (1998)	<u>'Hot-water treatment to control nematodes</u> The bulbs are pre-heated for at least 10 days at 25-30°C. They are then immersed for 4 h in a bath at 47°C, or for 4 h in a bath at 45°C after soaking in water at room temperature for 24 h. <u>Hot-water treatment to control insects and mites</u> The bulbs are immersed for 2 h in a water bath at 43.5°C. The water may contain plant protection products selected according to the national registration'.
TULIP PM4/13(1) (1998)	'In order to kill nematodes within bulbs, it is necessary to raise the temperature in the bulbs to 43.5°C and to maintain it for several hours. A pre-treatment storage for 1-3 weeks at 30°C can prevent damage to the bulbs. Bulbs are placed on mesh trays and immersed in water at room temperature (about 20°C) for 24 h. They are then transferred to a water bath at 43.5°C for 2.5 h. It is important that the temperature should be kept constant throughout the bath, and for this reason it is recommended to insulate the bath, to use forced water circulation and ensure that the bulbs are not touching each other so that the water can move between them. A small amount of wetter can aid penetration of hot water'.

- * no longer appears to be registered in Australia for use on plant material; a registered sanitiser and/or fungicide should be used instead

Other methods of disinfestation may become possible in the future. These may include use of irradiation and microwave heating. Much research will be needed to develop these methods to the point where they can control target pests without causing unacceptable damage to the bulbs.

Advantages

- Will control a wider range of pests than fumigation
- Low human health hazard and minimal environmental hazard; a sustainable process for the long-term
- Pests are unlikely to develop significant additional tolerance to the measure
- Relatively fast treatment
- Relatively simple to do, especially on a small scale
- A pest control method already in widespread use by major bulb producing countries
- Will also assist in cleaning bulbs of soil and other unwanted contaminants

Disadvantages

- Special facilities would be required to treat the quantities of bulbs that are currently imported. Such facilities are not currently available in Australia
- The high temperatures used in such treatments may cause bulbs to break dormancy. Such bulbs would need to be planted soon after treatment
- Disposal of used water, soil and other material washed off bulbs in an approved way may be expensive and difficult.

10. Insecticide dip and/or

11. Nematicide dip

To control arthropods and nematodes (vectors of phytoplasmas and viruses may be controlled).

Dipping mixtures consisting of either an insecticide, miticide or a nematicide have been reported as being used to control arthropods and nematodes. Currently no chemical appears to have an explicit registration for this purpose for bulbs in Australia. Off-label permits to use pesticides as dips have, however, been sought by individual growers. A recent example involved a grower obtaining permission to use an 'Actellic' (pirimiphos-methyl) dip for use on his own property to control bulb mites (*Rhizoglyphus* spp.) infesting *Freesia* corms.

Use of a dip for quarantine purposes will require extensive testing of both the chemical and the protocol to use it. It is unlikely that a single dip will be found that will be effective against all pests of quarantine concern.

Advantages

- Fast treatment
- Easy to undertake and potentially free of error

Disadvantages

- Protocol not yet in place
- Human health and safety concerns
- Environmental problems associated with disposal of used dip
- There is a need to ensure that use of these products as a dip is approved either on a product label or by an 'off-label' permit
- Special facilities would be required to treat the large quantities of bulbs that are currently imported
- May not provide sufficient control of organisms deep within a bulb
- Issues of resistance to pesticides would need to be monitored

12. Fungicide dip

To control fungi.

Use of a fungicide dip may assist in the control of bulb-borne fungi and fungal spores. No fungicide dips are currently registered in Australia for use on bulbs, although a number of fungicides are registered as foliar sprays. Off-label permits to use fungicides in this way have been sought by growers. For example (as of June 2000), an off-label permit exists in Tasmania to use certain fungicides containing the active ingredient prochloraz as a dip against *Botrytis* and *Fusarium* spp. on tulips. The efficacy of hot water treatment may be improved with the addition of a fungicide to the water.

Advantages

- Fast treatment
- Easy to undertake
- May provide more rapid and effective control of fungi than a field application of the same chemical

Disadvantages

- Uncertainty that treatment will control all quarantine pests.
- Human health and safety concerns.
- Environmental problems associated with disposal of used dip

- Easy to supervise – registered processes may be available overseas
- There is a need to ensure that use of these products as a dip is approved either on a product label or by an 'off-label' permit
- Special facilities would be required to treat the large quantities of bulbs that are currently imported

Measures taken after arrival

13. Growth in post-entry quarantine (PEQ)

To control weeds, arthropods, flatworms and nematodes, fungi, bacteria, phytoplasmas and viruses.

Current fumigation schedules are unlikely to be effective against nematode pests of quarantine concern to Australia. Growth in PEQ provides an opportunity for nematodes to be controlled by soil application of a nematicide (see below), although this would not eradicate 100% of nematodes.

Many diseases, especially viruses, are difficult or impossible to detect visually in a dormant bulb, but may become easier to detect in a growing crop. This process of symptoms becoming visible may take time. However, some viruses of serious economic importance to other horticultural industries are symptomless (latent) and harmless in ornamental bulb species. Growth of imported bulbs in PEQ provides an opportunity to detect and respond to the presence of some quarantine pests and diseases.

PEQ is not a suitable risk management measure for mobile pests such as insects, mites or fungi with air-borne spores such as rusts.

Plants grown under PEQ need to be managed under conditions of 'good horticultural practice', free of weeds and pests. Current AQIS requirements specify the extent of separation from other crops, the level of inspection and what actions are taken when quarantine pests and diseases are found.

Advantages

- Location of imports known and controlled
- Opportunity for containment if outbreak detected

Disadvantages

- Costs associated with setting up suitable area
- Inspection costs and registration of properties
- May not be possible to prevent outbreak even when in PEQ; separation from other crops may be insufficient
- Risk of removal or theft of plant material from PEQ
- Disease symptoms may not express in PEQ, eg. latent viruses

- Difficulty in properly inspecting large consignments
- Difficulty in controlling arthropods and especially movement of winged insects

14. Soil application of systemic insecticide before, during or after planting in PEQ and/or

15. Soil application of nematicide or fungicide before, during or after planting in PEQ

To control arthropods, flatworms and nematodes, other invertebrates, fungi, bacteria, phytoplasmas and viruses.

Application of a systemic insecticide and/or nematicide to soil before, during or after the planting of bulbs will assist in the control of local pests that may invade the crop. Such pests may vector and spread imported viruses (which may be symptomless in bulbs) to other plants and crops in the vicinity (Table 9).

Table 10 indicates which treatment (insecticide or nematicide) may be needed for each bulb genus. Freesias may require use of a fungicide to control the fungus *Olpidium brassicae*, that is a potential vector for *Freesia leaf necrosis virus*.

AQIS import condition C7416 currently states that *Narcissus* spp. (and bulbs found contaminated with soil) are to be treated with the nematicide fenamiphos at planting in post-entry quarantine or within two weeks before planting. Application two weeks after planting may be too late for short duration PEQ. Two applications would be better - at planting and after 2 weeks.

Not all formulations of the nematicide fenamiphos available in Australia have registrations for use on bulbs in all states. In Victoria, for example, only the lowest strength preparation is currently registered for bulbs.

Since nematodes are a risk associated with all bulb species, it could be argued that nematicide treatment be applied to all bulb species and not just *Narcissus* species. Such a treatment may not be needed for fumigated *Crocus, Freesia, Hippeastrum, Hyacinthus* and *Iris* bulbs, which are not known to be carriers of nematode-vectored diseases (Table 10). Fumigated bulbs of *Gladiolus, Lilium, Narcissus* and *Tulipa* would still require application of a nematicide in PEQ to minimise potential vectoring of disease by nematodes. This requirement could also be lifted if testing (eg. by ELISA or PCR technique) is undertaken that demonstrates freedom from quarantine viruses (Table 15). Hot water treatment will effectively control nematodes present in bulbs.

A number of studies have shown that non-volatile nematicides such as fenamiphos have only limited effect on soil-borne nematodes. These non-volatile nematicides are not persistent in soil for more than a few weeks. Once gone, non-affected nematodes can move into treated areas. Non-volatile 'nematicides' act as ‘nematistats’ on nematodes within the treated area, ie. they don't kill all stages of nematodes, but merely interrupt some parts of the nematode life cycle. Nematodes may recover and become active again as the chemical breaks down (Harris 1983, 1986). More than one application may be required to provide adequate suppression of nematode numbers. Two applications - at planting and after about 2 weeks - should give better control of nematode populations, but further research is needed for bulbs.

Table 9: Vectors of quarantine viral and phytoplasma diseases of bulbs.

Organism	Vectors
Aster yellows	Leaf hoppers, bulbs
Freesia leaf necrosis virus	Fungi -*Olpidium brassicae &* aphids (*Myzus persicae*), infected bulbs
Hippeastrum mosaic virus	Aphids, infected bulbs
Iris yellow spot virus	Thrips, infected bulbs
Lily mottle virus	Aphids, infected bulbs
Lily X virus	Infected bulbs, vectors not confirmed
Narcissus late season yellows virus	Aphids (*Myzus persicae*), infected bulbs
Narcissus tip necrosis virus	Infected bulbs
Nerine latent virus	Aphids, infected bulbs
Raspberry ringspot virus	Nematodes, seeds, pollen, infected bulbs
Rembrandt tulip breaking virus	Infected bulbs
Strawberry latent ringspot virus	Nematodes
Tomato black ring virus	Nematodes
Tulip band-breaking virus	Infected bulbs
Tulip severe mosaic virus	Infected bulbs
Tulip top breaking virus	Infected bulbs
Tulip X virus	Infected bulbs
Vallota mosaic virus	Aphids, infected bulbs

Table 10: Quarantine vectors of quarantine phytoplasmas and viruses of bulb genera relevant to this IRA.

Genera of bulbs	Insects	Nematodes	Fungi	Infected bulbs
Crocus				
Freesia	YES		YES	YES
Gladiolus		YES		YES
Hippeastrum	YES			YES
Hyacinthus	YES			YES
Iris	YES			YES
Lilium	YES	YES		YES
Narcissus	YES	YES		YES
Tulipa		YES		YES

Advantages

- Application of pesticide easy to integrate with cultivation
- Use of nematicide in PEQ may allow control of nematodes not killed by fumigation

Disadvantages

- May not give immediate and/or fully effective control

Measures taken at any time

16. Diagnostic testing (ELISA/PCR)

To detect phytoplasmas and viruses.

Presence of viruses and phytoplasmas can be detected by means of these tests, once test protocols are developed and the required specific antisera are available. These tests are specific to each disease. Antisera for target quarantine viruses (Table 15) are available from various sources, e.g.: DSMZ Plant Virus Collection (Germany), Plant Research International (The Netherlands), Bulb Research Centre (The Netherlands), and American Type Culture Collection (USA). AQIS recently contracted virologists at the Australian National University to develop a generic PCR test for all nepoviruses, and this diagnostic test is now available for quarantine use. All diagnostic tests (ELISA / PCR) must use proper controls during testing.

Use of such tests could replace the need for growth in PEQ, subject to other pests and diseases of quarantine concern being controlled. Tests should be undertaken on arrival **before** bulbs are planted.

The number of sampling units to take will vary according to the degree of tolerance deemed acceptable for presence of a particular organism. For example, inspection of 600 units (in this case bulbs) taken at random from a consignment will give a 95% certainty that a condition that affects 0.5% of bulbs will be detected. Larger sample sizes would be needed if a lower tolerance level is required.

Advantages

- Specific and accurate
- Once systems in place, testing can be rapid
- Can detect viruses that cannot be detected by simple visual inspection

Disadvantages

- Some viruses are rare in bulbs and detection may require large samples to be taken to provide assurance of virus freedom
- Tests not yet available for all viruses
- Could be expensive
- More work needed to develop simple robust tests for all quarantine viruses and phytoplasmas
- Logistics in sample collection and testing

Selection of management options

The management measures available to control quarantine pests vary in their efficacy. Regardless of what measures are chosen, treatment options should:

- Deal effectively with target pests and diseases

- Be practical and cost effective
- Be reliable
- Be safe and legal as undertaken
- Have minimal phyto-toxicity

Based on comments made above, Table 11 is an attempt to score qualitatively the likely efficacy of treatment options on the identified quarantine pests. It also summarises how these measures will affect a given group of pests, and estimates how practical and reliable such measures may be.

Identification of key control measures

To select the most effective control measures from options presented in Table 11, some simple rules were applied. These are shown in Table 12. Highest scores are given for methods that appear to be effective against a particular class of organism and are practical and reliable. Measures selected by this process for each group of quarantine pests are presented in Table 13.

Table 11: Summary of treatment options for control of quarantine pests of dormant bulbs relevant to this IRA

	Control measure	Efficacy of control measure on pest								Efficacy of measure on			Use of method		
		Weeds	Insects and mites	Nematodes	Other invertebrates##	Fungi	Bacteria	Phytoplasma	Viruses	Entry of pest	Establishment of pest	Spread of pest	Current practicality	Potential reliability	Phytotoxicity
	In country of origin														
1	Good horticultural practice during production	M	M	M	M	M	M	M	M	M			H	M	
2	Area freedom	M	L	M	M	M	M	H	M	M			M	M	
3	Selection of certified stock for import	M	L	M	M	M	H	M	M	M			H	H	
4	Selection of resistant varieties					L	?	?	?	L			L	L	
5	Cleaning of bulbs before export	H	M	M	M	M				M			H	M	L
6	Storage & transportation	L	L	M	L					L			H	H	L
	On arrival														
7	Visual inspection on arrival	M	M	L	L	H	H	M#	M#	H			H	H	
8	Fumigation on arrival		H	L	L			M#	M#	H			H	H	Possible
9	Hot water treatment	M	H*	H*	M?	H*	H*	M#	M#	H			M	H	Possible
10	Insecticide dip^		M					M#	M#	M	M		L	M	
11	Nematicide dip^		L	M		L			M#	M	M		L	M	
12	Fungicide dip^			L		H			M#	M	M		M	M	
	After arrival														
13	Growth in post-entry quarantine (PEQ)	H	L	L	L	H	H	H	M		H	M	H	H	
14	Soil application of systemic insecticide before planting in PEQ	M	M	L				M	M#		M	L	H	M	

	Control measure	Efficacy of control measure on pest								Efficacy of measure on			Use of method		
		Weeds	Insects and mites	Nematodes	Other invertebrates##	Fungi	Bacteria	Phytoplasma	Viruses	Entry of pest	Establishment of pest	Spread of pest	Current practicality	Potential reliability	Phytotoxicity
15	Soil application of nematicide before planting in PEQ		L	**M**	L				**M#**		**M**	L	**H**	**M**	
	At any time														
16	Diagnostic testing (ELISA/PCR)							**H***	**H***	**H***	**H***	**M***	**H***	**H***	

Key

H high efficacy
M medium efficacy
L low efficacy
will affect vectors, eg. arthropods and nematodes but not the disease organism directly

* where protocols exist

^ subject to registered product being available or other permit being obtained before use
includes New Zealand flatworm (for bulbs ex UK and NZ), slugs and snails

Table 12: Rules applied to Table 11 to select key control measures

Effectiveness of measure	Score in efficacy column	Score in current 'practicality' column	Score in 'reliability' column
High (most effective)	H	H	H or M
Medium (effective)	M	H	H or M
Medium (effective)	H	M	H or M
Others – not selected	M or less	M or less	M or less

Table 13: Key control measures for pests of bulbs

	Control measure	Efficacy of control measure on pest							
		Weeds	Arthropods	Nematodes	Other invertebrates ##	Fungi	Bacteria	Phytoplasmas	Viruses
	In country of origin								
1	Good horticultural practice during production	**M**	**M**	**M**	**M**	**M**	**M**	**M**	**M**
2	Area freedom			**M**				**M**	
3	Selection of certified stock for import	**M**		**M**	**M**	**M**	**H**	**M**	**M**
4	Selection of resistant varieties								
5	Cleaning of bulbs before export	**H**	**M**	**M**	**M**	**M**			
6	Storage & transportation			**M**					
	On arrival								
7	Visual inspection on arrival	**H**	**M**			**H**	**H**	**M#**	**M#**
8	Fumigation on arrival		**H**					**M#**	**M#**
9	Hot water treatment (HWT)	**M**	**H***	**H***	**M?**	**H***	**H***	**M#***	**M#***
10	Insecticide dip^								
11	Nematicide dip^								
12	Fungicide dip^					**M**			

	Control measure	Efficacy of control measure on pest							
		Weeds	Arthropods	Nematodes	Other invertebrates ##	Fungi	Bacteria	Phytoplasmas	Viruses
	After arrival								
13	Growth in post-entry quarantine (PEQ)	**M**				**H**	**H**	**H**	**M**
14	Soil application of systemic insecticide before planting in PEQ		**M**					**M#**	**M#**
15	Soil application of nematicide before planting in PEQ			**M**					
	At any time								
16	Diagnostic testing (ELISA/PCR)*							**H***	**H***

Key
H most effective control measure
M effective control measure

\# will affect vectors, eg. arthropods and nematodes but not the disease organism directly

\## includes New Zealand flatworm (bulbs ex UK and NZ), slugs and snails
* where protocols exist
^ subject to registered product being available or other permit being obtained before use

Efficacy of selected control measures on pest groups

This section describes the effect of selected management options on the identified pest groups.

Weeds

Cleaning of bulbs, visual inspection on arrival followed by hot water treatment and/or growth in PEQ are the most effective control measures for control of weed propagules. ‘Good horticultural practice’ during production (Table 14) and selection of certified stock (or its equivalent) will greatly reduce the initial level of contamination.

Arthropods

'Good horticultural practice' during production will reduce the number of insect pests and mites present. Cleaning of bulbs will further reduce numbers. The disinfestation carried out on arrival represents the last effective treatment that can be undertaken to prevent entry of these pests. In Australia this has been undertaken traditionally by fumigation with methyl bromide.

Examination of the original scientific data supporting the current fumigation rate has shown that these protocols are inadequate for mite control and are marginal for some insect pests. As a result, higher CT products (concentration X time) are recommended. Hot water treatment is a replacement for methyl bromide fumigation and is currently permitted by AQIS for treatment of arthropod pests. Hot water treatment would be more effective against mites than fumigation with methyl bromide at current dosages.

Given the probable loss of methyl bromide within the next few years (even for quarantine purposes, where alternative treatments are available) additional work to define and optimise hot water or other treatments should be a priority for the bulb industry. Without fumigation or an effective alternative, it is difficult to see how insect and mite pests can be controlled. A lack of an effective measure to control arthropod pests could prevent the continuance of this bulb trade at 'minimal' risk to Australia.

Nematodes

Control of nematodes is difficult. Certification (or equivalent) and/or production under 'good horticultural practice' will reduce levels of nematode infestation. Cleaning will minimise transportation of soil-borne nematodes. Area freedom is a practical reality for some nematodes, eg. *Globodera* spp. and *Meloidogyne chitwoodi*.

Soil testing under official protocols is carried out to determine 'freedom' from nematodes. While these protocols certify 'freedom', it is important to understand that no testing regime can ensure total freedom. The level of freedom assured is directly related to the intensity of a sampling regime that is practically possible. This limitation aside, such tests are an important component of a risk reduction strategy.

Nematodes are both hard to detect and difficult to kill with fumigants and nematicides. Even the proposed alterations to fumigation schedules used on bulbs will be insufficient to kill all life stages of nematodes. Dosage rates required to kill nematodes are much greater than dosages for insects. **Fumigation with methyl bromide is therefore not the treatment of choice for nematodes**. Moderate heat as provided by hot water treatment appears to be effective at killing these pests.

Use of nematicides in PEQ may be continued where there is a risk of local nematodes vectoring viruses that may be carried in imported bulbs. This soil nematicide treatment in PEQ may not be required if active testing found the consignment free of viruses of concern, or if soil testing of the PEQ area showed it to be free of virus-vector nematodes.

Other invertebrates

Certification (or equivalent) and/or production under 'good horticultural practice' will reduce levels of slugs and snails. Cleaning will minimise transportation of these pests. Visual inspection on arrival may locate large individuals, but may not detect immature specimens or eggs. Fumigation at rates used for arthropods are unlikely to control snails (data is unavailable for slugs and New Zealand flatworm). Efficacy data for hot water treatments is lacking and is urgently required.

Fungi, bacteria

Certification (or equivalent) and production of bulbs under 'good horticultural practice' will reduce levels of fungal and bacterial infestation. Cleaning will minimise transportation of soil-borne fungi and make inspection easier. Visual inspection on arrival may detect diseased bulbs, although it will not detect bulbs contaminated only with spores. Current fumigation schedules are unlikely to control either fungi or bacteria. Again, hot water treatments have potential to control fungi and bacteria, especially if a registered or permitted sanitiser or fungicide is added to the water. Dipping bulbs in a fungicide before planting is another possibility to control at least some fungi, but not all fungicides work on all strains or species of fungi.

Growth in PEQ allows time for disease symptoms to show and for infected or infested plants to be removed and destroyed. Without PEQ, current on-shore quarantine control would effectively end with a visual inspection and/or a fungicidal dip.

Viruses, phytoplasmas

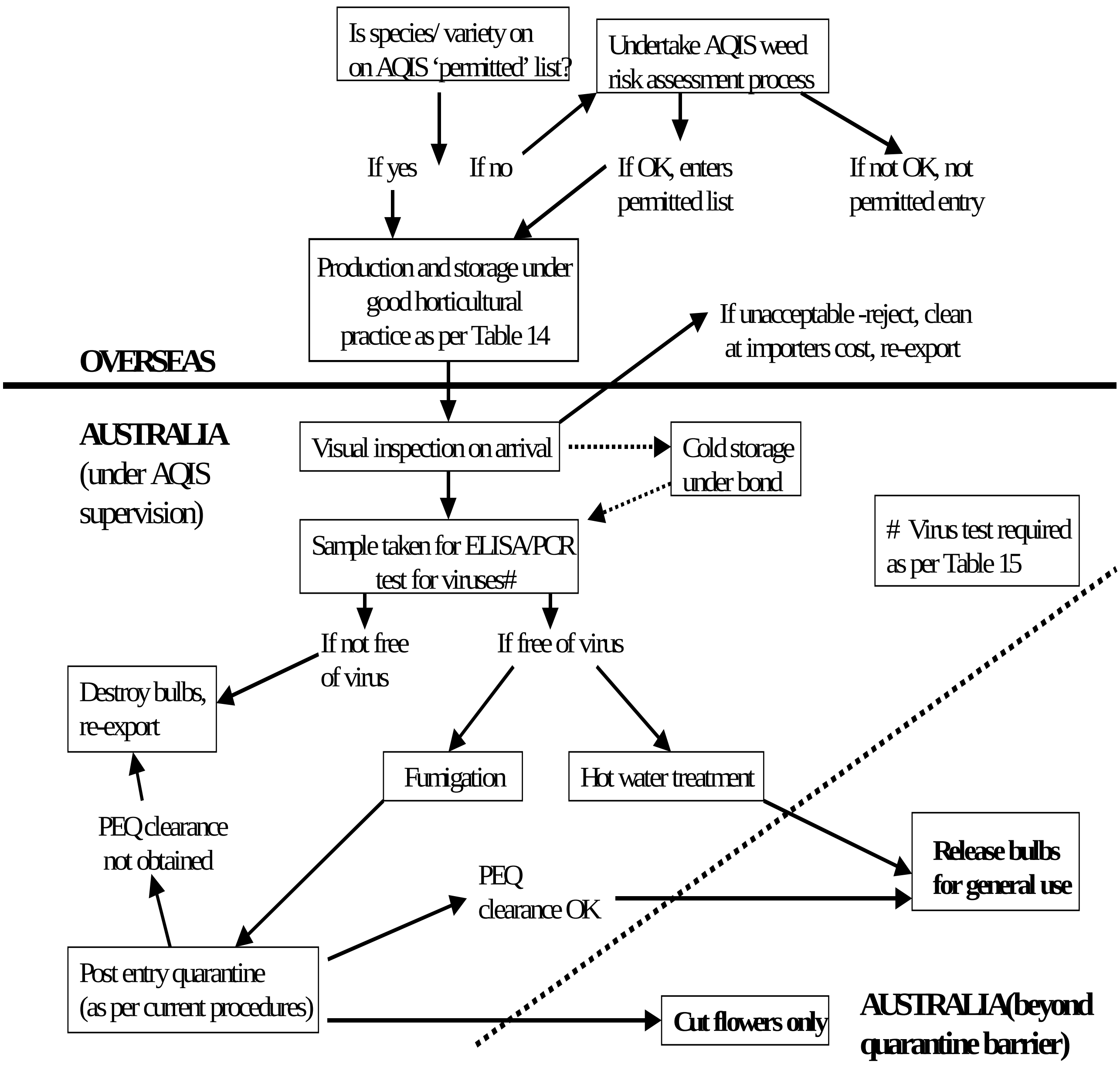
Selection of certified stock and 'good horticultural practice' will reduce potential virus load in bulbs on arrival. Processes that are done on arrival, namely fumigation, pesticide application and visual inspection will do little to prevent importation of viruses. Once the material is in Australia, the only practical options appear to be growth in PEQ and/ or testing and inspection for presence of viruses or phytoplasmas of concern. Currently, total reliance is placed upon control measures undertaken overseas, and PEQ inspections in Australia. This may not be acceptable to other horticultural industries and the wider community, especially in relation to a number of viruses that cause diseases in other crops. While these are of little or no importance to the bulb industry, they are potentially economically important to other horticultural industries.

The need for PEQ for viruses could be eliminated if sufficiently accurate tests were developed and used to test for quarantine viruses.

Proposed protocol to manage risks associated with the importation of ornamental bulbs.

Given that a number of groups of organisms are of quarantine concern, a range of measures is consequently needed to control them. Suggested management options are given below. A flow diagram (Figure 2) illustrates the relationship between the various control measures proposed.

Figure 1: Flowchart of proposed management options for the importation of ornamental bulbs produced under 'good horticultural practice'



Weed risk assessment

Before any plant species can be allowed entry into Australia, AFFA must first be satisfied that it does not pose an unacceptable risk of becoming a weed. The taxa consider in this IRA are currently permitted entry at the genus level. The permitted list is under review, and following development of a species list, all species not currently freely available for sale and/or recorded as naturalised in Australia will be assessed for potential weed risk using the current AQIS Weed Risk Assessment system. Details of the Weed Risk Assessment process are available via the AQIS web site at http://www.aqis.gov.au/docs/plpolicy/weeds1.htm. If this assessment finds that the candidate species poses an unacceptable weed risk then importation will not be permitted.

Production of candidate material for importation.

The risks of importation of unwanted pests, weeds and diseases are significantly reduced by the selection of material produced under conditions of 'good horticultural practice'. AFFA recognises that production of bulbs under a certification scheme goes a long way to reducing risks by management of the production process to ensure a healthy product.

Bulbs of permitted species grown under conditions of ‘good horticultural practice’ will be permitted entry to Australia subject to the following protocol. To approve importation of bulbs, AFFA would require evidence that such practices had been carried out. A definition of ‘good horticultural practice’ is given in Table 14.

Table 14: ‘Good horticultural practice’

- Use of healthy planting material (crop grown from material produced under these conditions or better)
- Bulbs hot water treated (3 hours at 43.5 - 47ºC) before planting to minimise pest and disease load at start of growing season
- Soil sampling by National Plant Protection Organisation (NPPO) as per local regulation to demonstrate bulbs have been grown in an area free from nematodes and flatworms of quarantine concern to Australia and potato wart disease (*Synchytrium endobioticum*)
  - OR certified growth of crop in soil-less media or sterilised soil
  - OR certification from NPPO that land used for bulb production has NOT been used for potato production in the last 20 years
- Local NPPO staff are satisfied that an effective pest, weed and disease control program is in place during growth of bulbs
- Physical separation of bulbs (at least 2 metres) produced under such a protocol from bulbs that are not produced under good horticultural practice
- Roguing out of unhealthy plants is permitted – records to be kept and made available on request regarding why and how many plants affected
- Inspection during growing, and of dry bulbs, by responsible government or government-approved inspectors to ensure freedom from visual symptoms of quarantine pests and diseases. At least two field inspections should be undertaken, at least one during flowering
- Secure storage of bulbs before export under appropriate conditions to prevent continuation of development of pests and diseases and prevent infestation/infection of bulbs in storage. Cover bulbs in storage to prevent re-infestation.(especially by insects)
- Soil cleaned from bulbs before shipment, preferably before storage
- A system of identity preservation/certification of production is in place to ensure bulbs produced under such a regime are kept apart from those that are not.

Suppliers of bulbs must have in place a documented Quality Assurance (QA) system which addresses the points above. This is subject to approval, auditing and monitoring by AQIS or by an AQIS-approved body in the exporting country.

Certification under a bulb scheme, such as an EPPO scheme or those currently in place in the Netherlands and the UK, would be accepted as evidence of compliance with the requirements above if they are specifically addressed by the particular scheme.

Suppliers of non-certified material would also have to demonstrate to AFFA that they can meet AFFA's requirements for good horticultural practice **by having an equivalent QA system in place that complies with the above points. Assessment of new applicants would be done on a case by case basis and would be undertaken on a cost recovery basis. It may be desirable for AFFA to visit the proposed supplier to audit their system prior to recognition being granted.**

For export under this protocol such approval would need to be obtained before export can commence.

With each consignment, the NPPO of the exporting country would be required to issue a phytosanitary certificate which states that bulbs are exported in accordance with Australian requirements. For those bulbs that require testing for viruses, the phytosanitary certificate should specify if the bulbs exported represent the product of a single act of cultivation (ie. from a single field) or are a blend/mixture from more than one field.

Subject to these protocols, bulbs may be imported in unlimited quantities.

Importation conditions for bulbs not able to meet requirements of 'good horticultural practice' are given below under 'Importation of non-accredited bulbs'.

Inspection on arrival

On arrival, bulbs are inspected to confirm identity, documentation and labelling, and to ensure they are free of soil, trash and obvious signs of pests and diseases. Bulbs landed without a satisfactory phytosanitary certificate will not be permitted entry. Current protocols for inspection will continue.

Material found unsatisfactory can either be re-exported, cleaned or destroyed under AQIS supervision at the importer's expense. Bulbs with unacceptable contamination with soil will not be permitted entry until they have been cleaned in an AQIS-approved facility at the importer's expense. The option of planting them in PEQ with an application of a nematicide will no longer be permitted. Only bulbs with a high standard of cleanliness will be permitted entry. Any costs associated with inspection, cleaning, etc. together with the cost of AQIS supervision of these procedures will be borne by the importer on a 'user pays' basis.

Cold storage under bond

Once bulbs have been hot water treated or warmed up for fumigation, they may break dormancy and start to grow, often at an inopportune time for the importer. In recognition of this, it is proposed to permit imported bulbs, once they pass visual inspection, to be immediately cold stored (temperature of 2ºC or less) in an AQIS-approved facility under bond.

If such a facility is built, it must be placed in a metropolitan area away from areas of horticultural or agricultural activity, preferably close to the point of importation. Access to cold storage under bond for imported bulbs will only be possible where the storage and

treatment facilities are under AQIS Compliance Agreements.

Costs associated with construction and use of such a facility together with any extra AQIS supervision will be borne by the user on a cost-recovery basis (for AQIS services) and on commercial basis (for a privately operated storage facility). This facility would also be a good place to install a hot water treatment unit.

Test for viruses of quarantine concern

A number of viruses identified by this IRA are of economic importance. Some of these are symptomless in bulbs and would be impossible to detect by visual means. It is proposed that viral testing using ELISA be carried out on imported bulbs for viruses of particular concern (Table 15). Testing will target those quarantine viruses that are symptomless on bulbs (eg. *Raspberry ringspot virus*) but are important pathogens of other plants. In addition, quarantine viruses that produce visible symptoms and are regarded as having significant economic importance to bulb and/or other plant production will also be tested for. These tests would be undertaken on dormant bulbs by an AQIS-approved laboratory either in Australia or overseas. Test results would be subject to independent review at the request of AQIS. In addition, if it can be demonstrated to the satisfaction of AFFA that viruses of concern listed in Table 15 are not present on candidate bulbs for export to Australia, then the requirement for a test may be dropped, subject to regular review.

For the bulbs covered in this IRA, testing is or is not required as below:

Tests will be required for *Gladioli, Iris* (ex. Israel, Netherlands), *Lilium*, *Narcissus*, *Tulipa* (ex. Netherlands) (as per Table 15 below);
Tests will not be required for *Crocus*, *Freesia*, *Iris* (ex UK), *Hippeastrum*, *Hyacinthus*, *Tulipa* (ex NZ).

Table 15: Target quarantine viruses for which tests are required before release of plants into PEQ (following fumigation) OR general release (following hot water treatment)

Bulb genus	Virus	Sources of bulbs requiring testing from countries covered in this IRA
Gladioli	*Strawberry latent ringspot virus* *Tomato black ring virus*	Netherlands Netherlands
Iris	*Iris yellow spot virus*	Netherlands, Israel
Lilium	*Iris yellow spot virus* *Lily mottle virus* *Strawberry latent ringspot virus*	Netherlands, Israel Netherlands, Israel Netherlands, NZ, Israel, UK
Narcissus	*Raspberry ringspot virus* *Tomato black ring virus*	Netherlands, UK Netherlands, UK
Tulipa	*Lily mottle virus* *Tomato black ring virus*	Netherlands Netherlands

Requirements for virus testing may be changed as new information becomes available, or tests may be required for bulbs from other countries that have different diseases.

Results from these tests are required before bulbs are allowed to be planted in PEQ following fumigation, or before general release following hot water treatment. Samples for virus testing are to be taken before the disinfestation process is undertaken.

Viruses in bulbs can be detected using Double Antibody Sandwich Enzyme Linked Immunosorbent Assay (DAS - ELISA) using virus-specific polyclonal antisera. *Lily mottle virus* has been successfully detected using DAS - ELISA by isolating virus from the fleshy outer scales of the *Lilium* bulbs (Derks *et al*., 1997). 600 bulbs are selected from one consignment and separated into 60 lots of 10 bulbs, and each group of 10 bulbs would be tested. A sample of this size gives a 95% probability of detecting 0.5% infection. Larger sample sizes may be required to detect viruses of low incidence or titre. Smaller samples could be allowed for small consignments of bulbs.

The sample used for virus testing would need to be taken in such a way as to ensure that it was representative of the consignment presented. This is especially important if bulbs in a consignment are the product of more than one act of cultivation. If a consignment consists of several growers' production from different places, then separate tests should be conducted on each batch of bulbs.

- **Bulbs which test free of quarantine viruses and have been hot water treated will be released from quarantine control and would be available for general use.**

- **Bulbs which test free of quarantine viruses and have been fumigated would enter post-entry quarantine.**

- **Bulbs which test positive for the target viruses must either be re-exported or destroyed at the importer's expense.**

Disinfestation procedures

Importers have a choice of two disinfestation treatments: fumigation by methyl bromide at amended rates or hot water treatment. Given the potential loss of methyl bromide as a quarantine treatment for bulbs, adoption of hot water treatment is strongly encouraged as a disinfestation treatment that will carry the industry into the future.

Given the fact that hot water treatment controls a wider range of pests and pathogens than fumigation, bulbs treated in this way will NOT need to be grown in PEQ. Following hot water treatment, they can be cleared for immediate general use, subject to results of a test (if required, see above) to detect presence of quarantine viruses.

Bulbs that are fumigated must also be tested for viruses (if required, see above) AND enter post-entry quarantine (see below).

The disinfestation process and facilities will be managed under AQIS Compliance Agreements.

Methyl bromide fumigation, a minimum CT product of 275 g m^{-3} h - 8.5 h at 32g m^{-3} (all bulbs except *Crocus*) or 128 g m^{-3} h - 4 h at 32g m^{-3} (*Crocus* only) is required to kill arthropod pests

likely to be present (This dose is ineffective against nematodes and snails, and the susceptibility of slugs and New Zealand flatworms is unknown). For the above doses, bulb core temperatures must be at least 21ºC. If bulb core temperatures are lower, the dose will be increased, at 16-20ºC - 40g m^{-3}, at 11-15ºC – 48g m^{-3}. Fumigation cannot be undertaken if the core temperature of bulbs is below 10ºC.
OR fumigation at the 'label rate', if this is required by state/federal law (eg. 'control of pesticide use' legislation or an 'off-label' permit) instead of the above rates, provided that label rates are not less than the proposed rates above. Packing material associated with the bulbs must be either fumigated at the label rate or destroyed by an AQIS-approved method.

To fumigate, bulbs must be unpacked and allowed to come up to the required fumigation temperature. It is expected that fumigations will be undertaken in accordance with 'AQIS Quarantine treatments – Aspects and Procedures (2000)' when this publication is released for general use. As discussed under 'Fumigation on arrival', methyl bromide is likely to be unavailable soon after 2005.

Hot water treatment, in which bulb core temperature is maintained at a minimum of 43.5 to 47ºC as per EPPO guidelines (Table 8) for a period of three hours, to control arthropods, nematodes, some fungi and bacteria (There is a need to produce data for slugs, snails and New Zealand flatworm). Where no EPPO guidelines are given for a particular genus, then a temperature of 44ºC for three hours is to be used. Packing material associated with the bulbs must be destroyed by an AQIS-approved method.

Post-entry quarantine

PEQ specifications currently in use for certified bulbs will be modified. Bulbs grown under PEQ need to be managed under conditions of 'good horticultural practice', free of weeds and pests. Current AQIS requirements specify the extent of separation from other crops, the level of inspection and what actions are taken when quarantine pests and diseases are found. An application of a granular nematicide registered for use on bulbs will be made to the soil as per label before or at planting, and a second application after two weeks.

Once bulbs have satisfactorily completed PEQ in accordance with procedures written in ICON, they may be released for general use. Bulbs that are no longer required, from which flowers have been harvested (eg. force-flowered tulips), but are still within the relevant PEQ period, may not be released but may only be removed and destroyed under AQIS supervision.

Force-flowered tulips

Force-flowered tulips do not grow for long enough in PEQ to allow the inspections required for other bulbs. If the tulip bulbs are from sources and grades that meet AQIS minimum health standards, there are three options:

1. If bulbs are virus tested and fumigated, the entire plants from PEQ may be released following a minimum of one inspection during the PEQ period (minimum of three weeks);

2. If bulbs are not virus tested, but are fumigated or hot water treated and grown in a closed glasshouse at an AQIS-approved quarantine facility, all the bulbs plus the propagating mix must be destroyed using an AQIS-approved method after completion of the closed PEQ period or after harvesting flowers;
3. If bulbs are virus tested and hot water treated, they do not require any growth in PEQ and may be released immediately.

Importation of bulb genera not covered in this IRA from any country, and any bulb genera from countries other than the Netherlands, the UK, Israel or New Zealand

Before permitting entry of other bulb genera under this protocol from any country, or any bulbs from countries other than the Netherlands, the UK, Israel or New Zealand, an assessment will need to be made that the management options developed here are appropriate. Irrespective of the country of origin, any plant that is not currently on the AQIS ‘permitted list’ will need to be assessed for weed risk as per the Weed Risk Assessment process. Only plant species that pose minimal weed risk as determined by the assessment will be further considered for entry. A pest list for the candidate bulb species and the source country will also be required. In particular, attention should be paid to the prevalence of pests and pathogens (especially viruses) within candidate exporting areas, including pests that are of quarantine concern to Australia in other crops, but that could be in the bulb pathway (eg. 'hitch-hiking' pests). This information is required to identify which protocols and tests are required to ensure imported material is free from quarantine pests.

Importation of non-accredited bulbs

For bulbs to be imported under the above protocol they must have been produced under a system of ‘good horticultural practice’ this may be demonstrated by being produced under a recognised certification scheme or under an equivalent QA system. Where this cannot be demonstrated, bulbs may be imported subject to weed risk assessment, inspection, disinfestation and virus testing requirements as above. Regardless of the method of disinfestation such bulbs will be required to be grown in post-entry quarantine in an AQIS-approved facility for an entire growing season.

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APPENDIX 1 – QUARANTINE PEST AND DISEASE LISTS OF BULB GENERA COVERED BY THIS IRA

Table 16: Quarantine pests - *Crocus* bulbs from the Netherlands.

The following pest list represents our present state of knowledge, and is subject to change as a result of reclassification of organisms and new scientific evidence.

(see below for key to table entries)

		Presence in country*				
Species	**Common name**	**NL**	**AU**	Econ. imp.#	Q. pest	In Pathway
Arthropods						
Agriotes spp.	wireworms	Yes	No	Yes	Yes	Yes
Agrotis segetum	cutworm	Yes	No	Yes	Yes	Yes
Aphis fabae	black bean aphid	Yes	No	Yes	Yes	Possible
Frankliniella fusca	tobacco thrips	Yes	No	Yes	Yes	Yes
Frankliniella occidentalis	western flower thrips	Yes	Yes^R	Yes	Yes	Yes
Hepialus humuli	ghost swift moth	Yes	No	Yes	Yes	Yes
Hepialus lupulinus	common swift moth	Yes	No	Yes	Yes	Yes
Liriomyza trifolii	serpentine leaf miner	Yes	No	Yes	Yes	Possible
Phenacoccus avenae	iris mealybug	Yes	No	Yes	Yes	Yes
Spodoptera littoralis	Egyptian cotton leafworm	?	No	Yes	Yes	Possible
Nematodes						
Ditylenchus destructor	potato rot nematode	Yes	No	Yes	Yes	Possible
Ditylenchus dipsaci	stem nematode	Yes	?	Yes	Yes	Yes
Globodera pallida	pale potato cyst nematode	Yes	No	Yes	Yes	Possible
Globodera rostochiensis	potato cyst nematode	Yes	Yes^R	Yes	Yes	Possible
Meloidogyne chitwoodi	Colombia root-knot nematode	Yes	No	Yes	Yes	Yes
Longidorus attenuatus	needle nematode	Yes	No	Yes	Yes	Possible
Longidorus macrosoma	needle nematode	Yes	No	Yes	Yes	Possible
Xiphinema spp.	dagger nematodes	Yes	?	Yes	Yes	Possible
Fungi						
Fusarium oxysporum f. sp. *gladioli*	basal rot	Yes	?	Yes	Yes	Yes
Fusarium oxysporum f. sp. *lilii*	basal rot	Yes	?	Yes	Yes	Yes
Uromyces croci	crocus rust	Yes	No	Yes	Yes	Yes

Key to table

*****	**NL-** Netherlands, **AU-** Australia.
#	Potential economic impact on bulb crops **and/or** other crops and/or the environment.
Yes^R	Recorded as present but with localised distribution, under official control.
?	Status confused, certain species/strains may be present but other important ones may not be present. Exotic strains or biotypes of some species of pests already in Australia (eg. some nematodes) may act differently as vectors of quarantine pests (eg. some viruses). Formae speciales of *Fusarium oxysporum* have been given this status pending confirmatory tests to determine their presence in Australia. *Spodoptera littoralis* has been reported from greenhouses in northern Europe and also as an occasional migrant, but is not normally established there.
Possible	May be found on or in bulbs; typically pests in this category occur as pests of active growing bulbiferous plants or are soil-borne contaminants from other crops (such as some nematodes).

Table 17: Quarantine pests - *Freesia* bulbs from the Netherlands.

The following pest list represents our present state of knowledge, and is subject to change as a result of reclassification of organisms and new scientific evidence.

(see below for key to table entries)

		Presence in country*				
Species	**Common name**	**NL**	**AU**	Econ. Imp.#	Q. pest	In pathway
Arthropods						
Agriotes spp.	wireworms	Yes	No	Yes	Yes	Yes
Agrotis segetum	cutworm	Yes	No	Yes	Yes	Yes
Aphis fabae	black bean aphid	Yes	No	Yes	Yes	Possible
Frankliniella fusca	tobacco thrips	Yes	No	Yes	Yes	Yes
Frankliniella occidentalis	western flower thrips	Yes	Yes^R	Yes	Yes	Yes
Hepialus humuli	ghost swift moth	Yes	No	Yes	Yes	Yes
Hepialus lupulinus	common swift moth	Yes	No	Yes	Yes	Yes
Liriomyza trifolii	serpentine leaf miner	Yes	No	Yes	Yes	Possible
Phenacoccus avenae	iris mealybug	Yes	No	Yes	Yes	Yes
Rhizoglyphus spp.	bulb mite	Yes	?	Yes	Yes	Yes
Spodoptera littoralis	Egyptian cotton leafworm	?	No	Yes	Yes	Possible
Nematodes						
Ditylenchus destructor	potato rot nematode	Yes	No	Yes	Yes	Possible
Ditylenchus dipsaci	stem nematode	Yes	?	Yes	Yes	Yes
Globodera pallida	pale potato cyst nematode	Yes	No	Yes	Yes	Possible
Globodera rostochiensis	potato cyst nematode	Yes	Yes^R	Yes	Yes	Possible
Meloidogyne chitwoodi	Colombia root-knot nematode	Yes	No	Yes	Yes	Yes
Longidorus attenuatus	needle nematode	Yes	No	Yes	Yes	Possible
Longidorus macrosoma	needle nematode	Yes	No	Yes	Yes	Possible
Xiphinema spp.	dagger nematodes	Yes	?	Yes	Yes	Possible
Fungi						
Embellisia hyacinthi	skin spot of hyacinths	Yes	No	UN	Yes	Yes
Fusarium oxysporum f. sp. *gladioli*	basal rot	Yes	?	Yes	Yes	Yes
Fusarium oxysporum f. sp. *lilii*	basal rot	Yes	?	Yes	Yes	Yes
Viruses						
Freesia leaf necrosis virus		Yes	No	Yes	Yes	Yes
Vallota mosaic virus		Yes	No	UN	Yes	Yes

Key to table

*****	**NL**- Netherlands**, AU**- Australia.
#	Potential economic impact on bulb crops **and/or** other crops and/or the environment.
Yes^R	Recorded as present but with localised distribution, under official control.
?	Status confused, certain species/strains may be present but other important ones may not be present. Exotic stains of some species of pests already in Australia (eg. some nematodes) may act differently as vectors of quarantine pests (eg. some viruses). Formae speciales of *Fusarium oxysporum* have been given this status pending confirmatory tests to determine their presence in Australia. *Spodoptera littoralis* has been reported from greenhouses in northern Europe and also as an occasional migrant, but is not normally established there.
UN	Unknown economic status
Possible	May be found on or in bulbs; typically pests in this category occur as pests of active growing bulbiferous plants or are soil-borne contaminants from other crops (such as some nematodes).

Table 18: Quarantine pests - *Gladiolus* bulbs from the Netherlands.

The following pest list represents our present state of knowledge, and is subject to change as a result of reclassification of organisms and new scientific evidence.

(see below for key to table entries)

		Presence in country*				
Species	**Common name**	**NL**	**AU**	Econ. Imp.#	Q. pest	In pathway
Arthropods						
Agriotes spp.	wireworms	Yes	No	Yes	Yes	Yes
Agrotis segetum	cutworm	Yes	No	Yes	Yes	Yes
Aphis fabae	black bean aphid	Yes	No	Yes	Yes	Possible
Eumerus strigatus	lesser bulb fly	Yes	No	Yes	Yes	Yes
Eumerus tuberculatus	lesser bulb fly	Yes	Yes[R]	Yes	Yes	Yes
Frankliniella fusca	tobacco thrips	Yes	No	Yes	Yes	Yes
Frankliniella occidentalis	western flower thrips	Yes	Yes[R]	Yes	Yes	Yes
Hepialus humuli	ghost swift moth	Yes	No	Yes	Yes	Yes
Hepialus lupulinus	common swift moth	Yes	No	Yes	Yes	Yes
Liriomyza trifolii	serpentine leaf miner	Yes	No	Yes	Yes	Possible
Macrosteles sexnotatus	aster leafhopper	Yes	No	Yes	Yes	Possible
Opogona sacchari	banana moth	Yes	No	Yes	Yes	Yes
Rhizoglyphus spp.	bulb mite	Yes	?	Yes	Yes	Yes
Spodoptera littoralis	Egyptian cotton leafworm	?	No	Yes	Yes	Possible
Nematodes						
Ditylenchus destructor	potato rot nematode	Yes	No	Yes	Yes	Possible
Ditylenchus dipsaci	stem nematode	Yes	?	Yes	Yes	Yes
Globodera pallida	pale potato cyst nematode	Yes	No	Yes	Yes	Possible
Globodera rostochiensis	potato cyst nematode	Yes	Yes[R]	Yes	Yes	Possible
Meloidogyne chitwoodi	Colombia root-knot nematode	Yes	No	Yes	Yes	Yes
Longidorus attenuatus	needle nematode	Yes	No	Yes	Yes	Possible
Longidorus macrosoma	needle nematode	Yes	No	Yes	Yes	Possible
Xiphinema spp.	dagger nematodes	Yes	?	Yes	Yes	Possible
Fungi						
Fusarium oxysporum f. sp. *gladioli*	basal rot	Yes	?	Yes	Yes	Yes
Sclerotium wakkeri	smoulder	Yes	No	Yes	Yes	Yes
Bacteria						
Corynebacterium fascians	fasciation	Yes	No	Yes	Yes	Yes
Phytoplasmas						
Aster yellows		Yes	No	Yes	Yes	Possible
Viruses						
Strawberry latent ringspot virus		Yes	?	Yes	Yes	Yes
Tomato black ring virus		Yes	No	Yes	Yes	Yes

Key to table

*****	**NL**- Netherlands, **AU**- Australia.
#	Potential economic impact on bulb crops **and/or** other crops and/or the environment.
Yes[R]	Recorded as present but with localised distribution, under official control.
?	Status confused, certain species/strains may be present but other important ones may not be present. Exotic stains of some species of pests already in Australia (eg. some nematodes) may act differently as vectors of quarantine pests (eg. some viruses). Formae speciales of *Fusarium oxysporum* have been given this status pending confirmatory tests to determine their presence in Australia. *Spodoptera littoralis* has been reported from greenhouses in northern Europe and also as an occasional migrant, and is not normally established there.
UN	Unknown economic status
Possible	May be found on or in bulbs; typically pests in this category occur as pests of active growing bulbiferous plants or are soil-borne contaminants from other crops (such as some nematodes).

Table 19: Quarantine pests - *Hippeastrum* bulbs from the Netherlands.

The following pest list represents our present state of knowledge, and is subject to change as a result of reclassification of organisms and new scientific evidence.

(see below for key to table entries)

		Presence in country*				
Species	**Common name**	**NL**	**AU**	Econ. Imp.#	Q. pest	In pathway
Arthropods						
Agriotes spp.	wireworms	Yes	No	Yes	Yes	Yes
Agrotis segetum	cutworm	Yes	No	Yes	Yes	Yes
Aphis fabae	black bean aphid	Yes	No	Yes	Yes	Possible
Eumerus strigatus	lesser bulb fly	Yes	No	Yes	Yes	Yes
Eumerus tuberculatus	lesser bulb fly	Yes	Yes[R]	Yes	Yes	Yes
Frankliniella fusca	tobacco thrips	Yes	No	Yes	Yes	Yes
Frankliniella occidentalis	western flower thrips	Yes	Yes[R]	Yes	Yes	Yes
Hepialus humuli	ghost swift moth	Yes	No	Yes	Yes	Yes
Hepialus lupulinus	common swift moth	Yes	No	Yes	Yes	Yes
Liriomyza trifolii	serpentine leaf miner	Yes	No	Yes	Yes	Possible
Merodon eques	large narcissus bulb fly	Yes	No	Yes	Yes	Yes
Merodon equestris	large narcissus bulb fly	Yes	No	Yes	Yes	Yes
Merodon spp.	large narcissus bulb fly	Yes	No	Yes	Yes	Yes
Opogona sacchari	banana moth	Yes	No	Yes	Yes	Yes
Phenacoccus avenae	iris mealybug	Yes	No	Yes	Yes	Yes
Spodoptera littoralis	Egyptian cotton leafworm	?	No	Yes	Yes	Possible
*Steneotarsonemus laticep*s	bulb scale mite	Yes	No	Yes	Yes	Yes
Nematodes						
Ditylenchus destructor	potato rot nematode	Yes	No	Yes	Yes	Possible
Ditylenchus dipsaci	stem nematode	Yes	?	Yes	Yes	Yes
Globodera pallida	pale potato cyst nematode	Yes	No	Yes	Yes	Possible
Globodera rostochiensis	potato cyst nematode	Yes	Yes[R]	Yes	Yes	Possible
Meloidogyne chitwoodi	Colombia root-knot nematode	Yes	No	Yes	Yes	Yes
Longidorus attenuatus	needle nematode	Yes	No	Yes	Yes	Possible
Longidorus macrosoma	needle nematode	Yes	No	Yes	Yes	Possible
Xiphinema spp.	dagger nematodes	Yes	?	Yes	Yes	Possible
Fungi						
Cercospora amaryllidis	leaf spot	Yes	No	UN	Yes	Possible
Viruses						
Hippeastrum mosaic virus		Yes	No	Yes	Yes	Yes
Nerine latent virus		Yes	No	UN	Yes	Yes

Key to table

*	**NL**- Netherlands**, AU**- Australia.
#	Potential economic impact on bulb crops **and/or** other crops and/or the environment.
Yes[R]	Recorded as present but with localised distribution, under official control.
?	Status confused, certain species/strains may be present but other important ones may not be present. Exotic stains of some species of pests already in Australia (eg. some nematodes) may act differently as vectors of quarantine pests (eg. some viruses). Formae speciales of *Fusarium oxysporum* have been given this status pending confirmatory tests to determine their presence in Australia. *Spodoptera littoralis* has been reported from greenhouses in northern Europe and also as an occasional migrant, and is not normally established there.
UN	Unknown economic status
Possible	May be found on or in bulbs; typically pests in this category occur as pests of active growing bulbiferous plants or are soil-borne contaminants from other crops (such as some nematodes).

Table 20: Quarantine pests - *Hyacinthus* bulbs from the Netherlands.

The following pest list represents our present state of knowledge, and is subject to change as a result of reclassification of organisms and new scientific evidence.

(see below for key to table entries)

		Presence in country*				
Species	**Common name**	**NL**	**AU**	Econ. Imp.#	Q. pest	In pathway
Arthropods						
Agriotes spp.	wireworms	Yes	No	Yes	Yes	Yes
Agrotis segetum	cutworm	Yes	No	Yes	Yes	Yes
Aphis fabae	black bean aphid	Yes	No	Yes	Yes	Possible
Eumerus strigatus	lesser bulb fly	Yes	No	Yes	Yes	Yes
Eumerus tuberculatus	lesser bulb fly	Yes	Yes[R]	Yes	Yes	Yes
Frankliniella fusca	tobacco thrips	Yes	No	Yes	Yes	Yes
Frankliniella occidentalis	western flower thrips	Yes	Yes[R]	Yes	Yes	Yes
Hepialus humuli	ghost swift moth	Yes	No	Yes	Yes	Yes
Hepialus lupulinus	common swift moth	Yes	No	Yes	Yes	Yes
Liriomyza trifolii	serpentine leaf miner	Yes	No	Yes	Yes	Possible
Macrosteles sexnotatus	aster leafhopper	Yes	No	Yes	Yes	Possible
Merodon equestris	large narcissus bulb fly	Yes	No	Yes	Yes	Yes
Merodon spp.	large narcissus bulb fly	Yes	No	Yes	Yes	Yes
Phenacoccus avenae	iris mealybug	Yes	No	Yes	Yes	Yes
Rhizoglyphus spp.	bulb mite	Yes	?	Yes	Yes	Yes
Spodoptera littoralis	Egyptian cotton leafworm	?	No	Yes	Yes	Possible
Nematodes						
Ditylenchus destructor	potato rot nematode	Yes	No	Yes	Yes	Possible
Ditylenchus dipsaci	stem nematode	Yes	?	Yes	Yes	Yes
Globodera pallida	pale potato cyst nematode	Yes	No	Yes	Yes	Possible
Globodera rostochiensis	potato cyst nematode	Yes	Yes[R]	Yes	Yes	Possible
Meloidogyne chitwoodi	Colombia root-knot nematode	Yes	No	Yes	Yes	Yes
Longidorus attenuatus	needle nematode	Yes	No	Yes	Yes	Possible
Longidorus macrosoma	needle nematode	Yes	No	Yes	Yes	Possible
Xiphinema spp.	dagger nematodes	Yes	?	Yes	Yes	Possible
Fungi						
Botrytis hyacinthi	hyacinth fire	Yes	No	Yes	Yes	Possible
Embellisia hyacinthi	skin spot of hyacinths	Yes	No	UN	Yes	Yes
Bacteria						
Corynebacterium fascians	fasciation	Yes	No	Yes	Yes	Yes
Phytoplasmas						
Aster yellows		Yes	No	Yes	Yes	Possible

Key to table

*****	**NL**- Netherlands**, AU**- Australia.
#	Potential economic impact on bulb crops **and/or** other crops and/or the environment.
Yes[R]	Recorded as present but with localised distribution, under official control.
?	Status confused, certain species/strains may be present but other important ones may not be present. Exotic stains of some species of pests already in Australia (eg. some nematodes) may act differently as vectors of quarantine pests (eg. some viruses). Formae speciales of *Fusarium oxysporum* have been given this status pending confirmatory tests to determine their presence in Australia. *Spodoptera littoralis* has been reported from greenhouses in northern Europe and also as an occasional migrant, and is not normally established there.
UN	Unknown economic status
Possible	May be found on or in bulbs; typically pests in this category occur as pests of active growing bulbiferous plants or are soil-borne contaminants from other crops (such as some nematodes).

Table 21: Quarantine pests - *Iris* bulbs from the Netherlands, the United Kingdom and Israel.

The following pest list represents our present state of knowledge, and is subject to change as a result of reclassification of organisms and new scientific evidence.

(see below for key to table entries)

		Presence in country*						
Species	**Common name**	**NL**	**UK**	**IS**	**AU**	Econ. Imp.#	Q. pest	In pathway
Arthropods								
Agriotes spp.	wireworms	Yes	Yes	Yes	No	Yes	Yes	Yes
Agrotis segetum	cutworm	Yes	Yes	Yes	No	Yes	Yes	Yes
Aphis fabae	black bean aphid	Yes	Yes	Yes	No	Yes	Yes	Possible
Eumerus strigatus	lesser bulb fly	Yes	Yes	No	No	Yes	Yes	Yes
Eumerus tuberculatus	lesser bulb fly	Yes	Yes	No	Yes^R	Yes	Yes	Yes
Eumerus spp.	lesser bulb fly	No	No	Yes	No	Yes	Yes	Yes
Frankliniella fusca	tobacco thrips	Yes	No	No	No	Yes	Yes	Yes
Frankliniella occidentalis	western flower thrips	Yes	Yes	Yes	Yes^R	Yes	Yes	Yes
Hepialus humuli	ghost swift moth	Yes	Yes	No	No	Yes	Yes	Yes
Hepialus lupulinus	common swift moth	Yes	Yes	No	No	Yes	Yes	Yes
Liriomyza trifolii	serpentine leaf miner	Yes	No	Yes	No	Yes	Yes	Possible
Merodon equestris	large narcissus bulb fly	Yes	Yes	No	No	Yes	Yes	Yes
Merodon spp. (other than *M. eques* and *M. equestri*s)	large narcissus bulb fly	Yes	No	Yes	No	Yes	Yes	Yes
Phenacoccus avenae	iris mealybug	Yes	No	Yes	No	Yes	Yes	Yes
Phenacoccus emansor	mealybug	Yes	No	No	No	Yes	Yes	Yes
Rhizoglyphus spp.	bulb mite	Yes	Yes	Yes	?	Yes	Yes	Yes
Spodoptera littoralis	Egyptian cotton leafworm	?	?	Yes	No	Yes	Yes	Possible
Flatworm and nematodes								
Arthurdendyus triangulatus	New Zealand flatworm	No	Yes	No	No	Yes	Yes	Possible
Ditylenchus destructor	potato rot nematode	Yes	Yes	No	No	Yes	Yes	Possible
Ditylenchus dipsaci	stem nematode	Yes	Yes	Yes	?	Yes	Yes	Yes
Globodera pallida	pale potato cyst nematode	Yes	Yes	No	No	Yes	Yes	Possible
Globodera rostochiensis	potato cyst nematode	Yes	Yes	No	Yes^R	Yes	Yes	Possible
Meloidogyne chitwoodi	Colombia root-knot nematode	Yes	No	No	No	Yes	Yes	Yes
Longidorus attenuatus	needle nematode	Yes	Yes	Yes	No	Yes	Yes	Possible
Longidorus macrosoma	needle nematode	Yes	Yes	Yes	No	Yes	Yes	Possible
Xiphinema spp.	dagger nematodes	Yes	Yes	Yes	?	Yes	Yes	Possible
Fungi								
Aecidium narcissi	narcissus rust	Yes	No	No	No	UN	Yes	Possible
Botrytis hyacinthi	hyacinth fire	Yes	Yes	No	No	Yes	Yes	Possible
Fusarium oxysporum f. sp. *gladioli*	basal rot	Yes	Yes	No	?	Yes	Yes	Yes
Hendersonia ucrainica		Yes	No	No	No	UN	Yes	Possible
Sclerotium wakkeri	smoulder	Yes	Yes	No	No	Yes	Yes	Yes
Viruses								
Iris yellow spot virus		Yes	No	Yes	No	Yes	Yes	Yes

Key to table

*	**NL-** Netherlands**, UK-** United Kingdom**, IS-** Israel**, AU-** Australia.
#	Potential economic impact on bulb crops **and/or** other crops and/or the environment.
Yes^R	Recorded as present but with localised distribution, under official control.
?	Status confused, certain species/strains may be present but other important ones may not be present. Exotic stains of some species of pests already in Australia (eg. some nematodes) may act differently as vectors of quarantine pests (eg. some viruses). Formae speciales of *Fusarium oxysporum* have been given this status pending confirmatory tests to determine their presence in Australia. *Spodoptera littoralis* has been reported

	from greenhouses in northern Europe and also as an occasional migrant, and is not normally established there.
UN	Unknown economic status
Possible	May be found on or in bulbs; typically pests in this category occur as pests of active growing bulbiferous plants or are soil-borne contaminants from other crops (such as some nematodes).

Table 22: Quarantine pests - *Lilium* bulbs from the Netherlands, the United Kingdom, Israel and New Zealand.

The following pest list represents our present state of knowledge, and is subject to change as a result of reclassification of organisms and new scientific evidence.

(see below for key to table entries)

		Presence in country*							
Species	**Common name**	**NL**	**UK**	**IS**	**NZ**	**AU**	Econ. Imp.#	Q. pest	In pathway
Arthropods									
Agriotes spp.	wireworms	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Agrotis segetum	cutworm	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Aphis fabae	black bean aphid	Yes	Yes	Yes	No	No	Yes	Yes	Possible
Eumerus strigatus	lesser bulb fly	Yes	Yes	No	Yes	No	Yes	Yes	Yes
Eumerus tuberculatus	lesser bulb fly	Yes	Yes	No	Yes	Yes[R]	Yes	Yes	Yes
Eumerus spp.	lesser bulb fly	No	No	Yes	No	No	Yes	Yes	Yes
Frankliniella fusca	tobacco thrips	Yes	No	No	No	No	Yes	Yes	Yes
Frankliniella occidentalis	western flower thrips	Yes	Yes	Yes	Yes	Yes[R]	Yes	Yes	Yes
Hepialus humuli	ghost swift moth	Yes	Yes	No	No	No	Yes	Yes	Yes
Hepialus lupulinus	common swift moth	Yes	Yes	No	No	No	Yes	Yes	Yes
Lilioceris spp.	lily beetles	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Liothrips vaneeckei	lily thrips	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Liriomyza trifolii	serpentine leaf miner	Yes	No	Yes	No	No	Yes	Yes	Possible
Merodon eques	large narcissus bulb fly	Yes	No	Yes	No	No	Yes	Yes	Yes
Merodon equestris	large narcissus bulb fly	Yes	Yes	No	Yes	No	Yes	Yes	Yes
Merodon spp.	large narcissus bulb fly	Yes	No	Yes	No	No	Yes	Yes	Yes
Phenacoccus avenae	iris mealybug	Yes	No	Yes	No	No	Yes	Yes	Yes
Phenacoccus emansor	mealybug	Yes	No	No	No	No	Yes	Yes	Yes
Rhizoglyphus spp.	bulb mite	Yes	Yes	Yes	Yes	?	Yes	Yes	Yes
Spodoptera littoralis	Egyptian cotton leafworm	?	?	Yes	No	No	Yes	Yes	Possible
Flatworm and nematodes									
Arthurdendyus triangulatus	New Zealand flatworm	No	Yes	No	Yes	No	Yes	Yes	Possible
Ditylenchus destructor	potato rot nematode	Yes	Yes	No	Yes	No	Yes	Yes	Possible
Ditylenchus dipsaci	stem nematode	Yes	Yes	Yes	Yes	?	Yes	Yes	Yes
Globodera pallida	pale potato cyst nematode	Yes	Yes	No	Yes	No	Yes	Yes	Possible
Globodera rostochiensis	potato cyst nematode	Yes	Yes	No	Yes	Yes[R]	Yes	Yes	Possible
Meloidogyne chitwoodi	Colombia root-knot nematode	Yes	No	No	No	No	Yes	Yes	Yes
Longidorus attenuatus	needle nematode	Yes	Yes	Yes	Yes	No	Yes	Yes	Possible
Longidorus macrosoma	needle nematode	Yes	Yes	Yes	Yes	No	Yes	Yes	Possible
Xiphinema spp.	dagger nematodes	Yes	Yes	Yes	Yes	?	Yes	Yes	Possible
Fungi									
Botrytis hyacinthi	hyacinth fire	Yes	Yes	No	No	No	Yes	Yes	Possible

		Presence in country*							
Species	**Common name**	**NL**	**UK**	**IS**	**NZ**	**AU**	Econ. Imp.#	Q. pest	In pathway
Fusarium oxysporum f. sp. *lilii*	basal rot	Yes	Yes	No	No	?	Yes	Yes	Yes
Mycosphaerella cinxia	leaf spot of liliums	No	No	Yes	No	No	UN	Yes	Possible
Mycosphaerella martagonas	leaf spot of liliums	No	Yes	No	No	No	UN	Yes	Unlikely
Phyllosticta liliicola		Yes	Yes	No	No	No	UN	Yes	Possible
Sclerotium wakkeri	smoulder	Yes	Yes	No	No	No	Yes	Yes	Yes
Septocylindrium spp.		Yes	No	No	No	No	Yes	Yes	Yes
Uromyces aecidiiformis	lily rust	Yes	Yes	No	No	No	Yes	Yes	Yes
Uromyces holwayi	lily rust	No	Yes	No	No	No	Yes	Yes	Yes
Bacteria									
Corynebacterium fascians	fasciation	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Viruses									
Iris yellow spot virus		Yes	No	Yes	No	No	Yes	Yes	Yes
Lily mottle virus		Yes	No	Yes	No	No	Yes	Yes	Yes
Lily X virus		Yes	Yes	No	No	No	UN	Yes	Yes
Rembrandt tulip breaking virus		Yes	Yes	No	No	No	UN	Yes	Yes
Strawberry latent ringspot virus		Yes	Yes	Yes	Yes	?	Yes	Yes	Yes

Key to table

*****	**NL**- Netherlands**, UK**- United Kingdom**, IS**- Israel**, NZ** -New Zealand**, AU**- Australia.
#	Potential economic impact on bulb crops **and/or** other crops and/or the environment.
Yes^R	Recorded as present but with localised distribution, under official control.
?	Status confused, certain species/strains may be present but other important ones may not be present. Exotic stains of some species of pests already in Australia (eg. some nematodes) may act differently as vectors of quarantine pests (eg. some viruses). Formae speciales of *Fusarium oxysporum* have been given this status pending confirmatory tests to determine their presence in Australia. *Spodoptera littoralis* has been reported from greenhouses in northern Europe and also as an occasional migrant, and is not normally established there.
UN	Unknown economic status
Possible	May be found on or in bulbs; typically pests in this category occur as pests of active growing bulbiferous plants or are soil-borne contaminants from other crops (such as some nematodes).

Table 23: Quarantine pests - *Narcissus* bulbs from the Netherlands and United Kingdom

The following pest list represents our present state of knowledge, and is subject to change as a result of reclassification of organisms and new scientific evidence.

(see below for key to table entries)

		Presence in country*					
Species	**Common name**	**NL**	**UK**	**AU**	Econ Imp.#	Q. pest	In pathway
Arthropods							
Agriotes spp.	wireworms	Yes	Yes	No	Yes	Yes	Yes
Agrotis segetum	cutworm	Yes	Yes	No	Yes	Yes	Yes
Aphis fabae	black bean aphid	Yes	Yes	No	Yes	Yes	Possible
Eumerus strigatus	lesser bulb fly	Yes	Yes	No	Yes	Yes	Yes
Eumerus tuberculatus	lesser bulb fly	Yes	Yes	Yes^R	Yes	Yes	Yes
Frankliniella fusca	tobacco thrips	Yes	No	No	Yes	Yes	Yes
Frankliniella occidentalis	western flower thrips	Yes	Yes	Yes^R	Yes	Yes	Yes
Hepialus humuli	ghost swift moth	Yes	Yes	No	Yes	Yes	Yes
Hepialus lupulinus	common swift moth	Yes	Yes	No	Yes	Yes	Yes
Liriomyza trifolii	serpentine leaf miner	Yes	No	No	Yes	Yes	Possible
Merodon equestris	large narcissus bulb fly	Yes	Yes	No	Yes	Yes	Yes
Merodon spp.	large narcissus bulb fly	Yes	No	No	Yes	Yes	Yes
Norellia spinipes	scathophagid fly	Yes	Yes	No	Yes	Yes	Possible

		Presence in country*					
Species	**Common name**	**NL**	**UK**	**AU**	Econ Imp.#	Q. pest	In pathway
Phenacoccus avenae	iris mealybug	Yes	No	No	Yes	Yes	Yes
Rhizoglyphus spp.	bulb mite	Yes	Yes	?	Yes	Yes	Yes
Spodoptera littoralis	Egyptian cotton leafworm	?	?	No	Yes	Yes	Possible
Steneotarsonemus laticeps	bulb scale mite	Yes	Yes	No	Yes	Yes	Yes
Flatworm and nematodes							
Arthurdendyus triangulatus	New Zealand flatworm	No	Yes	No	Yes	Yes	Possible
Ditylenchus destructor	potato rot nematode	Yes	Yes	No	Yes	Yes	Possible
Ditylenchus dipsaci	stem nematode	Yes	Yes	?	Yes	Yes	Yes
Globodera pallida	pale potato cyst nematode	Yes	Yes	No	Yes	Yes	Possible
Globodera rostochiensis	potato cyst nematode	Yes	Yes	Yes[R]	Yes	Yes	Possible
Meloidogyne chitwoodi	Colombia root-knot nematode	Yes	No	No	Yes	Yes	Yes
Longidorus attenuatus	needle nematode	Yes	Yes	No	Yes	Yes	Possible
Longidorus macrosoma	needle nematode	Yes	Yes	No	Yes	Yes	Possible
Xiphinema spp.	dagger nematodes	Yes	Yes	?	Yes	Yes	Possible
Fungi							
Aecidium narcissi	narcissus rust	Yes	No	No	UN	Yes	Possible
Botrytis polyblastis	narcissus fire	Yes	Yes	No	UN	Yes	Possible
Cercospora amaryllidis	leaf spot	Yes	Yes	No	UN	Yes	Possible
Coleosporium narcissi	narcissus rust	No	Yes	No	UN	Yes	Possible
Fusarium oxysporum f. sp. *narcissi*	basal rot	Yes	Yes	?	Yes	Yes	Yes
Puccinia narcissi	narcissus rust	Yes	No	No	UN	Yes	Possible
Puccinia schroeteri	rust	No	Yes	No	Yes	Yes	Possible
Ramularia vallisumbrosae	white mould of narcissus	Yes	Yes	No	Yes	Yes	Yes
Stromatinia narcissi	dry rot of narcissus	Yes	Yes	No	Yes	Yes	Yes
Urocystis colchici f. sp. *narcissi*	leaf smut of narcissus	Yes	Yes	No	Yes	Yes	Yes
Viruses							
Narcissus late season yellows virus		Yes	Yes	No	Yes	Yes	Yes
Narcissus tip necrosis virus		Yes	Yes	No	UN	Yes	Yes
Raspberry ringspot virus		Yes	Yes	No	Yes	Yes	Yes
Tomato black ring virus		Yes	Yes	No	Yes	Yes	Yes
Tulip X virus		Yes	Yes	No	UN	Yes	Yes

Key to table

*****	**NL-** Netherlands**, UK-** United Kingdom**, AU-** Australia.
#	Potential economic impact on bulb crops **and/or** other crops and/or the environment.
Yes[R]	Recorded as present but with localised distribution, under official control.
?	Status confused, certain species/strains may be present but other important ones may not be present. Exotic stains of some species of pests already in Australia (eg. some nematodes) may act differently as vectors of quarantine pests (eg. some viruses). Formae speciales of *Fusarium oxysporum* have been given this status pending confirmatory tests to determine their presence in Australia. *Spodoptera littoralis* has been reported from greenhouses in northern Europe and also as an occasional migrant, and is not normally established there.
UN	Unknown economic status
Possible	May be found on or in bulbs; typically pests in this category occur as pests of active growing bulbiferous plants or are soil-borne contaminants from other crops (such as some nematodes).

Table 24: Quarantine pests - *Tulipa* bulbs from the Netherlands and New Zealand

The following pest list represents our present state of knowledge, and is subject to change as a result of reclassification of organisms and new scientific evidence.

(see below for key to table entries)

		Presence in country*					
Species	**Common name**	**NL**	**NZ**	**AU**	Econ. Imp.#	Q. pest	In pathway
Arthropods							
Aceria tulipae	dry bulb mite	Yes	Yes	No	Yes	Yes	Yes
Agriotes spp.	wireworms	Yes	No	No	Yes	Yes	Yes
Agrotis segetum	cutworm	Yes	No	No	Yes	Yes	Yes
Aphis fabae	black bean aphid	Yes	No	No	Yes	Yes	Possible
Eumerus strigatus	lesser bulb fly	Yes	Yes	No	Yes	Yes	Yes
Eumerus tuberculatus	lesser bulb fly	Yes	Yes	Yes[R]	Yes	Yes	Yes
Frankliniella fusca	tobacco thrips	Yes	No	No	Yes	Yes	Yes
Frankliniella occidentalis	western flower thrips	Yes	Yes	Yes[R]	Yes	Yes	Yes
Hepialus humuli	ghost swift moth	Yes	No	No	Yes	Yes	Yes
Hepialus lupulinus	common swift moth	Yes	No	No	Yes	Yes	Yes
Liriomyza trifolii	serpentine leaf miner	Yes	No	No	Yes	Yes	Possible
Merodon eques	large narcissus bulb fly	Yes	No	No	Yes	Yes	Yes
Merodon equestris	large narcissus bulb fly	Yes	Yes	No	Yes	Yes	Yes
Merodon spp.	large narcissus bulb fly	Yes	No	No	Yes	Yes	Yes
Phenacoccus avenae	iris mealybug	Yes	No	No	Yes	Yes	Yes
Rhizoglyphus spp.	bulb mite	Yes	Yes	?	Yes	Yes	Yes
Spodoptera littoralis	Egyptian cotton leafworm	?	No	No	Yes	Yes	Possible
Flatworm and nematodes							
Arthurdendyus triangulatus	New Zealand flatworm	No	Yes	No	Yes	Yes	Possible
Ditylenchus destructor	potato rot nematode	Yes	Yes	No	Yes	Yes	Possible
Ditylenchus dipsaci	stem nematode	Yes	Yes	?	Yes	Yes	Yes
Globodera pallida	pale potato cyst nematode	Yes	Yes	No	Yes	Yes	Possible
Globodera rostochiensis	potato cyst nematode	Yes	Yes	Yes[R]	Yes	Yes	Possible
Meloidogyne chitwoodi	Colombia root-knot nematode	Yes	No	No	Yes	Yes	Yes
Longidorus attenuatus	needle nematode	Yes	Yes	No	Yes	Yes	Possible
Longidorus macrosoma	needle nematode	Yes	Yes	No	Yes	Yes	Possible
Xiphinema spp.	dagger nematodes	Yes	Yes	?	Yes	Yes	Possible
Fungi							
Fusarium oxysporum f. sp. *tulipae*	basal rot	Yes	No	?	Yes	Yes	Yes
Sclerotium perniciosum	smoulder of tulip	Yes	No	No	Yes	Yes	Yes
Sclerotium wakkeri	smoulder	Yes	No	No	Yes	Yes	Yes
Septocylindrium spp.		Yes	No	No	Yes	Yes	Yes
Urocystis colchici f. sp. *narcissi*	leaf smut of narcissus	Yes	No	No	Yes	Yes	Yes
Bacteria							
Curtobacterium flaccumfaciens pv. *oortii*	tulip canker	Yes	No	No	Yes	Yes	Yes
Viruses							
Lily mottle virus		Yes	No	No	Yes	Yes	Yes
Rembrandt tulip breaking virus		Yes	No	No	UN	Yes	Yes
Tomato black ring virus		Yes	No	No	Yes	Yes	Yes
Tulip band-breaking virus		Yes	No	No	UN	Yes	Yes
Tulip severe mosaic (?) *virus*		Yes	No	No	UN	Yes	Yes
Tulip top breaking virus		Yes	No	No	UN	Yes	Yes
Tulip X virus		Yes	No	No	UN	Yes	Yes

Key to table

*****	**NL**- Netherlands**, NZ** -New Zealand**, AU**- Australia.
#	Potential economic impact on bulb crops **and/or** other crops and/or the environment.
Yes[R]	Recorded as present but with localised distribution, under official control.
?	Status confused, certain species/strains may be present but other important ones may not be present. Exotic stains of some species of pests already in Australia (eg. some nematodes) may act differently as vectors of quarantine pests (eg. some viruses). Formae speciales of *Fusarium oxysporum* have been given this status pending confirmatory tests to determine their presence in Australia. *Spodoptera littoralis* has been reported from greenhouses in northern Europe and also as an occasional migrant, and is not normally established there.
UN	Unknown economic status
Possible	May be found on or in bulbs; typically pests in this category occur as pests of active growing bulbiferous plants or are soil-borne contaminants from other crops (such as some nematodes).

Table 25: List of pests that have been recorded as being present in Australia, are not of quarantine concern and are associated with genera of bulbiferous plants that are the subject of this IRA.

The following pest list represents our present state of knowledge, and is subject to change as a result of reclassification of organisms and new scientific evidence.

Arthropods	**Reference for its occurrence in Australia**
Agrotis ipsilon (Hufnagel, 1766) [Lepidoptera: Noctuidae]	Nielsen *et al.* (1996)
Aphis gossypii Glover, 1877 [Hemiptera: Aphididae]	Nauman (1993), CAB International (1999)
Aulacorthum (Neozymous) circumflexum (Buckton, 1876) [Hemiptera: Aphididae]	Nauman (1993), CAB International (1999)
Aulacorthum solani (Kaltenbach, 1843) [Hemiptera: Aphididae]	Nauman (1993), CAB International (1999)
Dysaphis tulipae (Boyer de Fonscolombe, 1841) [Hemiptera: Aphididae)	Nauman (1993), CAB International (1999)
Macrosiphum euphorbiae (Thomas, 1878) [Hemiptera: Aphididae]	Nauman (1993), CAB International (1999)
Myzus persicae (Sulzer, 1776) [Hemiptera: Aphididae].	Nauman (1993), CAB International (1999)
Thrips hawaiiensis (Morgan, 1913) [Thysanoptera: Thripidae]	Nauman (1993), CAB International (1999)
Thrips simplex (Morison, 1930) [Thysanoptera: Thripidae]	Nauman (1993), CAB International (1999)
Tyrophagus putrescentiae (Schrank, 1781)[Acari: Astigmata: Acaridae]	Halliday (1998)
Vryburgia amaryllidis (Bouché, 1937) [Hemiptera: Pseudococcidae]	Williams (1985), Ben Dov *et al.* (2000)
Nematodes	
Aphelenchoides fragariae (Ritzema-Bos) Christie [Aphelenchida: Aphelenchoididae]	McLeod *et al.* (1994)
Aphelenchoides ritzemabosi (Schwartz) Steiner and Buhrer [Aphelenchida: Aphelenchoididae]	McLeod *et al.* (1994)
Aphelenchoides subtenuis (Cobb) Steiner & Buhrer [Aphelenchida: Aphelenchoididae]	McLeod *et al.* (1994)
Meloidogyne hapla Chitwood [Tylenchida: Meloidogynidae]	McLeod *et al.* (1994)
Meloidogyne javanica (Treub) Chitwood [Tylenchida : Meloidogynidae]	McLeod *et al.* (1994)
Paratrichodorus lobatus (Colbran) Siddiqi [Dorylaimida: Trichodoridae]	McLeod *et al.* (1994)
Paratrichodorus minor (Colbran) Siddiqui [Dorylaimida : Trichodoridae]	McLeod *et al.* (1994)
Pratylenchus penetrans (Cobb) Chitwood and Oteifa [Tylenchida : Pratylenchidae]	McLeod *et al.* (1994)
Pratylenchus thornei Sher & Allen [Tylenchida: Pratylenchidae]	McLeod *et al.* (1994)
Fungi	

Athelia rolfsii (Curzi) C. C. Tu & Kimbr. (teleomorph) [Stereales : Corticiaceae]	Anon (1996)
Aspergillus niger Tiegh. ('mitosporic fungi', Hyphomycetes)	Anon (1996)
Botryotinia draytonii (Buddin & Wakefield) Seaver [Leotiales : Sclerotinaceae]	Anon (1996)
Botryotinia fuckeliana (de Bary) Whetzel 1945 (teleomorph) [Leotiales: Sclerotiniaceae]	Anon (1996)
Botrytis cinerea Pers.: Fr (anamorph) [Leotiales ; Sclerotinaceae]	Anon (1996)
Botrytis convoluta Whetz. & Drayt (anamorph) [Leotiales : Sclerotinaceae]	Anon (1996)
Botrytis elliptica (Berk.) Cooke ('mitosporic fungi', Hyphomycetes)	Anon (1996)
Botrytis gladiolorum Timmermans [Leotiales ; Sclerotinaceae]	Anon (1996)
Botrytis narcissicola Klebahn [Leotiales ; Sclerotinaceae]	Anon (1996)
Botrytis tulipae Lind (mitosporic fungi:Hyphomycetes)	Anon (1996)
Ceratobasidium cornigerum (Bourd.) Rogers [Basidiomycota : Basidiomycetes]	Anon (1996)
Ceratocystis narcissi (Limber) Hunt [Ophiostomatales : Ophiostomataceae]	Anon (1996)
Colletotrichum coccodes (Wallr.) Hughes [Fungi : mitosporic fungi]	Anon (1996)
Colletotrichum crassipes (Spegazzini) von Arx [Fungi : mitosporic fungi]	Anon (1996)
Colletotrichum dematium (Pers.) Grove [Fungi : mitosporic fungi]	Anon (1996)
Colletotrichum lilii Plakidas [Fungi : mitosporic fungi]	Anon (1996)
Curvularia trifolii (Kauff) f. sp. *gladioli* Boerema & Hamers [mitosporic fungi; Hyphomycetes]	Anon (1996)
Cylindrocarpon destructans (Zinssmeister) Scholten [anamorph] [Hypocreales : Hypocreaceae]	Anon (1996)
Dreschslera iridis (Oud.) Ell [mitosporic fungi : Hyphomycetes]	Anon (1996)
Eupenicillium crustaceum Ludwig. 1892. (teleomorph) [Eurotiales : Trichocomaceae]	Pitt (1987)
Fusarium avenaceum (Corda: Fr.) Sacc. (anamorph) [Hypocreales: Hypocreaceae]	Chambers (1973)
Fusarium culmorum (W.G. Sm.) Sacc [Fungi : mitosporic fungi]	Anon (1996)
Fusarium moniliforme var. *subglutinans* Wollenw. & Reinking [Fungi : mitosporic fungi]	Anon (1996)
Fusarium oxysporum var. *orthocerus* Schlechtendahl [Fungi : mitosporic fungi]	Anon (1996)
Fusarium solani (Martius) Sacc (anamorph) [Hypocreales: Hypocreaceae]	Anon (1996)
Gibberella avenacea R.J. Cook (teleomorph) [Hypocreales: Hypocreaceae]	Anon (1996)
Gliocladium roseum (Link) Barnier [mitosporic fungi : Hyphomycetes])	Anon (1996)
Glomerella cingulata (Stonem.) Spauld. & Schrenk [Phyllachorales : Phyllachoraceae]	Anon (1996)
Helicobasidium brebissonii (Desm.) Donk [Auriculariales: Auriculariaceae]	Anon (1996)
Helicobasidium purpureum [Tul] Pat [Auriculariales: Auriculariaceae]	Smith and Jenkins (1998)
Heterosporium sp. [Fungi : Ascomycota]	Anon (1996)
Macrophomina phaseolina (Tassi) Goid [Fungi : mitosporic fungi]	Anon (1996)
Nectria ochroleuca (teleomorph)[Hypocreales: Hypocreaceae]	Anon (1996)
Phytophthora cactorum (Leb. & Cohn) Schroeter (1886) [Pythiales : Pythiaceae]	Hardy and Sivasithamparam (1988)
Phytophthora cryptogea Pethybridge & Lafferty (1919) [Pythiales : Pythiaceae].	Stirling and Irwin (1986)
Phytophthora erythroseptica Pethybridge (1913) var. *erythroseptica* Waterhouse (1963) [Pythiales: Pythiaceae].	Hardy and Sivasithamparam (1988)
Phytophthora hibernalis Carne, 1925 [Pythiales: Pythiaceae]	Erwin and Ribeiro (1996)
Penicillium aurantiogriseum Dierckx. 1901 [Hyphomycetes: Moniliaceae]	Anon (1996)
Penicillium hirsutum Dierckx. 1901 [Hyphomycetes: Moniliaceae]	Pitt (1987)
Physarum cinereum [Physarales: Physaraceae]	Anon (1996)
Physoderma sp. Wallroth 1833. [Chytridiomycota: Chytridiomycetes: Physodermataceae]	Smith and Jenkins (1998)
Phytophthora megasperma Drechsler, 1931. [Pythiales : Pythiaceae].	Erwin and Ribeiro (1996)
Phytophthora nicotianae Breda de Hahn (1896). [Pythiales : Pythiaceae].	Hardy and Sivasithamparam (1988)
Puccinia iridis Rabenhorst 1844 [Uredinales : Pucciniaceae]	Smith and Jenkins (1998)
Pythium intermedium de Bary 1881 [Pythiales : Pythiaceae].	Smith and Jenkins (1998)
Pythium irregulare Buisman [Pythiales: Pythiaceae]	Burgess *et al.* (1973)
Pythium ultimum Trow [Pythiales : Pythiaceae]	Smith and Jenkins (1998)

Rhizopus sp. [Mucorales: Mucoraceae]	Hall (1974)
Rhizoctonia solani [Ceratobasidiales: Ceratobasidiaceae]	CAB International (1999)
Rhizopus arrhizus Fischer [Mucorales: Mucoraceae]	Dept. of Agric. Vic (1970)
Rhizopus stolonifer (Ehrenb.:Fr) Vuill. 1913 [Mucorales : Mucoraceae]	Smith and Jenkins (1998)
Rosellinia necatrix Prill. (teleomorph) [Sphaeriales: Sphaeriaceae]	Heaton & Dullahide, (1990)
Sclerotinia bulborum (Wakker) Saccardo [Leotiales: Sclerotiniaceae]	Smith and Jenkins (1998)
Sclerotinia minor Jagger 1920 [Leotiales: Sclerotiniaceae]	Smith and Jenkins (1998)
Sclerotinia narcissicola Greg. 1941 [Leotiales: Sclerotiniaceae]	Anon (1996)
Sclerotinia sclerotiorum [Leotiales: Sclerotiniaceae]	Wong and Williams (1975)
Sclerotium tuliparum Klebahn 1905 [Fungi : mitosporic fungi]	Smith and Jenkins (1998)
Septoria gladioli Passerini 1874 [Blastales: Blastopycnothyriineae].	Anon (1996)
Stagonospora sp. [Blastales: Blastopycnidiineae]	Anon (1996)
Stagonosporopsis curtisii (Berkeley) Boerema [Blastales: Blastopycnidiineae]	Anon (1996)
Stagonospora iridis Massal. 1890 [Blastales: Blastopycnidiineae]	Anon (1996)
Stemphylium sp. [Moniliales: Dematiaceae].	Anon (1996)
Stromatinia gladioli (Drayton) Whetzel [Leotiales : Sclerotiniaceae]	Anon (1996)
Trichoderma viride [Moniliales: Moniliaceae]	Anon (1996)
Trichothecium roseum Link [Moniliales: Moniliaceae]	Anon (1996)
Urocystis gladiolicola Ainsworth 1948 [Ustilaginales : Tilletiaceae].	Anon (1996)
Uromyces transversalis (Thüm.) G. Winter (1884) [Uredinales : Pucciniaceae]	Anon (1996)
Bacteria	
Burkholderia gladioli (Severini 1913) Yabuuchi *et al*. 1993 [Burkholderiales : Burkholderiaceae]	CAB International (1999)
Burkholderia gladioli pv. *alliicola* (Burkholder 1942) comb. nov. [Burkholderiales : Burkholderiaceae]	CAB International (1999)
Burkholderia gladioli pv. *gladioli* (Severini) Yabuuchi *et al*. 1993 [Burkholderiales : Burkholderiaceae]	CAB International (1999)
Erwinia carotovora (Jones 1901) Bergey *et al*. 1923 [Enterobacteriales : Enterobacteriaceae]	CAB International (1999)
Erwinia carotovora subsp. *carotovora* (Jones, 1901) Bergey *et al*. 1923 [Enterobacteriales : Enterobacteriaceae]	CAB International (1999)
Erwinia chrysanthemi (Burkholder *et al*. 1953) Dye 1969 [Enterobacteriales : Enterobacteriaceae]	CAB International (1999)
Erwinia herbicola (Löhnis 1911) Dye 1964 [Enterobacteriales : Enterobacteriaceae]	CAB International (1999)
Pseudomonas fluorescens (Trevisan) Migula 1895 [Pseudomonadales : Pseudomonadaceae]	CAB International (1999)
Xanthomonas hyacinthi (Wakker 1883) Vauterin *et al*. 1995 [Xanthomonadales : Xanthomonadaceae]	CAB International (1999)
Xanthomonas campestris pv. *gummisudans* (McCulloch 1924) Dye 1978 [Xanthomonadales : Xanthomonadaceae]	CAB International (1999)
Viruses	
Arabis mosaic virus Smith and Markham (1944) [Nepovirus]	Brunt *et al*. (1996) onwards
Bean yellow mosaic virus Doolittle and Jones (1925) [Potyvirus]	Brunt *et al*. (1996) onwards
Broad bean wilt virus Stubbs (1947) [Fabavirus]	Brunt *et al*. (1996) onwards
Cucumber mosaic virus Price (1934) [Cucumovirus]	Brunt *et al*. (1996) onwards
Freesia mosaic virus Van Koot *et al*. (1954) [Potyvirus]	Brunt *et al*. (1996) onwards
Gladiolus ringspot virus Brunt and Atkey (1967) [Macluravirus]	Brunt *et al*. (1996) onwards
Iris mild mosaic virus Van Slogteren (1958) [Potyvirus]	Brunt *et al*. (1996) onwards
Iris severe mosaic virus Atanasoff (1928) [Potyvirus]	Brunt *et al*. (1996) onwards
Lily symptomless virus Brierley and Smith (1944) [Carlavirus]	Brunt *et al*. (1996) onwards
Narcissus latent virus Brunt and Atkey (1967). [Macluravirus]	Brunt *et al*. (1996) onwards
Narcissus mosaic virus Van Slogteren and de Bruyn Ouboter (1946) [Potexvirus]	Brunt *et al*. (1996) onwards
Tobacco necrosis virus Smith and Bald (1935) [Necrovirus]	Brunt *et al*. (1996) onwards
Tobacco rattle virus Böning (1931) [Tobravirus]	Brunt *et al*. (1996) onwards
Tomato aspermy virus Ainsworth (1939) [Cucumovirus]	Brunt *et al*. (1996) onwards

Tobacco ringspot virus Fromme et al. (1927) [Nepovirus]	Brunt *et al*. (1996) onwards
Tomato spotted wilt virus Brittlebank (1919) [Tospovirus]	Brunt *et al*. (1996) onwards

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