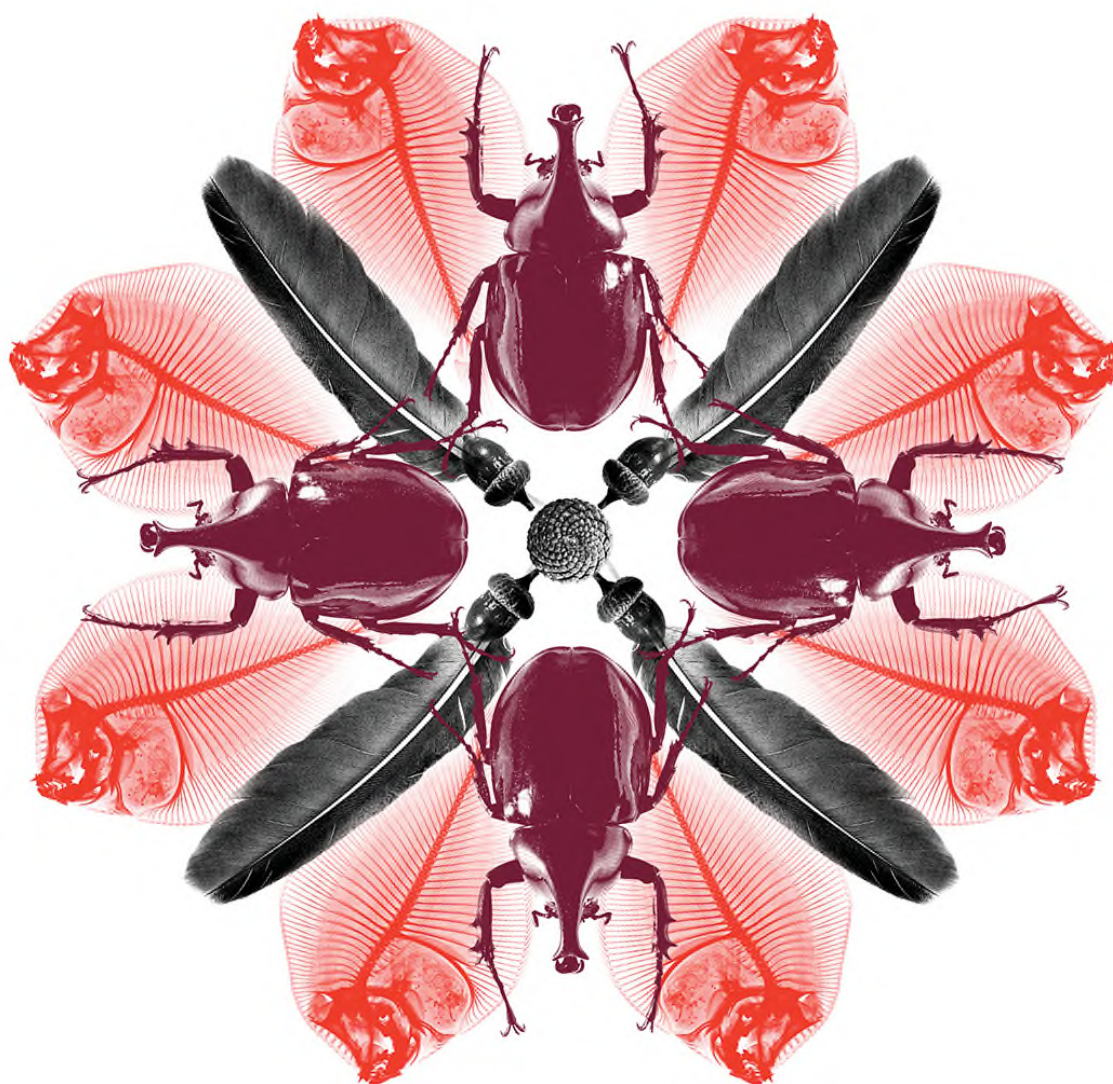




Australian Government
Department of Agriculture,
Water and the Environment

Final review of import conditions for cucurbitaceous vegetable seeds for sowing

June 2020



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Acronyms and abbreviations

Term or abbreviation	Definition
ACT	Australian Capital Territory
ALOP	Appropriate level of protection
BIRA	Biosecurity Import Risk Analysis
ELISA	Enzyme-linked immunosorbent assay
FAO	Food and Agriculture Organization of the United Nations
IPC	International Phytosanitary Certificate
IPPC	International Plant Protection Convention
ISPM	International Standard for Phytosanitary Measures
NSW	New South Wales
NPPO	National Plant Protection Organisation
NT	Northern Territory
PCR	Polymerase Chain Reaction
PRA	Pest risk analysis
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures
the department	The Department of Agriculture, Water and the Environment
WTO	World Trade Organization

Summary

Australia depends heavily on imported seeds to produce a wide range of crops, including vegetables, and imports large quantities of these seeds annually.

The distributions of seed-borne pathogens are expanding globally, and new risks continually emerge. The vegetable seeds trade has become globalised and is evolving—seed lines are usually developed, commercially multiplied and processed in various countries rather than at a single origin. Therefore, the risks of seeds' exposure to new pathogens and the likelihood that these pathogens may enter Australia via imported seeds have increased.

Acknowledging the change in risk profile associated with this trade, the Department of Agriculture, Water and the Environment (the department) is undertaking a series of seed reviews of the import conditions for four key vegetable families: Apiaceae, Brassicaceae, Cucurbitaceae, and Solanaceae. These reviews were initially funded by the Australian Government's Agricultural Competitiveness White Paper and are one means by which Australia is strengthening biosecurity surveillance and analysis. This review of cucurbitaceous vegetable seeds for sowing is the second of the series to be finalised.

Under Australia's existing import policy, all seeds for sowing, including cucurbitaceous vegetable seeds, are subject to the department's standard import conditions. However, this review of import conditions identified eight quarantine pests (one fungus and seven viruses) associated with the seeds of several cucurbitaceous vegetables.

The identified quarantine pests are *Bitter melon yellow mosaic virus* (BgYMV), *Cucumber fruit mottle mosaic virus* (CFMMV), *Cucumber green mottle mosaic virus* (CGMMV), *Diaporthe cucurbitae* (formerly *Phomopsis cucurbitae*), *Kyuri green mottle mosaic virus* (KGMMV), *Melon necrotic spot virus* (MNSV), *Tomato black ring virus* (TBRV) and *Zucchini green mottle mosaic virus* (ZGMMV).

The unrestricted risks of these quarantine pests on the seeds for sowing pathway do not achieve the appropriate level of protection (ALOP) for Australia. Consequently, additional pest risk management measures are required to mitigate the risks posed by the identified quarantine pests to achieve the ALOP for Australia.

In addition to the department's standard seeds for sowing import conditions, four pest risk management options (see Chapter 4) are recommended for seeds of *Citrullus lanatus*, *Cucumis melo*, *Cucumis sativus*, *Cucurbita maxima*, *Cucurbita moschata*, *Cucurbita pepo*, *Lagenaria siceraria*, *Momordica charantia*, *Trichosanthes cucumerina* and any hybrid of these species:

- Option 1. Polymerase chain reaction (PCR) test—an option that is applicable to all eight identified quarantine pests.
- Option 2. Enzyme-linked immunosorbent assay (ELISA) test—an option that is applicable to CGMMV, KGMMV, MNSV and ZGMMV.
- Option 3. Broad spectrum fungicidal treatment—an option that is applicable to *Diaporthe cucurbitae*.
- Option 4. Heat treatment—an option that is applicable to MNSV.

If the required treatment or testing is undertaken off-shore, phytosanitary certification is required with the additional declaration that the testing or treatment has been conducted in accordance with Australia's requirements.

Citrullus lanatus, *Cucumis melo*, *Cucumis sativus*, *Cucurbita maxima*, *Cucurbita moschata*, *Cucurbita pepo*, *Lagenaria siceraria*, *Momordica charantia* and *Trichosanthes cucumerina* seeds for sprouting or micro-greens production for human consumption are exempt from these additional measures if imported directly for germination at a production facility operated under an Approved Arrangement. This is to mitigate risks from the diversion of seeds to other end-uses.

Alternatives to testing or treatment, such as sourcing seed from pest-free areas or pest-free places of production, or sourcing seed produced under a systems approach, may be considered. However, supporting documentation demonstrating pest free area status, pest free place of production status, or details of a proposed systems approach will be required for the department to consider these options on a case-by-case basis.

Seeds of most cucurbitaceous vegetable species reviewed were not found to be hosts of quarantine pests for Australia and they will continue to be subject only to the department's standard seeds for sowing import conditions.

Comments raised by stakeholders on the 'Draft review of import conditions for cucurbitaceous crop seeds for sowing into Australia' were taken into consideration in the preparation of the final report (responses are presented in Appendix B).

The key changes made in the final report are:

- the inclusion of three additional quarantine pests (BgYMV, CFMMV and TBRV) associated with cucurbitaceous vegetable seeds
- the inclusion of other pest risk management options (heat treatment for MNSV and PCR testing for *Diaporthe cucurbitae*) that are suitable for both organic and non-organic seeds sectors.

The department considers that the pest risk management measures recommended in this review will mitigate the risks posed by the identified quarantine pests associated with cucurbitaceous vegetable seeds to a level that achieves the ALOP for Australia.

1 Introduction

1.1 Australia's biosecurity policy framework

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

The risk analysis process is an important part of Australia's biosecurity policy development. It enables the Australian Government to formally consider the level of biosecurity risk that may be associated with proposals to import goods into Australia. If the biosecurity risks do not achieve the appropriate level of protection (ALOP) for Australia, risk management measures are recommended to reduce the risks to an acceptable level. If the risks cannot be reduced to an acceptable level, the goods will not be imported into Australia until suitable measures are identified or developed.

Successive Australian Governments have maintained a stringent, but not a zero risk, approach to the management of biosecurity risks. This approach is expressed in terms of the ALOP for Australia, which is defined in the *Biosecurity Act 2015* as providing a high level of protection aimed at reducing risk to a very low level, but not to zero.

Australia's risk analyses are undertaken by the Department of Agriculture, Water and the Environment using technical and scientific experts in relevant fields and involves consultation with stakeholders at various stages during the process.

Risk analyses may take the form of a biosecurity import risk analysis (BIRA) or a review of biosecurity import requirements (such as scientific reviews of existing policy and import conditions, pest-specific assessments, weed risk assessments, biological control agent assessments or scientific advice).

Further information about Australia's biosecurity framework is provided in the *Biosecurity Import Risk Analysis Guidelines 2016* located on the [Department of Agriculture, Water and the Environment](#) website.

1.2 This risk analysis

1.2.1 Background

Seeds are essential to the agri-food system, with the global commercial seed market valued at around \$US 48.5 billion in 2015 (Bonny 2017; IIGB 2016). Safe seed trade demands appropriate phytosanitary measures.

The global vegetable seed sector has evolved through several waves of expansion, consolidation and technological innovation (Bonny 2017; Bruins 2009). It operates inter-continental and counter-seasonal production cycles with extensive pathways for exchange of seeds, which range from small seed lots for breeding or selection purposes to commercial wholesale and retail supplies. Processes such as seed multiplication, conditioning (drying, cleaning, sorting, priming and coating), testing and packing occur on a global scale. Frequently, these activities are sub-

contracted in regions with relatively lower production costs and often occur over lengthy periods (IIGB 2016).

Globalisation of vegetable seed production and trade is increasing the risk of the introduction of seed-borne pathogens to new areas. In September 2014, *Cucumber green mottle mosaic virus* (CGMMV) was detected in commercial watermelon farms near Katherine and Darwin, in the Northern Territory in Australia. In October 2014, Australia introduced emergency measures to manage the risk of further introductions of CGMMV into Australia. In December 2015, the emergency measures were updated in response to the detection of CGMMV in the seeds of additional hosts. In November 2017, the 'Final pest risk analysis for *Cucumber green mottle mosaic virus* (CGMMV)' was published providing the justification for the emergency measures (Australian Department of Agriculture and Water Resources 2017).

In May 2016, *Melon necrotic spot virus* (MNSV) was detected in the state of Victoria in Australia. This virus had previously been detected on two occasions in New South Wales in 2012 and 2013. In September 2016, emergency measures were introduced to manage the risk of further introduction of MNSV in Australia. In December 2017, emergency measures were introduced to mitigate the biosecurity risk posed by *Kyuri green mottle mosaic virus* (KGMMV), *Zucchini green mottle mosaic virus* (ZGMMV) and *Diaporthe cucurbitae* (formerly *Phomopsis cucurbitae*).

Several incidents of CGMMV and MNSV have occurred since the introduction emergency measures, however, these viruses remain under official control, and continue to be quarantine pests for Australia.

Further illustrating the risk to Australia, seed-borne pathogens have been frequently intercepted at the border on seeds exported from other countries. CGMMV was detected in 22 of 631 test samples of cucurbit seeds intended for import to Australia from Europe, the Middle East, Africa and North, Central and South America (Constable et al. 2018). Similarly, tomato and capsicum seeds intended for import to Australia from 18 countries have tested positive for the presence of potyviruses (Constable et al. 2019).

Acknowledging the change in risk profile, the department is undertaking an extensive review of the existing import conditions for vegetable seeds, including those for cucurbitaceous vegetables. The analysis is being conducted as a review of import conditions, consistent with the *Biosecurity Act 2015*, to assess the biosecurity risks associated with seeds being imported into Australia. The review of the seed pathway for several commodity groups, including cucurbitaceous vegetables, was initially funded under the Australian Government's Agricultural Competitiveness White Paper and is one means by which Australia is strengthening its biosecurity.

1.2.2 Scope

The family Cucurbitaceae has 122 genera and approximately 960 species (Mabberley 2008). However, this review of existing import conditions focusses on the seeds of nine genera of cucurbitaceous vegetables currently allowed entry into Australia from all sources (Table 1.1). The taxonomy of cucurbitaceous crops is complex, and the physical characteristics and uses of individual species can vary widely, as evidenced in Table 1.1.

This review aims to:

- identify pathogens associated with seeds of the cucurbitaceous vegetables listed in Table 1.1
- evaluate the effectiveness of the existing risk management measures for these pathogens
- recommend revised risk management measures, where necessary.

Table 1.1 Cucurbitaceous vegetable seeds under review

Scientific name	Synonym/subordinate taxa	Common name
<i>Benincasa hispida</i> (Thunb.) Cogn.	—	Wax gourd, white pumpkin, ash gourd
<i>Citrullus amarus</i> Schrad.	<i>Citrullus lanatus</i> var. <i>caffer</i> (Schrad.) Mansf.; <i>Citrullus lanatus</i> var. <i>citroides</i> (LH. Bailey) Mansf.; <i>Citrullus vulgaris</i> var. <i>citroides</i> LH. Bailey	Citron, preserving melon
<i>Citrullus colocynthis</i> (L.) Schrad.	<i>Cucumis colocynthis</i> L.	Bitter-apple, bitter cucumber
<i>Citrullus lanatus</i> (Thunb.) Matsum. & Nakai	<i>Citrullus aedulis</i> Pangalo; <i>Citrullus vulgaris</i> Schrad.; <i>Colocynthis citrullus</i> (L.) Kuntze; <i>Cucurbita citrullus</i> L.	Watermelon
<i>Cucumis anguria</i> L.	<i>Cucumis anguria</i> var. <i>longipes</i> (Hook) A. Meeuse; <i>Cucumis anguria</i> var. <i>anguria</i> L.; <i>Cucumis longipes</i> Hook	West Indian gherkin, bur gherkin
<i>Cucumis dipsaceus</i> Ehrenb. ex Spach	—	Hedgehog cucumber, hedgehog gourd
<i>Cucumis ficifolius</i> A. Rich.	—	—
<i>Cucumis melo</i> L.	<i>Cucumis chito</i> C. Morren; <i>Cucumis callosus</i> (Rottler) Cogn.; <i>Cucumis dudaim</i> L.; <i>Cucumis melo</i> subsp. <i>melo</i> L.; <i>Cucumis dudaim</i> var. <i>aegyptiacus</i> Sickenb.; <i>Cucumis flexuosus</i> L.; <i>Cucumis melo</i> var. <i>chito</i> (C. Morren) Naudin; <i>Cucumis melo</i> var. <i>conomon</i> (Thunb.) Greb; <i>Cucumis melo</i> var. <i>dudaim</i> (L.) Naudin; <i>Cucumis melo</i> var. <i>inodorus</i> H. Jacq.; <i>Cucumis melo</i> var. <i>acidulus</i> Naudin; <i>Cucumis melo</i> var. <i>aegyptiacus</i> (Sickenb.) Hassib; <i>Cucumis melo</i> var. <i>ameri</i> Gabaev; <i>Cucumis melo</i> var. <i>cantalupensis</i> Naudin; <i>Cucumis melo</i> var. <i>makua</i> Makino; <i>Cucumis melo</i> var. <i>microspermus</i> Nakai ex Kitam; <i>Cucumis melo</i> var. <i>reticulatus</i> Naudin; <i>Cucumis melo</i> var. <i>utilissimus</i> (Roxb.) Duthie & JB. Fuller; <i>Cucumis microspermus</i> Nakai; <i>Cucumis momordica</i> Roxb.; <i>Cucumis melo</i> var. <i>momordica</i> (Roxb.) Duthie & JB. Fuller; <i>Cucumis trigonus</i> Roxb.; <i>Cucumis utilissimus</i> Roxb.	Melon, cantaloupe
<i>Cucumis metuliferus</i> E. Mey. ex Naudin	—	African horned cucumber
<i>Cucumis myriocarpus</i> Naudin	<i>Cucumis leptodermis</i> Schweick.; <i>Cucumis myriocarpus</i> subsp. <i>leptodermis</i> (Schweick.) C. Jeffrey & P. Halliday; <i>Cucumis myriocarpus</i> subsp. <i>myriocarpus</i> Naudin	Gooseberry cucumber, prickly paddy melon
<i>Cucumis sativus</i> L.	<i>Cucumis hardwickii</i> Royle; <i>Cucumis sativus</i> var. <i>anatolicus</i> Gabaev; <i>Cucumis sativus</i> var. <i>anglicus</i> L.H. Bailey; <i>Cucumis sativus</i> var. <i>cilicius</i> Gabaev; <i>Cucumis sativus</i> var. <i>europaeus</i> Gabaev; <i>Cucumis sativus</i> var. <i>falcatus</i> Gabaev; <i>Cucumis sativus</i> var. <i>hardwickii</i> (Royle) Gabaev; <i>Cucumis sativus</i> var. <i>indo-europaeus</i>	Cucumber

Scientific name	Synonym/subordinate taxa	Common name
	<i>Gabaev; Cucumis sativus</i> var. <i>irano-turanicus</i> Gabaev; <i>Cucumis sativus</i> var. <i>izmir</i> Gabaev; <i>Cucumis sativus</i> var. <i>squamosus</i> Gabaev; <i>Cucumis sativus</i> var. <i>testudaceus</i> Gabaev; <i>Cucumis sativus</i> var. <i>tuberculatus</i> Gabaev; <i>Cucumis sativus</i> var. <i>vulgatus</i> Gabaev	
<i>Cucumis zeyheri</i> Sonder	—	South African spiny cucumber
<i>Cucurbita argyrosperma</i> Huber	<i>Cucurbita kellyana</i> Bailey; <i>Cucurbita mixta</i> Pangalo; <i>Cucurbita palmeri</i> Bailey; <i>Cucurbita sororia</i> Bailey; <i>Cucurbita argyrosperma</i> C. Huber subsp. <i>argyrosperma</i> ; <i>Cucurbita mixta</i> var. <i>stenosperma</i> Pangalo; <i>Cucurbita argyrosperma</i> var. <i>stenosperma</i> (Pangalo) Merrick & DM. Bates; <i>Cucurbita argyrosperma</i> C. Huber subsp. <i>sororia</i> (LH. Bailey) L. Merrick & DM. Bates	Cushaw, squash, silver-seed gourd, green-stripe cushaw
<i>Cucurbita ficifolia</i> Bouché	<i>Cucurbita melanosperma</i> Gasp.; <i>Pepo ficifolia</i> (Bouché) Britton	Malabar gourd, black seed squash
<i>Cucurbita foetidissima</i> Kunth	—	Buffalo gourd, Missouri gourd, prairie gourd
<i>Cucurbita maxima</i> Duchesne	<i>Cucurbita andreana</i> Naudin; <i>Cucurbita maxima</i> subsp. <i>andreana</i> Filov; <i>Cucurbita maxima</i> var. <i>turbaniformis</i> (M. Roem.) LH. Bailey; <i>Cucurbita maxima</i> subsp. <i>maxima</i> Duchesne; <i>Cucurbita turbaniformis</i> M. Roem.	Winter squash, buttercup squash, giant pumpkin, pumpkin, kabotcha
<i>Cucurbita moschata</i> Duchesne	<i>Cucurbita pepo</i> var. <i>moschata</i> Duchesne	Butternut squash, squash, butternut pumpkin, pumpkin, calabaza pumpkin, tropical pumpkin
<i>Cucurbita pepo</i> L.	<i>Cucumis pepo</i> (L.) Dumort; <i>Cucurbita pepo</i> subsp. <i>pepo</i> ; <i>Cucurbita fraterna</i> LH. Bailey; <i>Cucurbita pepo</i> subsp. <i>fraterna</i> Lira; <i>Cucurbita galeottii</i> Cogn; <i>Cucurbita mammeata</i> Molina; <i>Cucurbita melopepo</i> L.; <i>Cucurbita pepo</i> subsp. <i>ovifera</i> var. <i>ovifera</i> (L.) DS. Decker; <i>Cucurbita ovifera</i> L.; <i>Cucurbita pepo</i> var. <i>fraterna</i> (L.H. Bailey) Filov; <i>Cucurbita pepo</i> var. <i>melopepo</i> (L.) Harz; <i>Cucurbita pepo</i> subsp. <i>texana</i> (Scheele); <i>Cucurbita texana</i> (Scheele) A. Gray; <i>Tristemon texanus</i> Scheele	Summer squash, pumpkin, zucchini, acorn squash, bitter bottle gourd
<i>Lagenaria siceraria</i> (Molina) Standl.	<i>Cucurbita lagenaria</i> L.; <i>Lagenaria vulgaris</i> Ser; <i>Cucurbita siceraria</i> Molina	Bottle gourd, calabash, white-flower gourd, long melon
<i>Luffa acutangula</i> (L.) Roxb.	<i>Cucumis acutangulus</i> L.	Ribbed gourd, angled luffa, Chinese okra
<i>Luffa aegyptiaca</i> Mill.	<i>Luffa cylindrica</i> (L.) M. Roem.; <i>Momordica cylindrica</i> L.; <i>Momordica luffa</i> L.	Smooth loofah gourd, dish rag gourd, sponge gourd
<i>Luffa graveolens</i> Roxb.	—	Loofah
<i>Luffa operculata</i> (L.) Cogn.	<i>Momordica operculata</i> L.	Sponge cucumber

Scientific name	Synonym/subordinate taxa	Common name
<i>Momordica balsamina</i> L.	—	Balsam pear, balsam apple
<i>Momordica cardiospermoides</i> Klotzsch	—	Bitter gourd
<i>Momordica charantia</i> L.	<i>Momordica muricata</i> Willd.	Balsam-apple, bitter-cucumber, bitter gourd, karela
<i>Momordica cochinchinensis</i> (Lour.) Spreng.	—	Balsam-pear, Chinese bitter-cucumber
<i>Momordica foetida</i> Schumac.	—	Bombo
<i>Momordica friesiorum</i> C. Jeffrey	—	—
<i>Momordica grosvenorii</i> Swingle	<i>Siraitia grosvenorii</i> (Swingle) A.M. Lu & Zhi Y. Zhang	Buddhafruit, monk fruit, arhat fruit
<i>Momordica rostrata</i> A. Zimm.	—	—
<i>Sechium edule</i> (Jacq.) Sw.	<i>Chayota edulis</i> Jacq.; <i>Sicyos edulis</i> Jacq.	Chayote (vegetable pear), zucca, Christofine, choko
<i>Trichosanthes cucumerina</i> L.	<i>Trichosanthes anguina</i> L.	Serpent gourd, snake gourd

1.2.3 Existing import conditions for seeds for sowing

Standard conditions

Seeds of many species, including those of cucurbitaceous vegetables (Table 1.1) can be imported from all sources under the department's standard seeds for sowing import conditions. Details of these standard conditions are provided in Section 4.1.

Cucurbitaceous vegetable seeds imported for the end-use of sprouting or micro-greens production for human consumption are also currently subject to the department's standard seeds for sowing import conditions.

Specific measures

In addition to the standard seeds for sowing conditions, seeds of *Citrullus lanatus*, *Cucumis melo*, *Cucumis sativus*, *Cucurbita maxima*, *Cucurbita moschata*, *Cucurbita pepo*, *Lagenaria siceraria*, *Trichosanthes cucumerina* and any hybrid of these species are subject to additional pest risk management measures (testing or treatment, on-shore or off-shore) for the presence of CGMMV, *Diaporthe cucurbitae*, KGMMV, MNSV, or ZGMMV. The rationale for and details of these additional measures required are provided in Section 4.1.

Provided the additional requirements are met, seeds of these host species can be released from biosecurity control without further restrictions.

Domestic arrangements

The Australian Government is responsible for regulating the movement of goods such as plants and plant products into and out of Australia. However, the state and territory governments are responsible for plant health controls within their individual jurisdiction. Legislation relating to resource management or plant health may be used by state and territory government agencies

to control interstate movement of plants and their products. After imported plants and plant products have been cleared by Australian Government biosecurity officers, they may be subject to interstate movement regulations/arrangements. It is the importer's responsibility to identify and ensure compliance with all requirements.

1.2.4 Consultation

The draft report was released on 6 December 2017 (Biosecurity Advice 2017-12) for comment by stakeholders, for an extended period of 75 days that concluded on 19 February 2018, due to the Christmas/New Year holiday period. The department received 11 written technical submissions on the draft report. All submissions were carefully considered and, where relevant, changes were made to the final report.

A summary of key stakeholder comments and the department's responses are provided in Appendix B of this report. Supplementary details of potential risk mitigation options, and their consideration, are also provided in the report (Appendix C).

Further consultation with domestic stakeholders was undertaken during and after close of the stakeholder comment period. The department has also engaged with Australian state and territory governments, during the preparation of this report.

In addition, the department established the Imported Seeds Regulation Working Group (ISRWG) to engage across industry and government on effective regulatory management of seed biosecurity risks, including the progression of this review. The working group comprised representatives from the Australian Seed Federation, Grain Producers Australia, Nursery and Garden Industry Australia, AUSVEG, Australian Organic, Plant Health Australia, state and territory government agencies and the Department of Agriculture, Water and the Environment.

1.2.5 Next steps

This final report will be published on the department's website with a notice advising stakeholders of its release. The department will also notify the WTO Secretariat about the release of the final report. The biosecurity requirements recommended in this final report will form the basis of the revised import conditions published in the Biosecurity Import Conditions (BICON) system.

2 Method for pest risk analysis

This chapter sets out the method used for the pest risk analysis (PRA) in this report. The Department of Agriculture, Water and the Environment has conducted this PRA in accordance with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for pest risk analysis* (FAO 2019a) and ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2019c) that have been developed under the 'World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures' (WTO 1995).

A PRA is 'the process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any phytosanitary measures to be taken against it' (FAO 2019b). A pest is 'any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products' (FAO 2019b). This definition is also used in the *Biosecurity Act 2015*.

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

Unrestricted risk is estimated taking into account the existing commercial production practices of the exporting country and that, on arrival in Australia, the department will verify that the consignment received is as described on the commercial documents and its integrity has been maintained.

Restricted risk is estimated with phytosanitary measure(s) applied. A phytosanitary measure is 'any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests' (FAO 2019b).

A glossary of the terms used in the risk analysis is provided at the end of this report.

The PRAs are conducted in the following three consecutive stages: initiation, pest risk assessment and pest risk management.

2.1 Stage 1 Initiation

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

The identity of the pests considered in this review is given in Appendix A. The species name is used in most instances, but a lower taxonomic level is used where appropriate. Synonyms are provided where the current scientific name differs from instances where the cited literature has used a different scientific name.

A list of pathogens of the cucurbitaceous vegetables under review was tabulated from the available published scientific literature including, but not limited to, reference books, journals and database searches. This list identifies the pathway association of the pests recorded on cucurbitaceous vegetables under review and their status in Australia, their potential to establish or spread, and their potential for economic consequences. This information is set out in Appendix A, and forms the basis of the pest categorisation process. The department

acknowledges that several pathogens in the genera *Ascochyta*, *Cercospora*, *Fusarium*, *Mycosphaerella*, *Phoma*, *Septoria* and *Xanthomonas* are seed-borne in other hosts. However, at the time of publishing this document no evidence of their seed transmission with cucurbitaceous vegetables was available. Similarly, at the time of publishing this document, no evidence was available on the potential economic consequences of some of the pathogens associated with the seed pathway. Consequently, these pathogens were not considered further. The department will continue to review the literature in relation to the seed-borne nature and pest status of pathogens of cucurbitaceous vegetables and may amend this policy accordingly.

For this risk analysis, the 'PRA area' is defined as Australia for pests that are absent, or of limited distribution and under official control. For areas with regional freedom from a pest, the 'PRA area' may be defined on the basis of a state or territory of Australia or may be defined as a region of Australia consisting of parts of a state or territory or several states or territories.

2.2 Stage 2 Pest risk assessment

A pest risk assessment is an 'evaluation of the probability of the introduction and spread of a pest, and the magnitude of the associated potential economic consequences' (FAO 2019b). The pest risk assessment provides technical justification for identifying quarantine pests and for establishing phytosanitary import requirements.

2.2.1 Pest categorisation

Pest categorisation identifies which of the pests with the potential to be on the commodity are quarantine pests for Australia and require pest risk assessment. A 'quarantine pest' is a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO 2019b).

The pests identified in Stage 1 were categorised using the following primary elements to identify the quarantine pests for the commodity being assessed:

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

The results of pest categorisation are set out in Appendix A. The quarantine pests identified during categorisation were carried forward for pest risk assessment and are listed in Table 3.1.

2.2.2 Assessment of the probability of entry, establishment and spread

Details of how to assess the 'probability of entry', 'probability of establishment' and 'probability of spread' of a pest are given in ISPM 11 (FAO 2019c). The SPS Agreement (WTO 1995) uses the term 'likelihood' rather than 'probability' for these estimates. In qualitative PRAs, the department uses the term 'likelihood' for the descriptors it uses for its estimates of likelihood of

entry, establishment and spread. The use of the term 'probability' is limited to the direct quotation of ISPM definitions.

A summary of this process is given, followed by a description of the qualitative methodology used in this risk analysis.

Likelihood of entry

The likelihood of entry describes the likelihood that a quarantine pest will enter Australia as a result of trade in a given commodity, be distributed in a viable state in the PRA area and subsequently be transferred to a host. ISPM 11 (FAO 2019c) states that the likelihood of entry of a pest depends on the pathways from the exporting country to the destination, and the frequency and quantity of pests associated with them. ISPM 11 (FAO 2019c) lists various factors which should be taken into account when assessing the likelihood of entry.

For the purpose of considering the likelihood of entry, the department divides this step into two components:

- **Likelihood of importation**—the likelihood that a pest will arrive in Australia when a given commodity is imported.
- **Likelihood of distribution**—the likelihood that the pest will be distributed, as a result of the processing, sale or disposal of the commodity, in the PRA area and subsequently transfer to a susceptible part of a host.

Likelihood of establishment

Establishment is defined as the 'perpetuation for the foreseeable future, of a pest within an area after entry' (FAO 2019b). In order to estimate the likelihood of establishment of a pest, reliable biological information (for example, lifecycle, host range, epidemiology and survival) is obtained from the areas where the pest currently occurs. The situation in the PRA area can then be compared with that in the areas where it currently occurs, and expert judgement used to assess the likelihood of establishment.

Likelihood of spread

Spread is defined as 'the expansion of the geographical distribution of a pest within an area' (FAO 2019b). The likelihood of spread considers the factors relevant to the movement of the pest, after establishment on a host plant or plants, to other susceptible host plants of the same or different species in other areas. In order to estimate the likelihood of spread of the pest, reliable biological information is obtained from areas where the pest currently occurs. The situation in the PRA area is then carefully compared with that in the areas where the pest currently occurs and expert judgement used to assess the likelihood of spread.

Assigning likelihoods for entry, establishment and spread

Likelihoods are assigned to each step of entry, establishment and spread. Six descriptors are used: high; moderate; low; very low; extremely low; and negligible (Table 2.1). Definitions for these descriptors and their indicative probability ranges are given in Table 2.1. The indicative probability ranges are only provided to illustrate the boundaries of the descriptors and are not

used beyond this purpose in qualitative PRAs. These indicative probability ranges provide guidance to the risk analyst and promote consistency between different pest risk assessments.

Table 2.1 Nomenclature of likelihoods

Likelihood	Descriptive definition	Indicative range
High	The event would be very likely to occur	$0.7 < to \leq 1$
Moderate	The event would occur with an even likelihood	$0.3 < to \leq 0.7$
Low	The event would be unlikely to occur	$0.05 < to \leq 0.3$
Very low	The event would be very unlikely to occur	$0.001 < to \leq 0.05$
Extremely low	The event would be extremely unlikely to occur	$0.000001 < to \leq 0.001$
Negligible	The event would almost certainly not occur	$0 < to \leq 0.000001$

Combining likelihoods

The likelihood of entry is determined by combining the likelihood that the pest will be imported into the PRA area and the likelihood that the pest will be distributed within the PRA area, using a matrix of rules (Table 2.2). This matrix is then used to combine the likelihood of entry and the likelihood of establishment, and the likelihood of entry and establishment is then combined with the likelihood of spread to determine the overall likelihood of entry, establishment and spread.

For example, if the likelihood of importation is assigned a descriptor of 'low' and the likelihood of distribution is assigned a descriptor of 'moderate', then they are combined to give a likelihood of 'low' for entry. The likelihood for entry is then combined with the likelihood assigned for establishment of 'high' to give a likelihood for entry and establishment of 'low'. The likelihood for entry and establishment is then combined with the likelihood assigned for spread of 'very low' to give the overall likelihood for entry, establishment and spread of 'very low'. This can be summarised as:

importation x distribution = entry [E]

low x moderate = low

entry x establishment = [EE]

low x high = low

[EE] x spread = [EES]

low x very low = very low

Table 2.2 Matrix of rules for combining likelihoods

	High	Moderate	Low	Very low	Extremely low	Negligible
High	High	Moderate	Low	Very low	Extremely low	Negligible
Moderate		Low	Low	Very low	Extremely low	Negligible
Low			Very low	Very low	Extremely low	Negligible
Very low				Extremely low	Extremely low	Negligible
Extremely low					Negligible	Negligible
Negligible						Negligible

Time and volume of trade

One factor affecting the likelihood of entry is the volume and duration of trade. If all other conditions remain the same, the overall likelihood of entry will increase as time passes and the overall volume of trade increases. The department normally considers the likelihood of entry on

the basis of the estimated volume of one year's trade. However, in the case of a high risk propagative commodity such as seeds for sowing, the import volume may be restricted in order to effectively manage the biosecurity risks they present. Other factors listed in ISPM 11 (FAO 2019c) may not be relevant to seeds for sowing.

2.2.3 Assessment of potential consequences

The objective of the consequence assessment is to provide a structured and transparent analysis of the potential consequences if the pests or disease agents were to enter, establish and spread in Australia. The assessment considers direct and indirect pest effects and their economic and environmental consequences. The requirements for assessing potential consequences are given in Article 5.3 of the SPS Agreement (WTO 1995), ISPM 5 (FAO 2019b) and ISPM 11 (FAO 2019c).

Direct pest effects are considered in the context of the effects on:

- plant life or health
- other aspects of the environment.

Indirect pest effects are considered in the context of the effects on:

- eradication, control
- domestic trade
- international trade
- non-commercial and environmental.

The direct and indirect consequences were estimated over four geographic levels, defined as:

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

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

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

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

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

Indiscernible—pest impact unlikely to be noticeable.

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

Significant—expected to threaten the economic viability of production through a moderate increase in mortality/morbidity of hosts, or a moderate decrease in production. Expected to

significantly diminish or threaten the intrinsic value of non-commercial criteria. Effects may not be reversible.

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

The estimates of the magnitude of the potential consequences over the four geographic levels were translated into a qualitative impact score (A–G) using Table 2.3. For example, a consequence with a magnitude of ‘significant’ at the ‘district’ level will have a consequence impact score of D.

Table 2.3 Decision rules for determining the consequence impact score based on the magnitude of consequences at four geographical scales

Magnitude	Geographic scale			
	Local	District	Region	Nation
Indiscernible	A	A	A	A
Minor significance	B	C	D	E
Significant	C	D	E	F
Major significance	D	E	F	G

Note: In earlier qualitative PRAs, the scale for the impact scores went from A to F and did not explicitly allow for the rating ‘indiscernible’ at all four levels. This combination might be applicable for some criteria. In this report, the impact scale of A to F has been changed to become B–G and a new lowest category A (‘indiscernible’ at all four levels) was added. The rules for combining impacts in Table 2.4 Decision rules for determining the overall consequence rating for each pest were adjusted accordingly.

The overall consequence for each pest is achieved by combining the qualitative impact scores (A–G) for each direct and indirect consequence using a series of decision rules (Table 2.4). These rules are mutually exclusive, and are assessed in numerical order until one applies.

Table 2.4 Decision rules for determining the overall consequence rating for each pest

Rule	The impact scores for consequences of direct and indirect criteria	Overall consequence rating
1	Any criterion has an impact of ‘G’; or more than one criterion has an impact of ‘F’; or a single criterion has an impact of ‘F’ and each remaining criterion an ‘E’.	Extreme
2	A single criterion has an impact of ‘F’; or all criteria have an impact of ‘E’.	High
3	One or more criteria have an impact of ‘E’; or all criteria have an impact of ‘D’.	Moderate
4	One or more criteria have an impact of ‘D’; or all criteria have an impact of ‘C’.	Low
5	One or more criteria have an impact of ‘C’; or all criteria have an impact of ‘B’.	Very Low
6	One or more but not all criteria have an impact of ‘B’, and all remaining criteria have an impact of ‘A’.	Negligible

2.2.4 Estimation of the unrestricted risk

Once the assessment of the likelihood of entry, establishment and spread, and potential consequences are completed, the unrestricted risk can be determined for each pest or groups of

pests. This is determined by using a risk estimation matrix (Table 2.5) to combine the estimates of the likelihood of entry, establishment and spread and the overall consequences of pest establishment and spread. Therefore, risk is the product of likelihood and consequence.

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

Table 2.5 Risk estimation matrix

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

2.2.5 The appropriate level of protection (ALOP) for Australia

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

Like many other countries, Australia expresses its ALOP in qualitative terms. The ALOP for Australia, which is defined in the *Biosecurity Act 2015*, is a high level of sanitary or phytosanitary protection aimed at reducing risk to a very low level, but not to zero. The band of cells in Table 2.5 marked 'very low risk' represents the ALOP for Australia.

2.3 Stage 3 Pest risk management

Pest risk management describes the process of identifying and implementing phytosanitary measures to manage risks to achieve the ALOP for Australia, while ensuring that any negative effects on trade are minimised.

The conclusions from a pest risk assessment are used to decide whether risk management is required and if so, the appropriate measures to be used. Where the unrestricted risk estimate does not achieve the ALOP for Australia, risk management measures are required to reduce this

risk to a very low level. The guiding principle for risk management is to manage risk to achieve the ALOP for Australia. The effectiveness of any recommended phytosanitary measures (or combination of measures) is evaluated, using the same approach as used to evaluate the unrestricted risk, to ensure it reduces the restricted risk for the relevant pest or pests to achieve the ALOP for Australia.

ISPM 11 (FAO 2019c) provides details on the identification and selection of appropriate risk management options and notes that the choice of measures should be based on their effectiveness in reducing the likelihood of entry of the pest.

Examples of risk management measures which may be applied to seeds for sowing consignments include:

- Import from pest-free areas only (ISPM 4 and 10)—the establishment and use of a pest-free area by a National Plant Protection Organisation (NPPO) may provide for the export of seeds from the exporting country to the importing country without the need for the application of additional phytosanitary measures when certain requirements are met.
- Testing for freedom from regulated pests—this is a practical measure for management of pests which do not produce visible symptoms.
- Inspection and certification (ISPM 7, 12 and 23)—the exporting country may be asked to inspect the shipment and certify that the shipment is free from regulated pests before export.
- Specified conditions for preparation of the consignment—the importing country may specify steps that must be followed in order to prepare the consignment for shipment. These conditions can include the requirement for seeds to be produced from appropriately tested parent material.
- Removal of the pest from the consignment by treatment or other methods—the importing country can specify chemical or physical treatments that must be applied to the consignment before it may be imported.
- Prohibition of commodities—the importing country may prohibit the commodity if no satisfactory measure can be found.

Risk management measures are identified for each quarantine pest where the level of biosecurity risk does not achieve the ALOP for Australia. Relevant measures are presented in Chapter 4 of this report.

3 Pest risk assessment for quarantine pests

Pests of cucurbitaceous vegetable seeds considered in this review are listed in the pest categorisation table (Appendix A), and the identified seed-borne quarantine pests are listed in Table 3.1.

Table 3.1 Quarantine pests associated with seeds of cucurbitaceous vegetables

Scientific name	Common name	Host(s) (a)
Fungi		
<i>Alternaria burnsii</i>	Blight of cumin	<i>Cucurbita maxima</i>
<i>Diaporthe cucurbitae</i> (b)	Black rot	<i>Cucumis melo</i> , <i>Cucumis sativus</i>
Viruses		
<i>Bitter melon yellow mosaic virus</i> (BgYMV)	Yellow mosaic	<i>Momordica charantia</i>
<i>Cucumber fruit mottle mosaic virus</i> (CFMMV)	Cucumber fruit mottle mosaic	<i>Cucurbita pepo</i>
<i>Cucumber green mottle mosaic virus</i> (CGMMV) (c)	Cucumber green mottle mosaic	<i>Citrullus lanatus</i> , <i>Cucumis melo</i> , <i>Cucumis sativus</i> , <i>Cucurbita maxima</i> , <i>Cucurbita moschata</i> , <i>Cucurbita pepo</i> , <i>Lagenaria siceraria</i> , <i>Trichosanthes cucumerina</i>
<i>Kyuri green mottle mosaic virus</i> (KGMMV)	Kyuri green mottle mosaic	<i>Citrullus lanatus</i> , <i>Cucumis sativus</i> , <i>Cucurbita pepo</i>
<i>Melon necrotic spot virus</i> (MNSV)	Melon necrotic spot	<i>Citrullus lanatus</i> , <i>Cucumis melo</i>
<i>Tomato black ring virus</i> (TBRV)	Tomato black ring	<i>Cucumis sativus</i>
<i>Zucchini green mottle mosaic virus</i> (ZGMMV)	Zucchini green mottle mosaic	<i>Citrullus lanatus</i> , <i>Cucurbita pepo</i>

- (a) Host common names: *Citrullus lanatus* (watermelon), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita maxima* (squash), *Cucurbita moschata* (pumpkin), *Cucurbita pepo* (zucchini), *Lagenaria siceraria* (bottle gourd), *Momordica charantia* (bitter melon), *Trichosanthes cucumerina* (snake melon).
- (b) *Diaporthe cucurbitae* is the current name of *Phomopsis cucurbitae* (Udayanga et al. 2015) and this has been adopted in this final report
- (c) A species that has been assessed previously and an existing policy is in place.

Since publication of the draft report, four additional pests have been identified that are seed-borne in various cucurbitaceous hosts—three viruses (BgYMV, CFMMV and TBRV) and one fungus (*Alternaria burnsii*). Therefore, these additional pests have been included in this final report.

The department will also continue to review the literature in relation to the seed-borne status of any pathogens associated with cucurbitaceous vegetable seeds, and may amend this policy accordingly.

3.1 Assessment of the likelihood of entry, establishment and spread

This review collectively assesses the likelihood of entry, establishment and spread of the quarantine pests identified in Table 3.1. Key factors that contribute to the likelihood of entry,

establishment and spread have been highlighted in the risk assessment section. However, assessments of the potential consequences of entry, establishment and spread are individually presented for each pest to estimate the magnitude of the potential consequences.

ISPM 11 (FAO 2019c) states that the intended end-use of a commodity affects the risk of introduction and spread of associated pests. For example, an end-use such as seeds for sowing poses a higher risk of a pest establishing or spreading than an end-use such as processing (FAO 2019c).

Seeds also play an important role in the survival, introduction and spread of associated pests (Elmer 2001). Seed transmission provides a mechanism whereby a pathogen can survive under conditions in which other sources of inoculum have been eliminated (Stace-Smith & Hamilton 1988). Seed-infection is epidemiologically important because it ensures that the pest is physically associated with and distributed throughout the planted crop by means of infected seeds which are randomly dispersed in the field. The resultant infected seedlings can further serve as sources of inoculum from which secondary spread can occur (Stace-Smith & Hamilton 1988). Seeds for sowing are deliberately introduced, distributed and aided to establish. As a result, any pest that is associated with seeds of cucurbitaceous vegetables intended for sowing will be aided in its entry, establishment and spread in Australia.

3.1.1 Likelihood of entry

The likelihood of entry is considered in two parts, the likelihood of importation (the likelihood that the identified pathogens will arrive when host cucurbitaceous vegetable seeds for sowing are imported) and the likelihood of distribution (the likelihood that the identified pathogens will be viable and be transferred to a suitable host in Australia).

Likelihood of importation

The likelihood that the identified quarantine pests will be imported on host cucurbitaceous vegetable seeds for sowing is assessed as **High**.

This is because the identified quarantine pests are known to be seed-borne, and are likely to remain viable during transport and storage. They are also likely to be present but effectively undetectable in the large volumes of cucurbitaceous vegetable seeds for sowing which Australia imports each year.

The supporting evidence for this assessment is provided.

It is highly likely that the identified pests are associated with the pathway

- Infected seeds for sowing are one of the main pathways for the introduction of seed-borne pathogens into new areas. Global trade and the movement of infected seeds across borders is known to have introduced seed-borne pathogens into new areas (Constable et al. 2019; Constable et al. 2018; Cromney et al. 1987; Vannacci et al. 1999).
- A low incidence in the field may enhance a plant pathogen's chances of escaping detection. If the level of infection is very low and symptomatic plants are randomly scattered in the field, an infection may go undetected at the time of harvest.
- Large volumes of cucurbitaceous vegetable seeds are imported into Australia each year for planting. Seed-borne pathogens associated with the seed internally (endosperm and/or

embryo) or externally (seed surface) may not be detected during on-arrival visual inspection (Elmer 2001). Therefore, there is high potential for the identified pests to repeatedly enter Australia through the seeds for sowing pathway.

Alternaria burnsii

- *Alternaria* species can be host-specific or can attack a wide range of hosts. *Alternaria* can survive between crops as spores and mycelium in infected plant residues or within and on seeds (Laemmlen 2001; Pegg & Manners 2014).
- *Alternaria burnsii* has been reported to infect hosts in several families including Cucurbitaceae (Al-Nadabi et al. 2018; Mondal et al. 2002b; Paul et al. 2015). It is a significant pest of cumin in India (Singh et al. 2018a).
- *Alternaria burnsii* was isolated from naturally infected *Cucurbita maxima* (pumpkin) seeds. A pathogenicity test demonstrated that *Alternaria burnsii* infection can cause discolouration and weak blight in pumpkin seeds (Paul et al. 2015). Isolation of live *Alternaria burnsii* from pumpkin seeds provides direct evidence for this pathogen to be on the import pathway of pumpkin seeds (Paul et al. 2015).

Diaporthe cucurbitae

- *Diaporthe cucurbitae* naturally infects *Citrullus*, *Cucumis*, *Luffa* and *Cucurbita* species, causing fruit rot (Bertetti et al. 2011; Garibaldi et al. 2011; Guarnaccia et al. 2018; McKeen 1957; Udayanga et al. 2015; Udayanga et al. 2011).
- Dissanayake et al. (2017) and Udayanga et al. (2015) demonstrated the association of *Diaporthe cucurbitae* with *Cucumis* seeds.
- *Diaporthe cucurbitae* has been isolated from seeds of *Cucumis sativus* (Guarnaccia et al. 2018; NCBI 2019; Udayanga et al. 2015).
- The association of *Diaporthe cucurbitae* with cantaloupe (*Cucumis melo*) seeds has also been reported (Garibaldi et al. 2011; North Carolina State University 2019) and it was stated that this pathogen can be seed-borne and seed transmissible in *Cucumis melo*.
- *Diaporthe cucurbitae* has gradually expanded its global distribution since its initial report in melon. The first outbreak of this pathogen was reported from Canada in 1957 (McKeen 1957), followed by reports from the USA (Beraha & O'Brien 1979; North Carolina State University 2019; Zhang, Bruton & Biles 1999), Japan (Ohsawa & Kobayashi 1989) and more recently Italy (Bertetti et al. 2011; Garibaldi et al. 2011). Global movement via seed is the most credible explanation for its observed intercontinental movement.
- Based on the weight of evidence, it is concluded that *Diaporthe cucurbitae* is seed-borne and could enter Australia through infected seeds of *Cucumis sativus* and *Cucumis melo*.

Bitter melon yellow mosaic virus (BgYMV)

- Recently, BgYMV has been detected in seeds of naturally infected *Momordica charantia* (bitter melon) plants (Manivannan et al. 2019). BgYMV was only characterised as a virus species in 2019 and no other hosts have yet been reported.

Tobamoviruses (CFMMV, KGMMV and ZGMMV)

- Tobamoviruses are generally considered to be seed-borne, and can be transmitted by mechanical contact (Dombrovsky & Smith 2017). These viruses are also highly stable and

their infectivity can be preserved for months to years in plant debris, contaminated soil and clay (Dombrovsky & Smith 2017).

- KGMMV is known to infect *Citrullus lanatus* (watermelon), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucumis metuliferus* (African horned cucumber), *Cucurbita pepo* (zucchini) and *Luffa acutangula* (ribbed gourd) (Daryono & Natsuaki 2012; Daryono, Somowiyarjo & Natsuaki 2003, 2005a; Kim et al. 2009; Kwon et al. 2014; Lecoq & Katis 2014). KGMMV was demonstrated to be seed-borne in watermelon (Kwon et al. 2014), cucumber (Lecoq & Katis 2014) and zucchini (Kwon et al. 2014; Lee et al. 2000).
- ZGMMV is known to infect cucurbit crops, including *Citrullus lanatus* (watermelon), *Cucurbita pepo* (zucchini) and *Lagenaria siceraria* (bottle gourd) (Al-Dosary, Marraiki & Aref 2012; Kwon et al. 2014; Li et al. 2018; Ryu et al. 2000). It has been reported as seed-borne in watermelon (Kwon et al. 2014) and zucchini (Al-Dosary, Marraiki & Aref 2012; Choi 2001; Kwon et al. 2014; Lecoq & Katis 2014).
- KGMMV was initially considered to be a cucumber strain of CGMMV (Francki, Hu & Palukaitis 1986), which is known to be seed-transmitted (Australian Department of Agriculture and Water Resources 2017). Prior to the characterisation of ZGMMV, it was also considered to be a strain of either CGMMV or KGMMV due to the symptoms it caused and its virus particle morphology (Ryu et al. 2000; Yoon et al. 2002). Therefore, it is likely that many reports on seed transmission of CGMMV may refer to KGMMV or ZGMMV.
- CFMMV has been reported naturally infecting *Cucumis sativus* (cucumber), *Cucumis melo* (melon), and *Cucurbita pepo* (zucchini) causing severe mosaic, veinbanding, yellow to dark green mottling and bright mottling or mosaic on fruits (Antignus et al. 2005; Antignus et al. 2001; Rhee, Hong & Lee 2014a; Rhee, Jang & Lee 2016). This virus was demonstrated to be seed-borne in zucchini (Kwon et al. 2014).

Melon necrotic spot virus (MNSV)

- MNSV is known to infect a wide range of cucurbit hosts, including *Citrullus lanatus* (watermelon), *Cucumis melo* (melon), *Cucumis sativus* (cucumber) and *Lagenaria siceraria* (bottle gourd) (Ayo-John et al. 2014; Choi, Kim & Kim 2003; Sela, Lachman & Reingold 2013; Tomlinson & Thomas 1986).
- MNSV is seed-borne in *Citrullus lanatus* (Kwak et al. 2015) and *Cucumis melo* (Lecoq & Katis 2014).

Tomato black ring virus (TBRV)

- Nepoviruses are generally considered seed-borne, and can be dispersed long distances via infected seeds, pollen, and soil (EPPO 2019; Gibbs & Harrison 1964; Pospieszny et al. 2020). TBRV can remain persistent in the soil for long periods of time (Lister & Murrant 1967).
- TBRV is known to infect a wide range of hosts (EPPO 1990). This virus has been reported to be transmitted through the seeds of about 34 plant species, ranging from a few percent to 100% (Harrison, Mowat & Taylor 1961; Lister & Murrant 1967; Pospieszny et al. 2020).
- TBRV has been reported to naturally infect *Cucumis sativus* (cucumber) and *Cucurbita pepo* (zucchini) (Pospieszny & Borodynko 2005; Pospieszny, Jonczyk & Borodynko 2003).

- TBRV was intercepted by China on cucumber seeds exported from Italy (Gan et al. 2013). This provides direct evidence of the potential for this virus to be on the import pathway of cucumber seeds.

It is highly likely that the identified pests will survive storage and transport

- The identified pathogens are highly likely to survive during transport and storage since the primary conditions for their survival are fulfilled by the presence of the live host material and the associated environmental conditions. Conditions such as temperature and humidity are unlikely to affect the viability of the associated pathogens.
 - *Alternaria burnsii* was detected from *Cucurbita maxima* seeds after surface sterilisation (Paul et al. 2015). Due to the presence of this fungus within the seed, it is likely *Alternaria burnsii* will survive seed storage and transport conditions.
 - BgYMV was found to be present in the seed coat, endosperm and embryo of *Momordica charantia* seeds (Manivannan et al. 2019).
 - Tobamoviruses mostly infect the seed coat and endosperm of host seeds (Dombrovsky & Smith 2017). KGMMV and ZGMMV are known to be present in the seed coat of *Cucumis sativus* and *Cucurbita pepo* seeds respectively (Lecoq & Katis 2014).
 - MNSV is known to be present in the internal and external teguments of *Cucumis melo* seeds (Lecoq & Katis 2014).
- Most seed-borne pathogens infect and use seeds as a vehicle for transport and survival (Elmer 2001). Seed associations can provide long-term survival mechanisms for pathogens, and survival is not likely to be diminished during transport and storage (Elmer 2001).
- Previous interceptions of seed-borne pests in various countries demonstrate generally that these pests are highly likely to persist during processes of storage and transport to Australia.

Likelihood of distribution

To have an impact a pest must be transported in or on a pathway and must then be capable of transferring to a suitable host. The probability of this transfer occurring depends on the dispersal mechanisms of the pest and the intended use of the commodity.

The likelihood that the identified quarantine pests will be distributed across Australia on imported cucurbitaceous vegetable seeds for sowing and be transferred from the resulting plants to a suitable host is assessed as **High**.

This assessment is based on the facts that cucurbitaceous vegetable seeds intended for sowing are commercially distributed throughout Australia, and that seed association has been reported for the identified pathogens. This transmission mechanism provides the means by which these pests encounter a new host plant, most notably, the new seedling that is germinated from the seed.

The supporting evidence for this assessment is provided.

It is highly likely that imported cucurbitaceous vegetable seeds will be distributed throughout Australia

- Imported cucurbitaceous vegetable seeds are intended for commercial sale in vegetable growing areas throughout Australia. The imported seeds will be distributed through commercial and retail outlets to multiple destinations throughout Australia. Following sale, any infected imported seeds will be planted in suitable habitats.
- The distribution of infected imported seeds to commercial seedling nurseries may also facilitate the distribution of the identified seed-borne pathogens. Asymptomatic seedlings that develop from infected seeds may be overlooked and sold to commercial growers and householders.

It is highly likely that the identified seed-borne pests will be distributed in a viable state

- Seed-associated pests have evolved many different types of associations with their seed host. Pathogens associated with seeds can be transmitted as an internal infection of endosperm and/or embryo, or as an infestation of the seed surface (Agarwal & Sinclair 1996). The pathogen's ability to survive on or in a seed acts to ensure their viability on route to, and during distribution across Australia.
- Conditions during transport and storage, such as temperature and humidity, are unlikely to affect the viability of the associated pathogens.
- Seeds for sowing are imported specifically for the purpose of propagation, and are therefore likely to be sown directly into suitable habitats at multiple locations throughout Australia. The distribution of infected or infested seeds for sowing for commercial purposes is likely to facilitate the distribution of the associated pathogens.
- Seed-borne fungi exist in seeds as spores and hyphae, and can survive for long periods on the seed coat and in the internal diseased tissues (Elmer 2001).
- Seed-borne viruses exist in seed embryos, either through infection of gametes prior to fertilisation, or infection of the embryo after fertilisation (Maule & Wang 1996), and most survive for as long as the seed embryo remains viable (Stace-Smith & Hamilton 1988).

It is highly likely that the identified seed-borne pests will be transferred to a suitable host

- The identified pests in imported seeds for sowing are already associated with suitable hosts that will be planted and grown under favourable conditions. The pests will have no need to move from the import pathway to a suitable host.
- The seed-borne nature and seed transmissibility of the identified pests, and establishment of an infected plant, provide the means by which these pests become associated with a new host plant in Australia. The new seedling is the new host.
- *Alternaria burnsii* is favoured by cool, humid, cloudy weather and the pathogen spreads fast under moist and windy conditions (Mondal et al. 2002a; Singh et al. 2018b; Wadud et al. 2017).
- *Diaporthe* species can survive on crop and weed stubble (Schilder 2006; Udayanga et al. 2015; Udayanga et al. 2011), and are also opportunistic pathogens on various herbaceous weeds (Schilder 2006).

- Tobamoviruses (CFMMV, KGMMV and ZGMMV) can survive in crop (leaves, stems) and root debris on the soil surface for at least several months and can infect a new crop planted into a contaminated site (Dombrovsky & Smith 2017). These viruses can spread over short distances through contact via roots in soil contaminated by infected plant debris (Hollings, Komuro & Tochihara 1975).
- MNSV can survive for long periods in plant debris and soil without a living host (Herrera-Vásquez et al. 2009). This virus is easily spread by mechanical damage (grafting and plant-to-plant contact), infected soil and water (Agriculture Victoria 2015).
- TBRV can be dispersed over long distances via infected seeds, pollen, and soil (EPPO 2019; Gibbs & Harrison 1964; Pospieszny et al. 2020). This virus can remain infective for long periods of time in seeds of weeds, such as *Capsella bursa-pastoris* and *Stellaria media* (Lister & Murrant 1967), which are present in Australia (Choi et al. 2007; Miller & West 2012).
- BgYMV is known to be transmitted by the whitefly *Bemisia tabaci* (Onkara Naik et al. 2019), which is known to be present in Australia (Plant Health Australia 2019a). Therefore, BgYMV may be also transferred to suitable host plants through this pathway.

Overall likelihood of entry

The likelihoods of importation and distribution of the identified quarantine pests are combined to give an overall likelihood of entry using the matrix of rules for combining likelihoods (Table 2.2).

The overall likelihood that the identified quarantine pests will enter Australia and be transferred to a suitable host via cucurbitaceous seeds for sowing is assessed as **High**.

3.1.2 Likelihood of establishment

In overview, the likelihood of establishment of the identified quarantine pests within Australia will depend upon availability of hosts and suitable climate, and the reproductive strategies and methods of persistence of the pests. Based on a comparison of factors that affect pest survival and reproduction in the source and destination areas, the likelihood of establishment is assessed as **High**.

This assessment is based on the extensive planting of cucurbitaceous vegetables in Australia, the deliberate introduction and establishment of plants grown from imported seeds for sowing, the reported potential for the transmission of the identified quarantine pests from infected seed to seedlings, the wide distribution of suitable hosts, and the broad availability of suitable climates in Australia.

The supporting evidence for this assessment is provided.

It is highly likely that the identified seed-borne pests will establish in Australia given the broad availability of host plants

- Imported cucurbitaceous vegetable seeds are intended for propagation and are deliberately introduced, distributed and aided in establishment. Imported seeds will enter, potentially in substantial numbers, and then be maintained in a suitable habitat. Therefore, the introduction and establishment of plants from imported seeds in essence establishes those pests associated with the seed.

- Some of the identified pests (*Diaporthe cucurbitae*, CGMMV, CFMMV, KGMMV, ZGMMV, MNSV and BgYMV) are largely known to be pests of cucurbitaceous vegetables (Antignus et al. 2001; Bruton 1996; Fukuta et al. 2012; Kwon et al. 2014; Lecoq & Desbiez 2012; Manivannan et al. 2019; Yoon et al. 2002) and these crops are widely cultivated throughout Australia, with many residential and semi-rural properties in metropolitan areas growing vegetables in their backyards.
- The identified pests are already associated with the seeds of host plants, giving them a distinct advantage for establishment in Australia. The importation and distribution of imported seeds intended for sowing through commercial and retail outlets provides seed-borne pests with the means to establish in multiple cucurbitaceous vegetable growing areas across Australia.
- *Alternaria burnsii* and TBRV are known to infect crop plants of other families. *Alternaria burnsii* has been reported to cause leaf spots on date palm and wheat (Al-Nadabi et al. 2018) and disease records also exist for *Sorghum* and *Gossypium* spp. (Woudenberg et al. 2015). TBRV infects a range of crops including potato, raspberry, strawberry and peach (EPPO 1990). These crops are widely cultivated in Australia, increasing the potential hosts that could enable *Alternaria burnsii* and TBRV to establish in Australia.
- Asymptomatic infection or infestation of the seed by a pathogen can facilitate long-distance movement and establishment in new areas. This can allow a pathogen to repeatedly enter a new site and go unnoticed for an extended period of time (Elmer 2001).
- A low incidence of a pathogen in or on seeds can affect detection in routine seed health tests (McGee 1995). Therefore, a low incidence of the pathogen in the field may enhance a pathogen's chance of escaping detection. If the level of infection is very low and symptomatic plants are randomly scattered in the field, the infection may go undetected for some time. This would provide further opportunity for the pest to proliferate and establish in new areas.

It is highly likely that the identified seed-borne pests will establish in Australia given the suitability of climatic conditions

- The identified quarantine pests have established in areas with a wide range of climatic conditions (Daryono, Somowiyarjo & Natsuaki 2005a; Herrera-Vásquez et al. 2009; Manivannan et al. 2019; Zhang, Bruton & Biles 1999). There are similar climatic regions in parts of Australia that would be suitable for the establishment of these pests.
- Extensive cultivation of imported seeds potentially infested/infected with the identified pests, and seed-to-seedling transmission will help establish these pathogens in cucurbitaceous vegetable growing areas in Australia. As host plant material is likely to be maintained in places with similar climates to the area of production, climatic conditions are expected to favour the identified pest's establishment.
- Seed-borne pathogens commonly have traits that help them establish, such as an ability to rapidly infect new hosts and/or survive long-term in the soil.
- The establishment of seed-borne pathogens may be influenced by the length of time the commodity remains in production. For example, short crop cycles such as those of annual crops, like cucumber (Zitter, Hopkins & Thomas 1996), may limit pathogen build-up and

establishment. The opposite might be true for perennial crops which are kept longer in production, providing a greater opportunity for pathogen build-up that results in a high likelihood of survival and establishment.

3.1.3 Likelihood of spread

The likelihood of spread describes the likelihood that the identified quarantine pests, once having entered Australia on imported cucurbitaceous vegetable seeds and become established, will spread from a point of introduction to new areas.

Based on a comparison of factors relevant to the potential expansion of the geographic distribution of the pest in the source and destination areas, the assessed likelihood of spread for the identified pests is assessed as **Moderate**.

This assessment is based on the suitability of the natural and managed environments for natural spread, the ability of seed-borne pathogens to survive for long periods of time on seeds, the symptomless nature of some pathogens in assisting the inadvertent multiplication and distribution of pathogens across continental borders, and the known role of seeds in the spread of pathogens globally.

The supporting evidence for this assessment is provided.

It is highly likely that the environment in Australia will support the spread of the identified seed-borne pests

- Cucurbitaceous vegetables are grown in various regions of Australia. The natural environments in cucurbitaceous vegetable growing areas in Australia are conducive to the spread of the identified pests. The pests will be within suitable host growing areas where biotic factors such as wind, water, rain splash dispersal or mechanical transmission could aid spread once established.
 - The major pathway for the spread of *Alternaria* species occurs via infected seeds with spores on the seed coat or as mycelium under the seed coat. The dissemination of spores occurs by wind, water, tools and animals. The fungus can survive in susceptible weeds or perennials between cropping cycles or seasons (Laemmlen 2001; Pegg & Manners 2014).
 - Infection by *Alternaria burnsii* is favoured by cool, humid, cloudy weather and the pathogen spreads fast under moist and windy conditions (Mondal et al. 2002a; Singh et al. 2018b; Wadud et al. 2017). *Alternaria burnsii* is soil-borne and can survive in crop debris for extended periods (Deepak & Vidya 2004; Shelar, Nema & Harne 2019; Singh et al. 2018b).
 - *Diaporthe* species are spread by rain splash and irrigation water over short distances (Schilder 2006). They can survive on crop and weed stubble (Schilder 2006; Udayanga et al. 2015; Udayanga et al. 2011), and are also opportunistic pathogens on various herbaceous weeds (Schilder 2006). Alternative hosts may act as a source of inocula, posing a challenge to the management of spread (Udayanga et al. 2011).
 - Begomoviruses such as BgYMV are vectored in a circulative persistent manner by whiteflies such as *Bemisia tabaci* and *Trialeurodes vaporariorum* (Czosnek et al. 2017; Onkara Naik et al. 2019). These whitefly species are widespread in Australia (Plant Health Australia 2019a), providing high potential to spread the viruses to other suitable hosts across Australia.

- Tobamoviruses (CFMMV, CGMMV, KGMMV and ZGMMV) spread readily by mechanical contact (Dombrovsky, Tran-Nguyen & Jones 2017), and can survive in plant debris in contaminated soil for months to years (Dombrovsky & Smith 2017).
- MNSV is easily spread by mechanical damage (grafting and plant-to-plant contact), infected soil and water (Agriculture Victoria 2015). The virus can persist in the soil for several years and also in association with its soil-borne fungal vector *Olpidium bornovanus* (*O. radiale*), which is established in Australia (Hibi & Furuki 1985; Plant Health Australia 2019b).
- TBRV can be dispersed over long distances via infected seeds, pollen, and soil (EPPO 2019; Gibbs & Harrison 1964; Pospieszny et al. 2020). TBRV can remain infective for long periods of time in seeds of weeds, such as *Capsella bursa-pastoris* and *Stellaria media* (Lister & Murrant 1967), which are present in Australia (Choi et al. 2007; Miller & West 2012). Moreover, the survival of virus in dormant seeds could ensure its persistence in soils from one season to another, even in the absence of suitable vectors (Lister & Murrant 1967).
- TBRV is also known to be transmitted locally between host plants by the nematode vectors *Longidorus attenuatus* and *L. elongatus* (EPPO 2019), which are not known to be present in Australia. However, there are over 20 nematode species within the Longidoridae family recorded in Australia (Hodda & Nobbs 2008), many of which are reported to be vectors of nepoviruses. Therefore, the potential for local spread via nematode vectors in Australia cannot be excluded.
- Similar to other nepoviruses, the local spread of TBRV is not dependent on the presence of nematode vectors (El-Morsy et al. 2017). TBRV-infected seeds or seedlings often occur in the absence of vectors, both near infective sites and further afield (Lister & Murrant 1967).
- The managed environments in nurseries, garden centres and private gardens are all favourable for the spread of the identified pests, as host plants are abundantly available. The plants are closely placed and sprinkler irrigation favours pests' local spread. Nursery (transplant) trade networks, which are common between Australian nurseries, favour wider spread of these pests.

The presence of natural barriers in Australia could limit the spread of the identified pests

- Commercial seed distribution systems would help the identified seed-borne pests to establish throughout Australia, providing a high risk for continued spread post-border. However, natural barriers, such as arid areas, mountain ranges, climatic differentials and possible long distances between suitable hosts in parts of Australia may hinder or prevent the long-range natural spread of the identified pests.

There is potential for domestic trade to facilitate the spread of the identified pests

- Human-mediated movement of infected seeds and seedlings (transplants) is considered the primary method for the introduction of plant pathogens into new areas. As visual symptoms may not be present, infected seeds or seedlings could easily be moved into new areas. The introduction of infected seeds/seedlings establishes the pests in new areas and unregulated movement may accelerate the spread of the identified pests across Australia.

- Distribution of infected *Citrullus lanatus*, *Cucumis melo*, *Cucumis sativus*, *Cucurbita maxima*, *Cucurbita moschata*, *Cucurbita pepo*, *Lagenaria siceraria*, *Momordica charantia* and *Trichosanthes cucumerina* seeds throughout production areas will help spread the identified pests across Australia. Additionally, TBRV can be spread via infected lettuce seeds (Gumus & Paylan 2013) and *Alternaria burnsii* via cumin seeds (Singh et al. 2018a; Singh et al. 2016).
- Infected and/or infested seeds are the most effective way to spread seed-borne pests over long distances (Constable et al. 2019; Constable et al. 2018; Vannacci et al. 1999). The distribution and sowing of infected seeds will help the introduction and spread of these seed-borne pests throughout the crop-growing areas of Australia. Infected seeds can play a significant role in pathogens spreading over greater distances and can also serve as a reservoir for pathogens in the soil (du Toit & Pelter 2003; Elmer 2001; Elmer & Lacy 1987).
- In the absence of statutory control, it is likely that the identified pests will spread within Australia through the trade of seeds/seedlings for propagation. Planting of infected seeds and seedlings in production fields is likely to introduce the identified pests into the environment.

3.1.4 Overall likelihood of entry, establishment and spread

The overall likelihood of entry, establishment and spread is determined by combining the individual likelihoods of entry, of establishment and of spread using the matrix of rules for combining descriptive likelihoods (Table 2.2).

The overall likelihood that the identified quarantine pests will enter Australia, be distributed in a viable state to susceptible hosts, establish in that area and subsequently spread within Australia is assessed as **Moderate**.

3.1.5 Assessment of potential consequences

The entry, establishment and spread of the quarantine pests is likely to have unacceptable economic consequences, particularly for Australia's agricultural and food production sectors. Seed-borne pests are known to be able to affect germination, growth and crop productivity (Antignus et al. 2001; Lecoq & Katis 2014; Singh et al. 2018a).

The introduction and spread in Australia of pests with wide host ranges would affect both the imported host and alternate hosts. Once a pest gains entry into a new region or crop it may establish and spread quickly, requiring the implementation of costly and/or environmentally-damaging control measures. New control measures to minimise economic impacts may result in changes to the supply and production chain.

The establishment of new quarantine pests in Australia could also result in phytosanitary regulations being imposed by foreign or domestic trading partners. Trade restrictions on affected commodities could lead to loss of markets.

This section examines the potential consequences of *Alternaria burnsii*, *Diaporthe cucurbitae*, BgYMV, CFMMV, CGMMV, KGMMV, MNSV, TBRV, and ZGMMV were they to enter, establish and spread in Australia.

Consequences of *Alternaria burnsii*

The potential consequences of entry, establishment and spread of *Alternaria burnsii* in Australia

have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the potential consequences of a pest with respect to one or more (but not all) criteria have an impact of 'D', the overall consequences are estimated to be **Very Low**.

The supporting evidence for this assessment is provided.

Criterion	Estimated impact score and rationale
Direct	
Plant life or health	<p>C—Significant at the local level</p> <p>The direct impact of <i>Alternaria burnsii</i> on plant life or health would be of significance at the local level and minor significance at the district level, which has an impact score of 'C'.</p> <ul style="list-style-type: none"> <i>Alternaria burnsii</i> is a significant pest of cumin in India. The disease causes small, isolated whitish necrotic areas on aerial parts of the plant which enlarge and may result in death of the plant, and seeds produced may be shrivelled, darkened and non-viable (Singh et al. 2018a; Singh et al. 2016). Disease incidence of up to 80% in cumin fields have been recorded in India (Sharma et al. 2013). Complete failure of a crop may occur in more severe years, depending on climatic conditions (Özer & Bayraktar 2015). <i>Alternaria burnsii</i> also causes significant damage on black cumin (<i>Bunium persicum</i>) (Mondal et al. 2002b). Cumin is one of a number of spice seeds being researched as part of a federal government initiative to investigate potential for increased spice production in NT and Qld, which is projected to generate \$1.2 million at the farm gate level (Canavan 2019). If established, <i>Alternaria burnsii</i> has the potential to significantly reduce cumin production in Australia. <i>Alternaria burnsii</i> is also a latent minor pathogen of pumpkin. Infection causes discolouration and weak blight in pumpkin seeds (Paul et al. 2015). <i>Alternaria burnsii</i> causes leaf spots on date palm and wheat (Al-Nadabi et al. 2018) and disease records also exist for <i>Sorghum</i> and <i>Gossypium</i> spp. (Woudenberg et al. 2015).
Other aspects of the environment	<p>A—Indiscernible at the local level</p> <p>The direct impact of <i>Alternaria burnsii</i> on other aspects of the environment would be indiscernible at the local, district, regional and national levels, which has an impact score of 'A'.</p> <ul style="list-style-type: none"> <i>Alternaria burnsii</i> has a limited number of hosts and no impact of the pathogen has been reported on the environment internationally or domestically. <i>Alternaria burnsii</i> has only been reported from cultivated hosts, with no evidence of them infecting native or endangered flora.
Indirect	
Eradication, control, etc.	<p>B—Minor significance at the local level</p> <p>The indirect impact of <i>Alternaria burnsii</i> on eradication and control would be of minor significance at the local level, and indiscernible at the district, regional and national levels, which has an impact score of 'B'.</p> <ul style="list-style-type: none"> Containment and eradication actions such as movement restrictions of host seeds and planting material, and destruction of infected crops may cause disruption to agribusiness and associated trades within the affected area. Although <i>Alternaria burnsii</i> is a soil-borne pathogen (Khare, S.P. & Sharma 2014), it is expected that eradication or containment of <i>Alternaria burnsii</i> would be easily achieved through cultural practices including crop rotation and introduction of antagonistic fungi (Deepak, Saran & Lal 2008; Khalequzzaman 2016). Treatment of infected seeds with fungicides can completely eliminate <i>Alternaria burnsii</i> in its native range cumin fields (Lodha & Mawar 2007).

Criterion	Estimated impact score and rationale
Domestic trade	<p>C—Significant at the local level</p> <p>The indirect impact of <i>Alternaria burnsii</i> on domestic trade would be significant at the local level, of minor significance at the district level, and indiscernible at the regional level, which has an impact score of 'C'.</p> <ul style="list-style-type: none"> The presence of <i>Alternaria burnsii</i> could threaten economic viability through reduced trade or loss of domestic markets at the local level. Biosecurity measures to prevent the movement of plant material out of the initial incursion area would affect plant industries and business at the local level. The introduction of <i>Alternaria burnsii</i> into a state or territory would disrupt interstate trade due to the biosecurity restrictions on the domestic movement of seeds and planting material within Australia.
International trade	<p>C—Significant at the local level</p> <p>The indirect impact of <i>Alternaria burnsii</i> on international trade would be significant at the local level, of minor significance at the district level, and indiscernible at the regional level, which has an impact score of 'C'.</p> <ul style="list-style-type: none"> The introduction and spread of <i>Alternaria burnsii</i> in Australia could result in loss of commodity trade or restrictions on Australian exports of host material, threatening economic viability at the local level. <i>Alternaria burnsii</i> is a quarantine pest of <i>Cuminum</i> seed for New Zealand (MPI 2019). Australia currently has export market access for cumin seeds to Papua New Guinea and pumpkin seeds to Fiji and South Africa. If established, these trading partners may review their phytosanitary requirements, including the possibility of suspending or stopping trade and/or imposing additional measures. Existing market access would need to be re-established and opening of new markets would be difficult.
Environmental and non-commercial	<p>B—Minor significance at the local level</p> <p>The indirect impact of <i>Alternaria burnsii</i> on the environment would be of minor significance at the local level, and indiscernible at the district, regional and national levels, which has an impact score of 'B'.</p> <ul style="list-style-type: none"> The introduction of <i>Alternaria burnsii</i> may result in additional fungicide use, which may cause minor damage to the local environment. For example, the fungicide Rovral (active constituent iprodione), a fungicide shown to be effective for control of <i>Alternaria burnsii</i> on cumin (Khalequzzaman 2016), is known to affect soil microbial communities (Miñambres et al. 2010; Wang et al. 2004).

Consequences of *Diaporthe cucurbitae*

The potential consequences of the entry, establishment and spread of *Diaporthe cucurbitae* in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the potential consequences of a pest with respect to a single criterion have an impact of 'D', the overall consequences are estimated to be **Low**.

The supporting evidence for this assessment is provided.

Criterion	Estimated impact and rationale
Direct	
Plant life or health	<p>D—Significant at the district level</p> <p>The direct impact of <i>Diaporthe cucurbitae</i> on plant life or health would be of major significance at the local level, significant at the district level, and of minor significance at the regional level, which has an impact score of 'D'.</p>

Criterion	Estimated impact and rationale
	<ul style="list-style-type: none"> <i>Diaporthe cucurbitae</i> infects economically important Cucurbitaceae species causing black rot disease in cucumber, melon, watermelon, pumpkin/zucchini and angled luffa (Bertetti et al. 2011; Bruton 1996; Garibaldi et al. 2011; McKeen 1957; Udayanga et al. 2015; Udayanga et al. 2011). On cucumber, the disease appears as cankers or lesions on stems, blight of the inflorescence, rot of tendrils, petioles, fruit peduncles and rapid decay of the fruit (Bruton 1996; McKeen 1957). Infected fruits are soft, water soaked, shrunk, mummified, and emit a lemon-like odour. The fruit rind is studded with black spores (McKeen 1957). On melons, <i>Diaporthe cucurbitae</i> produces irregular, brown, soft sunken lesions on the fruit (Bertetti et al. 2011; Garibaldi et al. 2011) and cankers on the stem kills the vine (McKeen 1957). The infection can also be latent on unripe fruits, remain dormant until fruit is harvested, and cause serious post-harvest losses during fruit storage and marketing (Beraha & O'Brien 1979; Bruton 1995, 1996; Ohsawa & Kobayashi 1989; Zhang, Bruton & Biles 1999). <i>Diaporthe cucurbitae</i> causes fruit rot of watermelons (McKeen 1957). The fungus also infects roots of watermelon but rarely causes crown lesions (Bruton 1996).
Other aspects of the environment	<p>A—Indiscernible at the local level</p> <p>The direct impact of <i>Diaporthe cucurbitae</i> on other aspects of the environment would be indiscernible at the local, district, regional and national levels, which has an impact score of 'A'.</p> <ul style="list-style-type: none"> No impact of <i>Diaporthe cucurbitae</i> has been reported on the environment internationally or domestically. <i>Diaporthe cucurbitae</i> has only been reported from cultivated cucurbitaceous hosts, with no evidence of them infecting native or endangered flora.
Indirect	
Eradication, control, etc.	<p>A—Indiscernible at the local level</p> <p>The indirect impact of <i>Diaporthe cucurbitae</i> on eradication and control would be indiscernible at the local level, which has an impact score of 'A'.</p> <ul style="list-style-type: none"> Eradication or containment of <i>Diaporthe cucurbitae</i> would be easily achieved through cultural practices including crop rotation and fungicidal seed treatment. There would be little change to existing management measures to control other <i>Diaporthe</i> species in Australia.
Domestic trade	<p>C—Significant at the local level</p> <p>The indirect impact of <i>Diaporthe cucurbitae</i> on domestic trade would be significant at the local level, of minor significance at the district level, and indiscernible at the regional level, which has an impact score of 'C'.</p> <ul style="list-style-type: none"> The presence of <i>Diaporthe cucurbitae</i> could threaten economic viability through reduced trade or loss of domestic markets at the local level. Biosecurity measures to prevent the movement of plant material out of the initial incursion area would affect plant industries and business at the local level. The introduction of <i>Diaporthe cucurbitae</i> into a state or territory would disrupt interstate trade due to the biosecurity restrictions on domestic movement of seeds and planting materials of host species within Australia. Interstate restrictions on these commodities may lead to a loss of markets, which could threaten economic viability.
International trade	<p>A—Indiscernible at the local level</p> <p>The indirect impact of <i>Diaporthe cucurbitae</i> on international trade would be indiscernible at the local, district, regional and national levels, which has an impact score of 'A'.</p> <ul style="list-style-type: none"> <i>Diaporthe cucurbitae</i> is not currently regulated by Australia's trading partners. Therefore, it is estimated that the introduction and spread of this pathogen in

Criterion	Estimated impact and rationale
	Australia will not result in restrictions on Australian exports of cucurbit seed and propagative material.
Environmental and non-commercial	<p>B—Minor significance at the local level</p> <p>The indirect impact of <i>Diaporthe cucurbitae</i> on the environment would be of minor significance at the local level, and indiscernible at the district, regional and national levels, which has an impact score of 'B'.</p> <ul style="list-style-type: none"> • Introduction of <i>Diaporthe cucurbitae</i> may result in additional fungicide use that causes minor damage to the local environment. For example, copper-based fungicide residues in the soil can be lethal to or inhibit growth and reproduction of soil invertebrates in turn affecting soil processes such as the breakdown of plant litter (Wightwick et al. 2008).

Consequences of BgYMV

The potential consequences of entry, establishment and spread of BgYMV in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the potential consequences of a pest with respect to one or more (but not all) criteria have an impact of 'D', the overall consequences are estimated to be **Low**.

The supporting evidence for this assessment is provided.

Criterion	Estimated impact score and rationale
Direct	
Plant life or health	<p>D—Significant at the district level</p> <p>The direct impact of BgYMV on plant life or health would be of major significance at the local level, significant at the district level, and of minor significance at the regional level, which has an impact score of 'D'.</p> <ul style="list-style-type: none"> • BgYMV is a newly characterised species of virus which has been reported to cause a significant impact on bitter melon (<i>Momordica charantia</i>) (Manivannan et al. 2019). Since the species was only characterised in 2019, it is likely that more hosts for this virus will be identified in the future. • In India, BgYMV is known to cause yellow mottling, puckering, stunting and malformed fruits in infected bitter melon, with a disease incidence of 58%-100% (Manivannan et al. 2019). These symptoms are typical of yellow mosaic diseases, but it is important to note there is ambiguity on the identity of the virus(es) responsible for previous reports of yellow mosaic in bitter melon (e.g. Rajinimala, Rabindran and Ramaiah (2009); Rajinimala et al. (2005)). • Bitter melon is grown in small quantities in NSW, NT and Qld and is considered a developing industry in Australia. (AgriFutures Australia 2017). Yellow mosaic disease has the potential to significantly affect this industry.
Other aspects of the environment	<p>A—Indiscernible at the local level</p> <p>The direct impact of BgYMV on other aspects of the environment would be indiscernible at the local, district, regional and national levels, which has an impact score of 'A'.</p>

Criterion	Estimated impact score and rationale
Indirect	<ul style="list-style-type: none"> BgYMV only infects bitter gourd. No impact of the pathogen has been reported on the environment internationally or domestically. There is no evidence of BgYMV infecting native or endangered flora.
Eradication, control, etc.	<p>D—Significant at the district level</p> <p>The indirect impact of BgYMV on eradication and control would be of major significance at the local level, significant at the district level, and of minor significance at the regional level, which has an impact score of 'D'.</p> <ul style="list-style-type: none"> It is expected that efforts would be taken to control and potentially eradicate an outbreak of BgYMV in Australia, due to its potential ability to affect bitter gourd and possibly other cucurbit species under cultivation in Australia. Destruction of infected crops may cause disruption to agribusiness and associated trades within the affected area. BgYMV is known to be transmitted by the whitefly <i>Bemisia tabaci</i> (Onkara Naik et al. 2019). As this whitefly is known to be present within Australia (Plant Health Australia 2019a), control measures against whiteflies such as insecticides would need to be established in order to control and/or eradicate an outbreak of BgYMV. Control of BgYMV would be difficult as no effective management practices are known. According to Ilhe, Sarkate and Gangawane (2017) and Rajinimala, Rabindran and Ramaiah (2007), disease incidence of BgYMV infected bitter gourd plants were reduced by 33%–66% when treated with virus inhibiting chemicals, antiviral plant extracts, biological agents and insecticides. However, complete disease control was not achieved. The economic viability of production would be threatened through increases in costs associated with insecticide sprays for vector control or domestic seed testing which would be required to prevent further spread of BgYMV into new areas.
Domestic trade	<p>C—Significant at the local level</p> <p>The indirect impact of BgYMV on domestic trade would be significant at the local level, of minor significance at the district level, and indiscernible at the regional and national levels, which has an impact score of 'C'.</p> <ul style="list-style-type: none"> The presence of BgYMV could threaten economic viability at the local level through reduced commodity trade or loss of domestic markets. Biosecurity measures to prevent the movement of plant material out of the initial incursion area would affect plant industries and business at the local level. The introduction of BgYMV into a state or territory would disrupt interstate trade due to the biosecurity restrictions on the domestic movement of bitter gourd seeds and planting material within Australia.
International trade	<p>B—Minor significance at the local level</p> <p>The indirect impact of BgYMV on international trade would be of minor significance at the local level and indiscernible at the district level, which has an impact score of 'B'.</p> <ul style="list-style-type: none"> BgYMV is not currently regulated by Australia's trading partners and there are no established export markets for bitter gourd seeds. The introduction and spread of this virus in Australia would therefore not result in restrictions on current Australian exports. However opening of new markets in the future to where BgYMV is not present could be difficult and trading partners may impose additional measures.
Environmental and non-commercial	<p>B—Minor significance at the local level</p> <p>The indirect impact of BgYMV on the environment would be of minor significance at the local level and indiscernible at the district level, which has an impact score of 'B'.</p> <ul style="list-style-type: none"> Introduction of BgYMV may result in additional insecticide use that causes minor damage to the local environment. No other evidence was found indicating environmental and non-commercial indirect effects.

Consequences of CFMMV

The potential consequences of entry, establishment and spread of CFMMV in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the potential consequences of a pest with respect to one or more (but not all) criteria have an impact of 'E', the overall consequences are estimated to be **Moderate**.

The supporting evidence for this assessment is provided.

Criterion	Estimated impact score and rationale
Direct	
Plant life or health	<p>E—Major significance at the district level</p> <p>The direct impact of CFMMV on plant life or health would be of major significance at the district level, significant at the regional level, and of minor significance at the national level, which has an impact score of 'E'.</p> <ul style="list-style-type: none"> CFMMV naturally infects cucumber, melon, watermelon and zucchini (Antignus et al. 2005; Antignus et al. 2001; Kwon et al. 2014; Rhee, Hong & Lee 2014b; Rhee, Jang & Lee 2016). CFMMV was first isolated in cucumbers in a greenhouse in central Israel in 1992 (Antignus et al. 2005). It causes severe mottling or mosaic on cucumber fruits, rendering them unmarketable, and in some cases entire plants can experience severe wilting, resulting in vine collapse (Antignus et al. 2001). CFMMV infections can spread rapidly in greenhouses; widespread outbreaks normally occur during the summer with disease incidence sometimes reaching 100%, leading to significant economic losses in cucumber crops (Antignus et al. 2005).
Other aspects of the environment	<p>A—Indiscernible at the local level</p> <p>The direct impact of CFMMV on other aspects of the environment would be indiscernible at the local, district, regional and national levels, which has an impact score of 'A'.</p> <ul style="list-style-type: none"> No impact of CFMMV has been reported on the environment internationally or domestically. CFMMV has only been reported from cultivated cucurbitaceous hosts (Antignus et al. 2001; Kwon et al. 2014), with no evidence of it infecting native or endangered flora.
Indirect	
Eradication, control, etc.	<p>E—Major significance at the district level</p> <p>The indirect impact of CFMMV on eradication and control would be of major significance at the district level, significant at the regional level, and of minor significance at the national level, which has an impact score of 'E'.</p> <ul style="list-style-type: none"> Impacts of management activities could be expected to threaten economic viability through a large increase in costs for containment, eradication and control at a district level. It is expected that efforts would be taken to control and potentially eradicate an outbreak of CFMMV in Australia due to its potential ability to affect economically important crops such as cucumber, watermelon and pumpkin. Destruction of infected crops may cause disruption to agribusiness and associated trades in the affected area. CFMMV, like other <i>Tobamovirus</i> species, are soil-borne and the main method of infection is via entry of the virus into wounds in roots during transplanting (Antignus et al. 2005). The potential ability of CFMMV to survive for long periods in soil without a living host, combined with its potential human-mediated spread

Criterion	Estimated impact score and rationale
	<p>through trade in infected seed is likely to make this pathogen difficult to eradicate (Antignus et al. 2005).</p> <ul style="list-style-type: none"> • There are no effective agri-chemicals available for the control of CFMMV in host crops. In addition, weed and volunteer cucurbit control should be rigorous to prevent any alternate host CFMMV carryover. • The removal and destruction of all infected hosts may help in the management of the disease; however, CFMMV is likely to be able to survive in soil, so the removal of the host plants may not eliminate this virus from the growing area. • Like other tobamoviruses, CFMMV can be expected to spread through contact between healthy and infected plants during operations such as transplanting and pruning in infected soil. Therefore, strict controls for the movement of potentially contaminated equipment and people from affected farms, and increased use of labour and consumables for washing and disinfection, are likely to be required to manage the spread of the virus, which would increase production costs.
Domestic trade	<p>D—Significant at the district level</p> <p>The indirect impact of CFMMV on domestic trade would be of major significance at the local level, significant at the district level, and of minor significance at the regional level, which has an impact score of 'D'.</p> <ul style="list-style-type: none"> • The presence of CFMMV could threaten economic viability through reduced trade or loss of domestic markets at the district level. Biosecurity measures to prevent the movement of plant material out of the initial incursion area would affect plant industries and business at the district level. • The introduction of CFMMV into a state or territory would disrupt interstate trade due to the biosecurity restrictions on the domestic movement of seeds and planting materials of host species within Australia. Interstate restrictions on these commodities may lead to a loss of markets, which could threaten economic viability.
International trade	<p>B—Minor significance at the local level</p> <p>The indirect impact of CFMMV on international trade would be of minor significance at the local level and indiscernible at the district level, which has an impact score of 'B'.</p> <ul style="list-style-type: none"> • Australia currently has export market access for <i>Cucurbita pepo</i> seeds to Ethiopia, Timor-Leste, Syrian Arab Republic, New Caledonia, New Zealand, French Polynesia, Taiwan and Chile (Department of Agriculture 2019). • CFMMV is not currently regulated by Australia's trading partners. Therefore, it is considered that the introduction and spread of this virus in Australia would not result in immediate restrictions on current Australian exports.
Environmental and non-commercial	<p>A—Indiscernible at the local level</p> <p>The indirect impact of CFMMV on the environment would be indiscernible at the local, district, regional and national levels, which has an impact score of 'A'.</p> <ul style="list-style-type: none"> • No evidence was found indicating environmental and non-commercial indirect effects.

Consequences of CGMMV

Based on the department's final PRA for CGMMV (Australian Department of Agriculture and Water Resources 2017), the potential consequences of the introduction and spread of CGMMV in Australia are estimated to be **Moderate**.

Consequences of KGMMV

The potential consequences of entry, establishment and spread of KGMMV in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the potential consequences of a pest with respect to one or more (but not all) criteria have an impact of 'E', the overall consequences are estimated as **Moderate**.

The supporting evidence for this assessment is provided.

Criterion	Estimated impact score and rationale
Direct	
Plant life or health	<p>E—Major significance at the district level</p> <p>The direct impact of KGMMV on plant life or health would be of major significance at the district level, significant at the regional level, and of minor significance at the national level, which has an impact score of 'E'.</p> <ul style="list-style-type: none"> KGMMV has a significant effect on the health, life and yield of economically important cucurbit species such as cucumber, melon, ribbed gourd, watermelon and zucchini (Daryono, Somowiyarjo & Natsuaki 2003, 2005a; Kwon et al. 2014; Lecoq & Katis 2014; Reingold et al. 2015). KGMMV was first described as CGMMV cucumber strain in Japan (Inouye et al. 1967; Tan et al. 2000) and has since been reported from Korea (Lee et al. 2000) and Indonesia (Daryono, Somowiyarjo & Natsuaki 2003). KGMMV causes mosaic, severe fruit mottling and malformation (Brunt et al. 1996) which may result in severe reductions in fruit yield and quality, leading to serious economic losses in important crops such as cucumber and melon (Daryono, Somowiyarjo & Natsuaki 2005a; Reingold et al. 2015). In Japan, KGMMV is considered a major virus, causing severe yield reduction in cucumber (Fukuta et al. 2012).
Other aspects of the environment	<p>A—Indiscernible at the local level</p> <p>The direct impact of KGMMV on other aspects of the environment would be indiscernible at the local, district, regional and national levels, which has an impact score of 'A'.</p> <ul style="list-style-type: none"> KGMMV has a limited host range and is associated with cucumber, melon, ribbed gourd, watermelon and zucchini (Daryono, Somowiyarjo & Natsuaki 2003, 2005a; Kwon et al. 2014; Lecoq & Katis 2014; Reingold et al. 2015). No impact of the pathogen has been reported on the environment internationally or domestically.
Indirect	
Eradication, control, etc.	<p>E—Major significance at the district level</p> <p>The indirect impact of KGMMV on eradication and control would be of major significance at the district level, significant at the regional level, and of minor significance at the national level, which has an impact score of 'E'.</p> <ul style="list-style-type: none"> Impacts of management activities could be expected to threaten economic viability through a large increase in costs for containment, eradication and control at a district level. Containment and eradication costs and activities would also cause disruption to Australia's agribusiness and associated trades in the affected area. The ability of KGMMV to survive for long periods in soil without a living host and capacity for mechanical transmission (Fukuta et al. 2012), combined with its potential human-mediated spread through trade in infected seed, are likely to make this a difficult pathogen to eradicate. There are no effective agri-chemicals available for the control of KGMMV in host crops. In addition, weed and volunteer cucurbit control should be rigorous to prevent any alternate host KGMMV carryover. The removal and destruction of all infected hosts may help in the management of the disease; however, KGMMV can survive in soil, so the removal of the host plants may not eliminate KGMMV from the growing area.

Criterion	Estimated impact score and rationale
	<ul style="list-style-type: none"> KGMMV is very stable and is mechanically transmissible during harvesting and pruning operations or contact between infected and healthy foliage (Fukuta et al. 2012). Therefore, strict controls for the movement of potentially contaminated equipment and people from affected farms, and increased use of labour and consumables for washing and disinfection, are likely to be required to manage the spread of the virus, which would increase production costs.
Domestic trade	<p>D—Significant at the district level</p> <p>The indirect impact of KGMMV on domestic trade would be of major significance at the local level, significant at the district level, and of minor significance at the regional level, which has an impact score of 'D'.</p> <ul style="list-style-type: none"> The presence of KGMMV could threaten economic viability through reduced trade or loss of domestic markets at the district level. Biosecurity measures to prevent the movement of plant material out of the initial incursion area would affect plant industries and business at the district level. The introduction of KGMMV into a state or territory would disrupt interstate trade due to the biosecurity restrictions on the domestic movement of host commodities (for cucumber, watermelon and zucchini seeds and propagative material).
International trade	<p>D—Significant at the district level</p> <p>The indirect impact of KGMMV on international trade would be of major significance at the local level, significant at the district level, and of minor significance at the regional level, which has an impact score of 'D'.</p> <ul style="list-style-type: none"> Australia currently has export market access for <i>Citrullus lanatus</i>, <i>Cucumis sativus</i> and <i>Cucurbita pepo</i> seeds for several countries (Department of Agriculture 2019). The presence of KGMMV could threaten economic viability at the district level through loss of commodity trade and export markets. The presence of KGMMV in Australia would likely result in additional export requirements, such as testing of host propagative material for freedom from KGMMV. This would add significant costs to production in Australia. For example some countries, such as New Zealand and Netherlands, require country freedom or other certification requirements to address the risk of KGMMV in imported host commodities (Department of Agriculture 2019).
Environmental and non-commercial	<p>A—Indiscernible at the local level</p> <p>The indirect impact of KGMMV on the environment would be indiscernible at the local, district, regional and national levels, which has an impact score of 'A'.</p> <ul style="list-style-type: none"> No evidence was found indicating environmental and non-commercial indirect effects.

Consequences of MNSV

The potential consequences of the entry, establishment and spread of MNSV in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the potential consequences of a pest with respect to one or more (but not all) criteria have an impact of 'E', the overall consequences are estimated to be **Moderate**.

The supporting evidence for this assessment is provided.

Criterion	Estimated impact score and rationale
Direct	
Plant life or health	E—Major significance at the district level

Criterion	Estimated impact score and rationale
	<p>The direct impact of MNSV on plant life or health would be of major significance at the district level, significant at the regional level, and of minor significance at the national level, which has an impact score of 'E'.</p> <ul style="list-style-type: none"> • MNSV was first reported in Japan from melon plants showing necrotic spots (Kishi 1966), and since then has been reported from several countries (Choi, Kim & Kim 2003). • MNSV causes systemic necrotic spots on leaves, and streaks on stems of melon, cucumber and watermelon, and occasionally whole plants may collapse (Lecoq & Desbiez 2012). Necrotic spots on leaves and stems enlarge over time and appear on the fruit skin at ripening (Kwak et al. 2015). • MNSV has a significant effect on the health, yield and fruit quality of economically important Cucurbitaceae species such as melon, cucumber and watermelon (Lecoq & Desbiez 2012). • MNSV has been reported to cause up to 100% loss (Herrera-Vásquez et al. 2009; Kwak et al. 2015). In greenhouse grown watermelon plants, MNSV has been reported to cause rates of plant death of 80% (Ruiz et al. 2016).
Other aspects of the environment	<p>A—Indiscernible at the local level</p> <p>The direct impact of MNSV on other aspects of the environment would be indiscernible at the local, district, regional and national levels, which has an impact score of 'A'.</p> <ul style="list-style-type: none"> • No impact of the pathogen has been reported on the environment internationally or domestically. • MNSV has only been reported from cultivated cucurbitaceous hosts (Lecoq & Desbiez 2012), with no evidence of them infecting native or endangered flora.
Indirect Eradication, control, etc.	<p>E—Major significance at the district level</p> <p>The indirect impact of MNSV on eradication and control would be of major significance at the district level, significant at the regional level, and of minor significance at the national level, which has an impact score of 'E'.</p> <ul style="list-style-type: none"> • Impacts of management activities could be expected to threaten economic viability through a large increase in costs for containment, eradication and control at a district level. • Containment and eradication costs and activities would also cause disruption to Australia's agribusiness and associated trades at the district level. • The ability of MNSV to survive for long periods in plant debris and soil without a living host (Herrera-Vásquez et al. 2009), combined with its potential human-mediated spread through trade in infected seed, are likely to make this a difficult pathogen to eradicate. • There are no effective agri-chemicals available for the control of MNSV in host crops. In addition, weed and volunteer cucurbit control should be rigorous to prevent any alternate host MNSV carryover. • The removal and destruction of all infected hosts may help in the management of the disease; however, MNSV can survive in soil, so the removal of the host plants may not eliminate MNSV from the growing area. • MNSV was introduced into Korea in 2001 with infected seed imported from Japan (Kwak et al. 2015). Since then the virus has spread throughout the major melon growing areas in Korea (Kwak et al. 2015). • MNSV can be spread by the soil-borne fungal vector (<i>Olpidium bornovanus</i>), mechanical transmission, and pruning operations and probably by foliage contact (Lecoq & Desbiez 2012). Therefore, strict controls for the movement of potentially contaminated equipment and people from affected farms, and increased use of labour and consumables for washing and disinfection, are likely to be required to manage the spread of the virus, which would increase production costs.

Criterion	Estimated impact score and rationale
Domestic trade	<p>D—Significant at the district level</p> <p>The indirect impact of MNSV on domestic trade would be of major significance at the local level, significant at the district level, and of minor significance at the regional level, which has an impact score of 'D'.</p> <ul style="list-style-type: none"> The presence of MNSV could threaten economic viability through reduced trade or loss of domestic markets at the district level. Biosecurity measures to prevent the movement of plant material out of the initial incursion area would affect plant industries and business at the district level. The introduction of MNSV into a state or territory would disrupt interstate trade due to the biosecurity restrictions on the domestic movement of host commodities (watermelon and melon seeds and propagative material).
International trade	<p>D—Significant at the district level</p> <p>The indirect impact of MNSV on international trade would be of major significance at the local level, significant at the district level, and of minor significance at the regional level, which has an impact score of 'D'.</p> <ul style="list-style-type: none"> The presence of MNSV could threaten economic viability at the district level through loss of commodity trade and export markets. The presence of MNSV in Australia would likely result in additional export requirements, such as testing of host propagative material for freedom from MNSV. This would add significant costs to production in Australia. For example, the Netherlands currently requires production area freedom to address the risk of MNSV in <i>Cucumis sativus</i> seeds (Department of Agriculture 2019). Australia currently has market access for <i>Citrullus lanatus</i> and <i>Cucumis melo</i> seeds to several countries. If MNSV established in Australia, these trading partners may review their phytosanitary requirements, including the possibility of suspending or stopping trade and/or imposing additional measures. Existing market access would need to be re-established and opening of new markets would be difficult.
Environmental and non-commercial	<p>A—Indiscernible at the local level.</p> <p>The indirect impact of MNSV on the environment would be indiscernible at the local, district, regional and national levels, which has an impact score of 'A'.</p> <ul style="list-style-type: none"> No evidence was found indicating environmental and non-commercial indirect effects.

Consequences of TBRV

The potential consequences of the entry, establishment and spread of TBRV in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the potential consequences of a pest with respect to one or more (but not all) criteria have an impact of 'E', the overall consequences are estimated to be **Moderate**.

The supporting evidence for this assessment is provided.

Criterion	Estimated impact score and rationale
Direct	
Plant life or health	<p>E—Significant at the regional level</p> <p>The direct impact of TBRV on plant life or health would be of major significance at the district level, significant at the regional level, and of minor significance at the national level, which has an impact score of 'E'.</p> <ul style="list-style-type: none"> TBRV infects cucurbitaceous crops such as cucumber and zucchini and a significant number of economically important fruit and forest trees, vegetable

Criterion	Estimated impact score and rationale
Other aspects of the environment	<p>and ornamental hosts including artichoke, bean, beet, carrot, celery, onions, peas, potato, spinach, raspberry, strawberry and tomato (Gan et al. 2013; Mackesy & Sullivan 2016; Pospieszny & Borodynko 2005).</p> <ul style="list-style-type: none"> • TBRV has been shown to cause significant yield losses in grapevine (50%–66%) and potato (20%–33%) under experimental conditions (Harrison 1959; Laveau et al. 2019). TBRV was also reported to cause a decrease in the number of artichoke heads per plant by 42% (Gallitelli et al. 2004). • TBRV leads to stunted growth and eventually plant death in strawberry plants (Murant & Lister 1987). It also causes stunting, reduced growth and significantly reduced yields in infected raspberry plants in Scotland (Harrison 1958). TBRV can cause severe disease in some raspberry and peach cultivars in some localities, but the incidence of such infections is often low (CABI & EPPO 1997). • Improved control measures for TBRV have significantly reduced incidences of serious damage by this virus on crops (Murant & Lister 1987). Control measures also lead to infections being more localised with comparatively slow spread, potentially reducing levels of damage. • Given that the known nematode vectors of TBRV are not present in Australia, the potential for direct impacts on plant life or health may not be of the same magnitude as reported from areas where the vector is present. <p>A—Indiscernible at the local level</p> <p>The direct impact of TBRV on other aspects of the environment would be indiscernible at the local, district, regional and national levels, which has an impact score of 'A'.</p> <ul style="list-style-type: none"> • TBRV is known to infect a wide range of hosts (EPPO 1990). However, there are no reports of damage to native vegetation. Additionally, its nematode vectors are not present in Australia (Plant Health Australia 2019a), limiting the ability of this pest to move into natural environment and affect native plants.
Indirect Eradication, control, etc.	<p>E—Major significance at the district level</p> <p>The indirect impact of TBRV on eradication and control would be of major significance at the district level, significant at the regional level, and of minor significance at the national level, which has an impact score of 'E'.</p> <ul style="list-style-type: none"> • Impacts of management activities could be expected to threaten economic viability through a large increase in costs for containment, eradication and control at the district level. • Containment and eradication costs and activities would also cause disruption to Australia's agribusiness and associated trades at the district level. • TBRV is known to be transmitted through pollen (Gibbs & Harrison 1964) and has a wide host range, so any eradication measures would likely need to involve destruction of many potential host species. Movement of plant material would need to be restricted, as this is the main means of human-mediated spread (EPPO 1990). Seed transmission is also known to occur in multiple hosts (Lister & Murant 1967), which may further increase the cost of eradication measures. • TBRV can remain infective for long periods of time in seeds of weeds, such as <i>Capsella bursa-pastoris</i> and <i>Stellaria media</i> (Lister & Murant 1967), which are present in Australia (Choi et al. 2007; Miller & West 2012). Moreover, the survival of virus in dormant seeds could ensure its persistence in soils from one season to another, even in the absence of suitable vectors (Lister & Murant 1967). Therefore, long-term weed control measures are required for eradication and control of TBRV. • The nematode vectors of TBRV, <i>Longidorus attenuatus</i> and <i>L. elongatus</i> are not present in Australia (Plant Health Australia 2019a). However, there are over 20 nematode species within the Longidoridae family recorded in Australia (Hodda & Nobbs 2008), many of which are reported to be vectors of nepoviruses.

Criterion	Estimated impact score and rationale
	Therefore, the potential for local spread via nematode vectors in Australia cannot be excluded.
Domestic trade	<p>D—Significant at the district level</p> <p>The indirect impact of TBRV on domestic trade would be of major significance at the local level, significant at the district level, and of minor significance at the regional level, which has an impact score of 'D'.</p> <ul style="list-style-type: none"> The presence of TBRV could threaten economic viability through reduced trade or loss of domestic markets at the district level. Biosecurity measures to prevent the movement of plant material out of the initial incursion area would affect plant industries and business at the district level. The introduction of TBRV into a state or territory would disrupt interstate trade due to the biosecurity restrictions on the domestic movement of host commodities, such as cucumber, potato and grapevine propagative material.
International trade	<p>D—Significant at the district level</p> <p>The indirect impact of TBRV on international trade would be of major significance at the local level, significant at the district level, and of minor significance at the regional level, which has an impact score of 'D'.</p> <ul style="list-style-type: none"> TBRV is currently regulated by many of Australia's trading partners (China, France, Malaysia, Netherlands, New Zealand, Iran, Japan, South Africa, Sri Lanka, Turkey, USA) for several seed commodities such as artichoke, bean, beet, chillies, sunflower, lettuce, onion, tomato, etc. and nursery stock of <i>Fragaria</i>, <i>Prunus</i>, <i>Rubus</i> and <i>Vitis</i> spp. (Department of Agriculture 2019). If TBRV were to establish in Australia, trading partners may review their phytosanitary requirements, including the possibility of suspending or stopping trade and/or imposing additional measures. Existing market access would need to be re-established and opening of new markets would be difficult.
Environmental and non-commercial	<p>A—Indiscernible at the local level.</p> <p>The indirect impact of TBRV on the environment would be indiscernible at the local, district, regional and national levels, which has an impact score of 'A'.</p> <ul style="list-style-type: none"> No evidence was found indicating environmental and non-commercial indirect effects.

Consequences of ZGMMV

The potential consequences of the entry, establishment and spread of ZGMMV in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, that is, where the potential consequences of a pest with respect to one or more (but not all) criteria have an impact of 'E', the overall consequences are estimated to be **Moderate**.

The supporting evidence for this assessment is provided.

Criterion	Estimated impact score and rationale
Direct	
Plant life or health	<p>E—Major significance at the district level</p> <p>The direct impact of ZGMMV on plant life or health would be of major significance at the district level, significant at the regional level, and of minor significance at the national level, which has an impact score of 'E'.</p> <ul style="list-style-type: none"> ZGMMV naturally infects bottle gourd, watermelon and zucchini and it is seed-borne in watermelon and zucchini (Choi 2001; Kwon et al. 2014; Li et al. 2018;

Criterion	Estimated impact score and rationale
Other aspects of the environment	<p>Ryu et al. 2000). This virus has been reported to have a significant effect on the health, life and yield of zucchini (Yoon et al. 2002).</p> <ul style="list-style-type: none"> • Prior to its characterisation, ZGMMV was thought to be a strain of CGMMV or KGMMV due to the symptoms it caused and its virus particle morphology (Ryu et al. 2000; Yoon et al. 2002). Due to its similarities with CGMMV and KGMMV it is likely to have been misidentified in the past. Some past reports on economic losses associated with CGMMV or KGMMV could be caused by ZGMMV. • ZGMMV produces mottle and severe mosaic symptoms on plants, and abnormal malformation of fruits that display an irregular green mosaic (Ryu et al. 2000; Yoon et al. 2002). This may impact on the marketability of infected fruit.
	<p>A—Indiscernible at the local level</p> <p>The direct impact of ZGMMV on other aspects of the environment would be indiscernible at the local, district, regional and national levels, which has an impact score of 'A'.</p> <ul style="list-style-type: none"> • No impact of the pathogen has been reported on the environment internationally or domestically. • ZGMMV has only been reported from cultivated cucurbitaceous hosts (Kwon et al. 2014; Yoon et al. 2002), with no evidence of KGMMV infecting native or endangered flora.
Indirect	<p>E—Major significance at the district level</p> <p>The indirect impact of ZGMMV on eradication and control would be of major significance at the district level, significant at the regional level, and of minor significance at the national level, which has an impact score of 'E'.</p> <ul style="list-style-type: none"> • The impacts of management activities could be expected to threaten economic viability through a large increase in costs for containment, eradication and control at a district level. • Containment and eradication costs and activities would also cause disruption to Australia's agribusiness and associated trades at the district level. • Tobamoviruses are recognised as being very stable in the environment and are able to survive for a long time in soil and on equipment in the absence of host plant material. It is expected that as a member of the tobamoviruses, ZGMMV will behave in a similar manner. The ability of ZGMMV to survive for long periods in plant debris and soil without a living host, combined with its potential human-mediated spread through trade in infected seed would be likely to make this a difficult pathogen to eradicate. • There are no effective agri-chemicals available for the control of ZGMMV in host crops. In addition, weed and volunteer cucurbit control should be rigorous to prevent any alternate host ZGMMV carryover. • ZGMMV is likely to persist in the soil, therefore, removal and destruction of all infected hosts may not eliminate ZGMMV from the growing area. • Like other tobamoviruses, ZGMMV can be expected to spread through contact between healthy and infected plants during operations such as transplanting and pruning in infested soil. Therefore, strict controls for the movement of potentially contaminated equipment and people from affected farms, and increased use of labour and consumables for washing and disinfection, are likely to be required to manage the spread of the virus, which would increase production costs.
Domestic trade	<p>D—Significant at the district level</p> <p>The indirect impact of ZGMMV on domestic trade would be of major significance at the local level, significant at the district level, and of minor significance at the regional level, which has an impact score of 'D'.</p>

Criterion	Estimated impact score and rationale
International trade	<ul style="list-style-type: none"> Impacts would be expected to threaten economic viability at the district level through reduced trade or loss of domestic markets. Biosecurity measures to prevent the movement of plant material out of the initial incursion area would affect plant industries and business at the district level. The introduction of ZGMMV into a state or territory would disrupt interstate trade due to the biosecurity restrictions on the domestic movement of host commodities (watermelon and zucchini seeds and propagative material).
	<p>D—Significant at the district level</p> <p>The indirect impact of ZGMMV on international trade would be of major significance at the local level, significant at the district level, and of minor significance at the regional level, which has an impact score of 'D'.</p> <ul style="list-style-type: none"> Australia currently has export market access for watermelon and zucchini seeds for several countries (Department of Agriculture 2019). The presence of ZGMMV could threaten economic viability at the district level through loss of commodity trade and export markets. The presence of ZGMMV in Australia would likely result in additional export requirements, such as testing of host propagative material for freedom from ZGMMV. This would add significant costs to production in Australia. For example some countries, such as the Netherlands, require country freedom or other certification requirements to address the risk of ZGMMV in imported host commodities (Department of Agriculture 2019). If ZGMMV were to establish in Australia, trading partners may review their phytosanitary requirements, including the possibility of suspending or stopping trade and/or imposing additional measures. Existing market access would need to be re-established and opening of new markets would be difficult.
Environmental and non-commercial	<p>A—Indiscernible at the local level.</p> <p>The indirect impact of ZGMMV on the environment would be indiscernible at the local, district, regional and national levels, which has an impact score of 'A'.</p> <ul style="list-style-type: none"> No evidence was found indicating environmental and non-commercial indirect effects.

3.1.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihood of entry, establishment and spread with the outcome of overall consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 2.5. Table 3.2 summarises the unrestricted risk estimates for *Alternaria burnsii*, *Diaporthe cucurbitae*, BgYMV, CFMMV, CGMMV, KGMMV, MNSV, TBRV and ZGMMV.

Table 3.2 Unrestricted risk estimates for quarantine pests of cucurbitaceous vegetable seeds for sowing

Pest name	Likelihood of			Consequences	URE	
	Entry	Establishment	Spread	P[EES]		
Fungi						
<i>Alternaria burnsii</i>	High	High	Moderate	Moderate	Very Low	Very Low
<i>Diaporthe cucurbitae</i>	High	High	Moderate	Moderate	Low	Low
Viruses						
<i>Bitter melon yellow mosaic virus</i> (BgYMV)	High	High	Moderate	Moderate	Low	Low

Pest name	Likelihood of			Consequences		URE
	Entry	Establishment	Spread	P[EES]		
<i>Cucumber fruit mottle mosaic virus</i> (CFMMV)	High	High	Moderate	Moderate	Moderate	Moderate
<i>Cucumber green mottle mosaic virus</i> (CGMMV) ^{EP}	High	High	Moderate	Moderate	Moderate	Moderate
<i>Kyuri green mottle mosaic virus</i> (KGMMV)	High	High	Moderate	Moderate	Moderate	Moderate
<i>Melon necrotic spot virus</i> (MNSV)	High	High	Moderate	Moderate	Moderate	Moderate
<i>Tomato black ring virus</i> (TBRV)	High	High	Moderate	Moderate	Moderate	Moderate
<i>Zucchini green mottle mosaic virus</i> (ZGMMV)	High	High	Moderate	Moderate	Moderate	Moderate

EP—pests for which there is an existing policy

3.1.7 Pest risk assessment conclusions

The unrestricted risk estimate for *Alternaria burnsii* achieves the ALOP for Australia. Accordingly, risk management measures against this pest are not required.

The unrestricted risk estimates for *Diaporthe cucurbitae*, BgYMV, CFMMV, CGMMV, KGMMV, MNSV, TBRV and ZGMMV do not achieve the ALOP for Australia. Accordingly, risk management measures against these pests are required.

4 Pest risk management

The quarantine pests (one fungus and seven viruses) identified in this review (see Table 3.1) present unrestricted risks that do not achieve the appropriate level of protection (ALOP) for Australia. Consequently, the department recommends risk management measures to reduce the risk posed by these pests to levels that achieve the ALOP for Australia.

The department has evaluated existing measures to determine whether alternative or additional measures are required to manage the risks associated with the identified seed-borne pathogens.

4.1 Existing import conditions for seeds for sowing

Standard conditions

Under Australia's existing policy, all seeds for sowing, including cucurbitaceous vegetable seeds, are subject to the department's standard seeds for sowing import conditions.

These import conditions require that:

- each shipment must be packed in clean, new packaging and be clearly labelled with the full botanical name of the species.
- where the seed lot is greater than 10 kilograms and contains seed of less than eight millimetres in diameter, mandatory International Seed Testing Association (ISTA) sampling of each consignment must be used to establish freedom from contamination including weed seed. This testing may be performed at department approved ISTA laboratories overseas or on arrival in Australia. A biosecurity officer must conduct a visual inspection of each consignment on arrival in Australia to verify the results of the ISTA sampling, or collect a sample for analysis if testing was not conducted overseas.
- where the seed lot is less than or equal to 10 kilograms in weight, or contains seed of greater than eight millimetres in diameter, a biosecurity officer must conduct a visual inspection of each consignment on arrival in Australia for freedom from live insects, soil, disease symptoms, contaminant seed, other plant material (for example, leaf and stem material, fruit pulp, and pod material), animal material (for example, animal faeces and feathers) and any other extraneous contamination of biosecurity concern.

All consignments imported into Australia regardless of end-use (including seed for sowing) must meet departmental standards for seed contamination and tolerance.

Cucurbitaceous crop seeds other than *Citrullus lanatus*, *Cucumis melo*, *Cucumis sativus*, *Cucurbita maxima*, *Cucurbita moschata*, *Cucurbita pepo*, *Lagenaria siceraria*, *Trichosanthes cucumerina* and any hybrid of these species can be released from biosecurity control, if these import conditions are met.

Specific measures

Seeds of *Citrullus lanatus*, *Cucumis melo*, *Cucumis sativus*, *Cucurbita maxima*, *Cucurbita moschata*, *Cucurbita pepo*, *Lagenaria siceraria*, *Trichosanthes cucumerina* and any hybrid of these species are subject to additional pest risk management measures (testing or treatment) for the presence of *Cucumber green mottle mosaic virus* (CGMMV), *Diaporthe cucurbitae*, *Kyuri green mottle*

mosaic virus (KGMMV), *Melon necrotic spot virus* (MNSV), or *Zucchini green mottle mosaic virus* (ZGMMV). Details of the additional measures required for each species are summarised in Table 4.1.

Table 4.1 Additional measures for importing specified cucurbitaceous vegetable seeds for sowing

Host species (and hybrids)	Additional measure (on-shore or off-shore)	Pathogen
<i>Citrullus lanatus</i>	Testing (ELISA) (a)	CGMMV(b), KGMMV(c), MNSV(c), ZGMMV(c)
<i>Cucumis melo</i>	Testing (ELISA) and treatment (fungicide)	CGMMV, <i>Diaporthe cucurbitae</i> (c) MNSV
<i>Cucumis sativus</i>	Testing (ELISA)	CGMMV, KGMMV
<i>Cucurbita maxima</i>	Testing (ELISA)	CGMMV
<i>Cucurbita moschata</i>	Testing (ELISA)	CGMMV
<i>Cucurbita pepo</i>	Testing (ELISA)	CGMMV, KGMMV, ZGMMV
<i>Lagenaria siceraria</i>	Testing (ELISA)	CGMMV
<i>Trichosanthes cucumerina</i>	Testing (ELISA)	CGMMV

(a) ELISA tests require a sample of 9,400 seeds (or 20% for small seed lots) for all host species and viruses

(b) Existing policy applies to CGMMV (Australian Department of Agriculture and Water Resources 2017)

(c) Emergency measures apply to *Diaporthe cucurbitae*, KGMMV, MNSV and ZGMMV.

Seed lots tested or treated off-shore must be accompanied by an official government Phytosanitary Certificate endorsed with the additional declaration that the consignment has undergone mandatory treatment or testing in accordance with Australian import conditions.

Under the International Plant Protection Convention (IPPC) and World Trade Organisation (WTO) SPS Agreement, phytosanitary measures against the introduction of new pests must be technically justified. As part of this review, the department evaluated the appropriateness of the existing measures to determine if alternative or additional measures are required for the identified seed-borne pathogens.

4.2 Recommended risk management measures

This review recommends that cucurbitaceous vegetable seeds for sowing should be subject to:

- the department's standard seeds for sowing import conditions, AND
- additional mandatory treatment or testing for quarantine pests identified as associated with cucurbitaceous vegetable seeds, to manage the risk of their introduction.

The department recommends that where testing (PCR or ELISA) is required, the seed sample should be drawn prior to any treatment of seeds.

4.2.1 Species that remain subject to standard seeds for sowing import conditions

Most cucurbitaceous vegetable seeds species reviewed were not found to be hosts of quarantine pests for Australia and will therefore remain subject to the department's standard seeds for sowing import conditions.

The cucurbitaceous species that will remain subject to standard seeds for sowing import conditions are: *Benincasa hispida*, *Citrullus amarus*, *Citrullus colocynthis*, *Cucumis anguria*, *Cucumis dipsaceus*, *Cucumis ficifolius*, *Cucumis metuliferus*, *Cucumis myriocarpus*, *Cucumis zeyheri*, *Cucurbita argyrosperma*, *Cucurbita ficifolia*, *Cucurbita foetidissima*, *Luffa acutangula*, *Luffa aegyptiaca*, *Luffa graveolens*, *Luffa operculata*, *Momordica balsamina*, *Momordica cardiospermoides*, *Momordica cochinchinensis*, *Momordica foetida*, *Momordica friesiorum*, *Momordica grosvenorii*, *Momordica rostrata* and *Sechium edule*.

4.2.2 Species requiring additional measures

The department recommends testing or treatment to manage the risks posed by the identified quarantine pests associated with *Citrullus lanatus*, *Cucumis melo*, *Cucumis sativus*, *Cucurbita maxima*, *Cucurbita moschata*, *Cucurbita pepo*, *Lagenaria siceraria*, *Momordica charantia*, *Trichosanthes cucumerina* and any hybrid of these species, including their synonyms or subordinate taxa as listed in Table 1.1. These requirements are in addition to the standard seeds for sowing import conditions.

4.2.3 Testing or treatment options

Eight quarantine pests were identified to be associated with cucurbitaceous vegetable seeds for sowing: *Bitter gourd yellow mosaic virus* (BgYMV), *Cucumber fruit mottle mosaic virus* (CFMMV), CGMMV, *Diaporthe cucurbitae*, KGMMV, MNSV, *Tomato black ring virus* (TBRV) and ZGMMV. Consequently, additional risk management measures against these pests are required to achieve the ALOP for Australia.

Four risk management options are recommended:

- Option 1. PCR test—an option that is applicable to all eight identified quarantine pests.
 - PCR test using sample size of 9,400 seeds or 20% of small seed lots to verify freedom from detectable presence of *Diaporthe cucurbitae*, BgYMV, CFMMV, CGMMV, KGMMV, MNSV, TBRV and ZGMMV.
- Option 2. ELISA test—an option that is applicable to CGMMV, KGMMV, MNSV and ZGMMV.
 - ELISA test using sample size of 9,400 seeds or 20% of small seed lots to verify freedom from detectable presence of CGMMV, KGMMV, MNSV and ZGMMV.
- Option 3. Broad spectrum fungicidal treatment—an option that is applicable to *Diaporthe cucurbitae*.
- Option 4. Heat treatment—an option that is applicable to MNSV.
 - Dry heat treatment at 70 °C for 144 hours.

4.2.4 PCR testing protocols

PCR testing is recommended as an option to manage the risks posed by all eight identified quarantine pests associated with cucurbitaceous vegetable seeds. The department is in the process of validating the published PCR testing protocols. When this work is completed, the department will publish the approved protocols on its website. All stakeholders will be notified by a formal Biosecurity Import Conditions (BICON) alert before the PCR testing (on-shore or off-shore) commences.

The department may consider other PCR testing protocols on a case-by-case basis. NPPOs that propose other PCR testing protocols must provide the department with an appropriate submission with evidence of test efficacy for its consideration.

4.2.5 Phytosanitary certification

Off-shore tested seed lots

Seed lots of *Citrullus lanatus*, *Cucumis melo*, *Cucumis sativus*, *Cucurbita maxima*, *Cucurbita moschata*, *Cucurbita pepo*, *Lagenaria siceraria*, *Momordica charantia*, *Trichosanthes cucumerina* and any hybrid of these species that are tested off-shore must be accompanied by the laboratory test report and an official government Phytosanitary Certificate endorsed with the following additional declaration:

- 'The consignment of [*botanical name(s) (Genus species)*] comprises [*insert number of cucurbitaceous vegetable seed lots*] seed lot(s); for each seed lot, seeds were tested by PCR [*insert laboratory name(s) and report number(s)*] on a sample size of [*insert sample size i.e. 9,400 seeds or 20% of small seed lots*] and found free from [*name of the pests*];

OR

- 'The consignment of [*botanical name(s) (Genus species)*] comprises [*insert number of cucurbitaceous vegetable seed lots*] seed lot(s); for each seed lot, seeds were tested by ELISA [*insert laboratory name(s) and report number(s)*] on a sample size of [*insert sample size i.e. 9,400 seeds or 20% of small seed lots*] and found free from [*name of the pests*].'

Off-shore treated seed lots

Seed lots of *Cucumis melo* and *Cucumis sativus* that are treated with fungicide off-shore must be accompanied by an official government Phytosanitary Certificate endorsed with the following additional declarations:

- 'The consignment of [*botanical name(s) Genus species*] comprises [*insert seed lot numbers*] seed lot(s); for each seed lot, seed were treated with a broad spectrum fungicide [*insert name and active ingredient and dosage*] for control of *Diaporthe cucurbitae*.'

Seed lots of *Citrullus lanatus* and *Cucumis melo* that are heat treated off-shore must be accompanied by an official government Phytosanitary Certificate endorsed with the following additional declarations:

- 'The consignment of [*botanical name(s) Genus species*] comprises [*insert seed lot numbers*] seed lot(s); for each seed lot, seed were treated with dry heat at 70°C for 144 hours for control of MNSV.'

4.2.6 Summary of additional risk management measures

The additional pest risk management measures for cucurbitaceous vegetable seeds that are associated with the identified quarantine pests are summarised in Table 4.2.

Table 4.2 Summary of additional pest risk management measures for hosts of identified quarantine pests

Host species (incl. its hybrids)	Pathogens	Option 1 (PCR test) (a)	Option 2 (ELISA test) (a)	Option 3 (Fungicide treatment) (b)	Option 4 (Heat treatment) (a)
<i>Citrullus lanatus</i>	CGMMV	Yes	Yes	–	–
	KGMMV	Yes	Yes	–	–
	MNSV	Yes	Yes	–	Yes
	ZGMMV	Yes	Yes	–	–
<i>Cucumis melo</i>	CGMMV	Yes	Yes	–	–
	MNSV	Yes	Yes	–	Yes
	<i>Diaporthe cucurbitae</i>	Yes	–	Yes	–
<i>Cucumis sativus</i>	CGMMV	Yes	Yes	–	–
	KGMMV	Yes	Yes	–	–
	TBRV	Yes	–	–	–
	<i>Diaporthe cucurbitae</i>	Yes	–	Yes	–
<i>Cucurbita maxima</i>	CGMMV	Yes	Yes	–	–
<i>Cucurbita moschata</i>	CGMMV	Yes	Yes	–	–
<i>Cucurbita pepo</i>	CFMMV	Yes	–	–	–
	CGMMV	Yes	Yes	–	–
	KGMMV	Yes	Yes	–	–
	ZGMMV	Yes	Yes	–	–
<i>Lagenaria siceraria</i>	CGMMV	Yes	Yes	–	–
<i>Momordica charantia</i>	BgYMV	Yes	–	–	–
<i>Trichosanthes cucumerina</i>	CGMMV	Yes	Yes	–	–

(a) Options 1, 2 and 4 do not impact the organic status of seeds.

(b) For option 3, the removal of fungicide from the seed prior to planting is not permitted.

4.3 Evaluation of recommended risk management measures

The recommended pest risk management measures (Table 4.3) are designed to reduce the pest risk for each identified quarantine pest to a very low level, which will achieve the ALOP for Australia.

Table 4.3 Evaluation of the recommended pest risk management measures impact on risk estimates

Recommended measure	Effect of the measure	Risk estimates after measures (restricted risk)
Option 1. PCR test	Testing to verify freedom from BgYMV, CGMMV, CFMMV, <i>Diaporthe cucurbitae</i> , KGMMV, MNSV, TBRV and ZGMMV will reduce the risk of introducing these pests into Australia.	Very low
Option 2. ELISA test	Testing to verify freedom from CGMMV, KGMMV, MNSV and ZGMMV will reduce the risk of introducing these pests into Australia.	
Option 3. Broad spectrum fungicidal treatment	Treatment of seeds with an effective broad spectrum fungicide will reduce the risk of introducing <i>Diaporthe cucurbitae</i> into Australia.	Very low
Option 4. Heat treatment	Treatment of seeds with dry heat will reduce the risk of introducing MNSV into Australia.	Very low

4.4 Seeds imported for sprouting or micro-greens

Cucurbitaceous vegetable seeds imported for the end-use of sprouting or micro-greens production for human consumption are currently subject to the department's standard seeds for sowing import conditions.

Citrullus lanatus, *Cucumis melo*, *Cucumis sativus*, *Cucurbita maxima*, *Cucurbita moschata*, *Cucurbita pepo*, *Lagenaria siceraria*, *Momordica charantia* and *Trichosanthes cucumerina* seeds used for sprouting or micro-greens production are exempt from the additional measures for seeds for sowing if imported directly for germination at a production facility operated under an Approved Arrangement.

Facilities that operate under an Approved Arrangement will be required to demonstrate the existence of processes to ensure that seeds imported for the intended end-use of sprouting or micro-greens production will not be diverted for other purposes, and that other biosecurity risks are managed appropriately. Details of the requirements for registration and operation of an Approved Arrangement for the importation of cucurbitaceous vegetable seeds for sprouting or micro-greens production are available on the department's website: [Approved Arrangements for 3.0—Produce Processing—Requirements](#).

Departmental approval of an Approved Arrangement is subject to a range of requirements which include assessment of standard operating procedures, and pre-approval audit and verification by the department.

Citrullus lanatus, *Cucumis melo*, *Cucumis sativus*, *Cucurbita maxima*, *Cucurbita moschata*, *Cucurbita pepo*, *Lagenaria siceraria*, *Momordica charantia* and *Trichosanthes cucumerina* seeds that are not directly imported to be germinated at a production facility operated under an Approved Arrangement will require additional measures as specified in Section 4.2.

4.5 Alternative measures for seeds for sowing

Australia recognises the principle of equivalence, namely, 'the situation where, for a specified pest risk, different phytosanitary measures achieve a contracting party's appropriate level of protection'

(FAO 2019b). ISPM 24 (FAO 2017d) provides guidelines for the determination and recognition of equivalence of phytosanitary measures.

Where formal recognition of equivalence is required, the NPPO of the exporting country must provide a technical submission detailing relevant evidence for the proposed measures for consideration by the department.

Several ISPMs provide further guidance on alternative pest risk management options that may be appropriate to achieve the objective of freedom from the quarantine pests identified in this review. These include:

- ISPM 4: *Requirements for the establishment of pest free areas* (FAO 2017b)
- ISPM 10: *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 2016c)
- ISPM 14: *The use of integrated measures in a systems approach for pest risk management* (FAO 2019d)

These alternative pest risk management options are discussed in the following sections.

4.5.1 Sourcing seeds from pest-free areas

The establishment and use of a pest free area (PFA) by an NPPO provides assurance that specific pests are not present in a delimited geographic area. The delimitation of a PFA should be relevant to the biology of the pest concerned.

The requirements for establishing PFAs are set out in ISPM 4 (FAO 2017b). This ISPM defines a PFA as ‘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’. A PFA may concern all or part of several countries and is managed by the NPPO of the exporting country. The establishment and use of a PFA by an NPPO allows an exporting country to export plants and other regulated articles to an importing country without having to apply additional phytosanitary measures providing certain requirements are met.

Requirements for an NPPO to establish and maintain a PFA include:

- systems to establish freedom (general surveillance and specific surveys)
- phytosanitary measures to maintain freedom (regulatory actions, routine monitoring, and extension advice to producers)
- checks to verify freedom has been maintained.

NPPOs that propose to use area freedom as a measure for managing risks posed by the quarantine pests identified in this review must provide the Department of Agriculture, Water and the Environment with an appropriate submission demonstrating area freedom for its consideration.

4.5.2 Sourcing seeds from pest-free places of production

Requirements for establishing pest free places of production are set out in ISPM 10 (FAO 2016c). The concept of ‘pest freedom’ allows exporting countries to provide assurance to importing

countries that plants, plant products and other regulated articles are free from a specific pest or pests and meet the phytosanitary requirements of the importing country. Where a defined portion of a place of production is managed as a separate unit and can be maintained pest free, it may be regarded as a pest free production site.

Requirements for an NPPO to establish and maintain a pest free place of production or a pest free production site as a phytosanitary measure include:

- systems to establish pest freedom
- systems to maintain pest freedom
- verification that pest freedom has been attained or maintained
- product identity, consignment integrity and phytosanitary security.

Where necessary, a pest free place of production or a pest free production site must also establish and maintain an appropriate buffer zone.

Administrative activities required to support a pest free place of production or a pest free production site include documentation of the system and maintenance of adequate records about the measures taken. Review and audit procedures undertaken by an NPPO are essential to support assurance of pest freedom and for system appraisal. Bilateral agreements or arrangements may also be needed.

NPPOs that propose to use pest free places of production as a measure for managing risks posed by the quarantine pests identified in this review must provide the Department of Agriculture, Water and the Environment with an appropriate submission demonstrating pest free place of production status, for its consideration.

4.5.3 Sourcing seeds produced under a systems approach

ISPM 14 (FAO 2019d) provides guidelines on the use of systems approaches to manage pest risk. According to ISPM 14 (FAO 2019d), 'a systems approach requires the integration of different measures, at least two of which act independently, with a cumulative effect' to achieve the appropriate level of protection.

A systems approach could provide an alternative to relying on a single measure to achieve the ALOP of an importing country or could be used where no single measure is available. A systems approach is often tailored to specific commodity–pest–origin combinations and may be developed and implemented collaboratively by exporting and importing countries. The importing country specifies the appropriate approach after considering technical requirements, minimal impact, transparency, non-discrimination, equivalence and operational feasibility.

NPPOs that propose to use a systems approach as a measure for managing risks posed by the quarantine pests identified in this review must provide the Department of Agriculture, Water and the Environment with an appropriate submission describing their preferred systems approach and rationale, for its consideration.

4.5.4 Consideration of additional potential alternative options raised by stakeholders

After the release of the 'Draft review of import conditions for cucurbitaceous crop seeds for sowing into Australia,' the department received several responses from stakeholders, including

from the organic sector, about potential alternative risk mitigation measures to the proposed mandatory fungicidal treatment. In preparing this final report, consideration has been given to a broad range of these potential alternative options, details of which are provided in Appendix C.

4.6 Review of import conditions

The department reserves the right to review these import conditions if there is reason to believe that the pest or phytosanitary status of these organisms has changed or is likely to change. Similarly, a review may be required, for example, where scientific evidence or other information subsequently becomes available which improves knowledge of, or decreases uncertainty in treatment efficacy and/or the equivalence of measures.

5 Conclusion

The findings of this review of import conditions for cucurbitaceous vegetable seeds are based on a comprehensive scientific analysis of relevant literature.

The Department of Agriculture, Water and the Environment considers that the risk management measures recommended in this report will provide an appropriate level of protection against the identified quarantine pests associated with cucurbitaceous vegetable seeds.

Appendix A: Pest categorisation of pathogens associated with Cucurbitaceae species in scope

Pest categorisation determines whether the formal criteria for classification of a pest organism as a quarantine pest are satisfied. The process is based on the identity of the pest, its presence or absence in the pest risk analysis (PRA) area, regulatory status, potential for entry, establishment and spread in the PRA area, and potential for economic (including environmental) consequences in the PRA area (FAO 2019c).

Appendix A identifies pests that affect the cucurbitaceous vegetables under review from a worldwide perspective, and considers their status in Australia. It also identifies any region in Australia in which legislation governing that region lists the pest as prohibited. Regional pests are considered further if they are absent from the region, or present and under official control in the region as defined by the International Plant Protection Convention (FAO 2019b).

Estimates of each pest's potential for creating economic consequences is based on the assessment of its likelihood of meeting the ISPM 5 definition of a quarantine pest.

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Bacteria						
<i>Acidovorax citrulli</i> (Schaad et al. 1978) Schaad et al. 2008 [Burkholderiales: Comamonadaceae] (synonyms: <i>Acidovorax avenae</i> subsp. <i>citrulli</i> (Schaad et al. 1978) Willems et al. 1992; <i>Pseudomonas pseudoalcaligenes</i> subsp. <i>citrulli</i> Schaad et al. 1978)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Martin & Horlock 2002; Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No
<i>Acidovorax konjaci</i> (Goto 1983) Willems et al. 1992 [Burkholderiales: Comamonadaceae]	<i>Cucumis</i>	Not known to occur	No: This bacterium has been reported naturally occurring on <i>Cucumis sativus</i> (Back et al. 2016). To date there is no available evidence suggesting that this bacterium is seed-	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
			borne in this host. Therefore, seeds are not considered to provide a pathway for this bacterium.			
<i>Agrobacterium tumefaciens</i> (Smith & Townsend 1907) Conn 1942 [Rhizobiales: Rhizobiaceae]	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Momordica</i> , <i>Sechium</i>	Yes (Bradbury 1986; Hoque, Broadhurst & Thrall 2011; Ophel et al. 1988)	Assessment not required	Assessment not required	Assessment not required	No
<i>Dickeya chrysanthemi</i> pv. <i>chrysanthemi</i> (Burkholder et al. 1953) Brenner et al. 1973 [Enterobacteriales: Enterobacteriaceae]	<i>Cucurbita</i>	Yes (Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No
<i>Erwinia cacticida</i> Alcorn et al. 1991 [Enterobacteriales: Enterobacteriaceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Bradbury 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Erwinia carotovora</i> subsp. <i>atroseptica</i> (van Hall 1902) Dye 1969 [Enterobacteriales: Enterobacteriaceae]	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	Yes (Bradbury 1986; Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No
<i>Erwinia tracheiphila</i> (Smith 1895) Bergey et al. 1923 [Enterobacteriales: Enterobacteriaceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This bacterium has been reported naturally occurring on <i>Cucumis</i> and <i>Cucurbita</i> species (Ferreira & Boley 1992; Watterson, Williams & Durbin 1971). To date there is no available evidence suggesting	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pantoea ananatis</i> (Serrano 1928) Mergaert et al. 1993 [Enterobacterales: Enterobacteriaceae] (synonyms: <i>Erwinia ananas</i> Serrano 1928; <i>Erwinia ananatis</i> Corrig. Serrano 1928)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	Yes (Bradbury 1986; Persley, Cooke & House 2010). Western Australia's <i>Biosecurity and Agriculture Management (BAM) Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.	that this bacterium is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this bacterium. Assessment not required	Assessment not required	Assessment not required	No
<i>Pectobacterium carotovorum</i> subsp. <i>carotovorum</i> (Jones 1901) Hauben et al. 1999 emend. Gardan et al. 2003 [Enterobacterales: Enterobacteriaceae] (synonym: <i>Erwinia carotovora</i> subsp. <i>carotovora</i> (Jones 1901) Dye 1969)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	Yes (Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pseudomonas cichorii</i> (Swingle 1925) Stapp 1928 [Pseudomonadales: Pseudomonadaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i>	Yes (Bradbury 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pseudomonas fluorescens</i> bv. I Migula 1895 [Pseudomonadales: Pseudomonadaceae]	<i>Cucumis</i>	Not known to occur	No: This bacterium has been reported naturally occurring on <i>Cucumis melo</i> (Zhang et al. 2016). To date there is no available evidence suggesting that this bacterium is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this bacterium.	Assessment not required	Assessment not required	No
<i>Pseudomonas marginalis</i> pv. <i>marginalis</i> (Brown 1918) Stevens 1925 [Pseudomonadales: Pseudomonadaceae]	<i>Cucumis</i>	Yes (Bradbury 1986). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.	Assessment not required	Assessment not required	Assessment not required	No
<i>Pseudomonas syringae</i> pv. <i>aptata</i> (Brown & Jamieson 1913) Young et al. 1978	<i>Cucumis</i>	Yes (Bradbury 1986)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
[Pseudomonadales: Pseudomonadaceae]						
<i>Pseudomonas syringae</i> pv. <i>lachrymans</i> (Smith & Bryan 1915) Young et al. 1978	<i>Cucumis</i>	Yes (Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No
[Pseudomonadales: Pseudomonadaceae]						
<i>Pseudomonas syringae</i> pv. <i>savastanoi</i> (van Hall 1902) Janse 1982	<i>Cucumis</i>	Yes (Bradbury 1986)	Assessment not required	Assessment not required	Assessment not required	No
[Pseudomonadales: Pseudomonadaceae]						
<i>Pseudomonas syringae</i> pv. <i>syringae</i> (van Hall 1902) Janse 1982	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Whitelaw-Weckert et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
[Pseudomonadales: Pseudomonadaceae]						
<i>Pseudomonas syringae</i> pv. <i>tabaci</i> (Wolf & Foster 1917) Young et al. 1978	<i>Cucumis</i>	Yes (Bradbury 1986)	Assessment not required	Assessment not required	Assessment not required	No
[Pseudomonadales: Pseudomonadaceae]						
<i>Pseudomonas viridiflava</i> (Burkholder 1930) Dowson 1939 [Pseudomonadales: Pseudomonadaceae]	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i>	Yes (Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No
<i>Ralstonia solanacearum</i> (Smith 1896) Yabuuchi et al. 1996 [Burkholderiales: Burkholderiaceae] (synonym: <i>Pseudomonas</i>	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Trichosanthes</i>	Yes Race 1 and 3 are present in Australia (Graham, Jones & Lloyd 1979). However, other	No: This bacterium has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i> , <i>Momordica</i> and <i>Trichosanthes</i> species (Bradbury 1986; Janse et al.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>solanacearum</i> (Smith 1896) Smith 1914)		strains are not known to occur.	2004; Wicker et al. 2002). To date there is no available evidence suggesting that this bacterium is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this bacterium.			
<i>Rhodococcus fascians</i> (Tilford 1936) Goodfellow 1984 [Actinomycetales: Nocardiaceae]	<i>Cucumis</i>	Yes (EPPO 2014; Pilkington et al. 2003)	Assessment not required	Assessment not required	Assessment not required	No
<i>Rhizobium rhizogenes</i> (Young et al., 2001) [Rhizobiales: Rhizobiaceae] (synonym: <i>Agrobacterium rhizogenes</i> (Riker et al. 1930) Conn 1942)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Momordica</i> , <i>Sechium</i>	Yes (Bradbury 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Serratia marcescens</i> Bizio 1823 [Enterobacteriales: Enterobacteriaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Giles et al. 2007)	Assessment not required	Assessment not required	Assessment not required	No
<i>Sphingomonas melonis</i> Buonauro et al. 2002 [Sphingomonadales: Sphingomonadaceae]	<i>Cucumis</i>	Not known to occur	No: This bacterium has been reported naturally occurring on <i>Cucumis</i> species causing brown spots on fruit (Buonauro et al. 2002). To date there is no available evidence suggesting that this bacterium is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this bacterium.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Spiroplasma citri</i> Saglio et al. 1973 [Entomoplasmatales: Spiroplasmataceae]	<i>Cucurbita</i>	Not known to occur	No: This bacterium has been reported naturally occurring on <i>Cucurbita</i> species (Allen & Donndelinger 1981; Nejat, Vadamalai & Dickinson 2011). To date there is no available evidence suggesting that this bacterium is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this bacterium.	Assessment not required.	Assessment not required	No
<i>Xanthomonas campestris</i> pv. <i>cucurbitae</i> (Bryan 1926) Dye 1978 [Xanthomonadales: Xanthomonadaceae] (synonym: <i>Xanthomonas cucurbitae</i> (ex. Bryan 1926) Vauterin et al. 1995)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Persley, Cooke & House 2010). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.	Assessment not required	Assessment not required	Assessment not required	No
<i>Xanthomonas campestris</i> pv. <i>melonis</i> Neto et al. 1984 [Xanthomonadales: Xanthomonadaceae]	<i>Cucumis</i>	Not known to occur	No: This bacterium has been reported naturally occurring on <i>Cucumis</i> species, causing soft rot of the interior of the fruit (Bradbury 1986). To date there is no available evidence suggesting that this bacterium	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
CHROMALVEOLATA			is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this bacterium.			
<i>Peronospora cucubali</i> Ito & Tokun. [Peronosporales: Peronosporaceae]	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> species (Constantinescu 1991). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Peronospora cucumeris</i> (Sawada) Skalický [Peronosporales: Peronosporaceae] (synonym: <i>Peronoplasmopara cucumeris</i> Sawada)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Cucurbita</i> species (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Peronospora momordicae</i> (Sawada) Skalický [Peronosporales: Peronosporaceae] (synonym: <i>Peronoplasmopara momordicae</i> Sawada)	<i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Momordica</i> species (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
			Therefore, seeds are not considered to provide a pathway for this fungus.			
<i>Peronospora parasitica</i> (Pers.) Fr. [Peronosporales: Peronosporaceae] (synonym: <i>Hyaloperonospora parasitica</i> (Pers.) Constant.)	<i>Citrullus</i> , <i>Cucumis</i>	Yes (Cunnington 2003)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phytophthora cactorum</i> (Lebert & Cohn) Schröt. [Peronosporales: Peronosporaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Golzar, Phillips & Mack 2007; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phytophthora capsici</i> Leonian [Peronosporales: Peronosporaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i>	Yes (Weinert et al. 1998)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phytophthora citricola</i> Sawada [Peronosporales: Peronosporaceae]	<i>Cucurbita</i>	Yes (Stukely et al. 2007)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phytophthora citrophthora</i> (Sm. & Sm.) Leonian [Peronosporales: Peronosporaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Cook & Dubé 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phytophthora cryptogea</i> Pethybr. & Laff. [Peronosporales: Peronosporaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Stukely et al. 2007)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Phytophthora drechsleri</i> Tucker [Peronosporales: Peronosporaceae]	<i>Benincasa</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Stukely et al. 2007)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phytophthora megasperma</i> Drechsler [Peronosporales: Peronosporaceae]	<i>Cucumis</i>	Yes (Burgess et al. 2009; Stukely et al. 2007)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phytophthora melonis</i> Katsura [Peronosporales: Peronosporaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Trichosanthes</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucumis</i> species (Cho & Shin 2004; Ho, Gallegly & Hong 2007). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Phytophthora nicotianae</i> de Haan [Peronosporales: Peronosporaceae] (synonyms: <i>Phytophthora nicotianae</i> var. <i>parasitica</i> (Dastur) Waterh.; <i>Phytophthora parasitica</i> Dastur)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i> , <i>Sechium</i>	Yes (Shivas 1989; Stukely et al. 2007)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phytophthora palmivora</i> (Butler) Butler [Peronosporales: Peronosporaceae] (synonym: <i>Phytophthora palmivora</i> var. <i>palmivora</i> (Butler) Butler)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Trichosanthes</i>	Yes (Barber et al. 2013; O'Gara et al. 2004; Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Phytophthora tropicalis</i> Aragaki & Uchida [Peronosporales: Peronosporaceae]	<i>Sechium</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Sechium</i> species (Aragaki & Uchida 2001). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Phytophthium helicoides</i> (Drechsler) Abad et al. [Peronosporales: Pythiaceae] (synonym: <i>Pythium helicoides</i> Drechsler)	<i>Citrullus</i>	Yes (Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phytophthium vexans</i> (de Bary) Abad et al. [Peronosporales: Pythiaceae] (synonym: <i>Pythium vexans</i> de Bary)	<i>Cucumis</i>	Yes (Shivas 1989; Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No
<i>Plasmopara australis</i> (Speg.) Swingle [Peronosporales: Peronosporaceae] (synonym: <i>Peronospora sicyicola</i> Trel.)	<i>Luffa</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Luffa</i> species (Constantinescu 1991; Soares, Parreira & Barreto 2006). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Pseudoperonospora cubensis</i> (Berk. & Curtis) Rostovzev	<i>Benincasa</i> , <i>Citrullus</i> ,	Yes (Persley, Cooke & House	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
[Peronosporales: Peronosporaceae] (synonyms: <i>Peronospora cubensis</i> Berk. & Curtis; <i>Peronoplasmodium cubensis</i> (Berk. & Curtis) Clinton)	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i> , <i>Trichosanthes</i>	2010; Shivas 1989)				
<i>Pythium acanthicum</i> Drechsler [Peronosporales: Pythiaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium afertile</i> Kanouse & Humphrey [Peronosporales: Pythiaceae]	<i>Cucurbita</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium aphanidermatum</i> (Edson) Fitzp. [Peronosporales: Pythiaceae]	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i> , <i>Trichosanthes</i>	Yes (Male & Vawdrey 2010; Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium butleri</i> Subraman. [Peronosporales: Pythiaceae]	<i>Citrullus</i> , <i>Cucumis</i>	Yes (Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium catenulatum</i> Matthews [Peronosporales: Pythiaceae] (synonym: <i>Globisporangium carolinianum</i> (Matthews) Uzuhashi et al.)	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (McLeod et al. 2009). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pythium cucurbitacearum</i> Takim. [Peronosporales: Pythiaceae] (synonym: <i>Ovatisporangium cucurbitacearum</i> (Takim.) Uzuhashi et al.)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Trichosanthes</i>	Not known to occur	are not considered to provide a pathway for this fungus. No: This fungus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Trichosanthes</i> species (Farr & Rossman 2019; Watson 1971). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Pythium debaryanum</i> Hesse [Peronosporales: Pythiaceae] (synonym: <i>Glonisporangium debaryanum</i> (Hesse) Uzuhashi et al.)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i>	Yes (Shivas 1989; Wong, Barbetti & Sivasithamparam 1985)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium deliense</i> Meurs [Peronosporales: Pythiaceae]	<i>Cucumis</i> , <i>Momordica</i>	Yes (Sampson & Walker 1982). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pythium anandrum</i> Drechsler [Peronosporales: Pythiaceae] (synonym: <i>Elongisporangium anandrum</i> (Drechsler) Uzuhasi et al.)	<i>Cucumis</i>	Yes (Cook & Dubé 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium echinocarpum</i> Ito & Tokun. [Peronosporales: Pythiaceae]	<i>Cucumis</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium echinulatum</i> Matthews [Peronosporales: Pythiaceae] (synonym: <i>Globisporangium echinulatum</i> (Mathews) Uzuhashi et al.)	<i>Cucumis</i>	Yes (Cook & Dubé 1989; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium heterothallicum</i> Campb. & Hendrix [Peronosporales: Pythiaceae] (synonym: <i>Globisporangium heterothallicum</i> (Campb. & Hendrix) Uzuhashi et al.)	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (McLeod et al. 2009). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Pythium indigoferae</i> Butler [Peronosporales: Pythiaceae] (synonym: <i>Phytophythium indigoferae</i> (Butler) Kirk)	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pythium irregulare</i> Buisman [Peronosporales: Pythiaceae] (synonym: <i>Globisporangium irregulare</i> (Buisman) Uzuhashi et al.)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Sampson & Walker 1982; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium mamillatum</i> Meurs [Peronosporales: Pythiaceae] (synonym: <i>Globisporangium mamillatum</i> (Meurs) Uzuhashi et al.)	<i>Cucumis</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium myriotylum</i> Drechsler [Peronosporales: Pythiaceae]	<i>Citrullus</i> , <i>Cucumis</i>	Yes (Persley, Cooke & House 2010; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium oligandrum</i> Drechsler [Peronosporales: Pythiaceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium oopapillum</i> Bala & Lévesque [Peronosporales: Pythiaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (Bala et al. 2010). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Pythium paroecandrum</i> Drechsler [Peronosporales: Pythiaceae] (synonym: <i>Globisporangium paroecandrum</i> (Drechsler) Uzuhashi et al.)	<i>Cucumis</i>	Yes (Cook & Dubé 1989)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pythium periplocum</i> Drechsler [Peronosporales: Pythiaceae]	<i>Citrullus</i> , <i>Cucumis</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium spinosum</i> Sawada [Peronosporales: Pythiaceae] (synonym: <i>Globisporangium spinosum</i> (Sawada) Uzuhashi et al.)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium splendens</i> Braun [Peronosporales: Pythiaceae] (synonym: <i>Globisporangium splendens</i> (Braun) Uzuhashi et al.)	<i>Cucumis</i>	Yes (Cook & Dubé 1989; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium sulcatum</i> Pratt & Mitch. [Peronosporales: Pythiaceae]	<i>Cucumis</i>	Yes (Davison & McKay 2003)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium ultimum</i> Trow [Peronosporales: Pythiaceae] (synonym: <i>Globisporangium ultimum</i> (Trow) Uzuhashi et al.)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Shivas 1989; Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pythium vanterpoolii</i> Kouyeas & Kouyeas [Peronosporales: Pythiaceae]	<i>Cucumis</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
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<i>Absidia corymbifera</i> (Cohn) Sacc. & Trotter [Mucorales: Cunninghamellaceae] (synonym: <i>Litcheimia corymbifera</i> (Cohn) Vuill.)	<i>Cucurbita</i>	Yes (ALA 2019)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Absidia cylindrospora</i> Hagem [Mucorales: Cunninghamellaceae]	<i>Cucurbita</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Absidia glauca</i> Hagem [Mucorales: Cunninghamellaceae]	<i>Cucurbita</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Acremonium kiliense</i> Grütz [Hypocreales: Incertae sedis] (synonym: <i>Sarocladium kiliense</i> (Grütz) Summerb.)	<i>Cucurbita</i>	Yes (MacNish 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Acremonium sclerotigenum</i> (Moreau & Moreau ex Valenta) Gams [Hypocreales: Incertae sedis]	<i>Cucumis</i>	Yes (ALA 2019)	Assessment not required	Assessment not required	Assessment not required	No
<i>Acremonium strictum</i> Gams [Hypocreales: Incertae sedis] (synonyms: <i>Cephalosporium acremonium</i> Corda; <i>Sarocladium strictum</i> (Gams) Summerb.)	<i>Lagenaria</i> , <i>Luffa</i>	Yes (Plant Health Australia 2019a). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.	Assessment not required	Assessment not required	Assessment not required	No
<i>Aecidium charantiae</i> Mayor & Vienn.-Bourg. [Pucciniales: Incertae sedis]	<i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Momordica charantia</i> (Farr &	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
			Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.			
<i>Aecidium momordicae</i> Juel [Pucciniales: Incertae sedis]	<i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Momordica</i> species (Farr & Rossman 2019; Hennen, Hennen & Figueiredo 1982). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Albugo ipomoeae-panduratae</i> (Schwein.) Swingle [Albuginales: Albuginaceae]	<i>Momordica</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Alternaria alternata</i> (Fr.) Keissl. [Pleosporales: Pleosporaceae] (synonym: <i>Alternaria tenuis</i> Nees)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Trichosanthes</i>	Yes (Persley, Cooke & House 2010; Webley et al. 1997)	Assessment not required	Assessment not required	Assessment not required	No
<i>Alternaria alternata</i> f. sp. <i>cucurbitae</i> Vakal. [Pleosporales: Pleosporaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Lagenaria</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> , <i>Lagenaria</i> and <i>Momordica</i> species (Farr & Rossman 2019; Thaung 2008)	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
			causing leaf spot (Zhou & Everts 2008). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.			
<i>Alternaria brassicae</i> (Berk.) Sacc. [Pleosporales: Pleosporaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Alternaria brassicicola</i> (Schwein.) Wiltshire [Pleosporales: Pleosporaceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Alternaria burnsii</i> Uppla, Patel & Kamat [Pleosporales: Pleosporaceae]	<i>Cucurbita</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucurbita maxima</i> (Paul et al. 2015).	Yes: If introduced via the seed pathway this fungus could establish and spread in Australia. <i>Alternaria burnsii</i> has established in areas with a wide range of climatic conditions (Farr & Rossman 2019).	Yes: <i>Alternaria burnsii</i> is a significant pest of cumin. Cumin blight caused by this fungus has been recorded in India causing considerable yield losses (Singh et al. 2016) (Singh et al. 2018a). <i>Alternaria burnsii</i> has also been reported to cause significant damage on black cumin (<i>Bunium persicum</i>) (Mondal et al. 2002b).	Yes
<i>Alternaria cantlous</i> (Yong Wang bis & Zhang) Woundenberg & Crous	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis melo</i> (Farr & Rossman	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
[Pleosporales: Pleosporaceae] (synonym: <i>Ulocladium cantaloupi</i> Yong Wang bis & Zhang)			2019; Woudenberg et al. 2013). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.			
<i>Alternaria caudata</i> (Cooke & Ellis) E.G. Simmons [Pleosporales: Pleosporaceae] (synonyms: <i>Macrosporium caudatum</i> Cooke & Ellis; <i>Macrosporium rubi</i> Ellis; <i>Macrosporium nelumbii</i> Ellis & Everh.)	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis sativus</i> (Woudenberg et al. 2015). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Alternaria citrullicola</i> Woudenb. & Crous [Pleosporales: Pleosporaceae]	<i>Citrullus</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus lanatus</i> (Farr & Rossman 2019; Woudenberg et al. 2014). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Alternaria cucumerina</i> (Ellis & Everh.) Elliott [Pleosporales: Pleosporaceae] (synonym: <i>Macrosporium cucumerinum</i> Ellis & Everh; <i>Alternaria loofahae</i> Simmons & Aragaki)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	Yes (Persley, Cooke & House 2010; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Alternaria cucurbitae</i> Letendre & Roum. [Pleosporales: Pleosporaceae] (synonym: <i>Ulocladium cucurbitae</i> (Letendre & Roum.) Simmons)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Alternaria cylindrorostrata</i> Zhang [Pleosporales: Pleosporaceae]	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita pepo</i> , causing leaf spot (Farr & Rossman 2019; Simmons 2007). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Alternaria dianthicola</i> Neerg. [Pleosporales: Pleosporaceae]	<i>Cucurbita</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Alternaria linariae</i> (Neerg.) Simmons [Pleosporales: Pleosporaceae] (synonym: <i>Alternaria tomatophila</i> Simmons)	<i>Cucumis</i>	Yes (Andersen, Dongo & Pryor 2008)	Assessment not required	Assessment not required	Assessment not required	No
<i>Alternaria longipes</i> (Ellis & Everh.) Mason [Pleosporales: Pleosporaceae]	<i>Cucurbita</i>	Yes (Plant Health Australia 2019a; Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No
<i>Alternaria longissima</i> Deighton & MacGarvie	<i>Trichosanthes</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
[Pleosporales: Pleosporaceae]						
<i>Alternaria luffae</i> Zhang [Pleosporales: Pleosporaceae]	<i>Luffa</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Luffa cylindrica</i> (Farr & Rossman 2019; Zhang & Zhang 1999). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Alternaria obovoidea</i> (E.G. Simmons) Woudenb. & Crous [Pleosporales: Pleosporaceae] (synonym: <i>Ulocladium obovoideum</i> E.G. Simmons)	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (Woudenberg et al. 2013). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Alternaria peponicola</i> (Rabenh.) Simmons [Pleosporales: Pleosporaceae] (synonym: <i>Macrosporium lagenariae</i> Thüm)	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> and <i>Momordica</i> species (Farr & Rossman 2019; Greuter, Poelt & Raimondo 1991). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Alternaria pluriseptata</i> (Karst. & Har.) Jørst. [Pleosporales: Pleosporaceae] (synonym: <i>Sporidesmium mucosum</i> var. <i>pluriseptatum</i> Karst. & Har.)	<i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> and <i>Cucurbita</i> species (Ellis 1971; Farr & Rossman 2019; Mel'nik, Popov & Shabunin 2007). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Alternaria radicina</i> Meier et al. [Pleosporales: Pleosporaceae]	<i>Cucurbita</i>	Yes (Persley, Cooke & House 2010; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Alternaria septorioides</i> (Westend.) E.G. Simmons [Pleosporales: Pleosporaceae] (synonym: <i>Alternaria resedae</i> Neerg. 1945)	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis sativus</i> and <i>C. melo</i> (Gafforov 2017). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Alternaria tenuissima</i> (Kunze) Wiltshire [Pleosporales: Pleosporaceae]	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	Yes (Giles et al. 2002)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Ampelomyces quisqualis</i> Ces. [Pleosporales: Phaeosphaeriaceae] (synonym: <i>Cicinobolus cesatii</i> de Bary)	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Sechium</i>	Yes (Clare 1964; Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Arthrimum arundinis</i> (Corda) Dyko & Sutton [Incertae sedis: Apiosporaceae] (synonyms: <i>Apiospora montagnei</i> Sacc.; <i>Papularia arundinis</i> (Corda) Fr.)	<i>Cucumis</i>	Yes (Fröhlich, Hyde & Guest 1997)	Assessment not required	Assessment not required	Assessment not required	No
<i>Ascochyta cucumeris</i> Fautrey & Roum. [Pleosporales: Didymellaceae]	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Trichosanthes</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Ascochyta siraitiae</i> Chao & Chi [Pleosporales: Didymellaceae]	<i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Momordica</i> species (Bai 2003; Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Aspergillus chevalieri</i> Thom & Church [Eurotiales: Trichocomaceae] (synonym: <i>Eurotium chevalieri</i> Mangin)	<i>Cucumis</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Aspergillus clavatus</i> Desm. [Eurotiales: Trichocomaceae]	<i>Citrullus</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Aspergillus elegans</i> Gasperini [Eurotiales: Trichocomaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species, causing lesions (Farr & Rossman 2019; Raymond et al. 1959). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Aspergillus flavus</i> Link [Eurotiales: Trichocomaceae] (synonym: <i>Aspergillus oryzae</i> (Ahlb.) Cohn)	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	Yes (Hocking 2003; Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Aspergillus fumigatus</i> Fresen. [Eurotiales: Trichocomaceae]	<i>Benincasa</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Momordica</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Aspergillus glaucus</i> (L.) Link [Eurotiales: Trichocomaceae]	<i>Cucurbita</i>	Yes (Plant Health Australia 2019a; Washington & Nancarrow 1983)	Assessment not required	Assessment not required	Assessment not required	No
<i>Aspergillus nidulans</i> (Eidam) Winter [Eurotiales: Trichocomaceae] (synonym: <i>Emericella nidulans</i> (Eidam) Vuill.)	<i>Cucurbita</i>	Yes (Plant Health Australia 2019a; Yip & Weste 1985)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Aspergillus niger</i> Tiegh. [Eurotiales: Trichocomaceae]	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Trichosanthes</i>	Yes (Leong, Hocking & Pitt 2004; Midgley et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Aspergillus ochraceus</i> Wilh. [Eurotiales: Trichocomaceae]	<i>Momordica</i>	Yes (Hocking 2003; Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Aspergillus parasiticus</i> Speare [Eurotiales: Trichocomaceae]	<i>Cucurbita</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Aspergillus tamarii</i> Kita [Eurotiales: Trichocomaceae]	<i>Citrullus</i> , <i>Trichosanthes</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Citrullus lanatus</i> (Fagbohun, Lawal & Hassan 2011). This fungus has also been reported naturally occurring on <i>Trichosanthes</i> species (Chuku et al. 2008).	Yes: If introduced via the seed pathway, <i>Aspergillus tamarii</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2019). Spread of this fungus from the seed pathway could occur via air-borne spores.	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Aspergillus terreus</i> Thom [Eurotiales: Trichocomaceae]	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Momordica</i>	Yes (Midgley et al. 2011; Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Aspergillus unguis</i> (Émile-Weill & Gaudin) Thom & Raper [Eurotiales: Trichocomaceae] (synonym:	<i>Cucumis</i>	Yes (ALA 2019)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Emericella unguis</i> Malloch & Cain)						
<i>Aspergillus versicolor</i> (Vuill.) Tirab. [Eurotiales: Trichocomaceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Asteridiella anguriae</i> (Stevens) Hansf. [Meliolales: Meliolaceae]	<i>Citrullus</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> species (Farr & Rossman 2019; Minter, Hernández & Portales 2001). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Asteridiella confragosa</i> (Syd. & Syd.) Hansf. [Meliolales: Meliolaceae] (synonyms: <i>Irene confragosa</i> (Syd. & Syd.) Syd. & Syd.; <i>Irenina confragosa</i> (Syd. & Syd.) Stevens)	<i>Cucurbita</i> , <i>Luffa</i> , <i>Trichosanthes</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> , <i>Luffa</i> and <i>Trichosanthes</i> species (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Asterina momordicae</i> Yates [Asterinales: Asterinaceae] (synonym: <i>Parasterina momordicae</i> (Yates) Mend.)	<i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Momordica</i> species (Farr & Rossman 2019; Hosagoudar & Abraham 2000). To date there is no available evidence	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Asterina simillima</i> Syd. & Syd. [Asterinales: Asterinaceae]	<i>Luffa</i>	Not known to occur	suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus. No: This fungus has been reported naturally occurring on <i>Luffa</i> species (Farr & Rossman 2019; Hosagoudar & Abraham 2000). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Asterotexis cucurbitacearum</i> (Rehm) Arx [Asterinales: Asterinaceae] (synonyms: <i>Rhagadolobium cucurbitacearum</i> (Rehm) Theiss. & Syd.; <i>Dothidella cucurbitacearum</i> Rehm)	<i>Cucurbita</i> , <i>Sechium</i> , <i>Trichosanthes</i>	Not known to occur	No: This fungus has been reported naturally occurring on the foliage of <i>Cucurbita</i> , <i>Sechium</i> and <i>Trichosanthes</i> species (Guerrero et al. 2011). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Aureobasidium pullulans</i> (de Bary & Löwenthal) Arnaud [Dothideales: Dothioraceae] (synonym: <i>Pullularia pullulans</i> (de Bary & Löwenthal) Berkhout)	<i>Cucumis</i>	Yes (Shivas 1989; Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Bahusakala olivaceonigra</i> (Berk. & Broome) Subram. [Incertae sedis: Incertae sedis]	<i>Cucurbita</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucurbita pepo</i> (Rahim et al. 2013).	Yes: If introduced via the seed pathway, <i>Bahusakala olivaceonigra</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2019). Spread of this fungus from the seed pathway could occur via air-borne spores.	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Botryosphaeria quercuum</i> (Schwein.) Sacc. [Botryosphaeriales: Botryosphaeriaceae]	<i>Citrullus</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Botrytis cinerea</i> Pers [Helotiales: Sclerotiniaceae] (synonym: <i>Botryotinia fuckeliana</i> (de Bary) Whetzel)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i>	Yes (Nair et al. 1995; Salam et al. 2011; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Brachysporium obovatum</i> (Berk.) Sacc. [Trichosphaeriales: Trichosphaeriaceae]	<i>Cucurbita</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucurbita pepo</i> (Rahim et al. 2013).	Yes: If introduced via the seed pathway, <i>Brachysporium obovatum</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2019). Spread of this fungus from the	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Briosia cubispora</i> (Berk. & Curtis) Arx [Incertae sedis: Incertae sedis] (synonym: <i>Coremiella cubispora</i> (Berk. & Curtis) Ellis)	<i>Cucurbita</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucurbita pepo</i> (Rahim et al. 2013).	seed pathway could occur via air-borne spores. Yes: If introduced via the seed pathway, <i>B. cubispora</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2019; Rahim et al. 2013). Spread of this fungus from the seed pathway could occur via air-borne spores.	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Calonectria brassicae</i> (Panwar & Bohra) Lombard, Wingf. & Crous [Hypocreales: Nectriaceae] (synonyms: <i>Cylindrocladium clavatum</i> Hodges & May; <i>Cylindrocladium gracile</i> (Bugnic.) Boesew.)	<i>Sechium</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Sechium</i> species (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Cephalophora irregularis</i> Thaxt. [Pezizales: Incertae sedis]	<i>Cucurbita</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Ceraceomyces serpens</i> (Tode) Ginns [Amylocorticiales: Amylocorticiaceae]	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita maxima</i> (Farr & Rossman 2019). To date there is no available evidence	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
(synonym: <i>Merulius serpens</i> Tode)			suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.			
<i>Ceratocystis paradoxa</i> (Dade) Moreau [Microascales: Incertae sedis] (synonyms: <i>Thielaviopsis paradoxa</i> (De Seynes) Höhn; <i>Chalara thielavioides</i> (Peyronel) Nag Raj & Kendr.)	<i>Cucurbita</i> , <i>Lagenaria</i>	Yes (Bhuiyan, Croft & Tucker 2014)	Assessment not required	Assessment not required	Assessment not required	No
<i>Cercospora apii</i> Fresen. [Capnodiales: Mycosphaerellaceae] (synonym: <i>Cercospora citrullina</i> Cooke)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Momordica</i> , <i>Sechium</i>	Yes (Liberato & Stephens 2006)	Assessment not required	Assessment not required	Assessment not required	No
<i>Cercospora chidambarensis</i> Rangasw. & Chandras. [Capnodiales: Mycosphaerellaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis sativus</i> (Rangaswami & Chandrasekaran 1961, 1962). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Cercospora cocciniae</i> Munjal et al. [Capnodiales: Mycosphaerellaceae]	<i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Momordica</i> species (Braun & Sivapalan 1999). To date there is no available evidence	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Cercospora echinocystis</i> Ellis & Martin [Capnodiales: Mycosphaerellaceae]	<i>Benincasa</i>	Not known to occur	suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus. No: This fungus has been reported naturally occurring on <i>Benincasa hispida</i> , causing leaf spot (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Cercospora malloti</i> Ellis & Everh. [Capnodiales: Mycosphaerellaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (Groenewald et al. 2013). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Chaetomium aureum</i> Chivers [Sordariales: Chaetomiaceae]	<i>Cucumis</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucumis sativus</i> (Farr & Rossman 2019).	Yes: If introduced via the seed pathway, <i>Chaetomium aureum</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2019).	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Chaetomium bostrychodes</i> Zopf [Sordariales: Chaetomiaceae]	<i>Cucurbita</i>	Yes (Cribb 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Chaetomium brasiliense</i> Bat. & Pontual [Sordariales: Chaetomiaceae]	<i>Benincasa</i> , <i>Trichosanthes</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Benincasa hispida</i> and <i>Trichosanthes cucumerina</i> (HerbIMI 2019).	Yes: If introduced via the seed pathway, <i>Chaetomium brasiliense</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2019).	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Chaetomium crispatum</i> (Fuckel) Fuckel [Sordariales: Chaetomiaceae]	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucurbita pepo</i> , <i>Lagenaria siceraria</i> , <i>Luffa acutangula</i> and <i>Momordica charantia</i> (Avinash & Rai 2013; Rahim et al. 2013).	Yes: If introduced via the seed pathway, <i>Chaetomium crispatum</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2019).	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Chaetomium elatum</i> Kunze [Sordariales: Chaetomiaceae]	<i>Cucurbita</i>	Yes (ALA 2019)	Assessment not required	Assessment not required	Assessment not required	No
<i>Chaetomium erectum</i> Skolko & Groves [Sordariales: Chaetomiaceae]	<i>Benincasa</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Benincasa hispida</i> (HerbIMI 2019).	Yes: If introduced via the seed pathway, <i>Chaetomium erectum</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2019).	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Chaetomium funicola</i> Cooke [Sordariales: Chaetomiaceae]	<i>Cucurbita</i>	Yes (Minter 2006)	Assessment not required	Assessment not required	Assessment not required	No
<i>Chaetomium globosum</i> Kunze ex Fr. [Sordariales: Chaetomiaceae]	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	Yes (Plant Health Australia 2019a; Syed et al. 2009)	Assessment not required	Assessment not required	Assessment not required	No
<i>Chaetomium indicum</i> Corda [Sordariales: Chaetomiaceae]	<i>Cucurbita</i>	Yes (Garret et al. 1998)	Assessment not required	Assessment not required	Assessment not required	No
<i>Chaetomium megalocarpum</i> Bainier [Sordariales: Chaetomiaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Chaetomium murorum</i> Corda [Sordariales: Chaetomiaceae]	<i>Cucurbita</i>	Yes (Cribb 1999). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Choanephora cucurbitarum</i> (Berk. & Ravenel) Thaxt. [Mucorales: Choanephoraceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	could not be provided. Yes (Conde & Diatloff 1991; Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Cladosporium cladosporioides</i> (Fresen.) de Vries [Capnodiales: Cladosporiaceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Cladosporium cucumerinum</i> Ellis & Arthur [Capnodiales: Cladosporiaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i>	Yes (Persley, Cooke & House 2010). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.	Assessment not required	Assessment not required	Assessment not required	No
<i>Cladosporium herbarum</i> (Pers.) Link [Capnodiales: Cladosporiaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Cladosporium oxysporum</i> Berk. & Curtis [Capnodiales: Cladosporiaceae]	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i>	Yes (Bensch et al. 2012)	Assessment not required	Assessment not required	Assessment not required	No
<i>Cladosporium sphaerospermum</i> Penz. [Capnodiales: Cladosporiaceae]	<i>Cucurbita</i> , <i>Luffa</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Cladosporium tenuissimum</i> Cooke [Capnodiales: Cladosporiaceae]	<i>Cucumis</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Clonostachys rosea</i> (Link) Schroers et al. [Hypocreales: Nectriaceae] (synonym: <i>Gliocladium roseum</i>)	<i>Cucumis</i>	Yes (Plant Health Australia 2019a; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Cochliobolus geniculatus</i> Nelson [Pleosporales: Pleosporaceae] (synonym: <i>Curvularia geniculata</i> (Tracy & Earle) Boedijn)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Cochliobolus nodulosus</i> Luttr. [Pleosporales: Pleosporaceae]	<i>Cucurbita</i>	Yes (Manamgoda et al. 2012). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<p>official control could not be provided.</p> <p><i>*Colletotrichum</i>: the taxonomy of the <i>Colletotrichum</i> genus is undergoing significant revision (Damm et al. 2013; Damm et al. 2012a; Damm et al. 2012b; Damm et al. 2014; Damm et al. 2019; Damm et al. 2009; Weir, Johnston & Damm 2012).</p>						
<i>Colletotrichum acutatum</i> Simmonds [Glomerellales: Glomerellaceae] (synonym: <i>Glomerella acutata</i> Guerber & Correll)	<i>Cucurbita</i> (There was a single record in <i>Cucurbita</i> prior to taxonomic changes* (Guerber, Liu & Correll 2003). Since then, no records in Cucurbitaceae have been reported.)	Yes (Shivas et al. 2016; Whitelaw-Weckert et al. 2007)	Assessment not required	Assessment not required	Assessment not required	No
<i>Colletotrichum boninense</i> Moriwaki, Toy. Sato & Tsukib. [Glomerellales: Glomerellaceae]	<i>Cucumis</i> (There was a single record in <i>Cucumis</i> prior to taxonomic changes* (Moriwaki, Sato & Tsukiboshi 2003). Since then, no records in	Yes (Shivas et al. 2016)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
	Cucurbitaceae have been reported.)					
<i>Colletotrichum brevisporum</i> Noireung, Phouliv., L. Cai & K.D. Hyde [Glomerellales: Glomerellaceae]	<i>Cucurbita</i> , <i>Momordica</i> , <i>Sechium</i>	Yes (Damm et al. 2019; Shivas et al. 2016)	Assessment not required	Assessment not required	Assessment not required	No
<i>Colletotrichum coccodes</i> (Wallr.) Hughes [Glomerellales: Glomerellaceae]	<i>Cucurbita</i>	Yes (Persley, Cooke & House 2010; Shivas et al. 2016)	Assessment not required	Assessment not required	Assessment not required	No
<i>Colletotrichum dematium</i> (Pers: Fr) Grove [Glomerellales: Glomerellaceae]	<i>Cucumis</i> (There was a single record in <i>Cucumis</i> prior to taxonomic changes* (Farr & Rossman 2019). Since then, no records in Cucurbitaceae have been reported.)	Yes (Persley, Cooke & House 2010; Shivas et al. 2016)	Assessment not required	Assessment not required	Assessment not required	No
<i>Colletotrichum destructivum</i> O'Gara [Incertae sedis: Glomerellaceae] (synonym: <i>Colletotrichum sativum</i> Horn)	<i>Cucumis</i> (There was a single record in <i>Cucumis</i> prior to taxonomic changes* (Farr	Yes (Shivas 1989; Shivas et al. 2016)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
	& Rossman 2019). Since then, no records in Cucurbitaceae have been reported.)					
<i>Colletotrichum excelsum-altitudinum</i> Tao et al. [Glomerellales: Glomerellaceae]	<i>Momordica</i>	Not known to occur	No. This fungus has been reported naturally occurring on <i>Momordica charantia</i> (Damm et al. 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Colletotrichum gloeosporioides</i> (Penz.) Penz. & Sacc. [Glomerellales: Glomerellaceae] (synonyms: <i>Glomerella cingulata</i> (Stoneman) Spauld. & Schrenk; <i>Glomerella cingulata</i> var. <i>minor</i> Wollenw.)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i> , <i>Trichosanthes</i> (There were multiple records in several Cucurbitaceae hosts prior to taxonomic changes* (Farr	Yes (Persley, Cooke & House 2010; Shivas & Alcorn 1996; Shivas et al. 2016)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
	& Rossman 2019). Since then, only one record of this species on <i>Trichosanthes</i> was reported (Zhang et al. 2014).)					
<i>Colletotrichum karstii</i> Yang et al. [Glomerellales: Glomerellaceae]	<i>Cucumis</i> , <i>Citrullus</i>	Yes (Shivas et al. 2016)	Assessment not required	Assessment not required	Assessment not required	No
<i>Colletotrichum lindemuthianum</i> (Sacc. & Magnus) Briosi & Cavara [Glomerellales: Glomerellaceae]	<i>Citrullus</i> (There was a single record in <i>Citrullus</i> prior to taxonomic changes* (Farr & Rossman 2019). Since then, no records in Cucurbitaceae have been reported.)	Yes (Shivas et al. 2016)	Assessment not required	Assessment not required	Assessment not required	No
<i>Colletotrichum magnum</i> (Jenkins & Winstead) Rossman & W.C. Allen [Glomerellales: Glomerellaceae] (synonyms: <i>Colletotrichum magna</i> (Jenkins & Winstead) Bhairi,	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Trichosanthes</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> and <i>Luffa</i> species, causing anthracnose (Damm et al. 2019; Freeman & Rodriguez 1993; Jenkins & Winstead	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
E.P. Buckley & R.C. Staples; <i>Glomerella magna</i> Jenkins & Winstead)	(There were multiple records in several Cucurbitaceae hosts prior to taxonomic changes* (Farr & Rossman 2019). Since then, only <i>Citrullus</i> has been identified as a host of this species (Damm et al. 2019).)		1964; Tsay et al. 2010). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.			
<i>Colletotrichum melonis</i> Damm et al. [Glomerellales: Glomerellaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis melo</i> (Damm et al. 2012a; Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Colletotrichum orbiculare</i> (Berk.) Arx [Glomerellales: Glomerellaceae] (synonyms: <i>Colletotrichum oligochaetum</i> Cavara; <i>Colletotrichum</i>	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> ,	Yes (Persley, Cooke & House 2010; Shivas 1989; Shivas et al. 2016)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>lagenaria</i> (Pass.) Sacc. & Roum; <i>Gloeosporium orbiculare</i> (Berk.) Berk.; <i>Glomerella lagenaria</i> (Pass.) Stevens; <i>Glomerella cingulata</i> var. <i>orbiculare</i> Jenkins & Winstead)	<i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i> , <i>Trichosanthes</i> (There were multiple records in several Cucurbitaceae hosts prior to taxonomic changes* (Farr & Rossman 2019). Since then, <i>Cucumis</i> , <i>Lagenaria</i> and <i>Cucurbita</i> have been identified as hosts of this species (Damm et al. 2013).					
<i>Colletotrichum truncatum</i> (Schwein.) Andrus & W.D. Moore [Glomerellales: Glomerellaceae] (synonym: <i>Colletotrichum capsici</i> (Syd. & Syd.) Butler & Bisby)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	Yes (Shivas et al. 2016)	Assessment not required	Assessment not required	Assessment not required	No
<i>Coniothyrium fuckelii</i> Sacc. [Pleosporales: Coniothyriaceae] (synonym:	<i>Momordica</i>	Yes (Sampson & Walker 1982; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Paraconiothyrium fuckelii</i> (Sacc.) Verkley & Gruyter)						
<i>Coniothyrium tumefaciens</i> Güssow [Pleosporales: Coniothyriaceae]	<i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Momordica</i> species (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Corticium koleroga</i> (Cooke) Höhn. [Corticiales: Corticiaceae] (synonym: <i>Pellicularia koleroga</i> Cooke)	<i>Cucumis</i> , <i>Lagenaria</i> , <i>Luffa</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> , <i>Lagenaria</i> and <i>Luffa</i> species (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Corynascus sepedonium</i> (Emmons) Arx [Sordariales: Chaetomiaceae] (synonym: <i>Myceliophthora sepedonium</i> (Emmons) van den Brink & Samson)	<i>Benincasa</i>	Yes (Plant Health Australia 2019a; Salar & Aneja 2007)	Assessment not required	Assessment not required	Assessment not required	No
<i>Corynespora cassicola</i> (Berk. & Curtis) Wei [Pleosporales: Corynesporaceae] (synonyms: <i>Cercospora</i>	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> ,	Yes (Silva et al. 1995). Western Australia's <i>BAM Act 2007</i> prohibits this	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>melonis</i> Cooke; <i>Corynespora melonis</i> (Cooke) Lindau)	<i>Momordica</i> , <i>Sechium</i>	pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.				
<i>Cribraria violacea</i> Rex [Liceales: Cribrariaceae]	<i>Lagenaria</i>	Yes (McHugh et al. 2015)	Assessment not required	Assessment not required	Assessment not required	No
<i>Cunninghamella echinulata</i> (Thaxt.) Thaxt. ex Blakeslee [Mucorales: Cunninghamellaceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Curvularia affinis</i> Boedijn [Pleosporales: Pleosporaceae]	<i>Lagenaria</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Lagenaria vulgaris</i> (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Curvularia hawaiiensis</i> (Bugnic. ex Ellis) Manamogoda et al. [Pleosporales: Pleosporaceae] (synonyms: <i>Drechslera hawaiiensis</i> (Bunic.) Subram & Jain,	<i>Cucurbita</i>	Yes (Manamogoda et al. 2012; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Biplaris hawaiiensis</i> (Ellis) Uchida & Aragaki)						
<i>Curvularia lunata</i> (Wakker) Boedijn [Pleosporales: Pleosporaceae] (synonym: <i>Cochliobolus lunatus</i> Nelson & Haasis)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Curvularia ovoidea</i> (Hiroë) Munt.-Cvetk. [Pleosporales: Pleosporaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Lagenaria</i> , <i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> , <i>Lagenaria</i> and <i>Momordica</i> species (HerbIMI 2019). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required.	Assessment not required	No
<i>Curvularia penniseti</i> (Mitra) Boedijn [Pleosporales: Pleosporaceae]	<i>Cucurbita</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Curvularia robusta</i> Kilp. & Luttr. [Pleosporales: Pleosporaceae]	<i>Cucurbita</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucurbita pepo</i> (Rahim et al. 2013).	Yes: If introduced via the seed pathway, <i>Curvularia robusta</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2019; Rahim et al. 2013).	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Curvularia senegalensis</i> (Speg.) Subram. [Pleosporales: Pleosporaceae]	<i>Citrullus</i>	Yes (Shivas & Alcorn 1996)	Assessment not required	Assessment not required	Assessment not required	No
<i>Curvularia spicifera</i> (Bainier) Boedijn [Pleosporales: Pleosporaceae] (synonyms: <i>Cochliobolus spicifer</i> Nelson; <i>Bipolaris spicifera</i> (Bainier) Subram.; <i>Curvularia tetramera</i> (McKinney) Boedijn ex Gilman; <i>Drechslera tetramera</i> (McKinney) Subram. & Jain)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	Yes (Manamgoda et al. 2012)	Assessment not required	Assessment not required	Assessment not required	No
<i>Curvularia trifolii</i> (Kauffman) Boedijn [Pleosporales: Pleosporaceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Curvularia verrucosa</i> Sivan. [Pleosporales: Pleosporaceae]	<i>Lagenaria</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Lagenaria</i> species (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Cylindrocarpon didymum</i> (Harting) Wollenw. [Hypocreales: Nectriaceae]	<i>Cucumis</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Cylindrocladium scoparium</i> Morgan [Hypocreales: Nectriaceae]	<i>Citrullus</i> , <i>Cucumis</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Nectriaceae] (synonym: <i>Calonectria morganii</i> Crous et al.)						
<i>Cyphella heveae</i> Massee [Agaricales: Cyphellaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis melo</i> (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Dendryphiella infuscans</i> (Thüm.) Ellis [Pleosporales: Pleosporaceae] (synonym: <i>Cladosporium infuscans</i> Thüm.)	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (Matsushima 1980). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Dendryphiella vinosa</i> (Berk. & Curtis) Reisinger [Pleosporales: Pleosporaceae]	<i>Cucumis</i> , <i>Lagenaria</i> , <i>Trichosanthes</i>	Yes (Plant Health Australia 2019a; Queensland Department of Agriculture 1995)	Assessment not required	Assessment not required	Assessment not required	No
<i>Diaporthe cucurbitae</i> (McKeen) Udayanga & Castl. [Diaporthales: Diaporthaceae] (synonyms: <i>Phomopsis cucurbitae</i> McKeen)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Luffa</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucumis melo</i> (Garibaldi et al. 2011; North Carolina State University 2019) and <i>C. sativus</i> (Guarnaccia et al. 2018; NCBI	Yes: If introduced via the seed pathway, <i>D. cucurbitae</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic	Yes: <i>Diaporthe cucurbitae</i> produces irregular, brown, soft sunken lesions on fruit (Garibaldi et al. 2011). This fungus can produce latent infections, causing post-harvest fruit	Yes

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
			2019; Udayanga et al. 2015). This fungus has also been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Luffa</i> species (Conners 1967; Garibaldi et al. 2011; Urtiaga 1986).	conditions (Farr & Rossman 2019; Zhang, Bruton & Biles 1999).	decay (Zhang, Bruton & Biles 1999; Zhang 1997), resulting in severe losses during fruit storage and marketing (Zhang, Bruton & Biles 1999). Therefore, this fungus has the potential for economic consequences in Australia.	
<i>Diaporthe melonis</i> Beraha & O'Brien [Diaporthales: Diaporthaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis melo</i> (Dissanayake et al. 2017). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Diaporthe sojae</i> Lehman [Diaporthales: Diaporthaceae] (synonym: <i>Diaporthe melonis</i> var. <i>brevistylospora</i> Ohsawa & Kobayashi)	<i>Cucumis</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Diaporthe ueckerae</i> Udayanga & Castl. [Diaporthales: Diaporthaceae] (synonym: <i>Diaporthe ueckeri</i> Udayanga & Castl.)	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (Udayanga et al. 2015). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Diatrypella verruciformis</i> (Ehrh.) Nitschke [Xylariales: Diatrypaceae] (synonym: <i>Diatrypella favacea</i> (Fr.) Ces. & De Not.)	<i>Lagenaria</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Didymella applanata</i> (Niessl) Sacc. [Pleosporales: Didymellaceae] (synonym: <i>Phoma argillacea</i> (Bres.) Aa & Boerema)	<i>Cucurbita</i>	Yes (Plant Health Australia 2019a; Sampson & Walker 1982)	Assessment not required	Assessment not required	Assessment not required	No
<i>Didymella calidophila</i> (Aveskamp et al.) Chen & Cai. [Pleosporales: Didymellaceae] (synonym: <i>Phoma calidophila</i> Aveskamp et al.)	<i>Cucumis</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucumis sativus</i> (Chen et al. 2015).	Yes: If introduced via the seed pathway, <i>D. calidophila</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Chen et al. 2015; Farr & Rossman 2019).	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Didymella cucurbitacearum</i> Roy [Pleosporales: Didymellaceae]	<i>Lagenaria</i> , <i>Luffa</i> , <i>Trichosanthes</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Lagenaria</i> , <i>Luffa</i> and <i>Trichosanthes</i> species (Roy 1967). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Didymella lycopersici</i> Kleb. [Pleosporales: Didymellaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Cucurbita</i> species (Doidge 1950; Greuter, Poelt & Raimondo 1991). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Diplodia sparsa</i> Fuckel [Botryosphaeriales: Botryosphaeriaceae]	<i>Cucurbita</i>	Not known to occur	No: This fungus been reported naturally occurring on <i>Cucurbita</i> species (Mendes, da Silva & Dianese 1998). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Drechslera australiensis</i> (Bugnic) Subram. & Jain [Pleosporales: Pleosporaceae] (synonyms: <i>Curvularia australiensis</i> (Bugnic. ex Ellis) Manamgoda et al.; <i>Bipolaris australiensis</i> (Bunic. ex Ellis) Tsuda & Ueyama)	<i>Cucurbita</i>	Yes (Deng et al. 2015; Ellis 1971)	Assessment not required	Assessment not required	Assessment not required	No
<i>Drechslera bicolor</i> (Mitra) Subram. & Jain [Pleosporales:	<i>Cucurbita</i>	Yes (Ellis 1971)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Pleosporaceae] (synonyms: <i>Cochliobolus bicolor</i> Paul & Parbery; <i>Bipolaris bicolor</i> (Mitra) Shoemaker)						
<i>Drechslera cactivora</i> (Petr.) Ellis [Pleosporales: Pleosporaceae] (synonym: <i>Bipolaris cactivora</i> (Petr.) Alcorn)	<i>Cucurbita</i>	Yes (Cunnington 2003)	Assessment not required	Assessment not required	Assessment not required	No
<i>Drechslera ravenelii</i> (Curtis ex Berk.) Subram & Jain [Pleosporales: Pleosporaceae] (synonyms: <i>Bipolaris ravenelii</i> (Curtis ex Berk.) Shoemaker; <i>Helminthosporium ravenelii</i> Curtis ex Berk; <i>Curvularia ravenelii</i> (Curtis ex Berk.) Manamgoda et al.)	<i>Cucurbita</i>	Yes (Lenne 1990; Manamgoda et al. 2012; Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No
<i>Elsinoë lagenariae</i> Watson & Jenkins [Myriangiales: Elsinoaceae]	<i>Lagenaria</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Lagenaria</i> species (Watson & Jenkins 1969). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Emericellopsis terricola</i> Beyma [Hypocreales: Incertae sedis]	<i>Cucurbita</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in	Yes: If introduced via the seed pathway, <i>Emericellopsis terricola</i> could establish and	No: To date there is no evidence of economic consequences associated with this fungus.	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
			<i>Cucurbita pepo</i> (Rahim et al. 2013).	spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Rahim et al. 2013).	Therefore, it is not considered to pose risks of economic significance for Australia.	
<i>Epicoccum nigrum</i> Link [Pleosporales: Pleosporaceae] (synonym: <i>Epicoccum purpurascens</i> Ehrenb.)	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Brown, Hyde & Guest 1998; Fisher, Petrini & Sutton 1993)	Assessment not required	Assessment not required	Assessment not required	No
<i>Erysiphe communis</i> (Wallr.) Schltdl. [Erysiphales: Erysiphaceae] (synonym: <i>Erysiphe cruciferarum</i> Opiz ex Junell)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Momordica</i> , <i>Trichosanthes</i>	Yes (Gunasinghe et al. 2013)	Assessment not required	Assessment not required	Assessment not required	No
<i>Erysiphe polygoni</i> DC [Erysiphales: Erysiphaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Cook & Dubé 1989; Ryley et al. 2010; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Eutypella wistariae</i> Syd. & Syd. [Xylariales: Diatrypaceae]	<i>Lagenaria</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Lagenaria</i> species (Pande 2008; Patil 1983). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Fuligo gyrosa</i> (Rostaf.) Jahn [Physarales: Physaraceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
(synonym: <i>Physarum gyrosum</i> Rostaf.)			<i>Cucumis</i> species (Kim et al. 2009). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.			
<i>Fusarium acuminatum</i> Ellis & Everh. [Hypocreales: Nectriaceae] (synonyms: <i>Gibberella acuminata</i> Wollenw.; <i>Fusarium scirpi</i> Lambotte & Fautrey; <i>Fusarium caudatum</i> Wollenw.; <i>Fusarium scirpi</i> var. <i>caudatum</i> (Wollenw.) Wollenw.)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i>	Yes (Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium andiyazi</i> Marasas et al. [Hypocreales: Nectriaceae]	<i>Cucumis</i>	Yes (Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium avenaceum</i> (Fr.: Fr.) Sacc. [Hypocreales: Nectriaceae] (synonym: <i>Gibberella avenacea</i> Cook)	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium brachygibbosum</i> Padwick [Hypocreales: Nectriaceae]	<i>Citrullus</i>	Yes (Tan et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium chlamydosporum</i> Wollenw. & Reinking [Hypocreales: Nectriaceae]	<i>Cucumis</i>	Yes (Farr & Rossman 2019)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Fusarium compactum</i> (Wollenw.) Raillo [Hypocreales: Nectriaceae] (synonym: <i>Fusarium scirpi</i> var. <i>compactum</i> Wollenw.)	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Elmer et al. 1997; Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium commune</i> Skovg., O'Donnell & Nirenberg [Hypocreales: Nectriaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis melo</i> (Seo & Kim 2017). To date there is no published evidence that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Fusarium concolor</i> Reinking [Hypocreales: Nectriaceae]	<i>Cucumis</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium culmorum</i> (Sm.) Sacc. [Hypocreales: Nectriaceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium delphinoides</i> Schroers, Summerb., O'Donnell & Lampr. Hypocreales: Nectriaceae] (synonyms: <i>Bisifusarium dimerum</i> (Schroers et al.) Lombard & Crous)	<i>Cucumis</i>	Yes (Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium dimerum</i> Penz. [Hypocreales: Nectriaceae] (synonyms: <i>Microdochium dimerum</i> (Penz.) Arx; <i>Bisifusarium dimerum</i> (Penz.) Lombard & Crous)	<i>Cucurbita</i>	Yes (Plant Health Australia 2019a; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Fusarium equiseti</i> (Corda) Sacc. [Hypocreales: Nectriaceae] (synonyms: <i>Gibberella intricans</i> Wollenw.; <i>Fusarium equiseti</i> var. <i>bullatum</i> (Sherb.) Wollenw.)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Trichosanthes</i>	Yes (Elmer et al. 1997; Summerell et al. 2011; Wang, Brubaker & Burdon 2004)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium graminearum</i> Schwabe [Hypocreales: Nectriaceae] (synonym: <i>Gibberella zeae</i> (Schwein.) Petch)	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i> , <i>Momordica</i>	Yes (Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium heterosporum</i> Nees & Nees [Hypocreales: Nectriaceae] (synonym: <i>Gibberella gordonii</i> Booth)	<i>Lagenaria</i>	Yes (Shivas 1989; Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium lactis</i> Pirota & Riboni [Hypocreales: Nectriaceae]	<i>Citrullus</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus lanatus</i> (Gafforov 2017). To date there is no published evidence that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Fusarium oxysporum</i> Schltdl. [Hypocreales: Nectriaceae] (synonym: <i>Fusarium bulbigenum</i> Cooke & Massee; <i>Fusarium lagenariae</i> (Schwein.) Sacc.; <i>Fusarium</i>	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> ,	Yes (Elmer et al. 1997; Persley, Cooke & House 2010; Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>bulbigenum</i> var. <i>niveum</i> (Sm.) Wollenw.)	<i>Momordica</i> , <i>Sechium</i>					
<i>Fusarium oxysporum</i> f. sp. <i>cucumerinum</i> Owen [Hypocreales: Nectriaceae] (synonym: <i>Fusarium cucumerinum</i> Berk. & Broome)	<i>Cucumis</i>	Yes (Summerell et al. 2011). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium oxysporum</i> f. sp. <i>lagenariae</i> Matuo & Yamam. [Hypocreales: Nectriaceae]	<i>Lagenaria</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Lagenaria siceraria</i> (Kuniyasu 1977).	Yes: If introduced via the seed pathway, <i>Fusarium oxysporum</i> f. sp. <i>lagenariae</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2019).	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Fusarium oxysporum</i> f. sp. <i>luffae</i> Kawai [Hypocreales: Nectriaceae]	<i>Luffa</i>	Not present (Summerell et al. 2011)	No: This fungus has been reported naturally occurring on <i>Luffa</i> species (NCBI 2020). To date there is no available evidence suggesting that this fungus is seed-borne in this	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Fusarium oxysporum</i> f. sp. <i>melonis</i> Snyder & Hansen [Hypocreales: Nectriaceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Summerell et al. 2011)	host. Therefore, seeds are not considered to provide a pathway for this fungus. Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium oxysporum</i> f. sp. <i>mormodicae</i> Sun & Huang [Hypocreales: Nectriaceae]	<i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Momordica</i> species associated with Fusarium wilt diseases (Cumagun et al. 2010; Cumagun et al. 2008). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Fusarium oxysporum</i> f. sp. <i>niveum</i> Snyder & Hansen [Hypocreales: Nectriaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium oxysporum</i> f. sp. <i>radicis-cucumerinum</i> Vakil. [Hypocreales: Nectriaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species associated with stem and root disease (Vakalounakis 1996). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Fusarium redolens</i> Wollenw. [Hypocreales: Nectriaceae] (synonym: <i>Fusarium oxysporum</i> var. <i>redolens</i> (Wollenw.) Gordon)	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium reticulatum</i> Mont. [Hypocreales: Nectriaceae]	<i>Cucurbita</i>	Yes (Bentley et al. 2007)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium semitectum</i> Berk. & Ravenel [Hypocreales: Nectriaceae] (synonyms: <i>Fusarium incarnatum</i> (Desm.) Sacc.; <i>Fusarium pallidoroseum</i> (Cooke) Sacc.)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Trichosanthes</i>	Yes (Farr & Rossman 2019; Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium solani</i> (Mart) Sacc. [Hypocreales: Nectriaceae] (synonyms: <i>Fusarium solani</i> var. <i>minus</i> Wollenw.; <i>Fusarium javanicum</i> Koord.; <i>Fusarium javanicum</i> var. <i>radicicola</i> Wollenw.; <i>Nectria haematococca</i> Berk. & Broome; <i>Haematonectria haematococca</i> (Berk. & Broome) Samuels & Rossman)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Trichosanthes</i>	Yes (Pegg et al. 2002; Sangalang et al. 1995; Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium solani</i> f. sp. <i>cucurbitae</i> Snyder & Hansen [Hypocreales: Nectriaceae]	<i>Citrullus</i> , <i>Cucurbita</i>	Yes (Zitter, Hopkins & Thomas 1996)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Fusarium sporotrichioides</i> Sherb [Hypocreales: Nectriaceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Shivas 1989; Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium trichothecioides</i> Wollenw. [Hypocreales: Nectriaceae]	<i>Cucumis</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium tricinctum</i> (Corda) Sacc. [Hypocreales: Nectriaceae] (synonym: <i>Gibberella tricincta</i> El-Gholl et al.)	<i>Cucurbita</i>	Yes (Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Fusarium verticillioides</i> (Sacc.) Nirenberg [Hypocreales: Nectriaceae] (synonyms: <i>Fusarium moniliforme</i> Sheld; <i>Gibberella fujikuroi</i> (Sawada) Wollenw.; <i>Fusarium subglutinans</i> (Wollenw. & Reinking) Nelson et al.)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Trichosanthes</i>	Yes (Nelson et al. 1991; Petrovic et al. 2009; Summerell et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
<i>Geotrichum candidum</i> Link [Saccharomycetales: Dipodascaceae] (synonyms: <i>Dipodascus geotrichum</i> (Butler & Petersen) Arx; <i>Galactomyces geotrichum</i> (Butler & Petersen) Redhead & Malloch)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Persley, Cooke & House 2010; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Gibellulopsis nigrescens</i> (Pethybr.) Zare et al. [Incertae sedis: Plectosphaerellaceae]	<i>Cucumis</i>	Yes (Shivas 1989; Zare et al. 2007)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
(synonym: <i>Verticillium nigrescens</i> Pethybr.)						
<i>Golovinomyces cucurbitacearum</i> (Zhang & Chen) Vakal. & Kliron. [Erysiphales: Erysiphaceae] (synonym: <i>Erysiphe cucurbitacearum</i> Zhang & Chen)	<i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> and <i>Cucurbita</i> species (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Golovinomyces orontii</i> (Castagne) Heluta [Erysiphales: Erysiphaceae] (synonyms: <i>Erysiphe orontii</i> Castagne; <i>Erysiphe polyphaga</i> Hammarl)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Trichosanthes</i>	Yes (Cunnington 2003)	Assessment not required	Assessment not required	Assessment not required	No
<i>Haplaria dichotoma</i> Sawada [Helotiales: Sclerotiniaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis sativus</i> (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Helminthosporium cucumerinum</i> Garb.	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis sativus</i> (Farr &	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
[Pleosporales: Massarinaceae]			Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.			
<i>Helminthosporium sechiicola</i> Stev. [Pleosporales: Massarinaceae]	<i>Sechium</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Sechium</i> species (Farr & Rossman 2019; Stevenson 1975). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Humicola fuscoatra</i> Traaen [Sordariales: Chaetomiaceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (ALA 2019)	Assessment not required	Assessment not required	Assessment not required	No
<i>Hysterium calabash</i> Seaver [Hysteriales: Hysteriaceae]	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita pepo</i> (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Lasiodiplodia theobromae</i> (Pat.) Griffon & Maubl. [Botryosphaeriales: Botryosphaeriaceae]	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> ,	Yes (Burgess et al. 2006; Muller &	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
(synonyms: <i>Botryodiplodia theobromae</i> Pat.; <i>Physalospora rhodina</i> Berk. & Curtis; <i>Diplodia natalensis</i> Pole-Evans; <i>Botryosphaeria rhodina</i> (Berk. & Curtis) Arx)	<i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i> , <i>Trichosanthes</i>	Burt 1989; Taylor et al. 2005)				
<i>Leandria momordicae</i> Rangel [Incertae sedis: Incertae sedis]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Momordica</i> , <i>Sechium</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Momordica</i> and <i>Sechium</i> species (Blazquez 1983; Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Leptosphaeria alexandrinis</i> Negru [Pleosporales: Leptosphaeriaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (Crane & Shearer 1991). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Leptosphaeria cucurbitae</i> Montem. [Pleosporales: Leptosphaeriaceae]	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita pepo</i> (Farr & Rossman 2019). To date there is no available evidence	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
			suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.			
<i>Leptosphaerulina trifolii</i> (Rostr.) Petr. [Pleosporales: Didymellaceae]	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Momordica</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Leveillula cucurbitacearum</i> Golovin [Erysiphales: Erysiphaceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (Velkov & Masheva 2002). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Leveillula taurica</i> (Lév.) Arnaud [Erysiphales: Erysiphaceae] (synonym: <i>Oidiopsis taurica</i> (Lév.) Salmon)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i>	Yes (Cunnington 2003; Glawe et al. 2005)	Assessment not required	Assessment not required	Assessment not required	No
<i>Macrophoma luffae</i> Kavkas. [Botryosphaeriales: Botryosphaeriaceae]	<i>Luffa</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Luffa</i> species (Mycobank 2017). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Macrophoma passerinii</i> Sacc. [Botryosphaeriales: Botryosphaeriaceae]	<i>Lagenaria</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Lagenaria vulgaris</i> (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Macrophoma seminalis</i> (Berk. & Curtis) Berl. & Voglino [Botryosphaeriales: Botryosphaeriaceae]	<i>Citrullus</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> species (Duke 1993). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Macrophomina phaseolina</i> (Tassi) Goid. [Botryosphaeriales: Botryosphaeriaceae] (synonyms: <i>Sclerotium bataticola</i> Taub.; <i>Macrophomina phaseoli</i> (Maubl.) Ashby; <i>Rhizoctonia bataticola</i> (Taub.) Butler)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	Yes (Persley, Cooke & House 2010; Walker 1994)	Assessment not required	Assessment not required	Assessment not required	No
<i>Marasmius crescentiae</i> Murrill [Agaricales: Marasmiaceae] (synonym: <i>Cryptomarasmius crescentiae</i>)	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> species (Farr & Rossman 2019). To date there is no available evidence	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
(Murrill) Jenkinson & Desjardin)			suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.			
<i>Marssonina melonis</i> Dolan [Helotiales: Dermateaceae]	<i>Citrullus</i> , <i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucumis</i> species (Horst 2013). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Melioliphila volutella</i> (Berk. & Broome) Rossman [Pleosporales: Tubeufiaceae]	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> species (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Memnoniella echinata</i> (Rivolta) Galloway [Hypocreales: Incertae sedis] (synonym: <i>Stachybotrys echinata</i> (Rivolta) Sm.)	<i>Cucurbita</i>	Yes (Plant Health Australia 2019a). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
		Western Australia 2019). However, confirmation of official control could not be provided.				
<i>Micropeltis lufficola</i> Bat. [Microthyriales: Micropeltidaceae]	<i>Luffa</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Luffa</i> species (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Monodictys levis</i> (Wiltshire) Hughes [Incertae sedis: Incertae sedis]	<i>Cucurbita</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucurbita pepo</i> (Rahim et al. 2013).	Yes: If introduced via the seed pathway, <i>Monodictys levis</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2019).	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Monosporascus cannonballus</i> Pollack & Uecker [Sordariales: Incertae sedis]	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> and <i>Lagenaria</i> species (Crosby 2001; Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Monosporascus eutypoides</i> (Petr.) Arx [Sordariales: Incertae sedis]	<i>Citrullus</i> , <i>Cucumis</i>	Not known to occur	Therefore, seeds are not considered to provide a pathway for this fungus. No: This fungus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucumis</i> species (Ben Salem et al. 2013). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Mortierella alpina</i> Peyronel [Mortierellales: Mortierellaceae]	<i>Cucumis</i>	Yes (ALA 2019)	Assessment not required	Assessment not required	Assessment not required	No
<i>Mucor hiemalis</i> Wehmer [Mucorales: Mucoraceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Mucor racemosus</i> Fresen [Mucorales: Mucoraceae] (synonyms: <i>Mucor racemosus</i> f. <i>racemosus</i> Fr.; <i>Circinomucor racemosus</i> (Fr.) Arx)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Mycosphaerella kabocha</i> Hara [Capnodiales: Mycosphaerellaceae]	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> species (Watson 1971). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required.	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Mycosphaerella tassiana</i> (de Not.) Johanson [Capnodiales: Mycosphaerellaceae]	<i>Cucurbita</i>	Yes (Sharma & Heather 1981; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Mycovellosiella cucurbiticola</i> (Speg.) Deighton [Capnodiales: Mycosphaerellaceae]	<i>Sechium</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Sechium</i> species (Saade 1996). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Myrothecium cinctum</i> (Corda) Sacc. [Hypocreales: Incertae sedis] (synonyms: <i>Fusarium cinctum</i> Corda, <i>Striaticonidium cinctum</i> (Corda) Lombard & Crous)	<i>Cucurbita</i>	Yes (ALA 2019)	Assessment not required	Assessment not required	Assessment not required	No
<i>Myrothecium roridum</i> Tode [Hypocreales: Incertae sedis]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Trichosanthes</i>	Yes (Cook & Dubé 1989; Walker et al. 1988)	Assessment not required	Assessment not required	Assessment not required	No
<i>Myrothecium verrucaria</i> (Alb. & Schwein.) Ditmar [Hypocreales: Incertae sedis]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Momordica</i>	Yes (Lenne 1990; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Nectria inventa</i> Pethybr. [Hypocreales: Nectriaceae]	<i>Cucurbita</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Nectria ventricosa</i> Booth [Hypocreales: Nectriaceae]	<i>Cucurbita</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been	Yes: If introduced via the seed pathway, <i>Nectria</i>	No: To date there is no evidence of economic	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
(synonym: <i>Rectifusarium ventricosum</i> (Appel & Wollenw.) Lombard & Crous)			reported as seed-borne in <i>Cucurbita pepo</i> (Rahim et al. 2013).	<i>ventricosa</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Rahim et al. 2013).	consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	
<i>Neocosmospora falciformis</i> (Carrión) L. Lombard & Crous [Hypocreales: Nectriaceae] (Synonyms: <i>Cephalosporium falciforme</i> Carrión; <i>Acremonium falciforme</i> (Carrion) W. Gams; <i>Fusarium falciforme</i> (Carrion) Summerb. & Schroers)	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (Gonzalez et al. 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Neocosmospora petroliphila</i> (Q.T. Chen & X.H. Fu) Sand.-Den. & Crous [Hypocreales: Nectriaceae] (synonyms: <i>Fusarium solani</i> var. <i>Petroliphilum</i> Q.T. Chen & X.H. Fu; <i>Fusarium petroliphilum</i> (Q.T. Chen & X.H. Fu) Geiser, O'Donnell, D.P.G. Short & N. Zhang)	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> species (González, Armengol & Garcés-Claver 2018). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Neocosmospora vasinfecta</i> Smith [Hypocreales: Nectriaceae] (synonyms: <i>Fusarium neocosmosporiellum</i> O'Donnell & Geiser)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Fuhlbohms, Tatnell & Ryley 2007)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Neofusicoccum ribis</i> (Slippers et al.) Crous et al. [Botryosphaeriales: Botryosphaeriaceae] (synonym: <i>Botryosphaeria ribis</i> Grossenb. & Duggar)	<i>Cucumis</i>	Yes (Plant Health Australia 2019a; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Neosartorya fischeri</i> (Wehmer) Malloch & Cain [Eurotiales: Trichocomaceae] (synonym: <i>Aspergillus fischeri</i> Wehmer)	<i>Cucurbita</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Nigrospora oryzae</i> (Berk & Broome) Petch [Trichosphaeriales: Trichosphaeriaceae] (synonyms: <i>Khuskia oryzae</i> Huds.; <i>Nigrospora sphaerica</i> (Sacc.) Mason)	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i>	Yes (Shivas 1989; Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No
<i>Oidium ambrosiae</i> Thüm. [Erysiphales: Erysiphaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Cucurbita</i> species (Mendes, da Silva & Dianese 1998; Mujica & Vergara 1945). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Oidium lagasceae</i> Chidd. [Erysiphales: Erysiphaceae]	<i>Luffa</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Luffa</i> species (Farr & Rossman	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
(synonym: <i>Acrosporium lagasceae</i> (Chidd.) Subram.)			2019; Paul & Thakur 2006). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.			
<i>Olpidium bornovanus</i> (Sahtiy.) Karling [Olpidiales: Olpidiaceae] (synonym: <i>Leiolpidium bornovanum</i> Doweld)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Cucurbita</i> species (de Cara et al. 2008). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Olpidium brassicae</i> (Woronin) Dang [Olpidiales: Olpidiaceae] (synonym: <i>Olpidiaster brassicae</i> (Woronin) Doweld)	<i>Cucumis</i>	Yes (Cook & Dubé 1989). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.	Assessment not required	Assessment not required	Assessment not required	No
<i>Olpidium virulentus</i> (Sahtiy.) Karling [Rozellopsidiales:	<i>Citrullus</i> , <i>Cucumis</i>	Yes (Maccarone et al. 2010).	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Incertae sedis] (synonym: <i>Pleotrachelus virulentus</i> Sahtiy.)		Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.				
<i>Oothia spiraeae</i> (Fuckel) Fuckel [Incertae sedis: Incertae sedis]	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> species (Urtiaga 1986). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Ozonium texanum</i> Neal & Webster [Agaricales: Psathyrellaceae] (synonym: <i>Ozonium texanum</i> var. <i>parasiticum</i> Thirum.)	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> species (Watson 1971). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Papulaspora irregularis</i> Hotson [Incertae sedis: Incertae sedis]	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> species (Jamiolkowska, Wagner & Sawicki 2000). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Passalora cucurbiticola</i> (Henn.) Braun & Crous [Capnodiales: Mycosphaerellaceae] (synonyms: <i>Cercospora cucurbiticola</i> Henn.; <i>Phaeoramularia cucurbiticola</i> (Henn.) Deighton)	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> species (Mendes, da Silva & Dianese 1998). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Passalora fulva</i> (Cooke) Braun & Crous [Capnodiales: Mycosphaerellaceae] (synonym: <i>Cladosporium fulvum</i> Cooke)	<i>Cucumis</i>	Yes (Shivas 1989; Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No
<i>Passalora momordicae</i> (Heald & Wolf) Braun & Crous [Capnodiales: Mycosphaerellaceae] (synonyms: <i>Phaeoramularia momordicae</i> (Heald & Wolf)	<i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Momordica</i> species (Braun 1993). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Braun; <i>Ramularia momordicae</i> Heald & Wolf)			are not considered to provide a pathway for this fungus.			
<i>Penicillium atramentosum</i> Thom [Eurotiales: Trichocomaceae]	<i>Cucumis</i>	Yes (Farr & Rossman 2019)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium brevicompactum</i> Dierckx [Eurotiales: Trichocomaceae]	<i>Cucumis</i>	Yes (Lamb & Brown 1970)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium capsulatum</i> Raper & Fennell [Eurotiales: Trichocomaceae]	<i>Lagenaria</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Lagenaria</i> species (Ahmad, Iqbal & Khalid 1997). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Penicillium chrysogenum</i> Thom [Eurotiales: Trichocomaceae]	<i>Citrullus</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium citrinum</i> Thom [Eurotiales: Trichocomaceae] (synonym: <i>Penicillium steckii</i> Zalesky)	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium crustosum</i> Thom [Eurotiales: Trichocomaceae] (synonym: <i>Penicillium solitum</i> Westling)	<i>Cucumis</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Penicillium digitatum</i> (Pers.: Fr.) Sacc. [Eurotiales: Trichocomaceae]	<i>Citrullus</i> , <i>Cucumis</i>	Yes (Cook & Dubé 1989; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium expansum</i> Link [Eurotiales: Trichocomaceae]	<i>Cucumis</i>	Yes (Cook & Dubé 1989; Cunningham 2003)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium funiculosum</i> Thom [Eurotiales: Trichocomaceae] (synonym: <i>Talaromyces funiculosus</i> (Thom) Samson et al.)	<i>Cucumis</i>	Yes (Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium glabrum</i> (Wehmer) Westling [Eurotiales: Trichocomaceae] (synonym: <i>Penicillium frequentans</i> Westling)	<i>Cucumis</i>	Yes (Fisher, Petrini & Sutton 1993)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium gladioli</i> McCulloch & Thom [Eurotiales: Trichocomaceae] (synonym: <i>Penicillium gladioli</i> Machacek)	<i>Cucumis</i>	Yes (Shivas 1989; Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium herquei</i> Bainier & Sartory [Eurotiales: Trichocomaceae]	<i>Cucumis</i> , <i>Lagenaria</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> and <i>Lagenaria</i> species (Ahmad, Iqbal & Khalid 1997; Raymond et al. 1959). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Penicillium implicatum</i> Biourge [Eurotiales: Trichocomaceae]	<i>Cucumis</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium italicum</i> Wehmer [Eurotiales: Trichocomaceae]	<i>Cucumis</i> , <i>Trichosanthes</i>	Yes (Cook & Dubé 1989; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium janczewskii</i> Zalesky [Eurotiales: Trichocomaceae]	<i>Cucumis</i>	Yes (Yip & Weste 1985)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium olsonii</i> Bainier & Sartory [Eurotiales: Trichocomaceae]	<i>Cucumis</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium oxalicum</i> Currie & Thom [Eurotiales: Trichocomaceae]	<i>Citrullus</i> , <i>Cucumis</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium pinophilum</i> Hedgc. [Eurotiales: Trichocomaceae] (synonym: <i>Talaromyces pinophilus</i> (Hedgc.) Samson et al.)	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Trichosanthes</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium restrictum</i> Gilman & Abbott [Eurotiales: Trichocomaceae]	<i>Cucumis</i>	Yes (Plant Health Australia 2019a; Yip & Weste 1985)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium roquefortii</i> Thom [Eurotiales: Trichocomaceae]	<i>Cucumis</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium rugulosum</i> Thom [Eurotiales: Trichocomaceae] (synonym: <i>Talaromyces rugulosus</i> (Thom) Samson et al.)	<i>Cucumis</i>	Yes (Yip & Weste 1985)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Penicillium simplicissimum</i> (Oudem) Thom [Eurotiales: Trichocomaceae] (synonyms: <i>Penicillium janthinellum</i> Biourge; <i>Penicillium piscarium</i> Westling)	<i>Benincasa</i> , <i>Cucumis</i>	Yes (Fisher, Petrini & Sutton 1993; Yip & Weste 1985)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium spinulosum</i> Thom [Eurotiales: Trichocomaceae] (synonym: <i>Penicillium nigricans</i> Zalesky)	<i>Cucumis</i>	Yes (Lamb & Brown 1970; Yip & Weste 1985)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium thomii</i> Maire [Eurotiales: Trichocomaceae]	<i>Cucumis</i>	Yes (McGee et al. 2006; Yip & Weste 1985)	Assessment not required	Assessment not required	Assessment not required	No
<i>Penicillium viridicatum</i> Westling [Eurotiales: Trichocomaceae] (synonyms: <i>Penicillium aurantiogriseum</i> Dierckx; <i>Penicillium cyclopium</i> Westling)	<i>Cucumis</i>	Yes (Plant Health Australia 2019a; Yip & Weste 1985)	Assessment not required	Assessment not required	Assessment not required	No
<i>Periconia byssoides</i> Pers. [Pleosporales: Incertae sedis]	<i>Momordica</i>	Yes (Chakraborty, Charudattan & De Valerio 1994)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pestalotia gubaiana</i> Subramon. & Rao [Xylariales: Amphisphaeriaceae]	<i>Citrullus</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> species (Nag Raj 1993). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pestalotia torulosa</i> Berk. & Curtis [Xylariales: Amphisphaeriaceae]	<i>Citrullus</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus vulgaris</i> (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Pestalotiopsis versicolor</i> (Speg.) Steyaert [Xylariales: Amphisphaeriaceae]	<i>Momordica</i>	Yes (Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phaeomycoentrospora cantuariensis</i> (Salmon & Wormald) Crous et al. [Pleosporales: Incertae sedis]	<i>Luffa</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Luffa</i> species (Crous et al. 2013). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Phaeotrichoconis crotalariae</i> (Salam & Rao) Subram [Incertae sedis: Incertae sedis]	<i>Citrullus</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phoma anserina</i> Marchal [Pleosporales: Didymellaceae] (synonym: <i>Peyronellaea anserine</i> (Marchal) Aveskamp et al.)	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (de Gruyter & Noordeloos 1992). To date there is no available evidence suggesting that this fungus is seed-borne in this host.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Phoma citrullicola</i> Sawada [Pleosporales: Didymellaceae]	<i>Citrullus</i>	Not known to occur	Therefore, seeds are not considered to provide a pathway for this fungus. No: This fungus has been reported naturally occurring on <i>Citrullus</i> species (Rao 1966). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Phoma eupyrena</i> Sacc. [Pleosporales: Didymellaceae]	<i>Cucurbita</i>	Yes (Lenne 1990)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phoma exigua</i> Desm [Pleosporales: Didymellaceae] (synonym: <i>Ascochyta phaseolorum</i> Sacc.)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Sechium</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phoma jolyana</i> Piroz. & Morgan-Jones [Pleosporales: Didymellaceae] (synonym: <i>Phoma jolyana</i> var. <i>sahariensis</i> (Faurel & Schotter) Boerema et al.)	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (Boerema et al. 2004). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Phoma lagenicola</i> Sacc. [Pleosporales: Didymellaceae] (synonym: <i>Phoma lagenariae</i> Thüm)	<i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> , <i>Cucurbita</i> and <i>Lagenaria</i> species (Boerema et	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
			al. 2004; Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.			
<i>Phoma medicaginis</i> Malbr. & Roum. [Pleosporales: Didymellaceae]	<i>Cucurbita</i>	Yes (Cook & Dubé 1989; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phoma multirostrata</i> (Mathur et al.) Dorenb. & Boerema [Pleosporales: Didymellaceae] (synonyms: <i>Phoma multirostrata</i> var. <i>microspora</i> (Allesch.) Boerema; <i>Phoma decorticans</i> var. <i>microspora</i> Allesch)	<i>Cucumis</i> , <i>Luffa</i>	Yes (Golzar et al. 2015)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phoma peponis</i> Politis [Pleosporales: Didymellaceae]	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> species (Pantidou 1973). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Phoma pomorum</i> Thüm [Pleosporales: Didymellaceae] (synonym: <i>Peyronellaea pomorum</i> (Thüm) Aveskamp et al.)	<i>Trichosanthes</i>	Yes (Cook & Dubé 1989)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Phoma subvelata</i> Sacc. [Pleosporales: Didymellaceae]	<i>Cucurbita</i> , <i>Lagenaria</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> and <i>Lagenaria</i> species (Farr & Rossman 2019; Tai 1979). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Phoma terricola</i> Boerema [Pleosporales: Didymellaceae] (synonym: <i>Pyrenochaetopsis decipiens</i> (Marchal) Gruyter et al.)	<i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Lagenaria vulgaris</i> (Avinash & Rai 2013).	Yes: If introduced via the seed pathway, <i>Phoma terricola</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Avinash & Rai 2013).	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Phomatospora dinemasporium</i> Webster [Incertae sedis: Incertae sedis] (synonyms: <i>Dinemasporium graminum</i> (Lib) Lév; <i>Dinemasporium strigosum</i> (Pers.: Fr.) Sacc.)	<i>Citrullus</i>	Yes (Yuan & Mohammed 1999)	Assessment not required	Assessment not required	Assessment not required	No
<i>Phomopsis sclerotoides</i> Kesteren [Diaporthales: Diaporthaceae] (synonym: <i>Diaportha sclerotoides</i> (Kesteren) Udayanga et al.)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i>	Yes (Tesoriero & Bertus 2004). Western Australia's <i>BAM Act 2007</i> prohibits this pest	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
		(Government of Western Australia 2019). However, confirmation of official control could not be provided.				
<i>Phyllosticta lagenariae</i> Pass. [Botryosphaerales: Phyllostictaceae]	<i>Lagenaria</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Lagenaria leucantha</i> (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Phyllosticta momordicae</i> Tassi [Botryosphaerales: Phyllostictaceae]	<i>Luffa</i> , <i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Luffa</i> and <i>Momordica</i> species (Minter, Hernández & Portales 2001; Urtiaga 1986). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Phyllosticta sechii</i> Young [Botryosphaerales: Phyllostictaceae]	<i>Sechium</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Sechium edule</i> (Farr & Rossman 2019). To date there is no	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Phymatotrichopsis omnivora</i> (Duggar) Hennebert [Pezizales: Rhiziniaceae] (synonym: <i>Phymatotrichum omnivorum</i> Duggar)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i>	Not known to occur	available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus. No: This fungus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> and <i>Lagenaria</i> species (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Physarum cinereum</i> (Batsch) Pers. [Physarales: Physaraceae]	<i>Cucumis</i>	Yes (Cook & Dubé 1989; Sampson & Walker 1982)	Assessment not required	Assessment not required	Assessment not required	No
<i>Physarum nucleatum</i> Rex [Physarales: Physaraceae]	<i>Lagenaria</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Plectosphaerella citrullae</i> A.J.L. Phillips, A. Carlucci & M.L. Raimondo [Glomerellales: Plectosphaerellaceae]	<i>Citrullus</i> , <i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucumis</i> species (Carlucci et al. 2012). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Plectosphaerella citrulli</i> Carlucci, Raimondo, Santos & Phillips [Glomerellales: Plectosphaerellaceae]	<i>Citrullus</i> , <i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucumis</i> species (Su, Deng & Niu 2017). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Plectosphaerella cucumeris</i> Kleb. [Glomerellales: Plectosphaerellaceae] (synonyms: <i>Monographella cucumerina</i> (Lindf.) Arx; <i>Fusarium tabacinum</i> (Beyma) Gams; <i>Plectosporium tabacinum</i> (Beyma) Palm et al.; <i>Plectosphaerella cucumerina</i> (Lindf.) Gams)	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Palm, Gams & Nirenberg 1995). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, it is not considered further as it is reported to be present in Western Australia as <i>Fusarium tabacinum</i> (Pascoe, Nancarrow & Copes 1984) and confirmation of official control	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Plectosphaerella melonis</i> (Watan & Sato) Phillips et al. [Glomerellales: Plectosphaerellaceae] (synonym: <i>Acremonium cucurbitacearum</i> Alfaro-Garcia et al.)	<i>Citrullus</i> , <i>Cucumis</i>	could not be provided. Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucumis</i> species (Carlucci et al. 2012; Martinez-Culebras, Abad-Campos & Garcia-Jimenez 2004) infecting roots and causing fruit rot (Martinez-Culebras, Abad-Campos & Garcia-Jimenez 2004). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Plectosphaerella pauciseptata</i> A.J.L. Phillips, A. Carlucci & M.L. Raimondo [Glomerellales: Plectosphaerellaceae]	<i>Citrullus</i> , <i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucumis</i> species (Carlucci et al. 2012). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Plectosphaerella plurivora</i> A.J.L. Phillips, A. Carlucci & M.L. Raimondo [Glomerellales: Plectosphaerellaceae]	<i>Citrullus</i>	Yes (Giraldo & Crous 2019)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
[synonym: <i>Plectosphaerella niemeijerorum</i> L. Lombard] <i>Plectosphaerella ramiseptata</i> A.J.L. Phillips, A. Carlucci & M.L. Raimondo [Glomerellales: Plectosphaerellaceae]	<i>Citrullus</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> species (Carlucci et al. 2012). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Plectosphaerella sinensis</i> L. Su & Y.C. Niu [Glomerellales: Plectosphaerellaceae]	<i>Citrullus</i> , <i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucumis</i> species (Giraldo & Crous 2019). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Pleospora herbarum</i> (Pers.: Fr.) Rabenh. [Pleosporales: Pleosporaceae] (synonyms: <i>Stemphylium herbarum</i> Simmons; <i>Macrosporium sarcinula</i> Berk.)	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i>	Yes (Cook & Dubé 1989; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Podosphaera fuliginea</i> (Schltldl.) Braun & Takam. [Erysiphales: Erysiphaceae] (synonyms: <i>Sphaerotheca fuliginea</i> (Schltldl.) Pollacci; <i>Oidium erysiphoides</i> Fr.;	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> ,	Yes (Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Sphaerotheca macularis</i> var. <i>fuliginea</i> (Schltldl.) Cooke	<i>Momordica</i> , <i>Sechium</i>					
<i>Podosphaera fusca</i> (Fr.) Braun & Shishkoff [Erysiphales: Erysiphaceae] (synonyms: <i>Podosphaera xanthii</i> (Castagne) Braun & Shishkoff; <i>Sphaerotheca fusca</i> (Fr.) Blumer; <i>Oidium citrulli</i> Yen et al.; <i>Sphaerotheca cucurbitae</i> (Jacz.) Zhao; <i>Sphaerotheca fuliginea</i> f. <i>cucurbitae</i> Jacz.)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i> , <i>Trichosanthes</i>	Yes (Cunnington 2003; Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pseudocercospora cucurbitina</i> (Speg.) Braun [Capnodiales: Mycosphaerellaceae] (synonym: <i>Cercospora cucurbitina</i> Speg.)	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> species (Farr & Rossman 2019; Watson 1971). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Pseudocercospora sicerariae</i> Deighton [Capnodiales: Mycosphaerellaceae]	<i>Lagenaria</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Lagenaria</i> species (Deighton 1976). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Pseudocercospora trichoxanthidicola</i> Kamal et al. [Capnodiales: Mycosphaerellaceae]	<i>Trichosanthes</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Trichosanthes</i> species (Kamal, Rai & Moses 1991). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Pseudocochliobolus pallescens</i> Tsuda & Ueyama [Pleosporales: Pleosporaceae] (synonym: <i>Curvularia pallescens</i> Boedijn)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Shivas 1989; Sivanesan 1987)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pseudozyma flocculosa</i> (Traquair et al.) Boekhout & Traquair [Ustilaginales: Ustilaginaceae] (synonym: <i>Anthracoystis flocculosa</i> (Traquair et al.) Piątek et al.)	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (Urquhart, Sun & Punja 1997). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Puccinia cephalandrae</i> Thüm. [Pucciniales: Pucciniaceae]	<i>Cucumis</i> , <i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> and <i>Momordica</i> species (Crous, Phillips & Baxter 2000). To date there is no available evidence suggesting that this fungus is	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Puccinia citrulli</i> Syd. & Syd. [Pucciniales: Pucciniaceae]	<i>Citrullus</i>	Not known to occur	seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus. No: This fungus has been reported naturally occurring on <i>Citrullus</i> species (Iqbal & Khalid 1996). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Puccinia citrullina</i> Raghun. & Ramakr. Ex Hosag. & Raghun. [Pucciniales: Pucciniaceae]	<i>Citrullus</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> species (Berndt & Baiswar 2007). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Puccinia cucumeris</i> Henn. [Pucciniales: Pucciniaceae]	<i>Cucumis</i> , <i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> and <i>Momordica</i> species (Berndt & Baiswar 2007; Mendes, da Silva & Dianese 1998). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Puccinia momordicae</i> Kalchbr. [Pucciniales: Pucciniaceae]	<i>Momordica</i>	Not known to occur	Therefore, seeds are not considered to provide a pathway for this fungus. No: This fungus has been reported naturally occurring on <i>Momordica</i> species (Berndt & Baiswar 2007). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Puccinia vanderystii</i> Henn. [Pucciniales: Pucciniaceae]	<i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Momordica</i> species (Berndt & Baiswar 2007). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Pyrenochaeta lycopersici</i> Schneid. & Gerlach [Incertae sedis: Incertae sedis]	<i>Cucumis</i>	Yes (Cunnington 2003; Golzar 2009)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pyrenochaeta terrestris</i> (Hansen) Gorenz et al. [Incertae sedis: Incertae sedis] (synonyms: <i>Setophoma terrestris</i> (Hansen) Gruyter et al.; <i>Phoma terrestris</i> Hansen)	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Cook & Dubé 1989; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Ramichloridium apiculatum</i> (Mill et al.) de Hoog [Capnodiales: Mycosphaerellaceae]	<i>Cucumis</i>	Yes (Taylor & Hyde 2003)	Assessment not required	Assessment not required	Assessment not required	No
<i>Ramichloridium cucurbitae</i> Mayfield et al. [Capnodiales: Mycosphaerellaceae]	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> species (Li et al. 2012). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Ramichloridium punctatum</i> Mayfield et al. [Capnodiales: Mycosphaerellaceae]	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> species (Li et al. 2012). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Rhizoctonia ferruginea</i> Matz [Cantharellales: Ceratobasidiaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis sativus</i> (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Rhizoctonia solani</i> Kühn [Cantharellales: Ceratobasidiaceae] (synonyms: <i>Thanatephorus cucumeris</i> (Frank) Donk; <i>Corticium sasakii</i> (Shirai) Matsumoto; <i>Corticium solani</i> (Prill. & Delacr.) Bourdot & Galzin)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i> , <i>Trichosanthes</i>	Yes (Anderson et al. 2004; Neate & Warcup 1985; Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No
<i>Rhizoctonia zeae</i> Voorhees [Cantharellales: Ceratobasidiaceae] (synonym: <i>Waitea circinata</i> Warcup & Talbot)	<i>Cucumis</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Rhizopus arrhizus</i> Fisch. [Mucorales: Rhizopodaceae] (synonym: <i>Rhizopus oryzae</i> Went & Prins. Geerl.)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i>	Yes (Plant Health Australia 2019a; Simmonds 1966)	Assessment not required	Assessment not required	Assessment not required	No
<i>Rhizopus stolonifer</i> (Ehrenb. Fr.) Vuill. [Mucorales: Rhizopodaceae] (synonyms: <i>Rhizopus nigricans</i> Ehrenb; <i>Mucor mucedo</i> (Tode) Pers.)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i>	Yes (Persley, Cooke & House 2010; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Rhizopycnis vagum</i> Farr [Incertae sedis: Incertae sedis]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Cucurbita</i> species (Armengol et al. 2003; Farr, Miller & Bruton 1998; Trakunyingcharoen et al. 2014; Westphal, Xing & Goodwin 2011). To date there is no available evidence	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Schizothyra indica</i> Garud [Incertae sedis: Incertae sedis]	<i>Trichosanthes</i>	Not known to occur	suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus. No: This fungus has been reported naturally occurring on <i>Trichosanthes anguina</i> (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Sclerotinia sclerotiorum</i> (Lib.) de Bary [Helotiales: Sclerotiniaceae] (synonym: <i>Sclerotinia libertiana</i> Fuckel)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Trichosanthes</i>	Yes (Horne, de Boer & Crawford 2002; Li et al. 2006; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Sclerotium rolfsii</i> Sacc. [Incertae sedis: Incertae sedis] (synonyms: <i>Athelia rolfsii</i> (Curzi) Tu & Kimbr; <i>Corticium rolfsii</i> Curzi; <i>Pellicularia rolfsii</i> (Curzi) West)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i> , <i>Trichosanthes</i>	Yes (Burgess, Wearing & Toussoun 1975; Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No
<i>Sepedonium niveum</i> Massee & Salmon [Hypocreales: Hypocreaceae]	<i>Luffa</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Luffa cylindrica</i> (Farr & Rossman 2019). To date there is no available evidence	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Septoria apiicola</i> Speg. [Capnodiales: Mycosphaerellaceae] (synonym: <i>Septoria apii</i> Chester)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Shivas 1989)	suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus. Assessment not required	Assessment not required	Assessment not required	No
<i>Septoria citrulli</i> Ellis & Everh. [Capnodiales: Mycosphaerellaceae]	<i>Citrullus</i> , <i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucurbita</i> species (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus. Assessment not required	Assessment not required	Assessment not required	No
<i>Septoria cucumeris</i> Girz. [Capnodiales: Mycosphaerellaceae]	<i>Cucumis</i>	Yes (Punithalingam 1982)	Assessment not required	Assessment not required	Assessment not required	No
<i>Septoria cucurbitacearum</i> Sacc. [Capnodiales: Mycosphaerellaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i>	Yes (Persley, Cooke & House 2010; Watson & Napier 2009)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Septotrullula bacilligera</i> Höhn. [Incertae sedis: Incertae sedis]	<i>Cucurbita</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucurbita pepo</i> (Rahim et al. 2013).	Yes: If introduced via the seed pathway, <i>Septotrullula bacilligera</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Rahim et al. 2013).	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Setosphaeria prolata</i> Leonard & Suggs [Pleosporales: Pleosporaceae] (synonyms: <i>Exserohilum prolatum</i> Leonard & Suggs; <i>Drechslera prolata</i> (Leonard & Suggs) Sivan.)	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (Farr & Rossman 2019; Sivanesan 1987). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Setosphaeria rostrata</i> Leonard [Pleosporales: Pleosporaceae] (synonyms: <i>Exserohilum rostratum</i> (Drechsler) Leonard & Suggs; <i>Bipolaris rostrata</i> (Drechsler) Shoemaker)	<i>Cucumis</i> , <i>Momordica</i>	Yes (Hyde & Alcorn 1993; Plant Health Australia 2019a; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Sphaerotheca humuli</i> (DC.) Burrill [Erysiphales: Erysiphaceae] (synonym: <i>Podosphaera macularis</i> (Wallr.) Braun & Takam.)	<i>Cucurbita</i> , <i>Lagenaria</i> , <i>Sechium</i>	Yes (Cook & Dubé 1989)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Sphaerulina cucumeris</i> Sawada [Capnodiales: Mycosphaerellaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis sativus</i> (Farr & Rossman 2019; Watson 1971). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Sphaerulina cucurbitae</i> Naito [Capnodiales: Mycosphaerellaceae]	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucurbita</i> species (Farr & Rossman 2019; Watson 1971). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Sporidesmium mucosum</i> Sacc. [Incertae sedis: Incertae sedis]	<i>Citrullus</i> , <i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus vulgaris</i> (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Sporotrichum pruinosum</i> Gilman & Abbott [Polyporales:	<i>Cucumis</i>	Yes (Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Fomitopsidaceae] (synonym: <i>Phanerodontia chrysosporium</i> (Burds.) Hjortstam & Ryvarde)						
<i>Stachybotrys cylindrospora</i> Jensen [Hypocreales: Stachybotryaceae] (synonym: <i>Stachybotrys atra</i> var. <i>cylindrospora</i> (Jensen) Rayss & Borut)	<i>Cucurbita</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucurbita pepo</i> (Rahim et al. 2013).	Yes: If introduced via the seed pathway, <i>Stachybotrys cylindrospora</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2019; Rahim et al. 2013).	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Stagonosporopsis caricae</i> (Syd. & Syd.) Aveskamp et al. [Pleosporales: Incertae sedis]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Momordica</i>	Yes (Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No
<i>Stagonosporopsis citrulli</i> Brewer & Stewart [Pleosporales: Incertae sedis]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> and <i>Momordica</i> species (Stewart, Turner & Brewer 2015). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Stagonosporopsis cucurbitacearum</i> (Fr.) Aveskamp et al. [Pleosporales: Incertae sedis]	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> ,	Yes (Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
(synonyms: <i>Ascochyta citrullina</i> (Chester) C.O. Sm.; <i>Ascochyta cucumis</i> Fautrey & Roum.; <i>Didymella bryoniae</i> (Fuckel) Rehm; <i>Mycosphaerella citrullina</i> (Smith) Grossenb.; <i>Phoma cucurbitacearum</i> (Fr.) Sacc.)	<i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i> , <i>Trichosanthes</i>	2010; Shivas 1989)				
<i>Staphylotrichum coccosporum</i> Mey & Nicot [Incertae sedis: Incertae sedis]	<i>Cucurbita</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucurbita pepo</i> (Rahim et al. 2013).	Yes: If introduced via the seed pathway, <i>Staphylotrichum coccosporum</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2019; Rahim et al. 2013).	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Stemphylium botryosum</i> Wallr. [Pleosporales: Pleosporaceae] (synonym: <i>Pleospora tarda</i> Simmons)	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Hall et al. 2007)	Assessment not required	Assessment not required	Assessment not required	No
<i>Stemphylium cucumis</i> Pei & Zhang [Pleosporales: Pleosporaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> species (Farr & Rossman 2019; Pei et al. 2011). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Stemphylium luffae</i> Pei & Zhang [Pleosporales: Pleosporaceae]	<i>Luffa</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Luffa cylindrica</i> (Farr & Rossman 2019; Pei et al. 2011). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Stemphylium momordicae</i> Zhang & Zhang [Pleosporales: Pleosporaceae]	<i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Momordica</i> species (Mycobank 2017; Zhang, Wu & Zhang 2003). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Stemphylium solani</i> Weber [Pleosporales: Pleosporaceae]	<i>Cucumis</i>	Yes (Persley, Cooke & House 2010; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Stilbella annulata</i> (Berk. & Curtis) Seifert [Incertae sedis: Incertae sedis] (synonyms: <i>Acrostalagmus annulatus</i> (Berk. & Curtis) Seifert; <i>Stilbella proliferans</i> Stevens)	<i>Luffa</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Luffa</i> species (Farr & Rossman 2019; Minter, Hernández & Portales 2001). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Syncephalastrum racemosum</i> Cohn ex Schröt [Mucorales: Syncephalastraceae]	<i>Trichosanthes</i>	Yes (Cheong, Neumeister-Kemp & Kemp 2007; Plant Health Australia 2019a)	considered to provide a pathway for this fungus. Assessment not required	Assessment not required	Assessment not required	No
<i>Synchytrium lagenariae</i> Mathre & Mundkar [Chytridiales: Synchytriaceae] (synonym: <i>Synchytrium trichosanthidis</i> Mhatre & Mundk.)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> and <i>Luffa</i> species (Farr & Rossman 2019; Karling 1964). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Synchytrium wurthii</i> Rytz [Chytridiales: Synchytriaceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> and <i>Cucurbita</i> species (Farr & Rossman 2019; Watson 1971). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Talaromyces flavus</i> (Klöcker) Stolk & Samson [Eurotiales: Trichocomaceae]	<i>Benincasa</i>	Yes (Fravel & Adams 1986)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Tetraploa ellisii</i> Cooke [Pleosporales: Tetraplospheariaceae]	<i>Trichosanthes</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Thanatephorus microsclerotium</i> (Matz) Boidin et al. [Cantharellales: Ceratobasidiaceae] (synonym: <i>Corticium microsclerotium</i> (Matz) Weber)	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis sativus</i> (Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Thielavia basicola</i> Zopf [Sordariales: Chaetomiaceae]	<i>Citrullus</i> , <i>Cucumis</i>	Yes (Allen 1990; Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Thielaviopsis basicola</i> (Berk. & Broome) Ferraris [Microascales: Incertae sedis] (synonym: <i>Chalara elegans</i> Nag Raj & Kendr.)	<i>Citrullus</i> , <i>Momordica</i>	Yes (Cook & Dubé 1989; Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No
<i>Tilletiopsis pallescens</i> Gokhale [Incertae sedis: Incertae sedis]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis sativus</i> (Farr & Rossman 2019; Urquhart, Sun & Punja 1997). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Tilletiopsis washingtonensis</i> Nyland [Incertae sedis: Incertae sedis]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on the leaves of <i>Cucumis sativus</i> (Farr & Rossman 2019; Urquhart, Sun & Punja 1997). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Torula herbarum</i> (Pers.) Link [Capnodiales: Incertae sedis] (synonym: <i>Torula herbarum</i> f. <i>quaternella</i> Sacc.)	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Trichocladium opacum</i> (Corda) Hughes [Sordariales: Chaetomiaceae]	<i>Cucurbita</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucurbita pepo</i> (Rahim et al. 2013).	Yes: If introduced via the seed pathway, <i>Trichocladium opacum</i> could establish and spread in Australia. This fungus has established in areas with a wide range of climatic conditions (Farr & Rossman 2019; Rahim et al. 2013).	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Trichoderma ghanense</i> Doi et al. [Hypocreales: Hypocreaceae]	<i>Cucumis</i>	Yes (Schwarze et al. 2012)	Assessment not required	Assessment not required	Assessment not required	No
<i>Trichoderma hamatum</i> (Bonord.) Bainier [Hypocreales: Hypocreaceae]	<i>Cucurbita</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Trichoderma harzianum</i> Rifai [Hypocreales: Hypocreaceae]	<i>Cucurbita</i>	Yes (Fisher, Petrini & Sutton 1993)	Assessment not required	Assessment not required	Assessment not required	No
<i>Trichoderma longibrachiatum</i> Rifai [Hypocreales: Hypocreaceae]	<i>Luffa</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Trichoderma virens</i> (Mill et al.) Arx [Hypocreales: Hypocreaceae]	<i>Cucumis</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Trichoderma viride</i> Pers.: Fr. [Hypocreales: Hypocreaceae]	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Sechium</i>	Yes (Paulus, Gadek & Hyde 2007; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
<i>Trichothecium roseum</i> (Pers: Fr) Link [Hypocreales: Incertae sedis]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Trichosanthes</i>	Yes (Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No
<i>Trichurus spiralis</i> Hasselbr. [Microascales: Microascaceae]	<i>Momordica</i>	Yes (Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Ulocladium atrum</i> Preuss et al. [Pleosporales: Pleosporaceae] (synonyms: <i>Alternaria atra</i> (Preuss) Woudenb. & Crous; <i>Stemphylium atrum</i> (Preuss) Sacc.)	<i>Cucumis</i>	Yes (David 1995b; Plant Health Australia 2019a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Ulocladium consortiale</i> (Thüm) Simmons [Pleosporales: Pleosporaceae] (synonyms: <i>Stemphylium consortiale</i>)	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (David 1995a)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
(Thüm) Groves & Skolko; <i>Stemphylium ilicis</i> Tengwall)						
<i>Ulocladium oudemansii</i> Simmons [Pleosporales: Pleosporaceae] (synonym: <i>Alternaria oudemansii</i> (Simmons) Woudenb. & Crous)	<i>Cucumis, Luffa</i>	Not known to occur	No: This fungus has been reported naturally occurring on <i>Cucumis</i> and <i>Luffa</i> species (Farr & Rossman 2019; Woudenberg et al. 2013). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Uromyces cucumivorus</i> Berndt [Pucciniales: Pucciniaceae]	<i>Cucumis</i>	Not known to occur	No: This fungus has been reported naturally occurring on the leaves of <i>Cucumis</i> species (Berndt 2013; Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Uromyces neotropalis</i> Hern. & Aime [Pucciniales: Pucciniaceae]	<i>Cucurbita</i>	Not known to occur	No: This fungus has been reported naturally occurring <i>Cucurbita</i> species (Farr & Rossman 2019; Hernández, Aime & Henkel 1993). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Uromyces reynoldsii</i> Thaung [Pucciniales: Pucciniaceae]	<i>Trichosanthes</i>	Not known to occur	No: This fungus has been reported naturally occurring on the leaves of <i>Trichosanthes</i> species (Berndt 2013; Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Uromyces umiamensis</i> Berndt & Baiswar [Pucciniales: Pucciniaceae]	<i>Cucumis</i> , <i>Momordica</i>	Not known to occur	No: This fungus has been reported naturally occurring on the leaves of <i>Cucumis</i> and <i>Momordica</i> species (Berndt 2013; Berndt & Baiswar 2007; Farr & Rossman 2019). To date there is no available evidence suggesting that this fungus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this fungus.	Assessment not required	Assessment not required	No
<i>Uromyces viciae-fabae</i> (Pers.) Schröt. [Pucciniales: Pucciniaceae] (synonym: <i>Uromyces fabae</i> (Pers.) de Bary)	<i>Citrullus</i> , <i>Cucurbita</i>	Yes (Cook & Dubé 1989; Sampson & Walker 1982)	Assessment not required	Assessment not required	Assessment not required	No
<i>Uromyces yakushimensis</i> Hirats. & Katsuki [Pucciniales: Pucciniaceae]	<i>Trichosanthes</i>	Not known to occur	No: This fungus has been reported naturally occurring on the leaves of <i>Trichosanthes</i> species (Farr & Rossman 2019). To date there is no	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Verticillium albo-atrum sensu lato</i> Reinke & Berthold [Incertae sedis: Plectosphaerellaceae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Momordica</i>	Yes (Plant Health Australia 2019a; Shivas 1989). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, it is not considered further as it is reported to be present in Western Australia (Shivas 1989) and confirmation of official control could not be provided.	available evidence suggesting that this fungus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this fungus. Assessment not required	Assessment not required	Assessment not required	No
<i>Verticillium dahliae</i> Kleb. [Incertae sedis: Plectosphaerellaceae]	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Trichosanthes</i>	Yes (Ramsay, Multani & Lyon 1996). Western Australia's <i>BAM Act 2007</i>	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
		prohibits this pest (Government of Western Australia 2019). However, it is not considered further as it is reported to be present in Western Australia (Shivas 1989) and confirmation of official control could not be provided.				
<i>Verticillium tricorpus</i> Isaac [Incertae sedis: Plectosphaerellaceae]	<i>Cucumis</i>	Yes (Nair et al. 2015)	Assessment not required	Assessment not required	Assessment not required	No
<i>Viennotidia spermosphaerici</i> Negru & Verona ex Rogerson [Microascales: Incertae sedis]	<i>Cucurbita</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in <i>Cucurbita pepo</i> (Cannon & Hawksworth 1982).	Yes: If introduced via the seed pathway, <i>Viennotidia spermosphaerici</i> could establish and spread in Australia. This virus has established in areas with similar climates to parts of Australia (Farr & Rossman 2019).	No: To date there is no evidence of economic consequences associated with this fungus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Zopfiella karachiensis</i> (Ahmed & Asad) Guarro [Sordariales: Lasiosphaeriaceae]	<i>Benincasa</i>	Not known to occur	Yes: Seeds provide a pathway for this fungus, which has been reported as seed-borne in	Yes: If introduced via the seed pathway, <i>Zopfiella karachiensis</i> could establish and spread in	No: To date there is no evidence of economic consequences associated with this fungus.	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
			<i>Benincasa hispida</i> (Cybertruffle 2015; MGR 2015).	Australia. This fungus has established in areas with similar climates to parts of Australia (Farr & Rossman 2019).	Therefore, it is not considered to pose risks of economic significance for Australia.	
Nematodes						
<i>Belonolaimus longicaudatus</i> Rau 1958 [Panagrolaimida: Belonolaimidae]	<i>Momordica</i>	Yes (Nobbs 2003a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Ditylenchus destructor</i> Thorne 1945 [Panagrolaimida: Anguinidae]	<i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This nematode has been reported naturally occurring on <i>Cucumis</i> and <i>Cucurbita</i> species (Kruus 2012; Okten 1988). To date there is no available evidence suggesting that this nematode is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this nematode.	Assessment not required	Assessment not required	No
<i>Ditylenchus dipsaci</i> (Kühn 1857) Filipjev 1936 [Panagrolaimida: Anguinidae]	<i>Cucumis</i>	Yes (Ophel-Keller et al. 2008). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, it is not considered further as it is reported to be	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
		present in Western Australia (Stirling & Stanton 1997) and confirmation of official control could not be provided.				
<i>Helicotylenchus dihystra</i> (Cobb 1893) Sher 1961 [Panagrolaimida: Hoplolaimidae]	<i>Cucurbita</i>	Yes (Khair 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Helicotylenchus multicinctus</i> (Cobb 1893) Golden 1956 [Panagrolaimida: Hoplolaimidae]	<i>Citrullus</i> , <i>Cucumis</i>	Yes (Khair 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Hemicycliophora arenaria</i> Raski 1958 [Panagrolaimida: Hemicycliophoridae]	<i>Cucurbita</i>	Yes (Khair 1986; McLeod, Reay & Smyth 1994)	Assessment not required	Assessment not required	Assessment not required	No
<i>Heterodera trifolii</i> Goffart 1932 [Panagrolaimida: Heteroderidae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Khair 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Hoplolaimus indicus</i> Sher 1963 [Panagrolaimida: Hoplolaimidae]	<i>Cucumis</i>	Not known to occur	No: This nematode has been reported naturally occurring on <i>Cucumis</i> species (APHIS 2003). To date there is no available evidence suggesting that this nematode is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this nematode.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Hoplolaimus seinhorsti</i> Luc 1958 [Panagrolaimida: Hoplolaimidae]	<i>Cucumis</i>	Yes (McLeod, Reay & Smyth 1994; Nobbs 2003a; Sauer 1981)	Assessment not required	Assessment not required	Assessment not required	No
<i>Meloidogyne arenaria</i> (Neal 1889) Chitwood 1949 [Panagrolaimida: Meloidogynidae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Momordica</i>	Yes (Hay & Pethybridge 2005)	Assessment not required	Assessment not required	Assessment not required	No
<i>Meloidogyne enterolobii</i> Yang & Eisenback 1983 [Panagrolaimida: Meloidogynidae] (synonym: <i>Meloidogyne mayaguensis</i> Rammah & Hirschmann 1988)	<i>Citrullus</i> , <i>Cucurbita</i> , <i>Momordica</i>	Not known to occur	No: This nematode has been reported naturally occurring on <i>Citrullus</i> , <i>Cucurbita</i> and <i>Momordica</i> species (Hodda, Banks & Singh 2012; Perry, Moens & Starr 2009). To date there is no available evidence suggesting that this nematode is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this nematode.	Assessment not required	Assessment not required	No
<i>Meloidogyne ethiopica</i> Whitehead 1968 [Panagrolaimida: Meloidogynidae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This nematode has been reported naturally occurring on <i>Citrullus</i> and <i>Cucurbita</i> species (EPPO 2017). To date there is no available evidence suggesting that this nematode is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this nematode.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Meloidogyne exigua</i> Goeldi 1892 [Panagrolaimida: Meloidogynidae]	<i>Citrullus</i>	Yes (Nobbs 2003a). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.	Assessment not required	Assessment not required	Assessment not required	No
<i>Meloidogyne floridensis</i> Handoo et al. 2004 [Panagrolaimida: Meloidogynidae]	<i>Cucumis</i>	Not known to occur	No: This nematode has been reported naturally occurring on <i>Cucumis</i> species (Stanley et al. 2009). To date there is no available evidence suggesting that this nematode is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this nematode.	Assessment not required	Assessment not required	No
<i>Meloidogyne hapla</i> Chitwood 1949 [Panagrolaimida: Meloidogynidae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Pullman & Berg 2010; Quader, Riley & Walker 2001)	Assessment not required	Assessment not required	Assessment not required	No
<i>Meloidogyne incognita</i> (Kofoid & White 1919) Chitwood 1949 [Panagrolaimida: Meloidogynidae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> ,	Yes (Quader, Riley & Walker 2001; Stirling & Cirami 1984)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
	<i>Luffa</i> , <i>Momordica</i>					
<i>Meloidogyne javanica</i> (Treub 1885) Chitwood 1949 [Panagrolaimida: Meloidogynidae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Sechium</i>	Yes (Hay & Pethybridge 2005)	Assessment not required	Assessment not required	Assessment not required	No
<i>Merlinius brevidens</i> (Allen 1955) Siddiqi 1970 [Panagrolaimida: Telotylenchidae] (synonym: <i>Tylenchorhynchus brevidens</i> Allen 1955)	<i>Cucumis</i>	Yes (Khair 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Nacobbus aberrans</i> (Thorne 1935) Thorne & Allen 1944 [Panagrolaimida: Pratylenchidae] (synonym: <i>Nacobbus batatiformis</i> Thorne & Schuster 1959)	<i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This nematode has been reported naturally occurring on <i>Cucumis</i> and <i>Cucurbita</i> species (APHIS 2003; EPPO 2009). To date there is no available evidence suggesting that this nematode is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this nematode.	Assessment not required	Assessment not required	No
<i>Paralongidorus maximus</i> (Bütschli 1874) Siddiqi 1964 [Dorylaimida: Longidoridae]	<i>Cucumis</i>	Not known to occur	No: This nematode has been reported naturally occurring on <i>Cucumis</i> species (APHIS 2003). To date there is no available evidence suggesting that this nematode is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this nematode.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Paraphelenchus pseudoparietinus</i> Micoletzky 1922 [Panagrolaimida: Paraphelenchidae]	<i>Cucumis</i>	Yes (Nobbs 2003a)	Assessment not required	Assessment not required	Assessment not required	No
<i>Paratrachodorus lobatus</i> Colbran 1965 [Triplonchida: Trichodoridae]	<i>Cucumis</i>	Yes (Khair 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Paratrachodorus minor</i> (Colbran 1956) Siddiqi 1974 [Triplonchida: Trichodoridae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Sauer 1981)	Assessment not required	Assessment not required	Assessment not required	No
<i>Paratrachodorus porosus</i> Allen 1957 [Triplonchida: Trichodoridae]	<i>Citrullus</i> , <i>Cucurbita</i>	Yes (Sheedy et al. 2010)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pratylenchus brachyurus</i> (Godfrey 1929) Filipjev & Schuurmans-Stekhoven 1941 [Panagrolaimida: Pratylenchidae]	<i>Cucumis</i>	Yes (Khair 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pratylenchus coffeae</i> (Zimmerman 1898) Filipjev & Schuurmans-Stekhoven 1941 [Panagrolaimida: Pratylenchidae]	<i>Citrullus</i> , <i>Cucumis</i>	Yes (Khair 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pratylenchus crenatus</i> Loof 1960 [Panagrolaimida: Pratylenchidae]	<i>Cucumis</i>	Yes (Hay & Pethybridge 2005)	Assessment not required	Assessment not required	Assessment not required	No
<i>Pratylenchus neglectus</i> (Rensch 1924) Filipjev & Schuurmans-Stekhoven 1941	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Riley & Kelly 2002)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
[Panagrolaimida: Pratylenchidae]						
<i>Pratylenchus penetrans</i> (Cobb 1917) Filipjev & Schuurmans-Stekhoven 1941	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Riley & Kelly 2002)	Assessment not required	Assessment not required	Assessment not required	No
[Panagrolaimida: Pratylenchidae]						
<i>Quinisucius capitatus</i> (Allen 1955) Siddiqi 1971	<i>Cucurbita</i>	Yes (Khair 1986; Nobbs 2003a)	Assessment not required	Assessment not required	Assessment not required	No
[Panagrolaimida: Telotylenchidae] (synonym: <i>Tylenchorhynchus capitatus</i> Allen 1955)						
<i>Radopholus similis</i> (Cobb 1893) Thorne 1949	<i>Citrullus</i> , <i>Cucumis</i> , <i>Momordica</i>	Yes (Khair 1986). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, it is not considered further as it is reported to be present in Western Australia (DAFWA 2016; Nobbs 2003a) and confirmation of official control	Assessment not required	Assessment not required	Assessment not required	No
[Panagrolaimida: Pratylenchidae]						

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Radopholus vangundyi</i> Sher 1968 [Panagrolaimida: Pratylenchidae]	<i>Cucumis</i>	could not be provided. Yes (Khair 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Rotylenchulus reniformis</i> Linford & Oliveria 1940 [Panagrolaimida: Rotylenchulidae]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Momordica</i>	Yes (Khair 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Scutellonema brachyurum</i> (Steiner 1938) Andrassy 1958 [Panagrolaimida: Hoplolaimidae]	<i>Cucumis</i>	Yes (Khair 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Scutellonema clathricaudatum</i> Whitehead 1959 [Panagrolaimida: Hoplolaimidae]	<i>Cucumis</i>	Not known to occur	No: This nematode has been reported naturally occurring on <i>Cucumis</i> species (Hodda, Banks & Singh 2012). To date there is no available evidence suggesting that this nematode is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this nematode.	Assessment not required	Assessment not required	No
<i>Tylenchorhynchus clarus</i> Allen 1955 [Panagrolaimida: Telotylenchidae]	<i>Cucumis</i>	Yes (Khair 1986)	Assessment not required	Assessment not required	Assessment not required	No
<i>Xiphinema americanum</i> Cobb 1913 [Dorylaimida: Xiphinematidae]	<i>Citrullus</i> , <i>Cucumis</i>	Yes (Khair 1986)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Xiphinema rivesi</i> Dalmasso 1969 [Dorylaimida: Xiphinematidae]	<i>Cucumis</i>	Yes (Sharma et al. 2003)	Assessment not required	Assessment not required	Assessment not required	No
<i>Zygotylenchus guevarai</i> (Tobar Jiménez 1963) Braun & Loof 1966 [Panagrolaimida: Pratylenchidae]	<i>Cucumis</i>	Not known to occur	No: This nematode has been reported naturally occurring on <i>Cucumis</i> species, causing stunting and root damage (APHIS 2003; Karakas 2012). To date there is no available evidence suggesting that this nematode is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this nematode.	Assessment not required	Assessment not required	No
Phytoplasmas						
' <i>Candidatus</i> Phytoplasma asteris' [16SrI] (Aster yellows group) [Acholeplasmatales: Acholeplasmataceae]	<i>Cucumis</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i>	Not known to occur	No: This phytoplasma has been reported naturally occurring on <i>Cucumis</i> , <i>Luffa</i> , <i>Momordica</i> and <i>Sechium</i> species (Kumar, Singh & Lakhanpaul 2010; Win, Kim & Jung 2014). To date there is no available evidence suggesting that this phytoplasma is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this phytoplasma.	Assessment not required	Assessment not required	No
' <i>Candidatus</i> Phytoplasma australiense' [16SrXII-B] (Stolbur group) [Acholeplasmatales: Acholeplasmataceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Stubbs 2005)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
'Candidatus Phytoplasma pruni' [16 SrIII – Y] [Acholeplasmatales: Acholeplasmataceae]	<i>Lagenaria</i>	Not known to occur	No: This phytoplasma has been reported naturally occurring on <i>Lagenaria</i> species, causing reduced leaf size, leaf malformation and yellowing (Montano et al. 2015). To date there is no available evidence suggesting that this phytoplasma is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this phytoplasma.	Assessment not required	Assessment not required	No
Chayote witches' broom disease (ChWB) [16SrIII-J] X-disease group [Acholeplasmatales: Acholeplasmataceae]	<i>Momordica</i> , <i>Sechium</i>	Not known to occur	No: This phytoplasma has been reported naturally occurring on <i>Momordica</i> and <i>Sechium</i> species, causing stunting, yellowing and fruit malformation (Jiménez & Montano 2010; Montano et al. 2000; Munhoz, Pereira & Bedendo 2019). To date there is no available evidence suggesting that this phytoplasma is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this phytoplasma.	Assessment not required	Assessment not required	No
Loofah witches' broom phytoplasma [16SrVIII] (Loofah witches' broom (LufWB) group) [Acholeplasmatales: Acholeplasmataceae]	<i>Luffa</i>	Not known to occur	No: This phytoplasma has been reported naturally occurring on <i>Luffa</i> species (Lee et al. 1994). To date there is no available evidence suggesting that this phytoplasma is seed-borne in	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Peanut witches' broom group [16SrII-D] [Acholeplasmatales: Acholeplasmataceae]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Omar & Foissac 2012; White et al. 1998)	this host. Therefore, seeds are not considered to provide a pathway for this phytoplasma. Assessment not required	Assessment not required	Assessment not required	No
Viroids						
<i>Hop stunt viroid</i> (HSVd) [Pospiviroidae: Hostuviroid]	<i>Cucumis</i>	Yes (Koltunow, Krake & Rezaian 1988). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.	Assessment not required	Assessment not required	Assessment not required	No
Viruses						
<i>Ageratum enation virus</i> (AEV) [Geminiviridae: Begomovirus]	<i>Trichosanthes</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Trichosanthes</i> species causing mosaic and leaf curl symptoms, fruit deformation and stunting (Raj et al. 2011). To date there is no available evidence suggesting that this virus is	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Algerian watermelon mosaic virus</i> (AWMV) [Potyviridae: Potyvirus]	<i>Citrullus</i> , <i>Cucurbita</i>	Not known to occur	seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus. No: This virus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucurbita</i> species (Yakoubi, Lecoq & Desbiez 2008). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Arabis mosaic virus</i> (ArMV) [Secoviridae: Nepovirus]	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Sharkey, Hepworth & Whattam 1996). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.	Assessment not required	Assessment not required	Assessment not required	No
<i>Artichoke yellow ringspot virus</i> (AYRSV) [Secoviridae: Nepovirus]	<i>Cucumis</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Cucumis</i> species causing	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Bitter gourd yellow mosaic virus</i> (BgYMV) [Geminiviridae: Begomovirus]	<i>Momordica</i>	Not known to occur	stunting, and severe yellow mosaic of the leaves (Avgelis & Vovlas 1989; Gallitelli et al. 2004). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus. Yes: Seeds provide a pathway for this virus, which has recently been reported as seed-borne in <i>Momordica charantia</i> (Manivannan et al. 2019). This virus has been reported naturally occurring on <i>Momordica charantia</i> , causing yellow mottling, puckering, stunting and malformed fruits (Manivannan et al. 2019). BgYMV was only characterised as a virus species in 2019 (Manivannan et al. 2019) and no other hosts have yet been reported.	Yes: If introduced via the seed pathway, BgYMV could establish and spread in Australia. This virus has established in areas with similar climates to parts of Australia (Manivannan et al. 2019). Additionally, this virus is known to be transmitted by <i>Bemisia tabaci</i> (Manivannan et al. 2019; Onkara Naik et al. 2019), which is present in Australia (Plant Health Australia 2019a).	Yes: BgYMV causes yellowing, leaf lamina distortion, puckering and stunting, leading to extremely malformed fruit and reduced marketable yield. Disease incidences of 58%–100% has been reported in bitter gourd crop in India (Manivannan et al. 2019).	Yes
<i>Beet curly top virus</i> (BCTV) [Geminiviridae: Curtovirus]	<i>Citrullus</i> , <i>Cucumis</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucumis</i> species (Brunt et al. 1996). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Beet pseudo-yellow virus</i> (BPYV) [Closteroviridae: Crinivirus] (synonym: <i>Cucumber yellows virus</i>)	<i>Cucumis</i> , <i>Cucurbita</i>	Yes (Büchen-Osmond et al. 1988; Persley, Cooke & House 2010). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.	considered to provide a pathway for this virus. Assessment not required	Assessment not required	Assessment not required	No
<i>Beet western yellows virus</i> (BWYV) [Luteoviridae: Ploverovirus]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Coutts & Jones 2005)	Assessment not required	Assessment not required	Assessment not required	No
<i>Chayote mosaic virus</i> (ChMV) [Tymoviridae: Tymovirus]	<i>Sechium</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Sechium</i> species causing chlorotic spots and rings, blotchy mosaic and leaf deformation (Bernal et al. 2000; Hord et al. 1997). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Cherry rasp leaf virus</i> (CRLV) [Secoviridae: Cheravirus]	<i>Cucumis</i>	Not known to occur (IPPC 2016a). It was listed as present in Australia (Büchen-Osmond et al. 1988). However, the records are more than 30 years old, and are considered unreliable.	considered to provide a pathway for this virus. No: This virus has been reported naturally occurring on <i>Cucumis sativus</i> (Stace-Smith & Hansen 1976). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Chickpea chlorotic dwarf virus</i> (CpCDV) [Geminiviridae: Mastrevirus]	<i>Citrullus</i> , <i>Cucumis</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucumis</i> species (Hameed et al. 2017; Radouane et al. 2019; Zaagueri et al. 2016). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Chilli leaf curl virus</i> (ChiLCV) [Geminiviridae: Begomovirus]	<i>Citrullus</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus lanatus</i> (Shahid, Al-Sadi & Briddon 2017). To date there is no available evidence suggesting that this virus is seed-borne in this host.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Citrullus lanatus cryptic virus</i> (CLCV) [Partitiviridae: Unassigned]	<i>Citrullus</i>	Not known to occur	Therefore, seeds are not considered to provide a pathway for this virus. No: This virus has been reported naturally occurring on <i>Citrullus lanatus</i> co-infected with <i>Melon necrotic spot virus</i> (Sela, Lachman & Reingold 2013). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Clover yellow vein virus</i> (CIYVV) [Potyviridae: Potyvirus]	<i>Cucurbita</i>	Yes (Norton & Johnstone 1998)	Assessment not required	Assessment not required	Assessment not required	No
<i>Coccinia mosaic Virdhunagar virus</i> [Geminiviridae: Begomovirus]	<i>Momordica</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Momordica charantia</i> (Muthupandi, Marwal & Tennyson 2019). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Cucumber Bulgarian latent virus</i> (CBLV) [Tombusviridae: Tombusvirus]	<i>Cucumis</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Cucumis</i> species (Kostova et al. 2003; Menzel, Bananej & Winter 2015). To date there is	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Cucumber fruit mottle mosaic virus</i> (CFMMV) [Virgaviridae: Tobamovirus]	<i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus. Yes: Seeds provide a pathway for this virus, which has been reported as seed-borne in <i>Cucurbita pepo</i> (Kwon et al. 2014). This virus has also been reported naturally occurring on <i>Cucumis</i> species causing severe fruit mottling and mosaic (Antignus et al. 2001; Rhee, Hong & Lee 2014a; Rhee, Jang & Lee 2016).	Yes: If introduced via the seed pathway, CFMMV could establish and spread in Australia. This virus has established in areas with similar climates to parts of Australia (Antignus et al. 2001; Rhee, Hong & Lee 2014a; Rhee, Jang & Lee 2016).	Yes: CFMMV causes cucumber fruits to exhibit severe mottling or mosaic, rendering them unmarketable, and can cause severe wilting leading to plant collapse (Antignus et al. 2001). Under favourable conditions, the disease incidence may reach up to 100%, leading to significant economic losses in cucumber crops (Antignus et al. 2005).	Yes
<i>Cucumber green mottle mosaic virus</i> (CGMMV) [Virgaviridae: Tobamovirus]	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Trichosanthes</i>	Yes (under official control) (Australian Department of Agriculture and Water Resources 2017)	Yes: Seeds provide a pathway for this virus, which has been reported as seed-borne in <i>Citrullus lanatus</i> , <i>Cucumis melo</i> , <i>Cucumis sativus</i> , <i>Cucurbita maxima</i> , <i>Cucurbita moschata</i> , <i>Cucurbita pepo</i> , <i>Lagenaria siceraria</i> and <i>Trichosanthes cucumerina</i> (Fiona Constable [DED]TR 2015, pers. comm., 2 December)(Ali, Hussain &	Yes: If introduced via the seed pathway, CGMMV could establish and spread in Australia. This virus has established in areas with a wide range of climatic conditions (Biosecurity Queensland 2015; Lecoq & Desbiez 2012).	Yes: This virus is an economically important pathogen of cucumber, melon, squash and watermelon (Moradi & Jafarpour 2011). It is reported to cause yield losses of around 15% in cucurbitaceous crops (Nontajak et al. 2014). The damage it causes to the host plant and fruit can be	Yes (EP)

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
			Ahmad 2015; Nontajak et al. 2014).		extensive. Therefore, CGMMV is considered a threat to Australia's fresh vegetable market and the Cucurbitaceous seed industry.	
<i>Cucumber leafspot virus</i> (CLSV) [Tombusviridae: Aureusvirus]	<i>Cucumis</i>	Not known to occur	Yes: Seeds provide a pathway for this virus, which has been reported as seed-borne in <i>Cucumis sativus</i> (Sastry 2013; Zitter, Hopkins & Thomas 1996). This virus has also been reported naturally occurring on other <i>Cucumis</i> species causing chlorotic spots with necrotic centres on leaves (Brunt et al. 1996; Segundo et al. 2001).	Yes: If introduced via the seed pathway, CLSV could establish and spread in Australia. This virus has established in areas with a wide range of climatic conditions (Brunt et al. 1996; Segundo et al. 2001).	No: CLSV is considered a minor pathogen (Pospieszny, Jonczyk & Borodynko 2003; Zitter, Hopkins & Thomas 1996). To date there is no evidence of economic consequences associated with this virus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Cucumber mosaic virus</i> (CMV) [Bromoviridae: Cucumovirus]	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Sechium</i>	Yes (Alberts, Hannay & Randles 1985; Büchen-Osmond et al. 1988)	Assessment not required	Assessment not required	Assessment not required	No
<i>Cucumber mottle virus</i> (CuMoV) [Virgaviridae: Tobamovirus]	<i>Cucumis</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Cucumis</i> species, causing severe mosaic on leaves and fruit (Orita et al. 2007). As a tobamovirus it is likely to be seed-borne, but at this time there is no available evidence suggesting that this virus is	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Cucumber necrosis virus</i> (CNV) [Tombusviridae: Tombusvirus]	<i>Cucumis</i>	Not known to occur	seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus. No: This virus has been reported naturally occurring on <i>Cucumis</i> species, causing malformed chlorotic leaves (Brunt et al. 1996). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Cucumber vein-yellowing virus</i> (CVYV) [Potyviridae: Ipomovirus]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Cucurbita</i> species, causing vein yellowing, vein clearing and stunting (OEPP/EPP0 2005a). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Cucurbit aphid-borne yellows virus</i> (CABYV) [Luteoviridae: Polerovirus]	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> ,	Not known to occur	No: This virus has been reported naturally occurring on <i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> and <i>Momordica</i> species, causing severe leaf yellowing	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
	<i>Luffa</i> , <i>Momordica</i>		symptoms (Desbiez et al. 2019; Lecoq & Desbiez 2012; Mnari-Hattab, Gauthier & Zouba 2009). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.			
<i>Cucurbit chlorotic yellows virus</i> (CCYV) [Closteroviridae: Crinivirus]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> and <i>Luffa</i> species (Gyoutoku et al. 2009; Li et al. 2016; Okuda et al. 2010; Orfanidou et al. 2017). To date there is no available evidence suggesting that this virus is seed borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Cucurbit leaf crumple virus</i> (CuLCrV) [Geminiviridae: Begomovirus] (synonym: <i>Cucurbit leaf curl virus</i>)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Cucurbita</i> species causing stunted growth, leaf crumple and chlorosis (Hagen et al. 2008). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Cucurbit vein banding virus</i> (CVBV) [Potyviridae: Potyvirus]	<i>Cucurbita</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Cucurbit</i> species causing strong vein banding in the leaves (Perotto et al. 2017). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Cucurbit yellow stunting disorder virus</i> (CYSDV) [Closteroviridae: Crinivirus]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Cucurbita</i> species (OEPP/EPPO 2005b; UC IPM 2016). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Eggplant mottled dwarf virus</i> (EMDV) [Rhabdoviridae: Nucleorhabdovirus]	<i>Cucumis</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Cucumis</i> species causing vein clearing and severe inward curling symptoms (Lecoq & Desbiez 2012). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Groundnut bud necrosis virus</i> (GBNV) [Tospoviridae: Orthotospovirus] (synonym: <i>Peanut bud necrosis virus</i>)	<i>Momordica</i>	Not known to occur	considered to provide a pathway for this virus. No: This virus has been reported naturally occurring on <i>Momordica charantia</i> (Nagendran et al. 2018). To date there is no evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Groundnut ringspot virus</i> (GRSV) [Tospoviridae: Orthotospovirus]	<i>Citrullus</i> , <i>Cucumis</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucumis</i> species, causing vein clearing and severe inward curling symptoms (Leão et al. 2015; Spadotti et al. 2014). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Impatiens necrotic spot virus</i> (INSV) [Tospoviridae: Orthotospovirus]	<i>Cucumis</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Cucumis</i> species (EPPO 2004). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Kyuri green mottle mosaic virus</i> (KGMMV) [Virgaviridae: Tobamovirus]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i>	Not known to occur	considered to provide a pathway for this virus. Yes: Seeds provide a pathway for this virus, which has been reported naturally occurring as seed-borne in <i>Citrullus lanatus</i> (Kwon et al. 2014), <i>Cucumis sativus</i> (Lecoq & Katis 2014) and <i>Cucurbita pepo</i> (Kwon et al. 2014). This virus has also been reported naturally occurring on <i>Cucumis melo</i> (Daryono, Somowiyarjo & Natsuaki 2003; Kim et al. 2009), <i>Cucumis metuliferus</i> (Daryono & Natsuaki 2012), and <i>Luffa acutangula</i> (Daryono, Somowiyarjo & Natsuaki 2003, 2005a).	Yes: If introduced via the seed pathway, KGMMV could establish and spread in Australia. This virus has established in areas with a wide range of climatic conditions (Daryono, Somowiyarjo & Natsuaki 2005a; ICTVdB Management 2006a).	Yes: This virus causes mosaic, severe fruit mottling and malformation (Brunt et al. 1996) which may result in severe reductions in fruit yield and quality, leading to serious economic losses in important crops such as cucumber and melon (Daryono, Somowiyarjo & Natsuaki 2005a; Reingold et al. 2015). Therefore, KGMMV is considered a threat to Australia's fresh vegetable market and the cucurbitaceous seed industry.	Yes
<i>Lagenaria mild mosaic virus</i> (LaMMoV) [Flexiviridae: Potexvirus]	<i>Lagenaria</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Lagenaria</i> species, causing mosaic and mottle symptoms (Kim, Lee & Natsuaki 2010). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Lagenaria siceraria alphaendornavirus</i> (LsEV)	<i>Lagenaria</i>	Not known to occur	No: This virus has been reported naturally occurring on	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
[Endornaviridae: Alphaendornavirus] (synonym: <i>Lagenaria siceraria endornavirus</i>)			<i>Lagenaria siceraria</i> (Kwon, Tan & Vidalakis 2014; Peng et al. 2018). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.			
<i>Lettuce infectious yellows virus</i> (LIYV) [Closteroviridae: Crinivirus]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Cucurbita</i> species, causing chlorosis and leaf curling (Zitter, Hopkins & Thomas 1996). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Luffa aphid-borne yellows virus</i> (LABYV) [Luteoviridae: Polerovirus]	<i>Luffa</i>	Not known to occur	No: This virus has been reported naturally occurring in <i>Luffa acutangula</i> (Knierim et al. 2015). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Luffa yellow mosaic virus</i> (LYMV) [Geminiviridae: Begomovirus] (synonym:	<i>Luffa</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Luffa</i> species (Revill et al. 2004). To date there is no	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Loofa yellow mosaic virus</i> (LYMV))			available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.			
<i>Melon chlorotic leaf curl virus</i> (MCLCuV) [Geminiviridae: Begomovirus]	<i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Cucumis</i> and <i>Cucurbita</i> species, causing stunting, deformation, and chlorosis (Brown et al. 2001; ICTVdB Management 2006b). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Melon chlorotic mosaic virus</i> (MeCMV) [Geminiviridae: Begomovirus]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Cucurbita</i> species (Romy, Lecoq & Desbiez 2015). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Melon chlorotic spot virus</i> (MeCSV) [Phenuiviridae: Tenuivirus]	<i>Cucumis</i>	Not known to occur	No. This virus has been reported naturally occurring on <i>Cucumis melo</i> (Lecoq et al. 2019). To date there is no available evidence suggesting	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Melon mild mottle virus</i> (MMMV) [Secoviridae: Nepovirus]	<i>Cucumis</i>	Not known to occur	that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus. No: This virus has been reported naturally occurring on <i>Cucumis melo</i> (Tomitaka, Fujimoto & Nakata 2011). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Melon necrotic spot virus</i> (MNSV) [Tombusviridae: Gammacarmovirus] (synonym: <i>Muskmelon necrotic spot virus</i>)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Lagenaria</i>	Yes (under official control) (IPPC 2016b)	Yes: Seeds provide a pathway for this virus, which has been reported as seed-borne in <i>Citrullus lanatus</i> (Kwak et al. 2015) and <i>Cucumis melo</i> (Lecoq & Katis 2014). This virus has also been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Lagenaria</i> species, causing necrotic lesions on leaves and stems, and fruit deformation (Ayo-John et al. 2014; Herrera-Vásquez et al. 2009; Sela, Lachman & Reingold 2013).	Yes: If introduced via the seed pathway, MNSV could establish and spread in Australia. This virus has established in areas with a wide range of climatic conditions, including the Americas, Europe, and Asia (Herrera-Vásquez et al. 2009). Additionally, this virus is likely to be transmitted by its soil-borne fungal vector <i>Olpidium bornovanus</i> (Mochizuki & Ohki 2015; Tomlinson & Thomas 1986), which is present in	Yes: This virus is a serious pathogen causing fruit deformation and reduction in fruit quality (Herrera-Vásquez et al. 2009). Additionally, it may cause wilting and plant death (Herrera-Vásquez et al. 2009; Herrera, Cebrián & Jordá 2006; Lecoq & Desbiez 2012). Therefore, MNSV is considered a threat to Australia's fresh vegetable market and the Cucurbitaceous seed industry.	Yes

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Melon rugose mosaic virus</i> (MRMV) [Tymoviridae: Tymovirus]	<i>Citrullus</i> , <i>Cucumis</i>	Not known to occur	Yes: Seeds provide a pathway for this virus, which has been reported as seed-borne in <i>Citrullus lanatus</i> , <i>Cucumis melo</i> var. <i>flexuosus</i> and <i>Cucumis melo</i> (Mahgoub et al. 1997; Sastry 2013). This virus has also been reported naturally occurring on other <i>Citrullus</i> and <i>Cucumis</i> species, causing severe mosaic and leaf deformations (Mahgoub et al. 1997).	Australia (Plant Health Australia 2019b). Yes: If introduced via the seed pathway, MRMV could establish and spread in Australia. This virus has established in Sudan and Yemen (Mahgoub et al. 1997).	No: This virus causes yellowing, mosaic and leaf deformation (Mahgoub et al. 1997). To date there is no evidence of economic consequences associated with this virus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Melon vein-banding mosaic virus</i> (MVbMV) [Potyviridae: Potyvirus]	<i>Cucumis</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Cucumis</i> species, causing mosaic or vein-banding symptoms (Brunt et al. 1996; Huang, Chang & Tsai 1993). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Melon yellow spot virus</i> (MYSV) [Tospoviridae: Orthotospovirus]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Momordica</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Momordica</i> species, causing necrotic spots, yellowing, mosaic on leaves and stunting (Chao et al. 2010; Peng et al.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Melon yellowing-associated virus</i> (MYaV) [Betaflexiviridae: Carlavirus]	<i>Cucumis</i>	Not known to occur	2011; Quito-Avila et al. 2014; Takeuchi et al. 2001). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus. No: This virus has been reported naturally occurring on <i>Cucumis melo</i> , causing 'yellowing of melon plants' (Lima et al. 2009; Nagata et al. 2010). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Moroccan watermelon mosaic virus</i> (MWMV) [Potyviridae: Potyvirus]	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Momordica</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> and <i>Momordica</i> species, causing severe leaf and fruit deformation and necrosis (Lecoq et al. 2001; Malandraki et al. 2014). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Muskmelon vein necrosis virus</i> (MuVNV) [Betaflexiviridae: Carlavirus]	<i>Cucumis</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Cucumis</i> species (Brunt et al. 1996). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Ourmia melon virus</i> (OuMV) [Ourmiavirus] (synonym: <i>Melon ourmia virus</i>)	<i>Cucumis</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Cucumis</i> species (Brunt et al. 1996). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Papaya ringspot virus</i> type P (PRSV-P) [Potyviridae: Potyvirus]	<i>Cucurbita</i> , <i>Momordica</i>	Yes (under official control) (QDAF 2019)	No: This virus has been reported naturally occurring on <i>Cucurbita</i> and <i>Momordica</i> species (Chin, Ahmad & Tennant 2007; Mansilla et al. 2013). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Papaya ringspot virus</i> type W (PRSV-W) [Potyviridae: Potyvirus] (synonym: <i>Watermelon mosaic virus</i> -1)	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> ,	Yes (Büchen-Osmond et al. 1988; Persley,	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
	<i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i>	Cooke & House 2010)				
<i>Pepper golden mosaic virus</i> (PepGMV) [Geminiviridae: Begomovirus]	<i>Cucurbita</i> , <i>Sechium</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Cucurbita</i> and <i>Sechium</i> species (Castro et al. 2013). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Pepper leaf curl Bangladesh virus</i> (PepLCBV) [Geminiviridae: Begomovirus]	<i>Momordica</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Momordica charantia</i> (Raj et al. 2010). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Pumpkin yellow vein mosaic virus</i> (PYVMV) [Geminiviridae: Begomovirus]	<i>Cucurbita</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Cucurbita</i> species, causing yellow vein mosaic (Muniyappa et al. 2003). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Snake melon asteroid mosaic virus</i> (SMAMV) [Unassigned: Sobemovirus]	<i>Cucumis</i>	Not known to occur	Yes: Seeds provide a pathway for this virus, which has been reported as seed-borne in <i>Cucumis melo</i> var. <i>flexuosus</i> (Lecoq et al. 2011). This virus has also been reported naturally occurring on other <i>Cucumis</i> species causing severe mosaic, stunting and leaf deformations (Lecoq et al. 2011).	Yes: If introduced via the seed pathway, SMAMV could establish and spread in Australia. This virus has established in Sudan and can be spread via infected seed (Lecoq et al. 2011).	No: To date there is no evidence of economic consequences associated with this virus. Therefore, it is not considered to pose risks of economic significance for Australia.	No
<i>Squash leaf curl China virus</i> (SqLCCNV) [Geminiviridae: Begomovirus]	<i>Benincasa</i> , <i>Cucurbita</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Benincasa</i> and <i>Cucurbita</i> species, causing severe systemic stunting and leaf curling (Zitter, Hopkins & Thomas 1996). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Squash leaf curl virus</i> (SqLCV) [Geminiviridae: Begomovirus] (synonym: <i>Melon leaf curl virus</i>)	<i>Benincasa</i> , <i>Cucurbita</i> , <i>Sechium</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Benincasa</i> , <i>Cucurbita</i> and <i>Sechium</i> species, causing upward leaf curling, crinkling, puckering and yellowing (Mohammed-Riyaz et al. 2013; Vargas-Salinas et al. 2019). To date there is no available	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Squash mild leaf curl virus</i> (SMLCV) [Geminiviridae: Begomovirus]	<i>Cucurbita</i> , <i>Sechium</i>	Not known to occur	evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus. No: This virus has been reported naturally occurring on <i>Cucurbita</i> and <i>Sechium</i> species (Castro et al. 2013). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Squash mosaic virus</i> (SqMV) [Comovirinae: Comovirus]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Yes (Büchen-Osmond et al. 1988; Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No
<i>Squash vein yellowing virus</i> (SqVYV) [Potyviridae: Ipomovirus]	<i>Citrullus</i> , <i>Cucurbita</i> , <i>Momordica</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucurbita</i> and <i>Momordica</i> species, causing plants to collapse and die as leaves and stems develop necrotic areas (Acevedo et al. 2013; Webb, Adkins & Reitz 2012). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Tobacco ringspot virus</i> (TRSV) [Secoviridae: Nepovirus]	<i>Cucumis</i>	Yes (Büchen-Osmond et al. 1988). Western Australia's <i>BAM Act 2007</i> prohibits this pest (Government of Western Australia 2019). However, confirmation of official control could not be provided.	are not considered to provide a pathway for this virus. Assessment not required	Assessment not required	Assessment not required	No
<i>Tomato black ring virus</i> (TBRV) [Secoviridae: Nepovirus] (synonyms: <i>Grapevine Joannes-Seyve virus</i>)	<i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	Yes: Seeds provide a pathway for this virus, which has been reported as seed-borne in <i>Cucumis sativus</i> (Gan et al. 2013). This virus has also been reported naturally occurring on <i>Cucumis</i> and <i>Cucurbita</i> species (Pospieszny & Borodynko 2005; Pospieszny, Jonczyk & Borodynko 2003).	Yes: If introduced via the seed pathway, TBRV could establish and spread in Australia. <i>Tomato black ring virus</i> is known to be vectored by the nematodes <i>Longidorus attenuatus</i> and <i>L. elongatus</i> (CABI 2019; Digiario, Elbeaino & Martelli 2017). However, there are no records of either species being present in Australia (Plant Health Australia 2013, 2019a). Spread of	Yes. <i>Tomato black ring virus</i> naturally infects a wide range of economically important crops including artichoke, bean, carrot, celery, cucumber, pea, potato, spinach and zucchini causing chlorotic spotting, mosaic symptoms, necrotic lesions, ring spots and deformed fruits (Mackesy & Sullivan 2016). TBRV has been shown to decrease grapevine (<i>Vitis vinifera</i>)	Yes

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Tomato leaf curl New Delhi virus</i> (ToLCNDV) [Geminiviridae: Begomovirus]	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Sechium</i>	Not known to occur	No. This virus has been reported naturally occurring on <i>Benincasa</i> <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> and <i>Sechium</i> species, causing severe yellowing and mosaic in young leaves, curling, vein swelling, short internodes, fruit skin roughness and longitudinal cracking (EPPO 2015; Ito et al. 2008; Mnari-Hattab et al. 2015; Phaneendra et al. 2012; Roy et al. 2013; Sohrab et al. 2013; Tahir & Haider 2005). Among these hosts, ToLCNDV has been recorded in <i>Sechium edule</i> seed (Sangeetha et al. 2018). However, <i>Sechium edule</i> is propagated by the entire fruit (Aung, Ball & Kushad 1990). Therefore, seeds are not considered to provide a pathway for this virus.	this virus from the seed pathway could also occur via pollen (Gibbs & Harrison 1964). Assessment not required	yields by 37%–60% (Laveau et al. 2019), raspberry (<i>Rubus</i> sp.) yields by 13.6% (Taylor, Chambers & Pattullo 1965) and artichoke (<i>Cynara scolymus</i>) head weights by 19% (Gallitelli et al. 2004). Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Tomato leaf curl Palampur virus</i> (ToLCPaV) [Geminiviridae: Begomovirus]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Momordica</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> and <i>Momordica</i> species, causing severe yellow leaf curl disease (Ali, Malik & Mansoor 2010; Heydarnejad et al. 2013; Shafiq et al. 2019). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Tomato ringspot virus</i> (ToRSV) [Secoviridae: Nepovirus]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> and <i>Cucurbita</i> species, causing yellow mosaic, reduced leaf size and proliferation of flower buds (Zitter, Hopkins & Thomas 1996). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Tomato spotted wilt virus</i> (ToSWV) [Tospoviridae: Orthotospovirus]	<i>Citrullus</i> , <i>Cucumis</i>	Yes (Jones et al. 2009; Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Watermelon bud necrosis virus</i> (WBNV) [Tospoviridae: Orthotospovirus]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i> , <i>Momordica</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i> and <i>Momordica</i> species, causing leaf crinkling, mottling and yellowing (Holkar et al. 2019; Mandal et al. 2003; Priyanka et al. 2019). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Watermelon chlorotic stunt virus</i> (WmCSV) [Geminiviridae: Begomovirus]	<i>Citrullus</i> , <i>Cucumis</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucumis</i> species, causing severe yellowing symptoms and dwarfing (Domínguez-Durán et al. 2018; Lecoq & Desbiez 2012; Samsatly et al. 2012). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Watermelon crinkle leaf-associated virus 1</i> (WCLaV-1) [Phenuiviridae: Incertae sedis]	<i>Citrullus</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus lanatus</i> (Xin et al. 2017). To date there is no available evidence suggesting	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Watermelon crinkle leaf-associated virus 2</i> (WCLaV-2) [Phenuiviridae: Incertae sedis]	<i>Citrullus</i>	Not known to occur	that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus. No: This virus has been reported naturally occurring on <i>Citrullus lanatus</i> (Xin et al. 2017). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Watermelon green mottle mosaic virus</i> (WGMMV) [Virgaviridae: Tobamovirus]	<i>Citrullus</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus lanatus</i> (Cheng et al. 2018). As a tobamovirus it is likely to be seed-borne, but at this time there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Watermelon leaf mottle virus</i> (WLMV) [Potyviridae: Potyvirus]	<i>Citrullus</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> species (de Sa, Hiebert & Purcifull 2000). To date there is no available evidence suggesting that this virus is seed-borne in this host. Therefore, seeds are not	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Watermelon mosaic virus</i> (WMV) [Potyviridae: Potyvirus] (synonym: <i>Watermelon mosaic virus – 2</i>)	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i>	Yes (Persley, Cooke & House 2010)	considered to provide a pathway for this virus. Assessment not required	Assessment not required	Assessment not required	No
<i>Watermelon silver mottle virus</i> (WSMoV) [Tospoviridae: Orthotospovirus]	<i>Citrullus</i> , <i>Cucumis</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> and <i>Cucumis</i> species, causing severe stunting, leaf crinkling, shortened internodes, silver mottle symptoms and yield loss (Rao et al. 2011). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Zucchini green mottle mosaic virus</i> (ZGMMV) [Virgaviridae: Tobamovirus]	<i>Citrullus</i> , <i>Cucurbita</i> , <i>Lagenaria</i>	Not known to occur	Yes: Seeds provide a pathway for this virus, which has been reported as seed-borne in <i>Citrullus lanatus</i> and <i>Cucurbita pepo</i> (Kwon et al. 2014). This virus has also been reported naturally occurring on <i>Lagenaria siceraria</i> , causing mottle and mosaic on leaves (Li et al. 2018).	Yes: If introduced via the seed pathway, ZGMMV could establish and spread in Australia. This virus has established in areas with a wide range of climatic conditions (Al-Dosary, Marraiki & Aref 2012; Ryu et al. 2000).	Yes: ZGMMV-infected plants show severe mosaic and abnormal fruit symptoms (Yoon et al. 2002), which results in unmarketable fruit. Therefore, ZGMMV has the potential for economic consequences in Australia.	Yes

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Zucchini lethal chlorosis virus</i> (ZLCV) [Tospoviridae: Orthotospovirus]	<i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i> , <i>Sechium</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Luffa</i> and <i>Sechium</i> species, causing yellowing, mottling and vein banding on foliage (Camelo-García, Lima & Rezende 2015; Ramos et al. 2018; Yuki et al. 2000). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Zucchini shoestring virus</i> (ZSSV) [Potyviridae: Potyvirus]	<i>Cucurbita</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Cucurbita</i> species (Ibaba, Laing & Gubba 2016). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Zucchini tigre mosaic virus</i> (ZTMV) [Potyviridae: Potyvirus]	<i>Cucumis</i> , <i>Cucurbita</i> , <i>Momordica</i>	Not known to occur	No: This virus has been reported naturally occurring on <i>Cucumis</i> , <i>Cucurbita</i> and <i>Momordica</i> species (Wang et al. 2019; Xiao et al. 2016). To date there is no available evidence suggesting that this virus is seed-borne in these hosts.	Assessment not required	Assessment not required	No

Scientific name (s)	Host genera	Present in Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Zucchini yellow fleck virus</i> (ZYFV) [Potyviridae: Potyvirus]	<i>Cucumis</i> , <i>Cucurbita</i>	Not known to occur	Therefore, seeds are not considered to provide a pathway for this virus. No: This virus has been reported naturally occurring on <i>Cucumis</i> and <i>Cucurbita</i> species (Tomassoli, Tiberini & Meneghini 2010; Vovlas, Hiebert & Russo 1981). To date there is no available evidence suggesting that this virus is seed-borne in these hosts. Therefore, seeds are not considered to provide a pathway for this virus.	Assessment not required	Assessment not required	No
<i>Zucchini yellow mosaic virus</i> (ZYMV) [Potyviridae: Potyvirus]	<i>Benincasa</i> , <i>Citrullus</i> , <i>Cucumis</i> , <i>Cucurbita</i> , <i>Lagenaria</i> , <i>Luffa</i> , <i>Momordica</i> , <i>Trichosanthes</i>	Yes (Persley, Cooke & House 2010)	Assessment not required	Assessment not required	Assessment not required	No

Appendix B: Issues raised on the draft review and responses

The Department of Agriculture, Water and the Environment circulated the 'Draft review of import conditions for cucurbitaceous crop seeds for sowing into Australia' in December 2017 for stakeholder consultation. A WTO SPS notification G/SPS/N/AUS/439 was also issued at this time.

Comments were received on the draft review from stakeholders, including from industry representatives, trading partners and state and territory governments. A summary of the key issues raised, and the department's responses, is provided.

Issue 1: Pathway association

Stakeholders suggested that further evidence was required to support assessments that *Kyuri green mottle mosaic virus* (KGMMV), *Zucchini green mottle mosaic virus* (ZGMMV) and *Diaporthe cucurbitae* (then *Phomopsis cucurbitae*) are seed-borne in cucurbitaceous hosts.

KGMMV

KGMMV is known to infect cucurbitaceous crops such as watermelon (*Citrullus lanatus*), melon (*Cucumis melo*), cucumber (*Cucumis sativus*), horned melon (*Cucumis melo*), zucchini (*Cucurbita pepo*) and angled loofah (*Luffa acutangula*) (Daryono et al. 2016; Daryono & Natsuaki 2012; Daryono, Somowiyarjo & Natsuaki 2003; Daryono, Somowiyarjo & Natsuaki 2005b; Daryono, Somowiyarjo & Natsuaki 2005a, 2006; Kim et al. 2009; Kwon et al. 2014; Lee et al. 2000; Tan et al. 2000; Yoon et al. 2001).

KGMMV was first reported from Japan (Inouye et al. 1967) and has since been detected in Korea (Lee et al. 2000) and Indonesia (Daryono, Somowiyarjo & Natsuaki 2003). KGMMV is reported to be transmitted via seeds of cucurbitaceous crops (Daryono, Somowiyarjo & Natsuaki 2006; Dombrovsky & Smith 2017; Kubota, Hagiwara & Shirakawa 2012; Kubota, Shirakawa & Nishi 2010). The virus is reported to be associated with the seed coat of cucurbitaceous seeds (Lecoq & Katis 2014; Loebenstein & Katis 2014).

Two references (Kwon et al. 2014; Lecoq & Katis 2014) were cited in the draft report in support of KGMMV being seed-borne in watermelon, zucchini and cucumber respectively. Loebenstein and Katis (2014) is also added to the final report in support of KGMMV being seed-borne in cucumber seeds.

Kwon et al. (2014) detected KGMMV in watermelon and zucchini seeds and performed analyses using dual priming oligonucleotide (DPO) multiplex and monoplex PCRs. It was suggested that the results presented by Kwon et al. (2014) were not reliable as the authors did not include positive and negative seed controls, and hence that cross contamination or cross reactivity could not be excluded. The department accepts that the results presented by Kwon et al. (2014) are reliable, based on the observation that the detected presence of viruses in seeds confirmed by monoplex PCR did not result in production of amplicons in all instances, providing an inherent negative control for all primer sets. Corresponding viruses were also transmitted from seed extracts via inoculation of healthy *Nicotiana benthamiana*.

It was also suggested that Lecoq and Katis (2014) did not provide conclusive evidence to support transmission of KGMMV in cucumber seeds as the authors presented no data or references to support the information presented.

Lecoq and Katis (2014) provided scientific support for the transmission of KGMMV in cucumber seeds. Loebenstein and Katis (2014) also stated that KGMMV is in the seed coat of cucumber seeds. Due to its similarities with CGMMV, many reports on seed transmission of CGMMV in cucumber may refer to KGMMV (Francki, Hu & Palukaitis 1986). Therefore, it is reasonable to conclude, based on available evidence, that KGMMV is transmitted in cucumber seeds.

Stakeholders cited Muthaiyan (2009), claiming that KGMMV is not seed transmitted. The department considers that the data presented in this publication is out-of-date. In the paper, both CGMMV and MNSV were listed as 'not seed-transmitted'. However, the seed-borne and seed transmissible nature of both CGMMV and MNSV have been proven and well documented. For example, CGMMV is accepted as seed-borne in *Citrullus lanatus*, *Cucumis sativus*, *Cucumis melo*, *Cucurbita maxima*, *Cucurbita maxima* × *Cucurbita moschata*, *Cucurbita moschata*, *Cucurbita pepo*, *Lagenaria siceraria* and *Trichosanthes cucumerina* (Australian Department of Agriculture and Water Resources 2017). Seed to seedling transmission of CGMMV has also been demonstrated in several host species (Broadbent 1976; Lecoq & Desbiez 2012; Liu et al. 2014; Rast & Stijger 1987; Reingold et al. 2016).

Based on available evidence, it is concluded that KGMMV is seed-borne and could enter Australia through infected cucumber, watermelon and zucchini seeds.

ZGMMV

ZGMMV is known to infect cucurbit crops, including watermelon (*Citrullus lanatus*), zucchini (*Cucurbita pepo*) and bottle gourd (*Lagenaria siceraria*) (Al-Dosary, Marraiki & Aref 2012; Kwon et al. 2014; Li et al. 2018; Ryu et al. 2000).

Two references (Kwon et al. 2014; Lecoq & Katis 2014) were cited in the draft report in support of ZGMMV being seed-borne in watermelon and zucchini. Choi (2001), Al-Dosary et al. (2012) and Loebenstein and Katis (2014) are also added to the final report in support of ZGMMV being seed-borne in zucchini seeds.

It was suggested that the PCR results for the detection of ZGMMV presented by Kwon et al. (2014) are not reliable as the authors did not include positive and negative controls, hence cross-contamination or cross-reactivity cannot be excluded. As explained previously for KGMMV, the department considers the results presented by Kwon et al. (2014) to be reliable.

It was also suggested that Lecoq and Katis (2014) do not provide conclusive evidence to support transmission of ZGMMV in zucchini seeds as the authors presented no data or references to support the claim. As explained for KGMMV, this paper provided support for the transmission of ZGMMV in zucchini seeds.

Choi (2001) and Al-Dosary et al. (2012) provide additional evidence for association of ZGMMV in zucchini seeds. Prior to its characterisation, ZGMMV was considered as a strain of CGMMV or KGMMV due to the symptoms it caused and its virus particle morphology (Ryu et al. 2000; Yoon et al. 2002). Due to its similarities with CGMMV and KGMMV, it is likely that some past reports on seed transmission of CGMMV or KGMMV in zucchini may refer to ZGMMV.

Based on the weight of evidence, it is concluded that ZGMMV is seed-borne and could enter Australia through infected watermelon and zucchini seeds.

It was also suggested that Al-Dosary et al. (2012) and Ryu et al. (2000) do not provide traceable evidence to prove that ZGMMV is seed-borne. It should be noted that these references were not used to support seed pathway association of ZGMMV in the draft report.

Diaporthe cucurbitae

Diaporthe cucurbitae (formally *Phomopsis cucurbitae*) naturally infects *Citrullus*, *Cucumis*, *Luffa* and *Cucurbita* spp., causing fruit rot (Bertetti et al. 2011; Dissanayake et al. 2017; Garibaldi et al. 2011; McKeen 1957; Udayanga et al. 2015; Udayanga et al. 2011).

It was suggested that Garibaldi et al. (2011) was inadequate evidence to determine whether seed is a pathway for transmission of *Diaporthe cucurbitae* in cantaloupe (*Cucumis melo*). Garibaldi et al. (2011) provided support for *Diaporthe cucurbitae* to be seed-borne in melon. North Carolina State University (2019) also stated that this pathogen can be seed-borne and seed transmissible in *Cucumis melo*. Furthermore, *Diaporthe cucurbitae* has gradually expanded its global distribution since its initial report in 1957. The first outbreak of this pathogen was reported from Canada in 1957 (McKeen 1957), and it was then reported in the USA (Beraha & O'Brien 1979; North Carolina State University 2019; Zhang, Bruton & Biles 1999), Japan (Ohsawa & Kobayashi 1989) and more recently in Italy (Bertetti et al. 2011; Garibaldi et al. 2011). Global movement via seed is the only credible explanation for its observed intercontinental movement.

The department has conducted further assessment of the literature, and considers that Dissanayake et al. (2017), Udayanga et al. (2015) and NCBI (2019) provide supporting evidence that *Diaporthe cucurbitae* is seed-borne within the genus *Cucumis*.

Based on the weight of evidence, it is concluded that *Diaporthe cucurbitae* is seed-borne and could enter Australia through infected seeds of *Cucumis sativus* and *Cucumis melo*.

Issue 2: Pest free areas (PFAs)

Recognition of PFAs

Stakeholders suggested that instead of mandatory testing or treatment of cucurbitaceous vegetable seeds, Australia should consider PFAs, and accept an alternative declaration on the Phytosanitary Certificate for the pathogens identified in the review.

The department acknowledges that under the current international phytosanitary framework, the establishment of and use of a PFA by the National Plant Protection Organisation (NPPO) provides assurance that specific pests are not present in the production area of the plant products being exported. This facilitates entry into the importing country (in this case Australia), for the commodity (in this case cucurbitaceous vegetable seeds), without the need for application of additional phytosanitary measures, when certain requirements are met.

Consistent with the principle of equivalence detailed in International Standard for Phytosanitary Measures (ISPM) 1 (FAO 2016a) and ISPM 11 (FAO 2016d), the department will consider a PFA proposed by an NPPO, provided that it can achieve the appropriate level of protection (ALOP) for Australia. ISPM 4 (FAO 2017b) states that a PFA is an area in which a specific pest does not occur, as demonstrated by scientific evidence and, where appropriate, this condition is officially maintained.

The distributions of seed-borne pathogens are expanding globally, and new risks continually emerge. The vegetable seeds trade has become globalised and is evolving—seed lines are usually developed, commercially multiplied and processed in various countries rather than at a single origin. Therefore, in accordance with ISPM 4, area freedom would need to be demonstrated and officially maintained for all countries involved in the production chain.

NPPOs that propose to use area freedom as a measure for managing risks posed by the quarantine pests identified in this review must provide the Department of Agriculture, Water and the Environment with an appropriate submission demonstrating area freedom for its consideration. Requirements for the NPPO to establish and maintain a PFA were outlined in Section 4.5.1 of the final review.

Risks associated with recognition of PFAs

Some stakeholders raised concerns about the introduction of PFAs as an alternative risk management measure and suggested that the use of a PFA by an NPPO poses a very high risk.

As a member of the World Trade Organization's (WTO) and a signatory to the SPS Agreement, Australia is obliged to set the least trade restrictive phytosanitary measures necessary to achieve its ALOP.

Equivalence is described as the basic principle No. 1.1 in ISPM 1: "Equivalence: Importing contracting parties should recognise alternative phytosanitary measures proposed by exporting contracting parties as equivalent when those measures are demonstrated to achieve the appropriate level of protection determined by the importing contracting party" (FAO 2016a). If the exporting country is able to demonstrate that its measures achieve the ALOP of the importing country, then members shall accept the SPS measures of the other member as equivalent.

Consistent with the principle of equivalence detailed in ISPM 1 (FAO 2016a) and ISPM 11 (FAO 2016d), the department will consider alternative measures such as PFAs proposed by an NPPO, providing it achieves the ALOP for Australia.

Issue 3: Regional pest status

Stakeholders suggested that *Ditylenchus dipsaci*, *Neofusicoccum ribis* and *Tobacco ringspot virus* (TRSV) are listed under the *Biosecurity and Agriculture Management (BAM) Act 2007*, and their entry into Western Australia is restricted or prohibited under Western Australia's legislation.

However, these pathogens are present in Australia, including in Western Australia (CABI 2019; EPPO 2019; Nobbs 2003b; Plant Health Australia 2019a; Stirling & Stanton 1997). To justify implementation of phytosanitary regulations within a defined area, the pathogens must be under 'official control' as defined in ISPM 5.

To meet the definition of 'official control', two major requirements need to be satisfied: active enforcement of mandatory phytosanitary regulations (official rules such as state/territory legislation) and the application of mandatory phytosanitary procedures (officially prescribed methods for implementing phytosanitary regulations) with the objective of pest eradication or containment. At a minimum, official control programs must demonstrate program evaluation and pest surveillance to determine the need for, and effect of, control.

The department was not provided with evidence that demonstrates controls are in place to prevent movement of host material of these pathogens, or to prevent the spread of these pathogens from known infested areas to other areas in the state. Consequently, these pathogens are not considered to be under 'official control' in Western Australia.

It was also suggested that *Acremonium strictum*, *Alternaria alternata* f.sp. *cucurbitae*, *Alternaria alternata* pv. *citri*, *Arabid mosaic virus*, *Chaetomium murorum*, *Cherry rasp leaf virus*

(CRLV), *Cladosporium cucumerinum*, *Cochliobolus nodulosus*, *Corynespora cassiicola*, *Curvularia tuberculata*, *Erwinia ananatis*, *Fusarium oxysporum* f. sp. *cucumerinum*, *Hop stunt viroid*, *Memnoniella echinata*, *Olpidium brassicae*, *Verticillium albo-atrum* and *Xanthomonas campestris* pv. *cucurbitae* are absent from Western Australia. It was suggested these pests should be considered further in the pest categorisation process to establish their quarantine pest status and, where appropriate, a risk assessment should be conducted.

In accordance with ISPM 11 (FAO 2019c), to assess the probability of entry, an association of the pest with the import pathway is required. In this case, the pathogens must be seed-borne in one or more of the cucurbitaceous vegetable species. However, the references provided by the stakeholder do not support the pathway association of these pathogens with seeds of cucurbitaceous vegetable species under review. Therefore, these pathogens are not considered further in the pest categorisation process.

Issue 4: Particular pathogens should be highlighted in the group risk assessment

Stakeholders have acknowledged that the group risk assessment approach is appropriate given the nature of the seed pathway. However, it has been suggested that where any particular pathogen differs from the group assessment this should be highlighted.

The draft review explained the rationale for group assessment (Section 3.1). Seeds for sowing are deliberately introduced, distributed and aided to establish. As a result, any pest that is associated with seed for sowing will consequently be aided in its entry, establishment and spread in Australia. Given the nature of the seed pathway, with respect to assessment of entry, establishment and spread, the department has largely taken a group risk assessment approach in the draft review.

In the preparation of this final report, the department has further reviewed this group risk assessment approach and included specific risk assessment sections for each pathogen group with common biological characteristics. Consequently, key factors that contribute to the likelihood of entry, establishment and spread have been highlighted in the risk assessment section. The department also included specific risk assessments for individual pathogen groups to strengthen the pest risk assessment of this report.

Issue 5: Likelihood of spread of identified quarantine pests

Stakeholders suggested that the likelihood of spread of the quarantine pests identified in the draft review be changed from 'Moderate' to 'High'.

The department has conducted the pest risk assessment for quarantine pests in accordance with the ISPMs, including ISPM 2: *Framework for pest risk analysis* (FAO 2019a) and ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2019c) that have been developed under the SPS Agreement (WTO 1995). Spread is defined as 'the expansion of the geographical distribution of a pest within an area' (FAO 2016b). Based on a comparison of factors relevant to the potential expansion of the geographic distribution of the pest in the source and destination areas, the likelihood of spread for the identified pests is assessed as 'Moderate'.

As explained in the draft review (Section 3.1.3), this assessment is based on the suitability of the natural and managed environments for natural spread, the ability of seed-borne pathogens to survive for long periods of time on seeds, the symptomless nature of some pathogens, and the known role of seed in the spread of pathogens globally.

Seeds for sowing are deliberately introduced, distributed and aided to establish. As a result, any pest that is associated with cucurbitaceous vegetable seeds for sowing will consequently be aided in its entry, establishment and spread in Australia. Because of the commonality of risks associated with seeds for sowing, the department has taken a group risk assessment approach to the seed pathway in terms of entry, establishment and spread. In accordance with ISPM 11 (FAO 2019c), to estimate the likelihood of spread of each pest, reliable biological information is obtained from areas where the pest currently occurs. The situation in the PRA area is then compared with that of the areas where the pest currently occurs and expert judgement used to assess the likelihood of spread. Although the likelihood of spread was collectively assessed, the key factors that may impact the potential spread of individual pest have been carefully considered.

Issue 6: Low confidence of detection of pathogens in small seed lots

Stakeholders have suggested that the testing of 20% of small seed lots is insufficient to detect the identified pathogens.

The department developed import conditions for small seed lots following consultation with industry stakeholders. If the small seed lots definition is met, the importer has the option to test a sample size of 20% per small seed lot or to test 9,400 seeds per small seed lot. The sample size of 20% is generally calculated by weight; however, it can be calculated from the number of seeds if the lot is very small.

The department acknowledges that when the seed lot size is small, testing of a 20% sample does not provide the same level of confidence of detection as for a large seed lot. In accordance with ISPM 31, 20% to 100% of the lot would need to be tested for a small seed lot, depending on how small the lot size is. As testing is a destructive sampling method, a large proportional sample size is clearly impractical to implement and would prevent trade of small seed lots. In addition, some small seed lots are imported for research and breeding purposes. They are normally high value, often planted in a well-contained environments, and have a limited distribution within Australia compared to commercial imports.

According to the SPS Agreement, governments should use measures which are no more trade restrictive than required to achieve its health protection objectives. It would be trade restrictive and impracticality of testing a very large proportion of each seed lot and the potential lower risk of introduction of pathogens associated some small seed lots. Therefore, the department at this stage accepts the lower confidence of detection of pathogens in small seed lots, but reserves the right to review this policy.

Issue 7: Efficacy of fungicidal seed treatment for *Diaporthe cucurbitae*

Stakeholders have sought clarification on the published scientific evidence used to justify the efficacy of the recommended fungicidal seed treatment for *Diaporthe cucurbitae* in cucurbitaceous vegetable seeds.

ISPM 38 (*International movement of seeds*) recommends that phytosanitary import requirements do not specify chemical products, active ingredients or exact protocols (FAO 2017a). Therefore, consistent with ISPM 38, the department did not prescribe the names of specific fungicides for seed treatment.

Many reports have indicated that most fungicide seed treatments are effective against *Diaporthe* species. Vegetable seeds are generally treated with a broad spectrum fungicide, such as Thiram or Carboxin-Thiram, or another product with equivalent chemical constituents.

Historically, Australia has been importing cucurbitaceous vegetable seeds treated with fungicide, and *Diaporthe cucurbitae* has not been reported in Australian cucurbitaceous vegetables. This empirical evidence supports an assessment that fungicidal treatment is effective in managing the risk posed by this fungal pathogen.

Issue 8: Loss of export markets due to unavailability of organic seed

Stakeholders suggested that a mandatory fungicidal treatment proposed in the draft report would greatly impact organic farmers who rely on imported organic seed. It was suggested that Australian organic farmers may lose export markets for fresh and processed organic vegetables because they would not be able to meet Organic Certification for exportation.

As advised by the Australian organics sector, the majority of seeds used by organic growers are conventionally produced, and follow the same import processes as for non-organic seeds. Therefore, the majority of imported seeds used by Australian organic growers may not be considered strictly organic, because seed produced conventionally is unlikely to meet Australia's National Standard for Organic and Bio-Dynamic Produce (NSOBP) (Department of Agriculture and Water Resources 2016b). It is also likely that these seeds may have been exposed to fungicides.

This review has identified a fungal pathogen (*Diaporthe cucurbitae*) of biosecurity concern that are associated with cucurbitaceous vegetable seeds for sowing. The economic consequences that would result from the introduction of these pathogens to Australia would impact both the organic and non-organic production sectors. Therefore, the department proposed fungicidal seed treatment as an option to manage the risk of introducing fungal pathogens of biosecurity concern into Australia.

In addition to a fungicide treatment, alternative options are provided in this report for both organic and non-organic production sectors that achieve the appropriate level of protection for Australia (Section 4.4). Supplementary details of the potential range of options considered by the department are provided in Appendix C.

Issue 9: Review of standard seeds for sowing conditions for larger cucurbit seed species

Stakeholders questioned the department's standard import conditions for the inspection of lots of seed for sowing. As ISTA methods of sampling and inspection are suited for seed lots of any size and for seeds of any size, stakeholders suggested that the department's standard seeds for sowing conditions for larger cucurbit seed species be reviewed.

The seed size and lot weight of 10kg is an operational policy decision that has been implemented for many years in Australia. As sending all seed consignments for formal ISTA sampling and inspection is not practical, the policy setting is designed to allow visual inspection of seed lots under 10kg—without the formal requirement for an ISTA sample and certification. The seed size is also taken into consideration—for example, it would be easy to distinguish potential weed seed from the main commodity seed if that seed is large in size.

As seed that is less than 8mm (and seed lots greater than 10kg) represent a higher contaminant risk for inspection staff, mandatory ISTA sampling of each consignment to establish freedom

from contamination is required by the department. Where the seed lot is less than 10kg, or contains seed greater than 8mm in diameter, a visual inspection upon arrival is considered appropriate.

Issue 10: Introduction of PCR testing for CGMMV

Stakeholders suggested that ELISA testing is not sufficiently sensitive for the detection of CGMMV as compared to PCR testing. In addition, stakeholders suggested a standard PCR protocol be developed for MNSV, KGMMV and ZGMMV.

In the draft review, the department proposed ELISA or a department approved PCR testing method to manage the risk of viral pathogens, including CGMMV, KGMMV, MNSV and ZGMMV. ELISA is one of the serological methods which has been used extensively as an assay to detect plant viruses within plant material, insect vectors, and seeds. Since implementation of the ELISA testing method using a sample size of 9,400 seeds for detection of CGMMV, no new detections of this virus linked to imported seeds have occurred in Australia. This evidence suggests that ELISA testing has been adequate in detecting CGMMV in seed lots imported into Australia.

The department acknowledges that PCR/RT-PCR is a more sensitive test than serological methods such as ELISA. The department also agrees with the stakeholders' suggestions that a standard PCR/RT-PCR protocol should be developed for MNSV, KGMMV and ZGMMV. The Department of Economic Development, Jobs, Transport and Resources Victoria (DEDJTR) state laboratory, an Australian Government approved diagnostic laboratory for testing imported seeds, has been developing standard PCR protocols for several seed-borne viruses including CGMMV, KGMMV, ZGMMV and MNSV. However, it is critical to verify and validate the PCR protocols to ensure consistent results are achieved in different laboratories. When sufficiently validated, PCR testing (on-shore or off-shore) can commence.

Appendix C: Consideration of potential risk mitigation options

Introduction

The department is undertaking a series of seed reviews of the import conditions for four key vegetable families: Apiaceae, Cucurbitaceae, Brassicaceae and Solanaceae. This review of cucurbitaceous vegetable seeds for sowing is the second in this series, following the release of the brassicaceous vegetable seeds report.

After the release of the 'Draft review of import conditions for cucurbitaceous crop seeds for sowing into Australia', the department considered a broad range of potential alternative measures to minimise impacts on the organic seeds sector and non-organic producers. The purpose of this section is to provide supplementary details of these potential options.

Australia recognises the principle of equivalence, namely, '*the situation where, for a specified pest risk, different phytosanitary measures achieve a contracting party's appropriate level of protection*' (FAO 2017c). ISPM 24 (FAO 2017d) provides the principles and requirements that apply for the determination and recognition of equivalence of phytosanitary measures.

There is a substantial distinction between an acceptable seed treatment for use in a primary production setting compared to that required to be efficacious as a phytosanitary measure. For example, a pest management objective may be to suppress or reduce pest prevalence in the field to achieve an economically acceptable pest impact threshold. However, this would be unlikely to be a measure that would achieve an appropriate level of protection (ALOP) for Australia.

Seed testing

Diagnostic protocols are described in ISPM 27 (*Diagnostic protocols for regulated pests*) and adopted protocols are provided as annexes to ISPM 27 (FAO 2016e). Australia accepts validated on-shore or off-shore test protocols.

The PCR test described by Kwon et al. (2014) is effective for the detection of CGMMV, KGMMV, ZGMMV and CFMMV, and PCR tests described by Manivannan et al. (2019) and Gan et al. (2013) are effective for the detection of BgYMV and TBRV respectively. Therefore, these tests are recommended in this final report (see Chapter 4).

In addition, the PCR test described by Ramiro et al. (2019) is recommended for the detection of *Diaporthe cucurbitae* on melon and cucumber seeds as an alternative to fungicide treatment (see Chapter 4).

Seed heat treatments

Heat treatments, including hot water treatment and dry heat treatment have been applied to various seeds to mitigate the risk of seed-borne pathogens (Bang et al. 2011; Godefroid et al. 2017; McGrath, Wyenandt & Holmstrom 2016; Nega et al. 2003; Schmitt et al. 2009; Toporek & Hudelson 2017).

Dry heat treatment (DHT)—DHT has been applied to various vegetable seeds (Bang et al. 2011; Godefroid et al. 2017; Kubota, Hagiwara & Shirakawa 2012; Schmitt et al. 2009; Spadaro, Herforth-Rahmé & van der Wolf 2017). Much of the cucurbit seed commercially produced in the Mediterranean region is heat treated (Lecoq & Desbiez 2012). DHT of vegetable seeds (spinach,

watermelon, cucumber, bottle gourd, lettuce, Chinese cabbage, carrot and tomato) is routinely used by seed companies in Japan (Nakamura 1982).

Heat transfer in air is less efficient than in water, and DHT treated seeds may require rehydration before sowing (Spadaro, Herforth-Rahmé & van der Wolf 2017). Long exposure periods or high temperatures are likely to be required in order to eliminate seed-borne pathogens, which may impact seed viability and vigour. Exposure periods at high temperatures (above 75°C) during DHT have also been shown to reduce seed viability and seedling vigour (Kubota, Hagiwara & Shirakawa 2012; Nakamura 1982; Shi et al. 2016).

Herrera-Vasquez et al. (2009) found that heat treatment at 70°C for 144h can be used to eradicate MNSV in melon seeds, without significant impact on seed germination. Therefore, DHT is recommended as a measure to reduce the risk of MNSV in this final report (see Chapter 4).

There is no known scientific evidence that DHT is efficacious for the eradication of other quarantine pests associated with cucurbitaceous seeds in this review. Therefore, DHT is not recommended for other quarantine pests.

Hot water treatment (HWT)—HWT is effective against seed contaminating pests which penetrate the seed coat, but less effective against embryo-borne pathogens (Godefroid et al. 2017; McGrath, Wyenandt & Holmstrom 2016; Toporek & Hudelson 2017). Precise control of the intensity and duration of the treatment is required. Seed lots can differ in sensitivity to HWT, depending on the cultivar, maturity of the seed, water content, or the seed storage period, even those of the same cultivar (Miller & Lewis Ivey 2018; Spadaro, Herforth-Rahmé & van der Wolf 2017; Toporek & Hudelson 2017).

HWT also has some practical constraints, including the requirements for treating and re-drying large seed volumes (Borgen 2004) and has potential to impact germination and post-treatment maturation (Borgen 2004; McGrath, Wyenandt & Holmstrom 2016; Nega et al. 2003). However, this may provide a viable option in some circumstances.

There is no known scientific evidence that HWT is efficacious for the eradication of any quarantine pests associated with cucurbitaceous seeds in this review. Therefore, HWT is not recommended.

Other potential seed treatments

The department considered a broad range of potential alternative measures to minimise impacts on the organic seeds sector and non-organic producers. However, none of these were supported with efficacy data appropriate for phytosanitary measures.

Bleach or organic acids—Seed disinfectants have been used to manage some seed-borne infections or contamination of spores and other forms of disease organism on seeds. Disinfection may take place during various steps of seed production process (Mancini & Romanazzi 2014). Seed disinfection with sodium hypochlorite (bleach) is used in both conventional and organic agricultural production.

Bleach may be effective against some saprophytic fungi but is not generally effective in eliminating potentially internal seed-borne pathogens such as *Fusarium* spp. (Garibaldi et al.

2004; Gracia-Garza et al. 1999; Menzies & Jarvis 1994), and may be phytotoxic and/or impact germination (Cantliffe & Watkins 1983; Moutia & Dookun 1999; Sauer & Burroughs 1986).

Other disinfectants, such as acetic acid (CH_3COOH), hydrochloric acid (HCl) and hydrogen peroxide (H_2O_2) have been used to reduce bacteria on cabbage seed without affecting seed germination (Groot et al. 2004; van der Wolf et al. 2008).

However, these disinfectants rarely eliminate all of the microorganisms present, and there is no efficacy data to support the use of these substances as seed disinfectants against the specific fungal pathogens identified in this report.

Gaseous treatments—Ozone and chlorine dioxide (ClO_2) gases are strong oxidizing agents, with a broad antimicrobial spectrum, therefore are used to decontaminate various fruits and vegetables, reduce produce decay and extend storage shelf life (Trinetta et al. 2011). To date, these gases have been used mostly to inactivate food-borne pathogens on fruits, vegetables, sprouts and seeds intended for direct consumption (Gómez-López et al. 2009; Jin & Lee 2007; Paylan et al. 2014; Sharma et al. 2002). However, information on the application of these gases to manage seed-borne pathogens is limited. Trinetta et al. (2011) reported that ozone and ClO_2 gas treatments were able to significantly reduce the pathogenic bacteria contamination of tomato and lettuce seeds, but not eliminate the bacteria. However, there is no efficacy data to support the use of these gas treatments against the specific fungal pathogens identified in this report.

Biopesticides—Specific biopesticides including lecithin, copper (in various forms), lime, sulphur, calcium hydroxide and phosphates have been used to control a range of plant pathogens (EEC 1991). However, their application as seed treatments are rare (Spadaro, Herforth-Rahmé & van der Wolf 2017). In addition, there is no efficacy data to support the use of biopesticides against the specific fungal pathogens identified in this report.

Biocontrol agents—Several microbial formulations are commercially available for the control of seed-borne pathogens, which include strains of *Bacillus subtilis* (Kodiak), *Streptomyces grieseoviridis* (Mycostop), *S. lydicus* (Actinovate), *Gliocladium virens* (SoilGard) and *Trichoderma harzianum* (T-22 Planter Box) (Gatch 2016). For example, *B. subtilis* (Kodiak, Companion), has been used for many years to suppress plant pathogens with varying degrees of success (Araújo, Henning & Hungria 2005; Asaka & Shoda 1996; Turner & Backman 1991; Utkhede & Rahe 1983). Efficacy data on these formulations is limited and inconsistent (Gatch 2016). In addition, seed treatments with biocontrol agents have been shown to be less effective and the protection effect is often inconsistent in comparison to those achieved with chemical treatments (Gullino, Gilardi & Garibaldi 2014). It is considered that there is insufficient data to support the use of biocontrol agents against the specific fungal pathogens identified in this report.

Essential oils—Thyme oil has commonly been tested for its ability to control seed-borne pathogens of several crops (Groot et al. 2004; Schmitt et al. 2009; Tinivella et al. 2009; van der Wolf et al. 2008). Thyme oil contains thymol and other antifungal compounds, which provide general antimicrobial activity against seed-borne pathogens. Van de Wolf et al. (2008) reported a significant reduction from 70% to less than 10% in seeds contaminated with two fungi. Batista de Lima et al. (2016) also reported that essential oils extracted from orange peel reduced the incidence of *Alternaria alternata* and *A. dauci* in carrot seeds. Similarly, Schmitt et al. (2009)

demonstrated a reduction in infection of *Phoma valerianellae*, but not its eradication from lamb's lettuce seeds. However, there is insufficient efficacy data to support the use of essential oils against the specific fungal pathogens identified in this report.

In-field visual inspection

In-field visual inspection of crops may be an appropriate phytosanitary measure to detect some pests where they produce characteristic visible symptoms during the production cycle. However, in most cases it is impossible to discern a specific pest on the basis of generic symptoms. For this reason, in-field visual inspection alone is not generally recommended as an appropriate phytosanitary measure for the detection of seed-borne pathogens.

Glossary

Term or abbreviation	Definition
Additional declaration	A statement that is required by an importing country to be entered on a phytosanitary certificate and which provides specific additional information on a consignment in relation to regulated pests (FAO 2019b).
Appropriate level of protection (ALOP)	The level of protection deemed appropriate by the Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory (WTO 1995).
Appropriate level of protection (ALOP) for Australia	The <i>Biosecurity Act 2015</i> defines the appropriate level of protection (or ALOP) for Australia as a high level of sanitary and phytosanitary protection aimed at reducing biosecurity risks to very low, but not to zero.
Area	An officially defined country, part of a country or all or parts of several countries (FAO 2019b).
Biosecurity	The prevention of the entry, establishment or spread of unwanted pests and infectious disease agents to protect human, animal or plant health or life, and the environment.
Biosecurity measures	The <i>Biosecurity Act 2015</i> defines biosecurity measures as measures to manage any of the following: biosecurity risk, the risk of contagion of a listed human disease, the risk of listed human diseases entering, emerging, establishing themselves or spreading in Australian territory, and biosecurity emergencies and human biosecurity emergencies.
Biosecurity import risk analysis (BIRA)	The <i>Biosecurity Act 2015</i> defines a BIRA as an evaluation of the level of biosecurity risk associated with particular goods, or a particular class of goods, that may be imported, or proposed to be imported, into Australian territory, including, if necessary, the identification of conditions that must be met to manage the level of biosecurity risk associated with the goods, or the class of goods, to a level that achieves the ALOP for Australia. The risk analysis process is regulated under legislation.
Biosecurity risk	The <i>Biosecurity Act 2015</i> refers to biosecurity risk as the likelihood of a disease or pest entering, establishing or spreading in Australian territory, and the potential for the disease or pest causing harm to human, animal or plant health, the environment, economic or community activities.
Consignment	A quantity of plants, plant products or other articles being moved from one country to another and covered, when required, by a single phytosanitary certificate (a consignment may be composed of one or more commodities or lots) (FAO 2019b).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO 2019b).
Endangered area	An area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss (FAO 2019b).
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO 2019b).
Equivalence (of phytosanitary terms)	The situation where, for a specified pest, different phytosanitary measures achieve a contracting party's appropriate level of protection (FAO 2019b).
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2019b).
Genus	A taxonomic category ranking below a family and above a species and generally consisting of a group of species exhibiting similar characteristics. In taxonomic nomenclature the genus name is used, either alone or followed by a Latin adjective or epithet, to form the name of a species.
Goods	The <i>Biosecurity Act 2015</i> defines goods as an animal, a plant (whether moveable or not), a sample or specimen of a disease agent, a pest, mail or any other article, substance or thing (including, but not limited to, any kind of moveable property).
Host	An organism that harbours a parasite, mutual partner, or commensal partner, typically providing nourishment and shelter.

Term or abbreviation	Definition
Host range	Species capable, under natural conditions, of sustaining a specific pest or other organism (FAO 2019b).
Import permit	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2019b).
Infection	The internal 'endophytic' colonisation of a plant, or plant organ, and is generally associated with the development of disease symptoms as the integrity of cells and/or biological processes are disrupted.
Infestation (of a commodity)	Presence in a commodity of a living pest of the plant or plant product concerned. Infestation includes infection (FAO 2019b).
Inspection	Official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (FAO 2019b).
Intended use	Declared purpose for which plants, plant products, or other regulated articles are imported, produced or used (FAO 2019b).
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment (FAO 2019b).
International Plant Protection Convention (IPPC)	The IPPC is an international plant health agreement, established in 1952, that aims to protect cultivated and wild plants by preventing the introduction and spread of pests. The IPPC provides an international framework for plant protection that includes developing International Standards for Phytosanitary Measures (ISPMs) for safeguarding plant resources.
International Standard for Phytosanitary Measures (ISPM)	An international standard adopted by the Conference of the Food and Agriculture Organization, the Interim Commission on Phytosanitary Measures or the Commission on Phytosanitary Measures, established under the IPPC (FAO 2019b).
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO 2019b).
Lot	A number of units of a single commodity, identified by its homogeneity of composition, origin etc., forming part of a consignment (FAO 2019b).
National Plant Protection Organization	Official service established by a government to discharge the functions specified by the IPPC (FAO 2019b).
Non-regulated risk analysis	Refers to the process for conducting a risk analysis that is not regulated under legislation (Department of Agriculture and Water Resources 2016a).
Official control	The active enforcement of mandatory phytosanitary regulations and the application of mandatory phytosanitary procedures with the objective of eradication or containment of quarantine pests or for the management of regulated non-quarantine pests (FAO 2019b).
Pathogen	A biological agent that can cause disease to its host.
Pathway	Any means that allows the entry or spread of a pest (FAO 2019b).
Pest	Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2019b).
Pest categorisation	The process for determining whether a pest has or has not the characteristics of a quarantine pest or those of a regulated non-quarantine pest (FAO 2019b).
Pest free area (PFA)	An area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained (FAO 2019b).
Pest free place of production	Place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period (FAO 2019b).
Pest free production site	A defined portion of a place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period and that is managed as a separate unit in the same way as a pest free place of production (FAO 2019b).

Term or abbreviation	Definition
Pest risk assessment (for quarantine pests)	Evaluation of the probability of the introduction and spread of a pest and of the magnitude of the associated potential economic consequences (FAO 2019b).
Pest risk assessment (for regulated non-quarantine pests)	Evaluation of the probability that a pest in plants for planting affects the intended use of those plants with an economically unacceptable impact (FAO 2019b).
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2019b).
Pest risk management (for regulated non-quarantine pests)	Evaluation and selection of options to reduce the risk that a pest in plants for planting causes an economically unacceptable impact on the intended use of those plants (FAO 2019b).
Pest status (in an area)	Presence or absence, at the present time, of a pest in an area, including where appropriate its distribution, as officially determined using expert judgement on the basis of current and historical pest records and other information (FAO 2019b).
Phytosanitary certificate	An official paper document or its official electronic equivalent, consistent with the model of certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (FAO 2019b).
Phytosanitary certification	Use of phytosanitary procedures leading to the issue of a phytosanitary certificate (FAO 2019b).
Phytosanitary measure	Phytosanitary relates to the health of plants. Any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO 2019b). In this risk analysis the term 'phytosanitary measure' and 'risk management measure' may be used interchangeably.
Phytosanitary procedure	Any official method for implementing phytosanitary measures including the performance of inspections, tests, surveillance or treatments in connection with regulated pests (FAO 2019b).
Phytosanitary regulation	Official rule to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests, including establishment of procedures for phytosanitary certification (FAO 2019b).
PRA area	Area in relation to which a pest risk analysis is conducted (FAO 2019b).
Quarantine	Official confinement of regulated articles for observation and research or for further inspection, testing or treatment (FAO 2019b).
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO 2019b).
Regional pest	A pest of quarantine concern for a specified area, such as Western Australia.
Regulated article	Any plant, plant product, storage place, packaging, conveyance, container, soil and any other organism, object or material capable of harbouring or spreading pests, deemed to require phytosanitary measures, particularly where international transportation is involved (FAO 2019b).
Regulated non-quarantine pest	A non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party (FAO 2019b).
Restricted risk	Restricted risk is the risk estimate when risk management measures are applied.
Risk analysis	Refers to the technical or scientific process for assessing the level of biosecurity risk associated with the goods, or the class of goods, and if necessary, the identification of conditions that must be met to manage the level of biosecurity risk associated with the goods, or class of goods to a level that achieves the ALOP for Australia.
Risk management measure	Conditions that must be met to manage the level of biosecurity risk associated with the goods or the class of goods, to a level that achieves the ALOP for Australia. In this risk analysis, the term 'risk management measure' and 'phytosanitary measure' may be used interchangeably.

Term or abbreviation	Definition
Soil	The loose surface material of the earth in which plants grow, in most cases consisting of disintegrated rock with an admixture of organic material (NAPPO 2003).
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO 2019b).
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures.
Stakeholders	Government agencies, individuals, community or industry groups or organizations, whether in Australia or overseas, including the proponent/applicant for a specific proposal, who have an interest in the policy issues.
Surveillance	An official process which collects and records data on pest occurrence or absence by surveying, monitoring or other procedures (FAO 2019b).
Systems approach(es)	The integration of different risk management measures, at least two of which act independently, and which cumulatively achieve the appropriate level of protection against regulated pests.
Trash	Soil, splinters, twigs, leaves and other plant material, other than fruit as defined in the scope of this risk analysis. For example, stem and leaf material, seeds, soil, animal matter/parts or other extraneous material.
Treatment	Official procedure for the killing, inactivation or removal of pests, or for rendering pests infertile or for devitalisation (FAO 2019b).
Unrestricted risk	Unrestricted risk estimates apply in the absence of risk management measures.
Vector	An organism that does not cause disease itself, but which causes infection by conveying pathogens from one host to another.
Viable	Alive, able to germinate or capable of growth.

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