Ministry for Primary Industries
Manatū Ahu Matua

Risk Management Proposal:

Proposed Amendments to the Specific Requirements for *Cannabis sativa*, *Capsicum*, *Chrysanthemum coronarium*, *Petunia*, *Phaseolus*, *Pisum*, *Solanum lycopersicum* and *Vicia* in Import Health Standard Seeds for Sowing (155.02.05)

Prepared for public consultation
by Plant Germplasm Imports
Animal and Plant Health Directorate

April 2021

New Zealand Government

Disclaimer

While every effort has been made to ensure the information in this publication is accurate, the Ministry for Primary Industries does not accept any responsibility or liability for error of fact, omission, interpretation or opinion that may be present, nor for the consequences of any decisions based on this information.

This publication is also available on the Ministry for Primary Industries website at http://www.mpi.govt.nz/news-and-resources/publications/

Contents

Submissions

The Ministry for Primary Industries (MPI) invites comment from interested parties on proposed amendments to the Import Health Standard 155.02.05: *Seeds for Sowing* (the Standard).

An import health standard (IHS) "specifies requirements to be met for the effective management of risks associated with importing risk goods" (section 22 Biosecurity Act 1993).

MPI is seeking comment on the following proposed changes to the Standard:

- Removal of ELISA as a testing method for *Tomato brown rugose fruit virus* on *Capsicum* sp. and *Solanum lycopersicum* seeds for sowing from all countries.
- Removal of Hemp streak virus and Hemp mosaic virus from the pest list for *Cannabis sativa*, and removal of measures for these pests on *Cannabis sativa* seeds for sowing from all countries.
- Removal of *Artichoke yellow ringspot virus* from the pest list for *Phaseolus* sp., and removal of measures for this pest on *Phaseolus* sp. seeds for sowing from all countries.
- Removal of *Pea enation mosaic virus* from the pest lists for *Pisum* sp. and *Vicia* sp., and removal of measures for this pest on *Pisum* sp. and *Vicia* sp. seed for sowing from all countries.
- Removal of *Peanut stunt virus* from the pest lists for *Phaseolus* sp. and *Vicia* sp., and removal of measures for this pest on *Phaseolus* sp. and *Vicia* sp. seeds for sowing from all countries.
- Addition of requirements for *Potato spindle tuber viroid* (PSTVd) on *Glebionis coronaria* (synonym *Chrysanthemum coronarium*) and *Petunia* sp. seeds for sowing.

MPI encourages respondents to forward comments electronically. Please include the following in your submission:

- The title of the consultation document in the subject line of your email;
- Your name and title (if applicable);
- Your organisation's name (if applicable); and
- Your address.

Send submissions to plantimports@mpi.govt.nz.

However, should you wish to forward submissions in writing (hard copy), please send them to the following address to arrive by close of business on 21 May 2021:

Plant Germplasm Imports
Animal and Plant Health Directorate
Biosecurity New Zealand
Ministry for Primary Industries
PO Box 2526
Wellington 6140
New Zealand

Submissions received by the closure date will be considered during the development of the final standard. Submissions received after the closure date may be held on file for consideration when the issued standard is next revised/reviewed.

Official Information Act 1982

Please note that your submission is public information, and it is MPI policy to publish submissions and the review of submissions on the MPI website. Submissions may also be the subject of requests for information under the Official Information Act 1982 (OIA). The OIA specifies that information is to be made available to requesters unless there are sufficient grounds for withholding it, as set out in the OIA. Submitters may wish to indicate grounds for withholding specific information contained in their submission, such as information that is commercially sensitive or personal. Any decision to withhold information requested under the OIA is reviewable by the Ombudsman.

1 General information

1.1 Purpose

(1) The purpose of this document is to:

- Provide relevant background information about the Import Health Standard 155.02.05: *Seeds for Sowing* (the Standard);
- Outline a set of proposed changes to the testing requirements for *Tomato brown rugose fruit virus* on *Capsicum* spp. (capsicum) and *Solanum lycopersicum* (tomato) seeds for sowing required by the Standard;
- Outline a set of proposed changes to the regulated pest lists for *Cannabis sativa*, *Phaseolus*, *Pisum*, and *Vicia* seed listed in the Standard;
- Outline a set of proposed changes adding requirements for *Potato spindle tuber viroid* on *Chrysanthemum coronarium* and *Petunia* sp.;
- Provide the rationale for the proposed changes to the Standard; and
- Seek feedback on the proposed Standard.

(2) The subject of public consultation is the specific amendments proposed in the draft Standard. This risk management proposal supports the draft Standard and should be read in full, and in conjunction with the draft standard, to understand the rationale behind the proposed import requirements. The risk management proposal itself is not the subject of public consultation

1.2 Background

(3) The Standard was issued under section 22 of the Biosecurity Act (1993) and applies to seeds for sowing that are imported into New Zealand from foreign countries and territories.

1.3 Timing of consultation

(4) The proposed changes to the Standard were released for consultation on **20 April 2021** and will remain open for consultation until **21 May 2021**.

1.4 General context of consultation

1.4.1 International regulation of risk goods

(5) The World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures (the SPS Agreement) sets in place rules that protect each country's sovereign right to take the measures necessary to protect the life or health of its people, animals, and plants, while at the same time facilitating trade. It embodies and promotes the use of science-based risk assessments to manage the risks associated with the international movement of goods. "The SPS Agreement guides how New Zealand sets standards and makes decisions related to biosecurity. In particular, it is important to maintain the standards of transparency and scientific rigour required by the SPS Agreement and to make decisions as quickly as possible. This will encourage other countries to comply with the rules of the SPS Agreement and demonstrate that New Zealand's strict controls are justified to countries that challenge them." (MPI, 2009)

1.4.2 Domestic regulation of biosecurity risks associated with seeds for sowing

(6) The New Zealand biosecurity system is regulated through the Biosecurity Act 1993 (the Act). Section 22 of the Act describes an import health standard and requires all risk goods imported into New Zealand to be managed by an import health standard. MPI is the New Zealand government ministry responsible for maintaining biosecurity standards for the effective management of risks associated with the importation of risk goods into New Zealand (Part 3, Biosecurity Act 1993). MPI is committed to the principles of transparency and evidence-based technical justification for all phytosanitary measures, new and amended, imposed on importing pathways.

1.5 Background for proposed changes to testing requirements for *Tomato brown rugose fruit virus* on *Capsicum* sp. and *Solanum lycopersicum* seeds for sowing

(7) *Tomato brown rugose fruit virus* (TBRFV/ToBRFV)[1] (Tobamovirus: Virgaviridae) is a regulated quarantine pest of concern that is not known to be present in New Zealand (Official New Zealand Pest Register, 2020). TBRFV causes natural infection in its major hosts tomato (*Solanum lycopersicum*) and capsicum (*Capsicum annuum*) (EPPO, 2020 a). It is an unwanted organism, which, if introduced to New Zealand, could have unwanted impacts on New Zealand's tomato and capsicum industries.

(8) TBRFV can be associated with seeds. The virus is efficiently transmitted mechanically, but it has a low transmission rate from seed to seedling (1.8-2.8%) (Davino et al., 2020). TBRFV is highly stable and can persist in the environment for many years. The virus can cause 30-70% loss of tomato yield, reducing plant vigour and the length of the production period during which fruits are harvested, as well as fruit quality (EPPO, 2020 b).

(9) Seeds for sowing are considered a high-risk pathway for the introduction of TBRFV. The high potential risks associated with the introduction of TBRFV into a new area are attributed mainly to the virus's stability and high infectivity, through to mechanical transmission by workers, tools and equipment during handling of infected plants. TBRFV was first reported in 2014 from southern Israel. The virus further spread in Israel across the entire country within one year through human-assisted spread and local trade of infected seeds or seedlings. By 2020, TBRFV was reported to have spread to a number of countries including Germany, China, Turkey, Italy, the UK, Netherlands, Greece, Spain and France (Crop Protection Compendium, 2020).

(10) MPI implemented emergency measures for TBRFV on tomato and capsicum seeds for sowing in March 2019, as the likelihood of introduction on these pathways to cause unacceptable economic and social impacts to New Zealand was considered high. The following measures were required:

- Sourcing seeds from a 'pest-free area', free from TBRFV, or
- Sourcing seeds from a 'pest-free place of production', free from TBRFV, or
- Official testing for TBRFV on a representative sample of a minimum of 3,000 seeds drawn according to ISTA or AOSA methodology, using an NPPO-approved enzyme-linked immunosorbent assay (ELISA) testing method.

[1] Both TBRFV and ToBRFV are commonly used abbreviations for *Tomato brown rugose fruit virus*. This Risk Management Proposal uses the abbreviation TBRFV.

(11) At the time these measures were introduced, there was a validated ELISA test for TBRFV available for exporting national plant protection organisations (NPPOs) to use to test capsicum and tomato seeds for export to New Zealand. Polymerase chain reaction (PCR) assays for the virus were still being developed and validated at the time. Therefore, testing using ELISA was considered a feasible risk management measure for TBRFV.

(12) In 2020, MPI added to the Standard the option of testing tomato and capsicum seeds for TBRFV using an NPPO-approved PCR test, because sensitive and specific validated PCR assays for detecting and identifying TBRFV in seed samples had been developed.

(13) The ELISA testing option for TBRFV in the Standard is not currently considered to provide an appropriate level of protection from the virus. There is current awareness that PCR tests (RT-PCR and RT-qPCR[2]) are more sensitive and specific for detecting TBRFV than ELISA. Furthermore, the likelihood of entry of TBRFV on the capsicum and tomato seed import pathways is considered high. There were two post-border detections of TBRFV on capsicum and tomato seeds for sowing that were imported into New Zealand in 2020. The first post-border detection was on a capsicum seed lot destined for re-export. None of the contaminated seeds entered the New Zealand market, and all the seeds were destroyed. The second post-border detection was on a tomato seed lot that entered the New Zealand market. Seed samples from this lot tested positive for a low titre of virus. This incursion resulted in a joint MPI–GIA biosecurity response being undertaken to eliminate the virus, as entry of low levels of the virus were deemed a biosecurity risk for New Zealand.

(14) Following the TBRFV incursion and response, MPI proposed strengthening its phytosanitary import requirements for TBRFV on capsicum and tomato seeds for sowing. The post-border detections of the virus in 2020 indicate an increased likelihood of entry of the virus into New Zealand on commercial capsicum and tomato seed for sowing imports. Given the serious risk that TBRFV poses to New Zealand's capsicum and tomato industries, it is important that measures in the Standard provide a high level of assurance that seeds imported on these pathways are free from even low levels of the virus.

(15) MPI proposes strengthening its import requirements to manage biosecurity risk from TBRFV on the capsicum and tomato seeds for sowing import pathways by removing ELISA as a testing option and requiring that official testing of imported consignments is performed using an NPPO-approved PCR testing method.

1.6 Background for proposed changes to pest lists

(16) The International Standard for Phytosanitary Measures 38 (ISPM 38) is the international standard that covers the international movement of seeds and provides detailed guidance for the commodity class "seeds for planting" (known as "seeds for sowing" in the Standard). ISPM 38 was issued by the International Plant Protection

[2] Because TBRFV is an RNA-virus, a reverse transcription PCR assay is required to detect the virus. In this Risk Management Proposal, 'PCR' refers to a reverse transcription PCR assay for TBRFV. This can be undertaken as an endpoint reverse transcription PCR (RT-PCR) or as a real-time quantitative reverse-transcription PCR (RT-qPCR).

Convention (IPPC) to provide agreed guidelines and principles for countries to implement phytosanitary measures and procedures.

(17) New Zealand is a contracting party to IPPC, and supports coordinated, effective action to prevent and control the introduction and spread of pests of plants and plant products. In keeping with New Zealand's obligations under the SPS Agreement and the IPPC (International Plant Protection Convention), phytosanitary measures must be scientifically justified and only for regulated pests.

(18) With the adoption of ISPM 38 (IPPC, 2020) on the international movement of seeds for sowing, the national plant protection organisation (NPPO) of the Netherlands has begun reviewing the import requirements placed on seeds they export. The focus of their review was whether there is sufficient evidence of seed transmission for the organisms requiring import measures.

(19) Following their review, the NPPO of the Netherlands concluded that some of the regulated pests requiring measures in the Standard are not seedborne or seed-transmitted. For these pests, they have corresponded with MPI, providing technical information on host and pest transmission status and requesting that MPI provide the rationale for why the organism is regulated. They have also requested that the organisms be removed from the import requirements for seeds where evidence indicates regulation is not justified.

(20) MPI has considered the technical information in the letters from the Netherlands' NPPO, and additional scientific reports related to the pests, to assess whether the current import requirements for these organisms in the Standard are justified. After assessing this evidence, MPI considers that continued regulation of some of the pests identified by the NPPO of the Netherlands is unjustified and that the Standard should be amended to remove requirements for these organisms after public consultation.

(21) The requirements MPI is proposing to remove from the Standard relate to:

- Hemp streak virus and Hemp mosaic virus on *Cannabis sativa*
- *Artichoke yellow ringspot virus* (AYRSV) on *Phaseolus*
- *Pea enation mosaic virus* (PEMV) on *Pisum* and *Vicia*
- *Peanut stunt virus* (PSV) on *Phaseolus* and *Vicia*

1.7 Background for proposed requirements for *Potato spindle tuber viroid* (PSTVd) on *Chrysanthemum coronarium* and *Petunia* seed

(22) MPI risk assessment provided scientific and technical advice on potential seed transmissibility of PSTVd in several ornamental species. It was found that PSTVd is seed-transmitted and pollen-transmitted in *Petunia x hybrida* and seed-transmitted in *Glebionis coronaria* (the accepted name of the synonym *Chrysanthemum coronarium*).

(23) The risk associated with PSTVd on *Chrysanthemum coronarium* and *Petunia* is being considered here for the seeds for sowing pathway only, because the plants for planting pathway for these species already has measures in place to manage PSTVd. The

current phytosanitary measures in the seed IHS are insufficient to manage the risk of PSTVd. Currently *Chrysanthemum coronarium* must only comply with the basic requirements, and *Petunia* must comply with the basic requirements and the specific requirements of Part 2.58 *Petunia*.

(24) Due to the knowledge that PSTVd is seed-transmitted on *Chrysanthemum coronarium* and *Petunia*, and because the pathways are open and active, MPI considers that there is a lack of measures in place to manage the risk of introduction.

(25) PSTVd is the type member of the family Pospiviroidae. It is known to have an extremely high mutation rate. It has a wide host range asymptomatically (including *Chrysanthemum coronarium* and *Petunia*) and experimentally. Severe symptoms and large-scale outbreaks are mainly known to occur on *Capsicum annuum*, *Solanum lycopersicum* and *S. tuberosum*; all of which are important species for the New Zealand economy (see Table 1).

Table 1: FreshFacts 2019 report summary (Horticulture New Zealand, Plant & Food Research, 2019)

Species	Domestic (2018)	Exports (2019)
Capsicum annuum (capsicum)	NZ$25 million	NZ$20.6 million
Solanum lycopersicum (tomato)	$184.5 million	$14.5 million
Solanum tuberosum (potato)	$139 million	$129.4 million

(26) PSTVd is on the New Zealand Priority Plant Pests and Diseases list and is already managed on the Seeds for Sowing IHS under the special requirements for *Capsicum*, *Solanum* and *Solanum lycopersicum*..

1.8 Information sources

(27) The following information was used to assess the risk organisms related to the proposed changes, and the appropriate measures to manage their entry and establishment in New Zealand:

- The MPI Emerging Risks biosecurity risk monitoring system
- Technical advice in appendices 6.2, 6.3 and 6.4 of this RMP
- Relevant literature and database searches
- Technical information provided by the Netherlands' NPPO
- Stakeholder discussions prior to, and during, the development of this RMP

2 Proposed changes to the Standard

2.1 Proposed removal of ELISA as a testing option for *Tomato brown rugose fruit virus* on *Capsicum* sp. and *Solanum lycopersicum* seeds for sowing

(28) MPI proposes removing ELISA as a testing method for TBRFV from the Part 2: Specific requirements for *Capsicum* and *Solanum lycopersicum* in the Standard. Removing ELISA as a testing option will mean that capsicum and tomato seed consignments imported into New Zealand will need to be officially tested using an NPPO-approved PCR method (RT-PCR or RT-qPCR) and found free from TBRFV if they are not sourced from a 'pest-free area' or a 'pest-free place of production' free from TBRFV. The testing may be performed onshore or offshore on a representative sample of a minimum of 3,000 seeds officially drawn according to the ISTA or AOSA sampling methodology.

(29) The impact of the proposed changes to the Standard is illustrated in Appendix 6.1.

2.2 Proposed requirements for Hemp mosaic virus and Hemp streak virus on *Cannabis sativa*

(30) MPI proposes the following changes to the Standard:

- Remove "Hemp mosaic virus" and "Hemp streak virus" from the regulated pest list for *Cannabis sativa* seed for sowing.
- Remove the requirement for an additional declaration on phytosanitary certificates that *Cannabis sativa* seed for sowing has been sourced from a 'pest-free area' free from "Hemp mosaic virus" and "Hemp streak virus".
- Remove the requirement for an additional declaration on phytosanitary certificates that *Cannabis sativa* seed for sowing has been sourced from a 'pest-free place of production' free from "Hemp mosaic virus" and "Hemp streak virus".

(31) These proposed changes apply to *Cannabis sativa* seed for sowing imported from all countries.

(32) The impact of the proposed changes to the Standard is illustrated in Appendix 6.1.

2.3 Proposed requirements for *Artichoke yellow ringspot virus* on *Phaseolus*

(33) MPI proposes the following changes to the Standard:

- Remove *Artichoke yellow ringspot virus* from the regulated pest list for *Phaseolus* seed for sowing.
- Remove the requirement for an additional declaration on phytosanitary certificates that *Phaseolus* seed for sowing has been sourced from a 'pest-free area' free from *Artichoke yellow ringspot virus*.
- Remove the requirement for an additional declaration on phytosanitary certificates that *Phaseolus* seed for sowing has been sourced from a 'pest-free place of production' free from *Artichoke yellow ringspot virus*.

(34) These proposed changes apply to seed for sowing imported from all approved countries currently listed in the Standard.

(35) The impact of the proposed changes to the Standard is illustrated in Appendix 6.1.

2.4 Proposed requirements for *Pea enation mosaic virus* on *Pisum* and *Vicia*

(36) MPI proposes the following changes to the Standard:

- Remove *Pea enation mosaic virus* from the regulated pest lists for *Pisum* seed for sowing and *Vicia* seed for sowing.
- Remove the requirement for an additional declaration on phytosanitary certificates that *Pisum* seed for sowing has been sourced from a 'pest-free area' free from *Pea enation mosaic virus*.
- Remove the requirement for an additional declaration on phytosanitary certificates that *Pisum* seed for sowing has been sourced from a 'pest-free place of production' free from *Pea enation mosaic virus*.
- Remove the requirement for an additional declaration on phytosanitary certificates that *Vicia* seed for sowing has been sourced from a 'pest-free area' free from *Pea enation mosaic virus*.
- Remove the requirement for an additional declaration on phytosanitary certificates that *Vicia* seed for sowing has been sourced from a 'pest-free place of production' free from *Pea enation mosaic virus*.

(37) These proposed changes apply to seed for sowing imported from all approved countries currently listed in the Standard.

(38) The impact of the proposed changes to the Standard is illustrated in Appendix 6.1.

2.5 Proposed requirements for *Peanut stunt virus* on *Phaseolus* and *Vicia*

(39) MPI proposes the following changes to the Standard:

- Remove *Peanut stunt virus* from the regulated pest lists for *Phaseolus* seed for sowing and *Vicia* seed for sowing.
- Remove the requirement for an additional declaration on phytosanitary certificates that *Phaseolus* seed for sowing has been sourced from a 'pest-free area' free from *Peanut stunt virus*.
- Remove the requirement for an additional declaration on phytosanitary certificates that *Phaseolus* seed for sowing has been sourced from a 'pest-free place of production' free from *Peanut stunt virus*.
- Remove the requirement for an additional declaration on phytosanitary certificates that *Vicia* seed for sowing has been sourced from a 'pest-free area' free from *Peanut stunt virus*.
- Remove the requirement for an additional declaration on phytosanitary certificates that *Vicia* seed for sowing has been sourced from a 'pest-free place of production' free from *Peanut stunt virus*.

(40) These proposed changes apply to seed for sowing imported from all approved countries currently listed in the Standard.

(41) The impact of the proposed changes to the Standard is illustrated in Appendix 6.1.

2.6 Proposed requirements for *Potato spindle tuber viroid* on *Chrysanthemum coronarium* and *Petunia* sp.

(42) MPI proposes the following changes to the IHS:

- Add a *Glebionis* subpart in Part 2 specific requirements.
- Add *Glebionis coronaria* to the Plants Biosecurity Index with the seed for sowing import specification "see 155.02.05 under *Glebionis*" and the nursery stock import specification "L2 see 155.02.06 under *Chrysanthemum*".
- In the Plants Biosecurity index, change the entry for *Chrysanthemum coronarium* to show that it is a synonym of *Glebionis coronaria*, thereby giving *Chrysanthemum coronarium* a blank import specification and being subject to the import specification of the accepted name *Glebionis coronaria*.
- Add PSTVd to the pest lists for *Glebionis* and *Petunia* sp. seed for sowing.
- Add a requirement for *Glebionis* and *Petunia* sp. seed for sowing for a phytosanitary certificate with the following options for additional declarations:
  i. Produced in a pest free area free from *Potato spindle tuber viroid*.
  ii. Produced in a pest free place of production where parent plants have been tested according to an NPPO approved methodology and found free *Potato spindle tuber viroid*.
  iii. Officially tested, on a representative sample of a minimum of 3000 seeds officially drawn according to the ISTA or AOSA sampling methodology using an NPPO approved PCR testing method, and found to be free from *Potato spindle tuber viroid*.

(43) These proposed changes apply to seed for sowing imported from all approved countries listed in the Standard.

(44) The impact of the proposed changes to the Standard is illustrated in Appendix 6.1. There is also a proposed minor change to Part 2.58.2(1) for *Petunia*. This corrects the labelling of the subclauses to the letter "b" for option 2.

3 Rationale for the proposed changes to the Standard

(45) The following section outlines information that provides the reason for the proposed changes to measures in the Standard.

3.1 Removal of ELISA as a testing option for *Tomato brown rugose fruit virus* on *Capsicum* sp. and *Solanum lycopersicum* seeds for sowing

(46) ELISA is a less specific and less sensitive method than PCR for detection of TBRFV. The ELISA test for TBRFV has been found to cross-react with other tomato viruses, and the commercially available ELISA kits are not species-specific (Dombrovsky & Smith, 2017; EPPO, 2020 c). Several specific molecular tests have been described for the detection and identification of TBRFV, and development of new RT-PCR primers and validation of existing tests is in progress (EPPO, 2020 c).

(47) In general, analytical sensitivity of ELISA is lower than PCR. The sensitivity of RT-qPCR for detecting *Cucumber green mottle mosaic virus* (CGMMV), a cucurbit-infecting virus in the same *Tobamovirus* genus as TBRFV, was demonstrated to be 10,000 times more sensitive than double-antibody sandwich ELISA (Torre et al., 2019). Conventional RT-PCR methods were found to be 100 times more sensitive than ELISA.

(48) The current phytosanitary import regulations of a number of countries, including Australia, the European Union and Japan now require seed health testing for TBRFV to be performed using PCR and do not allow ELISA due to its lower sensitivity and specificity for detecting the virus compared to PCR.

(49) Onshore seed testing for TBRFV is performed by RT-qPCR using primers from the International Seed Federation's International Seed Health Initiative for Vegetable Crops (ISHI-veg) Protocol: *Detection of Infectious Tomato brown rugose fruit virus (TOBRFV) in Tomato and Pepper Seed*. Their test can detect the virus at low titres in imported tomato and capsicum seeds. The sensitivity and specificity of the test to allow detection of low levels of the virus ensures that an appropriate level of protection for New Zealand is achieved that reduces the likelihood of introduction of TBRFV into New Zealand to a very low level. It is necessary that the diagnostic testing for TBRFV performed on all seed lots imported into New Zealand, whether they are tested onshore or offshore, is sensitive and specific enough to detect the presence of low levels of the virus. Removal of ELISA as a testing option in the Standard will ensure that the level of protection achieved by offshore testing for TBRFV meets this requirement.

(50) The option to test capsicum and tomato seeds for TBRFV using ELISA was introduced in the Standard in March 2019 as an emergency measure to manage risk from TBRFV on these import pathways. The strength of the measure was calibrated on the level of perceived risk from TBRFV based on assessment of available scientific information about this pest available at the time. Since then, new information has become available about the biology and epidemiology of TBRFV as well as its rapidly expanding distribution to countries where it was previously not known to be present (Crop Protection Compendium datasheet, 2020). This indicates an increased

likelihood of entry of the virus into New Zealand, as tomato and capsicum seeds can be imported into New Zealand from all countries.

(51) In December 2020, a joint MPI–GIA biosecurity response was undertaken to contain and eradicate TBRFV that had entered New Zealand on an imported tomato seed lot that tested positive for the virus at a low titre. The decision to undertake the response was based on consideration that entry of even low levels of virus in the seeds had potential to establish and spread to cause unwanted impacts to New Zealand's capsicum and tomato industries.

(52) The likelihood of introduction of TBRFV to cause unwanted impacts for New Zealand's capsicum and tomato industries is non-negligible if multiple imports of seeds contaminated with TBRFV at levels below the limits of detection of ELISA testing occur. While a low level of virus may not immediately establish an infection, due to the virus' stability, there is potential for an environmental reservoir to build up, this could lead to future TBRFV outbreaks. Viral particles of tobamoviruses are extremely stable and infectivity is preserved in seeds for up to several years (Dombrovsky & Smith, 2017). TBRFV can survive in contaminated soils, crop debris and on implements for years. Contaminated soils, irrigation water and nutrient solutions are also potential sources of the virus (Crop Protection Compendium datasheet, 2020).

3.2 Non-viral nature of Hemp mosaic virus and Hemp streak virus on *Cannabis sativa*

(53) The proposed changes reflect the conclusion by MPI that there is insufficient scientific evidence to support measures for "Hemp mosaic virus" (HMV) and "Hemp streak virus" (HSV) on *Cannabis sativa* seed for sowing.

(54) This conclusion is based on a recent assessment of available scientific information (MPI, 2020). This assessment (see Appendix 0) found insufficient evidence to support the existence of "Hemp mosaic virus" and "Hemp streak virus" as causal agents for these similarly named diseases.

(55) The recent assessment by MPI was consistent with an earlier technical advice about growing season inspection for detection of HMV and HSV on *C. sativa* (MPI, 2018). That assessment by MPI recommended removing HMV and HSV from the list of pests regulated by the Standard, unless further evidence was found that these are actual biotic entities causing unwanted impacts.

(56) A further literature search using the terms " 'hemp mosaic' OR 'hemp streak' " and "cannabis" has now been conducted in CAB Abstracts and Google Scholar to check if there is any other causal agent that has been attributed to hemp mosaic or hemp streak disease since 2018.

(57) No study has identified the causal agent of hemp mosaic or hemp streak disease since 2018. As such, seed transmission of these diseases cannot be determined, as no causative agent has been confirmed for the diseases.

3.3 Host status of *Phaseolus* for *Artichoke yellow ringspot virus*

(58) The proposed changes reflect the conclusion by MPI that there is insufficient evidence to support measures for *Artichoke yellow ring spot virus* (AYRSV) on *Phaseolus* seed for sowing.

(59) This conclusion is based on an assessment of available scientific information (MPI, 2020).

(60) Technical assessment of evidence (see Appendix 0) found that natural host status could not be confirmed from the available evidence, although *Phaseolus* spp. have been reported as experimental hosts of AYRSV in some studies (Avgelis et al., 1992; Maliogka et al., 2006; Paylan et al., 2013; Rana et al., 1980).

(61) Literature searches using the terms "Artichoke yellow ring spot" and "Phaseolus" and "seed" did not provide evidence for seed transmission of AYRSV on *Phaseolus* spp.. Hence, in the absence of seed transmission, the virus is not a risk on the seed pathway.

3.4 Seed transmission of *Pea enation mosaic virus* on *Pisum* and *Vicia*

(62) The proposed changes reflect the conclusion by MPI that there is insufficient evidence to support measures for *Pea enation mosaic virus* (PEMV) on *Pisum* seed for sowing and *Vicia* seed for sowing.

(63) This conclusion is based on an assessment of available scientific information (MPI, 2019).

(64) The technical assessment by MPI (see Appendix 6.3) concluded:

- There is insufficient evidence to confirm that PEMV is seed-transmitted in *Pisum* sp. or *Vicia* sp., in agreement with the conclusion of the Netherlands' NPPO.
- There is evidence to suggest PEMV is seedborne in *Pisum* sp. and may also be seedborne in *Vicia* sp. However, no evidence was found PEMV is seed-transmitted in any host.
- Historical references cite that PEMV is seed-transmitted in *Pisum* sp. However, this observation has not been reproduced in recent literature.

(65) Literature searches using Google, Google Scholar and of CAB Abstracts did not provide evidence for seed transmission of PEMV in *Pisum* or *Vicia* spp.

3.5 Seed transmission of *Peanut stunt virus* on *Phaseolus* and *Vicia*

(66) The proposed changes reflect the conclusion by MPI that there is insufficient evidence to support measures for *Peanut stunt virus* (PSV) on *Phaseolus* seed for sowing and *Vicia* seed for sowing.

(67) This conclusion is based on an assessment of available scientific information (MPI, 2019).

(68) The technical assessment by MPI (see Appendix 6.3) concluded there is insufficient evidence to confirm that *Peanut stunt virus* is seed-transmitted on *Phaseolus* sp. or *Vicia* sp., in agreement with the conclusion of the Netherlands' NPPO.

(69) Literature searches using Google, Google Scholar and CAB Abstracts did not provide evidence to contradict older reports that indicated PSV is not seed-transmitted in *Phaseolus* nor did they provide evidence that it is seed-transmitted in *Vicia* spp.

3.6 Rationale for the proposed requirements for *Potato spindle tuber viroid* on *Chrysanthemum coronarium* and *Petunia* sp.

(70) There is risk associated with PSTVd entering New Zealand by the *Chrysanthemum coronarium* and *Petunia* seeds for sowing pathways, and specific requirements are needed for the following reasons:

- PSTVd has the potential to enter New Zealand on the *Chrysanthemum coronarium* and *Petunia* sp. seeds for sowing pathway.
  i) PSTVd is known to be seed-transmitted on both *Chrysanthemum coronarium* and *Petunia* sp.
  ii) PSTVd is globally widespread and is found in Africa, Asia, Australia, Central America, Europe and South America.
  iii) PSTVd is asymptomatic in both *Chrysanthemum coronarium* and *Petunia* sp., meaning that interception of the viroid without testing requirements is highly unlikely.
  iv) The *Chrysanthemum coronarium* and *Petunia* sp. seeds for sowing pathways are open and active.

- If entry occurred, spread and establishment of PSTVd is highly likely within New Zealand.
  i) PSTVd is not limited to insect vector transmission and is easily spread through mechanical transmission, pollen, distribution of seed and physical contact between healthy and diseased plants. This gives PSTVd the potential to infect symptomatic hosts of economic importance.
  ii) Asymptomatic host plants have the potential to serve as a reservoir for the disease.
  iii) Historic detections of PSTVd in New Zealand and PSTVd's wide global distribution suggest that climate will not be a limiting factor.

- If establishment and spread occurs, the likelihood of impact is high.
  i) Spread from asymptomatic hosts to symptomatic hosts has potential to cause undesirable economic impacts.
  ii) Severe symptoms and large-scale outbreaks of PSTVd are mainly known to occur on *Capsicum annuum*, *Solanum lycopersicum* and *S. tuberosum* with decreases in yield corresponding to increases in infection.

iii) Losses of yield in *Capsicum annuum*, *Solanum lycopersicum* and *S. tuberosum* could result in significant impact to their million-dollar industries (see table 1).

(71) It is worth noting that a concern that some may have is that the proposed changes concern managing a pest on seeds of a plant species, where those plant species themselves would be unlikely to be impacted. However, due to PSTVd being a high risk to the *Capsicum annuum*, *Solanum lycopersicum* and *S. tuberosum* industries, being managed on those pathways, and being easily spread between host species, management is necessary on *Chrysanthemum coronarium* and *Petunia* seeds for sowing.

(72) The measures for PSTVd are being proposed at a genus level for *Petunia* sp. as the evidence for seed transmission comes from a species within the genus *Petunia* (*Petunia x hybrida*). The level of reported seed transmission is also very high (81%), so the risk of other species within the genus having unreported seed transmission is of concern and measures are considered necessary for the entire genus.

(73) The measures for PSTVd are being proposed for the accepted name *Glebionis coronaria* and synonym *Chrysanthemum coronarium* because these are the only members of the genus *Glebionis* currently eligible for import. The evidence for seed transmission comes from a report on the accepted name *Glebionis coronaria*, with a 1.2% rate of seed transmission. Therefore, the high volumes of imported *Chrysanthemum coronarium* seed combined with the potential for PSTVd to build up an asymptomatic reservoir means even a low level of seed transmission is a concern for imports of this species.

(74) MPI proposes requiring pest-free places of production to be established and maintained based on parent plant testing according to an NPPO-approved methodology. This requirement aligns with the requirements for PSTVd on the *Chrysanthemum* sp. and *Petunia* sp. nursery stock pathways. The need for parent plant testing is a result of PSTVd being asymptomatic on these hosts, and growing season inspection being insufficient for detecting infection and establishing a pest-free place of production.

4 Feasibility of the proposed changes to the Standard

4.1 Proposed removal of ELISA as a testing option for *Tomato brown rugose fruit virus* on *Capsicum* sp. and *Solanum lycopersicum* seeds for sowing

(75) The proposed removal of ELISA as a testing option, thereby requiring 'official testing' of all capsicum and tomato seeds for sowing imported into New Zealand to be performed using an NPPO-approved PCR method, is feasible, as laid out below.

(76) Several specific molecular tests are now described for identifying TBRFV and are available for exporting NPPOs to use for testing capsicum and tomato seed lots to be exported to New Zealand if testing is done offshore (EPPO, 2020 c).

(77) The Standard does also offer the option for capsicum and tomato seeds to be tested for TBRFV onshore. MPI's Plant Health & Environment Laboratory is able to test imported capsicum and tomato seeds onshore for TBRFV using RT-qPCR. The indicative cost of RT-qPCR testing of a sample of 3,000 untreated seeds for TBRFV is NZ$1,020 (excl. GST). In the case of a positive RT-qPCR test, an additional sequencing charge of $100 to confirm virus identity would apply, bringing the cost to $1,120. On the other hand, the indicative cost of an ELISA assay is $650 (excl. GST). However, in the event of a positive ELISA result, confirmation of virus identity will require nucleic acid extraction, PCR and sequencing at an additional cost of $295 (excl. GST), bring the total cost to $945 (excl. GST). This is because the ELISA assay is generic for tobamoviruses, and molecular testing and sequencing would be required to confirm a TBRFV detection.

(78) Work on development and validation of RT-PCR tests is ongoing, which is expected to widen exporting NPPOs' access and ability to undertake RT-PCR testing for TBRFV on seeds exported to New Zealand in future. This includes work on an EPPO diagnostic protocol for TBRFV covering diagnosis of TBRFV on seed. An Euphresco project and activities within the H2020 Valitest Project (https://www.valitest.eu/) were also underway in 2020 to validate a number of RT-PCR and real-time RT-PCR tests for the detection and identification of TBRFV on seed. (EPPO, 2020 c).

(79) It is acknowledged that there may be shipments of capsicum and tomato seeds for sowing currently en route to New Zealand accompanied by phytosanitary certificates that certify official testing of the seeds for TBRFV using ELISA. To ease the compliance costs for these importers, a one-month implementation period is proposed before the new IHS measure comes into force.

(80) Requiring on-arrival PCR testing for TBRFV for these consignments instead of a one-month implementation period is not proposed, due to the additional testing costs that this would pose to importers. Furthermore, onshore RT-PCR testing will require testing a 3,000 seed sample from the consignment. This could potentially lead to destruction of a considerable proportion of the consignment, especially if small seed lots are being imported, incurring losses to the importer. Recognising that ELISA testing does provide a level of protection against TBRFV, a one-month implementation period is considered justified. This will allow importers to make the necessary arrangements with their overseas suppliers to ensure that the seeds are tested

offshore for TBRFV using an NPPO-approved PCR or alternatively are shipped to New Zealand to be tested onshore.

4.2 Proposed removal of measures for Hemp mosaic virus and Hemp streak virus on *Cannabis sativa* seed for sowing

(81) The proposed changes will align the requirements of the Standard with those requested by an exporting country. Those proposed changes would remove an existing requirement for an additional declaration to the phytosanitary certificate required by the Standard for imported seed consignments (see Appendix 6.3 for proposed changes to applied to the current IHS).

(82) The proposed changes apply to the requirements for *Cannabis sativa* seed for sowing only and do not affect measures required by the Standard for any other commodity.

(83) The proposed changes would not involve imposing new requirements for imported seed and do not affect other requirements of the Standard.

(84) The proposed changes will facilitate trade by removing a potential barrier to an offshore NPPO issuing a phytosanitary certificate for importation of *Cannabis sativa* seed for sowing into New Zealand.

(85) The proposed changes will not impose additional costs on New Zealand importers.

4.3 Proposed removal of measures for *Artichoke yellow ringspot virus* on *Phaseolus*

(86) The proposed changes will align the requirements of the Standard with those requested by an exporting country. Those proposed changes would remove an existing requirement for an additional declaration to the phytosanitary certificate required by the Standard for imported seed consignments (see Appendix 6.3 for proposed changes to applied to the current IHS).

(87) The proposed changes apply to the requirements for *Phaseolus* only and do not affect measures required by the Standard for other commodities[3].

(88) The proposed changes would not involve imposing new requirements for imported seed and do not affect other requirements of the Standard.

(89) The proposed changes will facilitate trade by removing a potential barrier to an offshore NPPO issuing a phytosanitary certificate for importation of *Phaseolus* seed for sowing into New Zealand.

(90) The proposed changes will not impose additional costs on New Zealand importers.

[3] The current Standard requires measures to manage risk from *Artichoke yellow ringspot virus* on *Vicia* seed for sowing.

4.4 Proposed removal of measures for *Pea enation mosaic virus* on *Pisum* and *Vicia*

(91) The proposed changes will align the requirements of the Standard with the requirements requested by an exporting country. Those proposed changes would remove an existing requirement for an additional declaration to the phytosanitary certificate required by the Standard for imported seed consignments (see Appendix 6.3 for proposed changes to applied to the current IHS).

(92) The current Standard requires measures to manage risk from *Pea enation mosaic virus* only for *Pisum* and *Vicia*.

(93) The proposed changes do not affect measures required by the Standard for other commodities.

(94) The proposed changes would not involve imposing new requirements for imported seed and do not affect other requirements of the Standard.

(95) The proposed changes will facilitate trade by removing a potential barrier to an offshore NPPO issuing a phytosanitary certificate for importation of *Pisum* seed for sowing into New Zealand.

(96) The proposed changes will not impose additional costs on New Zealand importers.

4.5 Proposed removal of measures for *Peanut stunt virus* on *Phaseolus* and *Vicia*

(97) The proposed changes will align the requirements of the Standard with those requested by an exporting country. Those proposed changes would remove an existing requirement for an additional declaration to the phytosanitary certificate required by the Standard for imported seed consignments (see Appendix 6.3 for proposed changes to applied to the current IHS).

(98) The proposed changes apply to the requirements for *Phaseolus* and *Vicia* only and do not affect measures required by the Standard for other commodities[4].

(99) The proposed changes would not involve imposing new requirements for imported seed and do not affect other requirements of the Standard.

(100) The proposed changes will facilitate trade by removing a potential barrier to an offshore NPPO issuing a phytosanitary certificate for importation of *Phaseolus* and *Vicia* seed for sowing into New Zealand.

(101) The proposed changes will not impose additional costs on New Zealand importers.

[4] The current Standard requires measures to manage risk from *Peanut stunt virus* on *Medicago* seed for sowing and *Pisum* seed for sowing.

4.6 Feasibility of the proposed requirements for *Potato spindle tuber viroid* on *Chrysanthemum coronarium* and *Petunia* sp.

(102) MPI proposes adding specific requirements for *Chrysanthemum coronarium* seeds, which currently only have to meet the basic conditions of the IHS. This means when importing *Chrysanthemum coronarium* seeds, a phytosanitary certificate will now be required which will incur an additional cost to importers.

(103) MPI proposes requiring another additional declaration on phytosanitary certificates for *Petunia* sp. seeds, which already require a phytosanitary certificate. There will be an additional cost for importers if testing is the option used to declare the consignment free from PSTVd.

(104) The proposed requirements are feasible, as they align with the established measures for PSTVd set out in the specific requirements for *Capsicum*, *Solanum*, and *Solanum lycopersicum*. While it is recognised that the proposed measures will incur an extra cost to importers, they will manage the risk of PSTVd on *Chrysanthemum coronarium* and *Petunia* sp. to an appropriate level of protection. Measures are deemed necessary to prevent the establishment in New Zealand of the high-priority pest PSTVd and the subsequent loss of yield to economically important symptomatic host species.

5 References

- Avgelis, A D; Katis, N; Grammatikaki, G (1992) Broad bean wrinkly seed caused by artichoke yellow ringspot nepovirus. *Annals of Applied Biology*, 121: 133–142.
- Crop Protection Compendium (2020) Tomato brown rugose fruit virus datasheet: https://www.cabi.org/cpc/datasheet/88757522 (Accessed 19/02/2020)
- Davino, S; Giovanni-Caruso, A; Bertacca, S; Barone, S; Panno, S (2020) *Tomato brown rugose fruit virus*: Seed transmission rate and efficacy of different seed disinfection treatments. *Plants*, 9(11): 1615.
- Dombrovsky A; Smith E (2017) Seed transmission of tobamoviruses: aspects of global disease distribution. In *Advances in Seed Biology* (INTECH, Vol. Chapter 12, pp. 233–260).
- EPPO (2020 a) *Tomato brown rugose fruit virus* datasheet. Tomato brown rugose fruit virus (TOBRFV)[Datasheet]| EPPO Global Database (Accessed 19/02/2020)
- EPPO (2020 b) *Tomato brown rugose fruit virus* – A threat to tomato and pepper. EPPO_poster_ToBRFV.pptx (live.com) (Accessed 19/02/2020)
- EPPO (2020 c) Pest Risk Analysis for *Tomato brown rugose fruit virus* https://pra.eppo.int/pra/e1e025c7-a704-46b8-90da-b26015bc6068 (Accessed 19/02/2020)
- Horticulture New Zealand, Plant & Food Research (2019). Fresh Facts 2019 edition, https://www.freshfacts.co.nz/files/freshfacts-2019.pdf
- IPPC (2020) International Standard for Phytosanitary Measures 38: International movement of seeds. https://www.ippc.int/static/media/files/publication/en/2017/05/ISPM_38_2017_En_2017-05-15.pdf
- Maliogka, V I; Dovas, C I; Lesemann D E; Winter, S; Katis, N I (2006) Molecular identification, reverse transcription-polymerase chain reaction detection, host reactions, and specific cytopathology of *Artichoke yellow ringspot virus* infecting onion crops. *Phytopathology*, 96: 622–629.
- MPI (2009) Balance in Trade. Ministry for Primary Industries, Wellington. [online reference. ISBN 978-0-478-33881-2]
- MPI (2019) Technical advice (17 Dec 2019), Plant Import Risk Assessment. Ministry for Primary Industries, Wellington.
- MPI (2020) Technical advice (21 April 2020), Plant Import Risk Assessment. Ministry for Primary Industries, Wellington.
- MPI (2020a) Scientific and technical advice on whether measures are required to manage the risk from *Potato spindle tuber viroid* (PSTVd) on seed for sowing of the ornamental species *Dahlia*, *Chrysanthemum* and *Diascia*, eligible to import under IHS 155.02.05: Seeds for Sowing.
- Official New Zealand Pest Register (2020) https://pierpestregister.mpi.govt.nz/PestsRegister/ImportCommodity/ (Accessed 10/02/2021)
- Paylan, C; Ergun, M; Erkan, S (2013) First report of *Artichoke yellow ringspot virus* in globe artichoke in Turkey. *Plant Disease*, 97(10): 1,388.1–1,388.1. http://dx.doi.org/10.1094/PDIS-04-13-0423-PDN
- Torre, C; Agüero, J; Gómez-Aix, C; Aranda, M A (2019) Comparison of DAS-ELISA and qRT-PCR for the detection of cucurbit viruses in seeds. *Annals of Applied Biology*, 176(2): 158–169. https://doi.org/10.1111/aab.12543

- Rana, G L; Gallitelli, D; Kyriakopoulou, P E; Russo, M; Martelli, G P (1980) Host range and properties of artichoke yellow ringspot virus. *Annals of Applied Biology*, 96(2): 177–185.

6 Appendices

6.1 Illustration of proposed changes applied to the Standard

Proposed changes applied to requirements for *Cannabis sativa* seed for sowing

2.13 *Cannabis sativa*

The following requirements only apply to species in the Plant Biosecurity Index listed under Import Specifications for Seed as "see 155.02.05 under *Cannabis sativa*".

Approved countries: All

Quarantine pests: Refer to pest list for *Cannabis sativa*

Import permit: Not Required

PEQ: Not required

Phytosanitary certificate: Required

Guidance
- Importers of *Cannabis sativa* must contact the Ministry of Health prior to importation for advice on licensing:
  Ministry of Health
  PO Box 5013
  Wellington
  Attention: Advisor, Controlled Drug Licensing
  Telephone: 04 496 2018

2.13.1 Approved treatments

(1) In lieu of pest free area or pest free place of production for *Pseudomonas syringae* pv. *cannabina* and *Xanthomonas campestris* pv. *cannabis*, the *Cannabis sativa* seeds must be treated using a hot water dip (for bacteria and parasitic weed) prior to shipment or on arrival in New Zealand;

a) hot water treatment must be conducted as per MPI Standard MPI-STD-ABTRT Approved Biosecurity Treatments.

(2) In lieu of pest free area for *Leptosphaeria woroninii, Septoria cannabis* and *Curvularia cymbopogonis*, the *Cannabis sativa* seeds must be treated with fungicide as per MPI Standard MPI-STD-ABTRT Approved Biosecurity Treatments.

2.13.2 Phytosanitary certificate - Additional declarations

(1) The exporting country NPPO must confirm any treatment(s) as required by the IHS in the disinfestation and/or disinfection treatment section.

(2) If satisfied that the pre-shipment activities have been undertaken, the exporting country NPPO must confirm this by providing the certifying statement as per Part 1.5.2 of this import health standard and also the following additional declaration (s) to the phytosanitary certificate:

a) "The *Cannabis sativa* seeds have been:

i) sourced from a 'pest free area' free from the named regulated bacteria (*Pseudomonas syringae* pv. *cannabina* and *Xanthomonas campestris* pv. *cannabis*)";

OR

ii) "sourced from a 'pest free place of production' free from the named regulated bacteria (*Pseudomonas syringae* pv. *cannabina* and *Xanthomonas campestris* pv. *cannabis*)";

OR

iii) "treated with hot water treatment in MPI approved treatments";

AND

b) "The *Cannabis sativa* seeds have been:

i) sourced from a 'pest free area' free from the named regulated fungi (*Leptosphaeria woroninii, Septoria cannabis* and *Curvularia cymbopogonis*)";

OR

ii) "treated with an approved fungicide combination in MPI approved treatments".

~~**AND**~~

~~b) "The *Cannabis sativa* seeds have been:~~

~~v) sourced from a 'pest free area' free from the named regulated viruses (*Hemp mosaic virus* and *Hemp streak virus*)";~~

~~**OR**~~

~~vii) "sourced from a 'pest free place of production' free from the named regulated viruses (*Hemp mosaic virus* and *Hemp streak virus*)".~~

Guidance

- The hot water treatment that would be carried out in New Zealand as an alternative to the same treatment prior to shipment, cannot be permitted as no MPI- approved facility is currently available in New Zealand.
- Refer section 1.11 Seeds of MPI Standard MPI-STD-ATBRT Approved Biosecurity Treatments

References:

- Hemp Diseases and Pests: Management and Biological Control. J. M. McPartland, R. C. Clarke and D. P. Watson 2000. CAB International.

Pest List for *Cannabis*

REGULATED PESTS (actionable)		
Insect		
	Pyrrhocoris apterus	fire bug
	Episyrphus balteatus	
	Ischiodon scutellaris	syrphid fly
	Metasyrphus latifasciatus	syrphid fly
	Sphaerophoria scripta	hover fly
	Syritta pipiens	hover fly
Mite		
	Aculops cannabicola	hemp russett mite
Fungus		
	Curvularia cymbopogonis	
	Leptosphaeria woroninii	
	Septoria cannabis	yellow leaf spot
Bacterium		
	Pseudomonas syringae pv. cannabina	
	Xanthomonas campestris pv. cannabis	
~~Virus~~		
	~~*Hemp mosaic virus*~~	
	~~*Hemp streak virus*~~	
Weed		
	Orobanche ramosa	branched broomrape

Proposed changes applied to requirements for *Capsicum* seeds for sowing

2.14 *Capsicum*

The following requirements only apply to species in the Plant Biosecurity Index listed under Import Specifications for Seed as "see 155.02.05 under *Capsicum*".

Approved countries: All countries

Quarantine pests: *Pepper chat fruit viroid; Potato spindle tuber viroid, Tomato brown rugose fruit virus, Tomato mottle mosaic virus*

Import permit: Not required

PEQ: Not required

Approved treatment: Not required

Phytosanitary certificate: Required

2.14.1 Phytosanitary certificate - Additional declaration

(1) If satisfied that the pre-shipment activities have been undertaken, the exporting country NPPO must confirm this by providing the certifying statement as per Part 1.5.2 of this import health standard and also the following additional declaration (s) to the phytosanitary certificate:

"The [*Capsicum annuum; C. baccatum; C. cardenasii; C. chinense; C. eximium; C. frutescens; C. microcarpum; C. pendulum; C. pubescens*] seeds for sowing have been

a) For *Potato spindle tuber viroid* (PSTVd):

i) sourced from (country name) where *Potato spindle tuber viroid* is not known to occur."

OR

ii) sourced from a 'pest free place of production', where parent plants were tested according to a NPPO approved methodology and found free from *Potato spindle tuber viroid*"

OR

iii) officially tested, on a representative sample of a minimum of 3000 seeds officially drawn according to the ISTA or AOSA sampling methodology using an approved PCR NPPO testing method, and found to be free from *Potato spindle tuber viroid*"

AND

b) For *Pepper chat fruit viroid* (PCFVd):

i) sourced from a 'pest free area' free from *Pepper chat fruit viroid*"

OR

ii) *Pepper chat fruit viroid* (PCFVd) is absent/not known to occur in _____(name of country)

OR

iii) sourced from a 'pest free place of production' free from *Pepper chat fruit viroid*"

OR

iv) officially tested, on a representative sample of a minimum of 3000 seeds officially drawn according to the ISTA or AOSA sampling methodology using an approved PCR NPPO testing method, and found to be free from *Pepper chat fruit viroid*"

AND

c) For *Tomato brown rugose fruit virus* (ToBRFV):

i) sourced from 'pest free area', free from *Tomato brown rugose fruit virus*".

OR

ii) ~~ii)~~ sourced from a 'pest free place of production' free from *Tomato brown rugose fruit virus*".

OR

iii) ~~iii)~~ officially tested, on a representative sample of a minimum of 3000 seeds officially drawn according to the ISTA or AOSA sampling methodology, using an ~~NPPO-approved ELISA or~~ NPPO-approved PCR testing method and found free from *Tomato brown rugose fruit virus*".

AND

d) For *Tomato mottle mosaic virus* (ToMMV):

i) sourced from a 'pest free area' free from *Tomato mottle mosaic virus*"

OR

ii) sourced from a 'pest free place of production' free from *Tomato mottle mosaic virus*"

OR

iii) officially tested, on a representative sample of a minimum of 3000 seeds officially drawn according to the ISTA or AOSA sampling methodology, using an NPPO-approved ELISA or NPPO-approved PCR testing method, and found free from *Tomato mottle mosaic virus*"

2.14.2 Testing requirements

(1) Testing is required to be completed offshore prior to export, or on arrival in New Zealand.

(2) Pre-export testing for each seed lot must be endorsed by the NPPO on the phytosanitary certificate, or if tested on arrival in New Zealand, must be completed by an MPI-approved testing laboratory.

(3) Testing on-shore will be performed using an MPI-approved testing method.

Guidance

- The ISHI-Veg local lesion bioassay for *Tomato brown rugose fruit virus* and *Tomato mottle mosaic virus* is not accepted as a valid test by MPI.
- Additional declarations on phytosanitary certificates to meet the offshore testing requirements for *Tomato brown rugose fruit virus* ~~and *Tomato mottle mosaic virus*~~ in Import Health Standard 155.02.05: *Seeds for sowing* should be based only on a negative result obtained in an ~~NPPO-approved ELISA or~~ NPPO-approved PCR test and not on results from a bioassay.
- Additional declarations on phytosanitary certificates to meet the offshore testing requirements for *Tomato mottle mosaic virus* in Import Health Standard 155.02.05: *Seeds for sowing* should be based only on a negative result obtained in an NPPO-approved ELISA or NPPO-approved PCR test and not on results from a bioassay.
- ~~Measures for *Columnea latent viroid*, *Tomato apical stunt viroid* and *Tomato planta macho viroid* will come into force on 22 August 2020.~~

- Removal of ELISA as a testing option for Tomato brown rugose fruit virus will come into force on xx 2021.

Proposed new schedule for *Glebionis* (including *Chrysanthemum coronarium*) seed for sowing

2.34 *Glebionis*

The following requirements only apply to species in the Plant Biosecurity Index listed under Import Specifications for Seed as "see 155.02.05 under *Glebionis*."

Approved countries: All countries

Quarantine pests: *Potato spindle tuber viroid*

Import permit: Not required

PEQ: Not required

Approved treatment: Not required

Phytosanitary certificate: Required

2.34.1 Phytosanitary certificate - Additional declarations

(1) If satisfied that the pre-shipment activities have been undertaken, the exporting country NPPO must confirm this by providing the certifying statement as per Part 1.5.2 of this import health standard and also the following additional declaration (s) to the phytosanitary certificate:

a) "The [insert species name] seeds have been:

i) produced in a 'pest free area' free from *Potato spindle tuber viroid*;

OR

ii) produced in a 'pest free place of production' where parent plants have been tested according to an NPPO approved methodology and found free from *Potato spindle tuber viroid*;

OR

iii) officially tested, on a representative sample of a minimum of 3000 seeds officially drawn according to the ISTA or AOSA sampling methodology using an NPPO approved PCR testing method, and found to be free from *Potato spindle tuber viroid*".

2.34.2 Testing requirements

(1) Testing is required to be completed offshore prior to export, or on arrival in New Zealand.

(2) Pre-export testing for each seed lot must be endorsed by the NPPO on the phytosanitary certificate, or if tested on arrival in New Zealand, must be completed by an MPI-approved testing laboratory.

(3) Testing on-shore will be performed using an MPI-approved testing method.

Proposed changes applied to requirements for *Petunia* seed for sowing

~~2.58~~2.59 *Petunia*

These requirements only apply to species in the Plant Biosecurity Index listed under Import Specifications for Seed as "see 155.02.05 under *Petunia*".

Approved countries: All

Quarantine pests: *Potato spindle tuber viroid*, *Tomato chlorotic dwarf viroid*

Import Permit: Permit not required, unless seeds are to be grown in PEQ.

PEQ: Not required, unless imported under options 2.2.2 or 2.2.3 of the MPI Protocol for Testing for the Presence of Genetically Modified Plant Material.

Approved treatment: Not required

Phytosanitary certificate: Required

~~2.58.1~~2.59.1 Phytosanitary requirements

(1) If satisfied that the pre-shipment activities have been undertaken, the exporting country NPPO must confirm this by providing the certifying statement as per Part 1.5.2 of this import health standard and also the following additional declaration(s) to the phytosanitary certificate:

a) "The [insert species name] seeds for sowing have been:

i) produced in a 'pest free area' free from *Potato spindle tuber viroid;*

OR

ii) produced in a 'pest free place of production', where parent plants have been tested according to a NPPO approved methodology and found free from *Potato spindle tuber viroid;*

OR

iii) officially tested, on a representative sample of a minimum of 3000 seeds officially drawn according to the ISTA or AOSA sampling methodology using a NPPO approved PCR testing method, and found to be free from *Potato spindle tuber viroid*".

~~a)~~b) "The [insert species name] seeds for sowing have been:

~~i)~~i) produced in a 'pest free area' free from *Tomato chlorotic dwarf viroid;*

OR

~~i)~~ii) produced in a 'pest free place of production', where parent plants have been tested according to a NPPO approved methodology and found free from *Tomato chlorotic dwarf viroid;*

OR

~~ii)~~iii) officially tested, on a representative sample of a minimum of 3000 seeds officially drawn according to the ISTA or AOSA sampling methodology using a NPPO approved PCR testing method, and found to be free from *Tomato chlorotic dwarf viroid*".

(2) The full scientific name of the *Petunia* species and variety must be specified on the phytosanitary certificate.

~~2.58.2~~2.59.2 GM seed testing

(1) For all lots of *Petunia*, in addition to the phytosanitary requirements above, importers are required to comply with **one of** the two options listed below:

Option 1:

a) a declaration signed by the exporter and importer must accompany the consignment declaring that the consignment does not contain GM seeds (refer to Appendix 3: Declaration form).

Option 2:

~~a)~~b) samples from each lot must be representatively sampled, tested, and found to be free of unapproved GM seed according to the MPI Protocol for Testing for the Presence of Genetically Modified Plant Material (refer to Part 1.5.3: Genetically Modified Testing Certificate). Every lot tested must be specified on the testing certificate.

~~2.58.3~~2.59.3 Testing requirements

(1) Testing is required to be completed offshore prior to export, or on arrival in New Zealand.

(2) Pre-export testing for each seed lot must be endorsed by the NPPO on the phytosanitary certificate, or if tested on arrival in New Zealand, must be completed by an MPI-approved testing laboratory.

(3) Testing on-shore will be performed using an MPI-approved testing method.

Guidance

- The MPI Protocol for Testing for the Presence of Genetically Modified Plant Material can be found at http://www.mpi.govt.nz/document-vault/10250
- More information on genetically modified seeds can also be found at https://www.mpi.govt.nz/importing/plants/seeds-for-sowing/genetically-modified-seeds/
- Measures for *Tomato chlorotic dwarf viroid* will come into force on 22 August 2020.

Proposed changes applied to requirements for *Phaseolus* seed for sowing

~~2.59~~2.60 *Phaseolus*

The following requirements only apply to species in the Plant Biosecurity Index listed under Import Specifications for Seed as "see 155.02.05 under *Phaseolus*."

Approved countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, United Kingdom and United States of America.

Quarantine pests: Refer to "Pest List for Phaseolus".

Import permit: Not required

PEQ: Not required

Phytosanitary certificate: Required

~~2.59.1~~2.60.1 Approved treatments

(1) In lieu of pest free area for *Cochliobolus miyabeanus, Elsinoe phaseoli,* and *Phoma exigua* var. *diversispora* all *Phaseolus* seeds must be treated as per MPI Standard MPI-STD-ABTRT Approved Biosecurity Treatments.

~~2.59.2~~2.60.2 Phytosanitary certificate - Additional declarations

(1) The exporting country NPPO must confirm any treatment(s) as required by the IHS in the disinfestation and/or disinfection treatment section.

(2) If satisfied that the pre-shipment activities have been undertaken, the exporting country NPPO must confirm this by providing the certifying statement as per Part 1.5.2 of this import health standard and also the following additional declaration (s) to the phytosanitary certificate:

a) "The *Phaseolus* seeds have been:

i) sourced from a 'pest free area' free from the named regulated bacteria (*Curtobacterium flaccumfaciens pv. flaccumfaciens*) and viruses (~~*Artichoke yellow ringspot virus,*~~ *Bean common mosaic virus* [blackeye cowpea mosaic strain], *Broad bean mottle virus, Cowpea severe mosaic virus, Pea early-browning virus, Peanut mottle virus,* ~~*Peanut stunt virus,*~~ *Southern bean mosaic virus*);

OR

ii) sourced from a 'pest free place of production' free from the named regulated bacteria (*Curtobacterium flaccumfaciens* pv. *flaccumfaciens*) and viruses (~~*Artichoke yellow ringspot virus,*~~ *Bean common mosaic virus* [blackeye cowpea mosaic strain], *Broad bean mottle virus, Cowpea severe mosaic virus, Pea early-browning virus, Peanut mottle virus,* ~~*Peanut stunt virus,*~~ *Southern bean mosaic virus*)";

AND

b) "The *Phaseolus* seeds have been:

i) sourced from a 'pest free area' free from the named regulated fungi (*Cochliobolus miyabeanus, Elsinoe phaseoli, Phoma exigua* var. *diversispora*)";

OR

ii) "treated with one of the fungicide combinations in MPI approved treatments".

Guidance

- Refer section 1.11 Seeds of MPI Standard MPI-STD-ATBRT Approved Biosecurity Treatments

Pest list for *Phaseolus*

REGULATED PESTS (actionable)

Insect		
Insecta		
Coleoptera		
Bostrichidae		
	Prostephanus truncatus	larger grain borer
Bruchidae		
	Acanthoscelides argillaceus	bean weevil
	Acanthoscelides obvelatus	bruchid beetle
	Bruchidius atrolineatus	seed beetle
	Bruchidius incarnatus	seed beetle
	Bruchus pisorum	pea weevil
	Callosobruchus analis	cowpea weevil
	Callosobruchus maculatus	cowpea weevil
	Callosobruchus phaseoli	cowpea weevil
	Zabrotes subfasciatus	mexican bean weevil
Lepidoptera		
Pyralidae		
	Etiella grisea	pod borer
	Etiella grisea drososcia	pod borer
	Etiella zinckenella	limabean pod borer
Tortricidae		
	Cydia fabivora	pod moth
	Matsumuraeses phaseoli	adzuki pod worm
Fungus		
Ascomycota		
Dothideales		
Elsinoaceae		
	Elsinoe phaseoli	scab
Pleosporaceae		
	Cochliobolus miyabeanus (anamorph Bipolaris oryzae)	
	mitosporic fungi (Coelomycetes)	
Sphaeropsidales		
Sphaerioidaceae		
	Phoma exigua var. diversispora	ascochyta leaf spot
Bacterium		
Corynebacteriaceae		
	Curtobacterium flaccumfaciens pv. flaccumfaciens	bacterium wilt
Virus		
	~~*Artichoke yellow ringspot virus*~~	
	Bean common mosaic virus [blackeye cowpea mosaic strain]	

Broad bean mottle virus
Cowpea severe mosaic virus
Pea early-browning virus
Peanut mottle virus
~~*Peanut stunt virus*~~
Southern bean mosaic virus

Proposed changes applied to requirements for *Pisum* seed for sowing

~~2.62~~2.63 *Pisum*

The following requirements only apply to species in the Plant Biosecurity Index listed under Import Specifications for Seed as "see 155.02.05 under *Pisum*."

Approved countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, Taiwan, United Kingdom and United States of America.

Quarantine pests: Refer to "Pest List for Pisum".

Import permit: Not required

PEQ: Not required

Phytosanitary certificate: Required

~~2.62.1~~2.63.1 Approved Fumigation treatment

(1) All lots of *Pisum* seed imported into New Zealand are required to be fumigated according to the specifications listed in MPI-STD-ABTRT Approved Biosecurity Treatment.

(2) The treatment is required to be completed offshore prior to export, or on arrival in New Zealand by an MPI approved treatment provider.

(3) Pre-export treatment for each seed lot must be endorsed by the NPPO on the phytosanitary certificate, where the fumigant used and application rate must be clearly stated, or if done on arrival in New Zealand, must be completed at an MPI-approved facility.

~~2.62.2~~2.63.2 Approved Fungicide Treatments

(1) In lieu of pest free area for *Cladosporium cladosporioides f. sp. pisicola* all pisum seed must be treated as per MPI Standard MPI-STD-ABTRT Approved Biosecurity Treatments.

~~2.62.3~~2.63.3 Phytosanitary certificate - Additional declarations

(1) The exporting country NPPO must confirm any treatment(s) as required by the IHS in the disinfestation and/or disinfection treatment section.

(2) If satisfied that the pre-shipment activities have been undertaken, the exporting country NPPO must confirm this by providing the certifying statement as per Part 1.5.2 of this import health standard and also the following additional declaration (s) to the phytosanitary certificate:

a) "The *Pisum* seeds have been:

i) sourced from a 'pest free area' free from *Broad bean mottle virus, Broad bean stain virus, Pea early-browning virus, ~~Pea enation mosaic virus,~~ Peanut mottle virus, Peanut stunt virus*.

OR

ii) sourced from a 'pest free place of production' free from *Broad bean mottle virus, Broad bean stain virus, Pea early-browning virus, ~~Pea enation mosaic virus,~~ Peanut mottle virus, Peanut stunt virus*";

AND

b) "The *Pisum* seeds have been:

i) sourced from a 'pest free area' free from *Cladosporium cladosporioides* f. sp. *Pisicola*";

OR

ii) treated with one of the fungicide combinations in MPI approved treatments".

Guidance

- MPI may verify treatment certification provided from both offshore and onshore treatments through an audit sampling regime, as per **ISPM 20.** *Guidelines for a phytosanitary import regulatory system.*
- Refer section 1.11 Seeds of MPI Standard MPI-STD-ATBRT Approved Biosecurity Treatments

Pest List for *Pisum*

REGULATED PESTS (actionable)		
Insect		
Insecta		
Coleoptera		
Bruchidae		
	Acanthoscelides zeteki	bruchid beetle
	Bruchidius atrolineatus	seed beetle
	Bruchidius incarnatus	seed beetle
	Bruchidius quinqueguttatus	bruchid beetle
	Bruchus affinis	bruchid beetle
	Bruchus emarginatus	Mediterranean pulse beetle
	Bruchus ervi	bruchid beetle
	Bruchus lentis	bruchid beetle
	Bruchus pisorum	pea weevil
	Bruchus rufimanus	broad bean weevil
	Bruchus tristis	bruchid beetle
	Callosobruchus analis	cowpea weevil
	Callosobruchus chinensis	oriental cowpea weevil
	Callosobruchus maculatus	cowpea weevil
Dermestidae		
	Trogoderma granarium	khapra beetle
Lepidoptera		
Lycaenidae		
	Euchrysops cnejus	blue butterfly
Noctuidae		
	Spodoptera praefica	western yellowstriped armyworm
Pyralidae		
	Etiella zinckenella	limabean pod borer
Tortricidae		
	Cydia nigricana	pea moth
Mitosporic fungi (Hyphomycetes)		
Hyphomycetales		
Dematiaceae		
	Cladosporium cladosporioides f. sp. pisicola	cladosporium blight
Virus		
	Broad bean mottle virus	
	Broad bean stain virus	
	Pea early-browning virus	
	~~*Pea enation mosaic virus*~~	
	Peanut mottle virus	
	Peanut stunt virus	

Proposed changes applied to requirements for *Solanum lycopersicum* seed for sowing

~~2.73~~2.74 *Solanum lycopersicum*

The following requirements only apply to species in the Plant Biosecurity Index listed under Import Specifications for Seed as "see 155.02.05 under *Solanum lycopersicum*."

Approved countries: All countries

Quarantine pests: *Columnea latent viroid, Pepino mosaic virus, Potato spindle tuber viroid, Tomato chlorotic dwarf viroid, Tomato brown rugose fruit virus, Tomato apical stunt viroid, Tomato plant macho viroid, Tomato mottle mosaic virus*

Import permit: Not required

PEQ: Not required

Approved treatment: Not required

Phytosanitary certificate: Required

~~2.73.1~~2.74.1 Phytosanitary certificate - Additional declarations

(1) If satisfied that the pre-shipment activities have been undertaken, the exporting country NPPO must confirm this by providing the certifying statement as per Part 1.5.2 of this import health standard and also the following additional declaration (s) to the phytosanitary certificate:

a) "The *Solanum lycopersicum* seeds have been prepared to industry standards with thorough cleaning to remove all traces of flesh from the seeds".

AND

b) "The *Solanum lycopersicum* seeds have been:

i) sourced from a 'pest free area' free from *Pepino mosaic virus*.

OR

ii) sourced from a pest free place of production' free from *Pepino mosaic virus*.

OR

iii) officially tested, on a representative sample, and using appropriate methods, and found to be free from *Pepino mosaic virus*".

AND

c) " The *Solanum lycopersicum* seeds have been:

i) produced in a 'pest free area' free from *Columnea latent viroid, Potato spindle tuber viroid, Tomato apical stunt viroid, Tomato chlorotic dwarf viroid,* and *Tomato planta macho viroid*.

OR

ii) produced in a 'pest free place of production' free from *Columnea latent viroid, Potato spindle tuber viroid, Tomato apical stunt viroid, Tomato chlorotic dwarf viroid,* and *Tomato planta macho viroid*.

OR

iii) produced in a 'pest free place of production' where parent plants have been tested according to a NPPO approved methodology and found free from *Columnea latent viroid, Potato spindle tuber viroid, Tomato apical stunt viroid, Tomato chlorotic dwarf viroid,* and *Tomato planta macho viroid*.

OR

iv) officially tested, on a representative sample of a minimum of 3000 seeds officially drawn according to the ISTA or AOSA sampling methodology using a NPPO approved PCR testing method, and found to be free from *Columnea latent viroid, Potato spindle tuber viroid, Tomato apical stunt viroid, Tomato chlorotic dwarf viroid,* and *Tomato planta macho viroid*".

AND

d) "-The *Solanum lycopersicum* seeds have been:

i) sourced from a 'pest free area', free from *Tomato brown rugose fruit virus*

OR

ii) sourced from a 'pest free place of production' free from *Tomato brown rugose fruit virus*.

OR

iii) officially tested, on a representative sample of a minimum of 3000 seeds officially drawn according to the ISTA or AOSA sampling methodology, using an ~~NPPO-approved ELISA or~~ NPPO-approved PCR testing method and found free from *Tomato brown rugose fruit virus*".

AND

e) "-The *Solanum lycopersicum* seeds have been:

i) sourced from a 'pest free area', free from *Tomato mottle mosaic virus*

OR

ii) sourced from a 'pest free place of production' free from *Tomato mottle mosaic virus*.

OR

iii) officially tested, on a representative sample of a minimum of 3000 seeds officially drawn according to the ISTA or AOSA sampling methodology, using an NPPO-approved ELISA or NPPO-approved PCR testing method and found free from *Tomato mottle mosaic virus*".

~~2.73.2~~2.74.2 Testing requirements

(1) Testing is required to be completed offshore prior to export, or on arrival in New Zealand.

(2) Pre-export testing for each seed lot must be endorsed by the NPPO on the phytosanitary certificate, or if tested on arrival in New Zealand, must be completed by an MPI-approved testing laboratory.

(3) Testing on-shore will be performed using an MPI-approved testing method.

Guidance

- The ISHI-Veg local lesion bioassay for *Tomato brown rugose fruit virus* and *Tomato mottle mosaic virus* is not accepted as a valid test by MPI.
- Additional declarations on phytosanitary certificates to meet the offshore testing requirements for *Tomato brown rugose fruit virus* ~~and *Tomato mottle mosaic virus*~~ in Import Health Standard 155.02.05: *Seeds for sowing* should be based only on a negative result obtained in an ~~NPPO-approved ELISA or~~ NPPO-approved PCR test and not on results from a bioassay.
- Additional declarations on phytosanitary certificates to meet the offshore testing requirements for *Tomato mottle mosaic virus* in Import Health Standard 155.02.05: *Seeds for sowing* should be based only on a negative result obtained in an NPPO-approved ELISA or NPPO-approved PCR test and not on results from a bioassay.

- For tomato seed lots tested for quarantine pests onshore in New Zealand at an MPI-approved testing laboratory, additional declarations by the exporting NPPO are not required to be endorsed on the phytosanitary certificate.
- Removal of ELISA as a testing option for *Tomato brown rugose fruit virus* will come into force on xx 2021.

Proposed changes applied to requirements for *Vicia* seed for sowing

~~2.81~~2.82 *Vicia*

The following requirements only apply to species in the Plant Biosecurity Index listed under Import Specifications for Seed as "see 155.02.05 under *Vicia*."

Approved countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, United Kingdom and United States of America.

Quarantine pests: Refer to pest list for Vicia

Import permit: Not required.

PEQ: Not required

Phytosanitary certificate: Required

~~2.81.1~~2.82.1 Approved treatments

(1) All *Vicia* seeds must be treated as per MPI Standard MPI-STD-ABTRT Approved Biosecurity Treatments.

~~2.81.2~~2.82.2 Phytosanitary certificate - Additional declarations

(1) The exporting country NPPO must confirm any treatment(s) as required by the IHS in the disinfestation and/or disinfection treatment section.

(2) If satisfied that the pre-shipment activities have been undertaken, the exporting country NPPO must confirm this by providing the certifying statement as per Part 1.5.2 of this import health standard and also the following additional declaration (s) to the phytosanitary certificate:

a) "The *Vicia* seeds have been:

i) sourced from a 'pest free area' free from the named regulated viruses (*Artichoke yellow ringspot virus, Broad bean mottle virus, Broad bean stain virus, Broad bean true mosaic virus, Pea early-browning virus~~, Pea enation mosaic virus, Peanut stunt virus~~*)".

OR

ii) "sourced from a 'pest free place of production' free from the named regulated viruses (*Artichoke yellow ringspot virus, Broad bean mottle virus, Broad bean stain virus, Broad bean true mosaic virus, Pea early-browning virus~~, Pea enation mosaic virus, Peanut stunt virus~~*)".

Guidance

- Refer section 1.11 Seeds of MPI Standard MPI-STD-ATBRT Approved Biosecurity Treatments

Vicia REGULATED PESTS (actionable)

Insect	
Insecta	
Coleoptera	
Bruchidae	
Bruchidius incarnatus	seed beetle
Bruchidius quinqueguttatus	bruchid beetle
Bruchus atomarius	bruchid beetle
Bruchus dentipes	bruchid beetle
Bruchus pisorum	pea weevil
Bruchus rufimanus	broad bean weevil
Callosobruchus chinensis	oriental cowpea weevil
Callosobruchus maculatus	cowpea weevil
Callosobruchus phaseoli	cowpea weevil
Dermestidae	
Trogoderma granarium	khapra beetle
Tenebrionidae	
Tribolium destructor	dark flour beetle
Diptera	
Cecidomyiidae	
Contarinia pisi	pea midge
Lepidoptera	
Lycaenidae	
Virachola livia	pomegranate butterfly
Virus	
Artichoke yellow ringspot virus	
Broad bean mottle virus	
Broad bean stain virus	
Broad bean true mosaic virus	
Pea early-browning virus	
~~*Pea enation mosaic virus*~~	
~~*Peanut stunt virus*~~	

6.2 Technical advice on whether *Phaseolus* spp. is a natural host of *Artichoke yellow ringspot virus* (AYRSV), and seed transmission of Hemp mosaic virus and Hemp streak virus on *Cannabis sativa*

Background

With the adoption of ISPM 38 (IPPC 2017) on international movement of seed, the NPPO-NL has started with the analysis of import requirements for seeds on its merits. The focus of the analysis is on whether or not organisms are seed-transmissible. For those organisms which the NPPO-NL concludes are not seed-borne or seed-transmitted, or that the plant species is not a host, the NPPO-NL will request the rationale for having such organisms regulated from the counterpart NPPO, and if possible, to have these organisms removed from the import requirement for seeds.

Definitions of seed-borne pest and seed-transmitted pest (IPPC 2017):

- Seed-borne pest: A pest carried by seeds externally or internally that may or may not be transmitted to plants growing from these seeds and cause their infestation.
- Seed-transmitted pest: A seed-borne pest that is transmitted via seeds directly to plants growing from these seeds and causes their infestation.

Summary of advice

- This advice agrees with the NPPO-NL conclusion that there is insufficient evidence suggesting that *Phaseolus* spp. are natural hosts of AYRSV. Also, there is no evidence showing that AYRSV is seed-transmissible on *Phaseolus* spp.
- This advice agrees with the statement made by the NPPO-NL that the virial nature of hemp mosaic disease and hemp streak disease is unknown, and there is no such virus as HMV or HSV. Given that:
    - A previous advice on hemp mosaic and hemp streak disease provided by MPI and drafted in 2018, provides supporting evidence for the statement made by the NPPO-NL.
    - No study has identified the causal agent of the hemp mosaic disease and hemp streak disease since 2018.

Supporting information

1. Is a *Phaseolus* spp. a natural host of *Artichoke yellow ringspot virus* (AYRSV)?
The NPPO-NL concludes that *Phaseolus* sp. is not a natural host of AYRSV. The following information is collected by MPI. It is concluded that *Phaseolus* sp. is an experimental host of AYRSV, but there is insufficient evidence indicating *Phaseolus* sp. is a natural host of AYRSV. The experimental conditions for infection of *Phaseolus* are not likely to be replicated in field situations. Namely, the information MPI has found supports the conclusion made by the NPPO-NL.

A literature search has been conducted in CAB Abstract and Google Scholar using terms “Artichoke yellow ring spot” and “Phaseolus”. *Phaseolus* spp. have been reported as experimental hosts of AYRSV in some studies (Avgelis et al. 1992; Maliogka et al. 2006; Paylan et al. 2013). Systemic mosaic, reddish necrotic, local lesions, and malformation symptoms were observed when *P. vulgaris* was mechanically inoculated with sap from globe artichoke (*Cynara cardunculus* L. subsp. *scolymus* (L.) Hayek) that were infected by AYRSV. *Phaseolus aureus* has also been reported to be infected by AYRSV after artificial inoculation, and symptoms include necrotic local lesions, and vein clearing (Rana et al. 1980).

Two online databases (Descriptions of Plant Viruses – Rana et al. 1983; Plant Viruses Online – Brunt et al. 1996) indicate that *P. vulgaris* is a natural host of AYRSV, however, source

publications could not be found. Rana et al. (1983) claim that, in nature, the virus was found infecting 32 different plant species including French bean (*P. vulgaris*). However, the natural host information of AYRSV from this database cited unpublished information from P E Kyriakopoulou, and the source of this unpublished information could not been found. Symptoms on *P. vulgaris* are described in Brunt et al. (1996) under the "Natural host range and symptoms" section, but there is no reference cited for its natural host status. As such, this is an unconfirmed record.

Another literature search was conducted in CAB Abstract and Google Scholar using terms "Artichoke yellow ring spot" and "Phaseolus" and "seed", and no evidence for seed transmission of AYRSV on *Phaseolus* spp. was found.

2. Seed transmission of Hemp mosaic virus (HMV) and Hemp streak virus (HSV) on *Cannabis sativa*

The NPPO-NL suggests removing HMV and HSV from the import requirement for *Cannabis* seeds, and concludes that: 1) the virial nature of hemp mosaic disease and hemp streak disease is unknown; 2) there is no such virus as hemp mosaic virus and hemp streak virus (ICTV, 2020). A recent technical advice provided by MPI, which was drafted in 2018, and any new information collected and examined by MPI, supports the conclusion made by the NPPO-NL. A summary of the previous MPI technical advice and the new information collected is presented in the following paragraphs.

The previous technical advice on growing season inspection for detection of HMV and HSV on *C. sativa* recommended removing HMV and HSV from the list of pests of concern in the IHS unless further evidence is found that these are actual biotic entities causing unwanted impacts. However, the advice suggests that the diseases of unknown aetiology referred to as hemp streak and hemp mosaic disease should still be considered a biosecurity concern to New Zealand and be included in the IHS.

As the above technical advice was drafted in 2018, a literature search using terms "'hemp mosaic' or 'hemp streak'" and "cannabis" was conducted in CAB Abstracts and Google Scholar to check if there is any other causal agent that has been attributed to hemp mosaic or hemp streak disease since 2018. No study has identified the causal agent of hemp mosaic or hemp streak disease since 2018. As such, seed transmission of these diseases cannot be determined, as no causative agent has been confirmed for the diseases.

References

- Avgelis, A D; Katis, N; Grammatikaki, G (1992) Broad bean wrinkly seed caused by artichoke yellow ringspot nepovirus. Ann. Appl. Biol., 121: 133 – 142.
- Brunt, A; Crabtree, K; Dallwitz, M; Gibbs, A; Watson, L; Zurcher, E (1996) Plant viruses online and lists from the VIDE. Available at: http://bio-mirror.im.ac.cn/mirrors/pvo/vide/descr044.htm#Range
- CPC (2020) Crop Protection Compendium. Available at: https://www.cabi.org/cpc, accessed on 30/04/2020. EPPO (2020) EPPO Global Database. Available at: https://gd.eppo.int/taxon/CORBSE, accessed on 30/04/2020.
- ICTV (2020) International Committee on Taxonomy of Viruses. Available at: https://talk.ictvonline.org/taxonomy/
- IPPC (2020) International Standard for Phytosanitary Measures 38: International movement of seeds. Available at: https://www.ippc.int/static/media/files/publication/en/2017/05/ISPM_38_2017_En_2017-05-15.pdf
- Maliogka, V I; Dovas, C I; Lesemann D E; Winter, S; Katis, N I (2006) Molecular Identification, Reverse Transcription-Polymerase Chain Reaction Detection, Host

Reactions, and Specific Cytopathology of *Artichoke yellow ringspot virus* Infecting Onion Crops. Phytopathology, 96: 622-629.

- Paylan, C; Ergun, M; Erkan, S (2013) First Report of *Artichoke yellow ringspot virus* in Globe Artichoke in Turkey. Plant Disease, 97(10): 1,388.1 – 1,388.1. Available at: http://dx.doi.org/10.1094/PDIS-04-13-0423-PDN
- Rana, G; Gallitelli, D; Kyriakopoulou, P; Russo, M; Martelli, G (1980) Host range and properties of artichoke yellow ringspot virus. Ann. Appl. Biol., 96: 177 – 185.
- Rana, G; Kyriakopoulou, P; Martelli, G (1983) *Artichoke yellow ringspot virus*. Descriptions pf plant viruses. Available at: http://www.dpvweb.net/dpv/showdpv.php?dpvno=271

6.3 MPI technical assessment: seed transmission of *Pea enation mosaic virus* (PEMV) on *Pisum* sp. and *Vicia* sp. and *Peanut stunt virus* (PSV) on *Phaseolus* sp. and *Vicia* sp.

Background

With the adoption of ISPM 38 on the international movement of seeds for sowing, the NPPO of the Netherlands has begun reviewing the import requirements placed on seeds they export. The focus of their review is whether or not there is sufficient evidence for the organisms requiring import measures being seed-transmissible. For organisms that the NPPO of the Netherlands concludes are not seed-borne or seed-transmitted, they will request the rationale from the counterpart NPPO as to why the organism is regulated. Furthermore, if possible, to have the organism removed from the import requirements for seeds.

Summary of advice

- This advice agrees with the conclusion by the Netherlands' NPPO that there is insufficient evidence to suggest that *Pea enation mosaic virus* (PEMV) is seed-transmitted in *Pisum* sp. or *Vicia* sp.
- There is evidence to suggest that PEMV is seed-borne in *Pisum* sp. and may also be on *Vicia* sp. However, no evidence was found that PEMV is seed-transmitted in any host.
- Historical references cite that PEMV is seed-transmitted in *Pisum* sp. However, this observation has not been reproduced in recent literature.
- This advice agrees with the conclusion by the Netherlands' NPPO that there is insufficient evidence to suggest that *Peanut stunt virus* (PSV) is seed-transmitted on *Phaseolus* sp. or *Vicia* sp.
- *Peanut stunt virus* (PSV) has been reported to be seed-transmitted at low rates on *Arachis hypogaea* (peanut) and *Glycine max* (soybean) seeds.

Supporting information

Seed transmission of *Pea enation mosaic virus* on *Pisum* sp. and *Vicia* sp.
The Dutch NPPO conclude that seed transmission of *Pea enation mosaic virus* in *Pisum* sp. is unlikely. They also conclude that the virus is not seed transmitted in *Vicia* sp. The information outlined below was collected by MPI for this advice. It is concluded that the evidence found supports the conclusions made by the Dutch NPPO that there is insufficient evidence that PEMV is seed transmitted in *Pisum* sp. or *Vicia* sp. However, there is evidence to suggest that PEMV is seed-borne in *Pisum* sp. and may also be on *Vicia* sp.

Pea enation mosaic disease is caused by two obligatory symbiotic viral genomes, PEMV-1, a member of the *Enamovirus* genus (family *Luteoviridae*) and PEMV-2, in the *Umbravirus* genus (Demler et al, 1993; ICTV, 2019). There are no known examples of Enamoviruses or Umbraviruses being seed- transmitted (ICTV, 2019).

Infection of many cultivars of *Pisum* sp. with PEMV results in morphological changes. Small growths originating from the underside of the leaves (enations) can develop. Seed pods may appear bumpy, twisted and deformed. On plants that are infected before flower bloom, the pods do not develop or fill normally (Kraft and Pfleger, 2001). This would reduce the risk of infected seeds being produced. However, plants may appear normal if infected after the flower bloom stage. The virus is transmitted in a persistent manner by eight species of aphids, with *Acyrthosiphon pisum* (pea aphid) being the most significant (Kraft and Pfleger, 2001). *Acyrthosiphon pisum* is present in New Zealand (NZOR, 2019). Kraft and Pfleger (2001) do not make any reference to the virus being seed transmitted.

Seed transmission of PEMV in *Pisum sativum* was reported by Kovachevsky (1978) (cited in Timmerman-Vaughan et al, 2009 and Sastry, 2013). They reported the early-season development of PEMV disease in seedlings grown in the field from seeds collected from infected plants. They concluded that the spread of PEMV was due to seed transmission of the virus, rather than de novo infection (Kovachevsky (1978); cited in Timmerman-Vaughan et al, 2009). The Kovachevsky paper was not able to be checked in full, as an English version could not be found. However, Timmerman-Vaughan et al (2009) state that the experiment described in Kovachevsky (1978) is described as being conducted in the field and does not mention that measures were put in place to prevent aphid vectors becoming associated with the plants. Therefore, the PEMV symptoms may have been due to transmission of the virus to the plants via aphids. Furthermore, no work has been found that substantiated the results mentioned by Kovachevsky (1978).

The description of PEMV by Skaaf and de Zoeten (2000) states that PEMV is seed transmitted at low levels (1.5%), citing Kovachevsky (1978). However, the original paper did not quantify the frequency of seed transmission (Timmerman-Vaughan et al, 2009). Therefore, this is considered incorrect. Sastry (2013) cite Blattry (1956), Kovachevsky (1978), Kheder and Eppler (1988) as reporting seed transmission of PEMV in *Pisum sativum*. However, no details were given and the papers were not able to be checked as they were not published in English. Given that there has been no corroboration of the results described by Kovachevsky (1978) and a viable alternative explanation for the results has been put forward by Timmerman-Vaughan et al, 2009 this paper is not considered strong, reliable evidence that PEMV is seed-transmitted.

Timmerman-Vaughan et al, (2009) investigated the accumulation of PEMV in *P. sativum* seeds and seed transmission of the virus in this host. The conclusion of the study was that the virus can be seed-borne, but there was no evidence of seed transmission. It was found that PEMV-1 and PEMV-2 genomic RNA accumulated to high levels in all pod and seed coat samples tested. The genomes of PEMV-1 and PEMV-2 were also detected in some seed embryo tissue samples, but at much lower levels. Seeds collected from *P. sativum* (variety Medora) plants infected with PEMV was used in one set of seed transmission experiments. Approximately 5000 seeds were grown out in an aphid free environment. No symptoms of PEMV disease were observed in any plants. A further 3000 of the seeds from the diseased Medora plants were grown under field conditions and inspected for PEMV disease. Again, no symptoms of PEMV were observed. In another seed transmission test, 286 seedlings were grown from seeds collected from PEMV infected *P. sativum* (variety Joel) pods. The plants didn't show any symptoms of PEMV disease at 27 days post germination and PEMV was not detected in the plants by ELISA testing.

The evidence of Timmerman-Vaughan et al, (2009) suggests that it is unlikely that PEMV is seed transmitted in *Pisum* sp. However, their data does suggest that the virus is seed-borne. As mentioned in the paper 'The possibility that altering factors such as plant genotype, virus strain, presence of other viruses, or environmental factors would result in PEMV seed transmissibility cannot be completely ruled out because these possibilities have not been tested exhaustively'. Therefore, if new evidence was to become available, it may warrant the risk associated with PEMV to be reassessed.

No evidence for seed transmission of PEMV was found using Google or Google Scholar, using the search terms 'seed transmission pea enation mosaic virus Pisum', 'seed transmission pea enation mosaic virus Vicia' or 'seed transmission pea enation virus'. The description by Skaaf and de Zoeten (2000) was found, however as mentioned above this information is not considered to be correct. A CAB Abstract using the search term 'seed

transmission pea enation mosaic virus' did not produce any results. There are no alerts relating to PEMV in the emerging risks system.

Seed transmission of Peanut stunt virus (PSV) on *Phaseolus* sp. and *Vicia* sp.
The Dutch NPPO conclude that *Peanut stunt virus* is not seed transmitted in *Phaseolus* sp. or *Vicia* sp. The information outlined below was collected by MPI for this advice. No evidence was found that PSV is seed transmitted in *Phaseolus* sp. or *Vicia* sp. Therefore, the conclusion of this advice agrees with the Dutch NPPO.

The *Peanut stunt virus* is a virus in the genus *Cucumovirus*, family *Bromoviridae* (ICTV, 2019). A characteristic of PSV disease is the sudden outbreak of disease, with an unexplained origin (Schwarz et al, 2005). The virus is easily transmitted mechanically and by several aphid species. Symptoms of PSV infection include leaf mosaic, plant deformation and stunting. Infected plants produce fewer seed pods than healthy plants. Pods that are produced are small, malformed and produce few seeds (Schwarz et al, 2005). Therefore, infected plants rarely produce viable seeds and seeds are unlikely to be an important source of viral inoculum.

Evidence was found of low rates of PSV seed transmission in *Arachis hypogaea* (peanut) (Troutman et al, 1967; Sastry, 2013). Transmission rates of 3-4% in seeds of 2 cultivars of Glycine max (soybean) have been reported (Iizuka and Yunoki 1974; Sastry, 2013). As only the abstracts of the papers are available, it is not known how the seed transmission experiments were carried out.

The virus is not reported to be seed transmitted in *Phaseolus* sp.. Echandi and Hebert (1971) collected seeds, large enough for sowing, from infected commercially grown *Phaseolus* sp. plants (variety Dade). The disease incidence of PSV in the field was reported to be 100%. The seeds were grown out in a glasshouse and examined for disease symptoms. Of the 2000 seedlings, no infection was observed. In a separate experiment it was observed that infection with PSV reduced flower and seed pod production in beans by 50 and 90% respectively. Iizuka and Yunoki (1974) report that the virus is not transmitted through *P. vulgaris* or cowpea seeds. No more recent studies were found contradicting this evidence on Google, Google Scholar or CAB Abstracts using the search term 'Peanut stunt virus seed Phaseolus'.

No evidence was found of PSV being seed transmitted in *Vicia* sp. seeds on Google, Google Scholar or CAB Abstracts using the search term 'Peanut stunt virus seed Vicia'.

References

- Demler, S A; Rucker, D G; De Zoeten, G A (1993) The chimeric nature of the genome of pea enation mosaic virus: the independent replication of RNA 2. Journal of General Virology, 74(1): 1–4.
- Echandi, E; Hebert, T T (1971) Stunt of beans incited by peanut stunt virus. Phytopathology, 61: 328–330. ICTV (2019) https://talk.ictvonline.org/taxonomy/ https://talk.ictvonline.org/taxonomy/
- Iizuka, N; Yunoki, T (1974) *Peanut stunt virus* isolated from soybeans, Glycine max Merr. Bulletin of the Tohoku National Agricultural Experiment Station, (47): 1–12. [Abstract only]
- Kraft, J M; Pfleger, F L (2001) Compendium of pea diseases and pests (No. Ed. 2). American Phytopathological Society (APS Press). NZOR (2019). Available at: http://www.nzor.org.nz/names/d7e1fbf8-f846-4f18-952c-579b1a804cec (Accessed 6/12/19) http://www.nzor.org.nz/names/d7e1fbf8-f846-4f18-952c-579b1a804cec (Accessed 6/12/19)

- Sastry, K S (2013) Seed-borne plant virus diseases. Springer Science & Business Media. Skaaf and de Zoeten (2000) Available at: http://www.dpvweb.net/dpv/showadpv.php?dpvno=372 (Accessed 6/12/19) http://www.dpvweb.net/dpv/showadpv.php?dpvno=372 (Accessed 6/12/19)
- Schwartz, H F; Steadman, J R; Hall, R; Forster, R L (2005) Compendium of bean diseases (No. Ed. 2). American Phytopathological Society (APS Press).
- Timmerman-Vaughan, G; Larsen, R; Murray, S; McPhee, K; Coyne, C (2009) Analysis of the accumulation of *Pea enation mosaic virus* genomes in seed tissues and lack of evidence for seed transmission in pea (*Pisum* sativum). Phytopathology, 99(11): 1281–1288.
- Troutman, J L; Bailey, W K; Thomas, C A (1967) Seed transmission of *Peanut stunt virus*. Phytopathology, 57(11): 1280–1281. [Abstract only]

6.4 Scientific and technical advice on whether measures are required to manage the risk from *Potato spindle tuber viroid* (PSTVd) on seed for sowing of the ornamental species *Dahlia, Chrysanthemum* and *Diascia*, eligible to import under IHS 155.02.05: Seeds for Sowing

Background

TomatoesNZ has requested MPI to assess the risks of PSTVd on *Dahlia*, *Chrysanthemum* and *Diascia* seeds for sowing. Introduction of PSTVd in New Zealand could have serious implications on export assurances for other important host crops (for example *Solanum tuberosum*, *S. lycopersicum* and *Capsicum annuum*).

Summary of Advice

- *Potato spindle tuber viroid* (PSTVd) is reported to be seed-transmitted in *Glebionis coronaria* (=*Chrysanthemum coronarium*); seed-transmission has not yet been tested in *Dahlia* and *Diascia* but seems likely based on the biology of PSTVd and known seed-transmission of PSTVd in asymptomatic non-Solanaceous hosts.
- Seed-transmission is reported for a range of other hosts, such as *Solanum tuberosum, S. lycopersicum, Capsicum annum, Petunia* x *hybrida*, likely for *Physalis peruviana*. The biology of the viroid supports possible embryo infection in many hosts.
- PSTVd is reported as mainly asymptomatic in *Dahlia*, *Chrysanthemum* and *Diascia*; many other ornamental hosts are known to serve as an asymptomatic source of inoculum.
- The potential for PSTVd to establish and spread in New Zealand is likely to be high, with low uncertainty.
- The potential impact of PSTVd to New Zealand is likely to be high, with low uncertainty.

Supporting information

Taxonomy and evolution

Potato spindle tuber viroid (PSTVd) is the type member of the family Pospiviroidae. Its genome (~359 nucleotides) consists of a small, circular, single-stranded RNA molecule that, unlike viruses, is not associated with proteins. Consequently, PSTVd relies entirely on their sequence, structure and host factors for replication and propagation. PSTVd is known for one of the highest known mutation rates among all organisms and for a constant change in sequence variation throughout infection (so-called quasispecies, Adkar-Purushothama et al. 2020). An arbitrary level of less than 90% sequence identity and distinct biological properties are the main criteria for separating viroid species within a genus (Adkar-Purushothama et al. 2020). PSTVd is also known as *Tomato bunchy top virus*, *potato gothic virus*, *potato spindle viroid* and *spindle tuber viroid*.

Biology

Variants consisting of 356-363 nucleotides have been described and, because of its extremely high mutation rate, PSTVd is highly adaptable (i.e. hosts, environment and highly variable in terms of symptoms) (CPC 2020). PSTVd replicates autonomously in susceptible plant hosts via a rolling circle mechanism. Viroids are low molecular weight infectious nucleic acids predominantly located in the nuclei of infected cells (CPC 2020). Therefore, PSTVd is usually found in all parts of the susceptible plant and is efficiently transmitted by propagation, cutting knives, contaminated sap, physical contact between healthy and diseased plants (even asymptomatic), tractor wheels, seed, pollen, irrigation water and occasionally insects, such as aphids (CPC 2020, Mackie et al. 2016).

Host range

Severe symptoms and large-scale outbreaks are mainly known from potato, tomato and pepper (*Capsicum annuum*). Sometimes mild variants of PSTVd cause no obvious symptoms in these hosts (CPC 2020). Reported asymptomatic hosts include avocado (*Persea americana*), *Brugmansia* spp., *Chrysanthemum* sp., *Calibrachoa* sp., *Cestrum* spp., *Dahlia* sp., *Datura* sp., *Lycianthes rantonnei*, *Petunia* sp., *Physalis peruviana*, *Solanum pseudocapsicum*, *Streptosolen jamesonii*, *Solanum jasminoides*, *Solanum muricatum*, sweet potato (*Ipomoea batatas*) and wild *Solanum* spp. (CPC 2020). The experimental host range of PSTVd includes a wide range of Solanaceous species, as well as species from other families, such as Convolvulaceae and Lauraceae (CPC 2020).

Potential to establish

The potential for PSTVd to establish in New Zealand is likely to be high, with low uncertainty.

Host plants the viroid can cause considerable damage on (e.g. potatoes, capsicum, and tomatoes) are commonly grown in and economically important for New Zealand. Reported asymptomatic hosts, which may act as a source of inoculum for the viroid, such as avocado, black nightshade and petunia, are also common. The viroid does not require an insect vector for transmission. Furthermore, the aphid described as being possibly able to transmit the viroid (*Macrosiphum euphorbiae*) is present in New Zealand. PSTVd is easily spread, for example, through botanical seed and pollen. The New Zealand climate does not seem to be a limiting factor for PSTVd as it has been found on *Capsicum annum* in the Auckland region and on *Physalis peruviana* in Christchurch prior to its eradication (Lebas et al. 2005, Ward et al. 2010). Its global distribution (all continents, from the tropics as far north as Russia) reinforces this conclusion (EPPO 2020). Suitable host plants are widely distributed in New Zealand and PSTVd has the ability to spread asymptomatically. Thus, the likelihood to establish naturally in New Zealand is considered high.

Potential impact

The potential impact of PSTVd to New Zealand is likely to be high, with low uncertainty.

Direct impacts would likely occur on the tomato, potato and capsicum industry. Yield losses vary with host cultivar, PSTVd variety and season, but are particularly severe under dry conditions (CPC 2020). The general pattern is of a progressive decrease in yield as infection increases. FreshFacts (2019) estimated New Zealand's tomato exports at around 15 million NZD, capsicum exports at around 20 million NZD and potato exports at around 130 million NZD. Likely there would be additional implications from export or trade restrictions imposed by other countries and costs from eradication attempts or a response which are hard to estimate but would likely be high. Furthermore, indirect impacts would likely occur on other industries, such as the avocado industry, which could face trade restrictions due to avocado being an asymptomatic host of PSTVd (FreshFacts 2019, 105 million NZD export value).

Seedborne, seed- and pollen-transmission reports of PSTVd

Many Pospiviroids, including PSTVd, are seed-transmitted due to their low molecular weight and are predominately located in the nuclei of infected cells (CPC 2020). However, the rate of seed-transmission of Pospiviroids is also dependent on the viroid strain, host plant species, cultivar and distribution of viroids in seed parts (Matsushita et al. 2018). For example, the rate of seed-transmission of PSTVd was found to be 0–90.2 % in tomato, 0.3 % in *Capsicum annuum* var. *grossum*, 0.5 % in *C. annuum* var. *angulosum*, 1.2 % in *Glebionis coronaria*, and 81 % in *Petunia* × *hybrida* (Matsushita and Tsuda 2016), while no seed-

transmission was observed for *C. annuum* cv. Yolo Wonder (Verhoeven et al. 2020). Contaminated seed is an important source of PSTVd infection for crops that are grown from seed but efficiency of transmission of PSTVd can be highly variable in the same and in different hosts (CPC 2020). Table 1 summarises published reports of seed and pollen transmitted incidences of PSTVd.

Table 1. Reports of seed- and pollen-transmitted PSTVd.

Host plant species	Seed-transmitted	Pollen-transmitted	Reference
Solanum tuberosum	yes	yes	Fernow et al. 1970, Hunter et al. 1969, Singh 1970
S. lycopersicum	yes	yes	Benson and Singh 1964, Constable et al. 2019, Kryczyński et al. 1988, Matsushita and Tsuda 2016, Singh 1970
Capsicum annum	yes		Botermans et al. 2020, Constable et al. 2019, Matsushita and Tsuda 2016
Glebionis coronaria	yes		Matsushita and Tsuda 2016
Petunia × *hybrida*	yes	Yes	Matsushita and Tsuda 2014, Yanagisawa and Matsushita 2017
Physalis peruviana	highly likely		Ward et al. 2010 (contaminated seed imported from Germany was considered the cause of the outbreak)

Significance of ornamental hosts in the spread of PSTVd

Ornamental asymptomatic hosts are significant for the introduction and spread of PSTVd. For example, comparison of the respective nucleotide sequences of PSTVd indicated connections between PSTVd infections in several lots of tomato and infections in lots of the ornamental *Solanum jasminoides* (CPC 2020). As vegetatively propagated plants of *S. jasminoides* were kept in greenhouses year-round, they could serve as a permanent source of inoculum for tomato crops, which were removed from the greenhouse after every production cycle. This indicated that *S. jasminoides* was the original source of PSTVd infection in various outbreaks in tomato (CPC 2020).

Recent analyses demonstrated spreading of a PSTVd population in ornamentals that included isolates from species like *Brugmansia* sp., *S. jasminoides*, *S. muricatum*, *S. pseudocapsicum*, *S. rantonnetii*, *Datura* sp., *Chrysanthemum* sp., *Cestrum* sp., *Dahlia* sp., *Petunia* sp., *Matricaria chamomilla*, *Argyranthemum frutescens* and *Diascia* sp. (citations within Matoušek et al. 2014).

***Dahlia*, *Chrysanthemum* and *Diascia* species as asymptomatic hosts of PSTVd**

- PSTVd has been reported as being mainly asymptomatic from *Dahlia* spp. (Fujiwara et al. 2013, IPPC 2014, Monger 2018, Tsushima et al. 2011, Tsushima et al. 2016).
- PSTVd has been reported mainly asymptomatic from *Chrysanthemum* spp. (citations within Matoušek et al. 2014).

- PSTVd has been reported mainly asymptomatic from *Diascia* spp. (Matoušek et al. 2014).

Although reported as mainly asymptomatic in these ornamental host species, the same isolates of PSTVd have been reported to be able to induce symptoms in tomato (Tsushima et al. 2016).

Dahlia, *Chrysanthemum* and *Diascia* species allowed for import

There are several species of *Dahlia*, *Chrysanthemum* and *Diascia* allowed for import under the specifications for seed for sowing and nursery stock (see Table 1).

Table 1. *Dahlia*, *Chrysanthemum* and *Diascia* allowed for import under the import specifications for seed for sowing and nursery stock (Plant Biosecurity Index 2020).

***Dahlia* spp.**	***Chrysanthemum* spp.**	***Diascia* spp.**
Dahlia coccinea	*Chrysanthemum alpinum (= Leucanthemopsis alpina)*	*Diascia barberae*
Dahlia coccinea x *pinnata*	*Chrysanthemum anethifolium (= Argyranthemum foeniculaceum)*	*Diascia cordata (= Diascia barberae)*
Dahlia excelsa	*Chrysanthemum arcticum (= Arctanthemum arcticum)*	*Diascia elegans*
Dahlia imperialis	*Chrysanthemum atlanticum (= Rhodanthemum atlanticum)*	*Diascia fetcaniensis*
Dahlia merckii	*Chrysanthemum balsamita (= Tanacetum balsamita)*	*Diascia flanagani*
Dahlia pinnata	*Chrysanthemum carinatum*	*Diascia integerrima*
Dahlia tenuicaulis	*Chrysanthemum catananche (= Rhodanthemum catananche)*	*Diascia lilacina*
Dahlia variabilis	*Chrysanthemum cinerariifolium (= Tanacetum cinerariifolium)*	*Diascia mollis*
Dahlia xhortensis	*Chrysanthemum coccineum (= Tanacetum coccineum)*	*Diascia patens*
	Chrysanthemum coronarium	*Diascia racemulosa*
	Chrysanthemum frutescens (= Argyranthemum frutescens)	*Diascia rigescens*
	Chrysanthemum haradjanii (= Tanacetum haradjanii)	*Diascia stachyoides*
	Chrysanthemum hosmariense (= Rhodanthemum hosmariense)	*Diascia tugelensis*
	Chrysanthemum indicum (= Dendranthema indicum)	*Diascia vigilis*
	Chrysanthemum inodorum	
	Chrysanthemum leucanthemum (= Leucanthemum vulgare)	
	Chrysanthemum mawii (= Rhodanthemum gayanum)	
	Chrysanthemum maximum (= Leucanthemum maximum)	
	Chrysanthemum morifolium (= Dendranthema xgrandiflorum)	
	Chrysanthemum paludosum (= Leucanthemum paludosum)	

	Chrysanthemum parthenium (= Tanacetum parthenium)	
	Chrysanthemum ptarmiciflorum (= Tanacetum ptarmiciflorum)	
	Chrysanthemum rubellum (= Dendranthema zawadskii)	
	Chrysanthemum segetum	
	Chrysanthemum weyrichii	

Seedborne/seed transmission reports (*Dahlia*, *Chrysanthemum* and *Diascia* species)

A seed-transmission rate of 1.2 % of PSTVd has been reported for *Glebionis coronaria* (=*Chrysanthlemum coronarium*) (Matsushita and Tsuda 2016).

No publications about seed-transmission tests of PSTVd in *Dahlia* and *Diascia* species were found. However, seed-transmission of PSTVd in *Dahlia* and *Diascia* seems likely considering 1) the biology of PSTVd (especially the low molecular weight and the ability to infect every susceptible plant cell including the embryo, ovules and pollen), and 2) known seed-transmission in asymptomatic non-Solanaceous hosts, such as *Glebionis coronaria* (=*Chrysanthlemum coronarium*) (Matsushita and Tsuda 2016).

References

- Adkar-Purushothama, C R; Bolduc, F; Bru, P; Perreault, J P (2020) Insights into *Potato spindle tuber viroid* quasi-species from infection to disease. Frontiers in Microbiology, 11: 1235.
- Benson, A P; Singh, R P (1964) Seed transmission of *Potato spindle tuber virus* in tomato. Am. Potato J., 41: 294.
- Botermans, M; Roenhorst, J W; Hooftman, M; Verhoeven, J T J; Metz, E; van Veen, EJ; et al. (2020) Development and validation of a real-time RT-PCR test for screening pepper and tomato seed lots for the presence of pospiviroids. PloS ONE *15*(9): e0232502. https://doi.org/10.1371/journal.pone.0232502
- Constable, F; Chambers, G; Penrose, L; Daly, A; Mackie, J; Davis, K; ... Gibbs, M (2019) Viroid-infected tomato and capsicum seed shipments to Australia. *Viruses, 11*(2): 98.
- CPC (2020) Datasheet on *Potato spindle tuber viroid* (PSTVd). Available at https://www.cabi.org/cpc/datasheet/43659 accessed 10/10/2020.
- EPPO (2020) Datasheet on *Potato spindle tuber viroid* (PSTVd). Available at https://gd.eppo.int/taxon/PSTVD0/distribution accessed 19/10/2020.
- Fernow, K H; Peterson, L C; Plaisted, R L (1970) *Spindle tuber virus* in seeds and pollen of infected potato plants. Am. Potato J. 47: 75–80.
- FreshFacts (2019) Available at https://www.freshfacts.co.nz/ accessed 10/10/2020.
- Fujiwara, Y; Nomura, Y; Hiwatashi, S; Shiki, Y; Itto, T; Hamanaka, D; Saito, N (2013) Pathogenicity of potato of *Potato spindle tuber viroid* isolated from dahlia and its transmissibility in dahlia. Research Bulletin of the Plant Protection Service, Japan, *49*: 41-46.
- Hunter, D E; Darling, H M; Beale, W L (1969) Seed transmission of *Potato spindle tuber virus*. Am. Potato J. *46*: 247–250.
- IPPC (2014) First finding of *Potato Spindle Tuber Viroid* (PSTVd) in *Dahlia* sp. corm production in the Netherlands. IPPC Official Pest Report, No. NLD-21/1. Rome, Italy: FAO. https://www.ippc.int/

- Kryczyński, S; Paduch-Cichal, E; Skrzeczkowski, L J (1988). Transmission of three viroids through seed and pollen of tomato plants. *Journal of Phytopathology*, *121*(1): 51-57.
- Lebas, B S M; Clover, G G; Ochoa-Corona, F M; Elliott, D R; Tang, Z; Alexander, B J R (2005) Distribution of *Potato spindle tuber viroid* in New Zealand glasshouse crops of capsicum and tomato. Australasian Plant Pathology, *34*(2): 129-133.
- Mackie, A E; Rodoni, B C; Barbetti, M J; McKirdy, S J; Jones, R A (2016) *Potato spindle tuber viroid*: alternative host reservoirs and strain found in a remote subtropical irrigation area. *European Journal of Plant Pathology, 145*(2): 433-446.
- Matoušek, J; Piernikarczyk, R J; Dědič, P; Mertelík, J; Uhlířová, K; Duraisamy, G S; et al. (2014) Characterization of *Potato spindle tuber viroid* (PSTVd) incidence and new variants from ornamentals. European journal of plant pathology, *138*(1): 93-101.
- Matsushita, Y; Yanagisawa, H; Sano, T (2018) Vertical and Horizontal Transmission of Pospiviroids. Viruses, *10*(12): 706.
- Matsushita, Y; Tsuda, S (2016) Seed transmission of *Potato spindle tuber viroid*, tomato chlorotic dwarf viroid, tomato apical stunt viroid, and Columnea latent viroid in horticultural plants. European Journal of Plant Pathology, *145*(4): 1007-1011.
- Matsushita, Y; Tsuda, S (2014) Distribution of *Potato spindle tuber viroid* in reproductive organs of petunia during its developmental stages. Phytopathology, *104*: 964–969.
- Monger, W A (2018) Dahlia latent viroid and *Potato spindle tuber viroid* in dahlia plants in the UK. New Disease Reports, 38, 8-8.
- Plant Biosecurity Index (2020) Available at https://www1.maf.govt.nz/cgi-bin/bioindex/bioindex.pl accessed 19/10/2020.
- Singh, R P (1970) Seed transmission of *Potato spindle tuber virus* in tomato and potato. Am. Potato J., 47: 225–227.
- Tsushima, T; Murakami, S; Ito, H; He, Y H; Raj, A P C; Sano, T (2011) Molecular characterization of *Potato spindle tuber viroid* in dahlia. Journal of General Plant Pathology, *77*(4): 253-256. http://www.springerlink.com/content/15v2p31231j4516w/
- Tsushima, D; Tsushima, T; Sano, T (2016) Molecular dissection of a dahlia isolate of *Potato spindle tuber viroid* inciting a mild symptoms in tomato. Virus research, 214, 11-18.
- Verhoeven, J T J; Koenraadt, H M S; Jodlowska, A; Hüner, L; Roenhorst, J W (2020) Pospiviroid infections in *Capsicum annuum*: disease symptoms and lack of seed transmission. European Journal of Plant Pathology, *156*(1): 21-29.
- Ward, L I; Tang, J; Veerakone, S; Quinn, B D; Harper, S J; Delmiglio, C; Clover, G R G (2010) First report of *Potato spindle tuber viroid* in cape gooseberry (*Physalis peruviana*) in New Zealand. Plant Disease, *94*(4): 479-479.
- Yanagisawa, H; Matsushita, Y (2017) Host ranges and seed transmission of *Tomato planta macho viroid* and *Pepper chat fruit viroid*. Eur. J. Plant Pathol., *149*: 211–217.