Importation of Potato Mini-tubers for Propagation from the United Kingdom into the United States

A Qualitative, Pathway-Initiated Pest Risk Assessment

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Executive Summary

The Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) prepared this risk assessment document to examine plant pest risks associated with importing commercially produced potato, *Solanum tuberosum* (Solanaceae), mini-tubers for propagation from the United Kingdom into the United States. Based on the market access request from the United Kingdom, we considered the pathway to include the following processes and conditions: potato mini-tubers are only produced in Scotland under a production program officially recognized and certified by the Scottish Agricultural Science Agency (SASA). Mini-tuber production facilities are aphid-proof polythene tunnels or glasshouses and are located in areas with low aphid populations and subsequently low aphid vector pressure. Mini-tubers are produced in facilities that meet the requirements of pest-free places of production as defined by ISPM 33. All processes and conditions considered during the risk assessment process become mandatory conditions for entry of the commodity.

Based on the scientific literature, port-of-entry pest interception data, and information from the government of the United Kingdom we developed a list of all potential pests with actionable regulatory status for the United States that are known to occur in the United Kingdom and that are known to be associated with commercially produced potato mini-tubers anywhere in the world. We determined that no organisms on that list have a reasonable likelihood of being associated with this commodity.

Although no pests are expected to be on the commodity at the time of export, the following pests are of quarantine significance for the United States and are discussed further in the document:

Pest type	**Scientific name**
Bacteria	*'Dickeya solani'*
	Ralstonia solanacearum (Smith) Yabuuchi et al. R3 B2
Fungi	*Boeremia foveata* (Foister) Aveskamp, Gruyter & Verkley Syn. ≡*Phoma exigua var. foveata* (Foister) Boerema
	Synchytrium endobioticum (Schilb.) Percival
Nematodes	*Globodera pallida* (Stone) Behrens
	Globodera rostochiensis (Wollenweber) Behrens
	Meloidogyne minor Karssen et al.
Viruses	*Potato virus V* (PVV)
	Tomato black ring virus (TBRV)

Potato mini-tubers produced in the United Kingdom are subject to strict phytosanitary processes that mitigate pest risk, and these processes are addressed in this document.

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1. Introduction

1.1. Background

This document was prepared by the Plant Epidemiology and Risk Analysis Laboratory of the Center for Plant Health Science and Technology, USDA Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ), to evaluate the pest risk associated with the importation of commercially produced potato, *Solanum tuberosum* L., mini-tubers for propagation from the United Kingdom into the United States. These mini-tubers are only produced by six officially approved companies in Scotland. Production takes place in areas with low aphid populations in aphid-proof polythene tunnels or glasshouses. Production facilities meet the requirements of pest-free places of production as defined by the International Plant Protection Convention (IPPC) International Standard for Phytosanitary Measures (ISPM) on "Pest free potato (*Solanum* spp.) micropropagative material and minitubers for international trade" (IPPC, 2010).

The IPPC provides guidance for conducting pest risk analyses. The methods used here are consistent with guidelines provided by the IPPC, specifically the ISPM on "Pest Risk Analysis for Quarantine Pests, Including Analysis of Environmental Risks and Living Modified Organisms" (IPPC, 2011). The use of biological and phytosanitary terms is consistent with the "Glossary of Phytosanitary Terms" (IPPC, 2012).

Three stages of pest risk analysis are described in international standards: Stage 1, Initiation; Stage 2, Risk Assessment; and Stage 3, Risk Management. This document satisfies the requirements of Stages 1 and 2. Stage 3, the identification of appropriate phytosanitary measures to mitigate the identified pest risk, is undertaken in a separate document and is not covered in this risk assessment.

This is a qualitative risk assessment. We express the risk based on qualitative ratings for the likelihood and consequences of pest introduction via the imported potato mini-tubers for propagation from the United Kingdom. The details of the methodology and rating criteria are found in the *Guidelines for Plant Pest Risk Assessment of Imported Fruit and Vegetable Commodities* (PPQ, 2012).

1.2. Initiating event

The importation of plants for planting into the United States is regulated under Title 7 of the Code of Federal Regulations, Part 319.37 (7 CFR §319.37, 2012). Currently, under this regulation, the entry of potato from the United Kingdom into the United States is not authorized. This risk assessment was prepared in response to a request from the Scottish Agricultural Science Agency (SASA) to change the Federal Regulation to allow entry (SASA, 2010).

1.3. Determination of the necessity of a weed risk assessment for the commodity

In some cases, the imported commodity may have the potential of becoming invasive in the pest risk analysis (PRA) area. The likelihood that this may happen is evaluated in a weed risk assessment, conducted separately from the commodity risk assessment. Weed risk assessments do not need to be conducted for plant species that are widely established (native or naturalized)

or cultivated in the PRA area, which is the case for potato (Kartesz, 2013). A weed risk assessment is therefore not needed for potato.

1.4. Description of the pathway

The IPPC (2011) defines a pathway as "any means that allows the entry or spread of a pest." In the context of commodity pest risk assessments, the pathway is the commodity to be imported, together with all the production, post-harvest, and shipping processes that the commodity undergoes and that may have an impact on pest risk. In this risk assessment, the specific pathway of concern is the importation of potato mini-tubers (*Solanum tuberosum* L.) for propagation from the United Kingdom into the United States; the movement of this commodity provides a potential pathway for the introduction and/or spread of plant pests.

The following description of this pathway focuses on the conditions that may affect plant pest risk, including morphological and physiological characteristics of the commodity, as well processes the commodity will undergo from production in the United Kingdom through importation and distribution in the United States. The pathway provides the basis for creating the pest list and assessing likelihood of introduction. Therefore, all components of the pathway, as they are described below, should be considered mandatory conditions for importation of the commodity.

1.4.1. Description of the commodity and production procedures in the exporting area

The commodity, potato micro-propagative material, consists of plants *in vitro* of tuber-forming *Solanum tuberosum* (IPPC, 2010). Per information supplied by the United Kingdom as part of this market access request, mini-tubers produced for export to the United States must be derived by micro-propagation from nuclear stock (pathogen-tested micro-plants) produced by the Scottish Agricultural Science Agency (SASA) and multiplied either at SASA or at a laboratory officially approved for the production of mini-tubers.

This scope of this risk assessment only includes propagative material produced in commercial potato micro-propagation laboratories approved by the Scottish Agricultural Science Agency (SASA) to multiply and maintain micro-plants for entry to the Scottish Seed Potato Classification Scheme. Per SASA (2010), potato mini-tubers for export to the United States must be produced in facilities that meet the requirements of pest-free places of production or pest-free production sites as defined in ISPM 33 (IPPC, 2010). Specifically, the facilities must meet the following conditions:

- Only pathogen-tested potato nuclear stock from SASA is handled at the premises.
- Laboratories and equipment are fit for the purpose and are well maintained.
- Staff are trained in potato micro-propagation techniques.
- Good laboratory practice is used.
- Detailed records are kept of the lineage of the material.
- Access to laboratories is restricted.
- Premises are audited by SASA inspectors at least once every 18 months (SASA, 2004a).
- Micro-propagative material is grown in pest-free growing medium.
- Production systems are hydroponics or peat based. Peat is tested for freedom from *Globodera rostochiensis* and *G. pallida* (potato cyst nematodes, PCN).

- Mini-tubers are grown at sites where *Synchytrium endobioticum* (potato wart disease) has never been found.
- The facilities are located in areas with naturally low aphid vector pressure and mini-tubers are produced in polythene tunnels or glasshouses with aphid proofing.
- Disinfection procedures are in place.
- The premises and growing crops are regularly inspected by SASA inspectors during the growing season; growing crops are subject to at least two official inspections by SASA inspectors and must be free from diseases, rogues, and off types.
- Mini-tubers are stored in a dedicated store with dedicated handling equipment.
- Harvested mini-tubers are inspected by SASA inspectors and must be free of pests and diseases and can have only minimal defects in accordance with the requirements of the Scottish Seed Potato Classification Scheme (Table 1).

Mini-tubers meeting the official tolerances during growing crop and tuber inspections (Table 1) are classified as Pre-basic TC class seed as specified in the Scottish Seed Potato Classification Scheme (SASA, 2004a). These certified seeds are the basis for subsequent production events. Samples of all marketed mini-tubers are planted at SASA to check for variety and trueness-to-type. Our analysis of risk is based on consistent, efficacious pathogen testing and application of phytosanitary measures to ensure that potato micro-propagative material is free from pathogens.

In prerequisite material provided to APHIS, SASA (2010) confirmed that nuclear rootstock is tested for the following pathogens (SASA, 2010):

Viroids: Potato spindle tuber viroid (PSTVd); **Bacteria**: *Pectobacterium chrysanthemi* (Pca), *Ralstonia solanacearum* (Rs), *Pectobacterium atrosepticum* and *P. carotovorum* subsp. *carotovorum* (Pa, Pcc), and *Clavibacter michiganensis* subsp. *sepedonicus* (Cms); **Viruses**: Alfalfa mosaic virus (AMV), Andean potato latent virus (APLV), Andean potato mottle virus (APMoV), Arracacha virus B-oca strain (AVB-O), Beet curly top virus (BCTV), Cucumber mosaic virus (CMV), Eggplant mottled dwarf virus (EDMV), Potato aucuba mosaic virus (PAMV), Potato black ringspot virus (PBRSV), Potato deforming mosaic virus (Brazil) (PDMV [Brazil]), Potato latent virus (PotLV), Potato leafroll virus (PLRV), Potato mop-top virus (PMTV), Potato rough dwarf virus (PRDV), Potato virus A (PVA), Potato virus M (PVM), Potato virus P (PVP), Potato virus S (PVS), Potato virus T (PVT), Potato virus U (PVU), Potato virus V (PVV), Potato virus X (PVX), Potato virus Y (PVY), Potato yellow dwarf virus (PYDV), Potato yellow mosaic virus (PYMV), Potato yellow vein virus (PYVV), Potato yellowing virus (PYV), Solanum apical leaf curling virus (SALCV), Sowbane mosaic virus (SoMV), Tobacco mosaic virus (TMV), Tobacco necrosis virus (TNV), Tobacco rattle virus (TRV), Tobacco streak virus (TSV), Tomato black ring virus (TBRV), Tomato mosaic virus (ToMV), Tomato spotted wilt virus (TSWV), and Wild potato mosaic virus (WPMV)

The testing is conducted in the following manner (SASA, 2004b):

- **For material submitted as tubers:** Tubers are washed, surface-sterilized, and then a heel-end core and an eye plug are taken from each tuber. The heel end core is tested for ring rot (*Clavibacter michiganensis* subsp. *sepedonicus*) and brown rot (*Ralstonia solanacearum*) bacteria. Tuber cores are also tested for PMTV. The eye plug is grown in a glasshouse and leaflets are tested for PSTVd and viruses. After micro-plants have

established from sprout buds, the candidate tubers are planted and leaflets from the resulting plants are tested for viruses. The basal piece of the initial micro-plant culture is tested for *Erwinia* spp.[1] (*Pectobacterium* spp.) and a subculture retested for PMTV.

- **For material submitted as micro-plant cultures from within the European Community:** Material is tested as five separate cultures. Initially, one culture is tested for PSTVd and one for quarantine bacteria. If these tests are negative, micro-plants are established from a third culture. The basal piece is tested for *Erwinia* bacteria[1], and subcultures are tested for PMTV. A glasshouse grown micro-plant is tested for PSTVd and viruses, and daughter tubers are tested for ring rot and brown rot bacteria. Micro-plants from the United Kingdom Potato Quarantine Unit at SASA are also subdivided and tested in this way. If all tests are negative, the micro-plant is transferred to the Nuclear Stock collection.

For the purpose of this risk assessment and as defined in ISPM 33 (IPPC, 2010), potato mini-tubers are tubers produced from potato micro-propagative material in pest-free growing media in a facility under specified protected conditions. Only risks associated with mini-tuber production units officially approved by SASA to produce mini-tubers for entry to the Scottish Seed Potato Classification Scheme are considered in this risk assessment. Production systems are hydroponic or peat based. Procedures and hygiene measures used at the mini-tuber production premises to minimize the risk of contamination by pathogens and infestation by pests include: only micro-plants derived from nuclear stock by an approved micro-propagation laboratory may be planted; peat is tested for freedom from *Globodera rostochiensis* and *G. pallida* (potato cyst nematodes, PCN); mini-tubers are grown at sites where *Synchytrium endobioticum* (potato wart disease) has never been found; the facilities are located in areas with naturally low aphid vector pressure; there is restricted access to the facilities; mini-tubers are produced in polythene tunnels or glasshouses with aphid proofing; micro-plants are grown in a pest-free medium; disinfection procedures are in place; staff are properly trained in procedures; detailed records are kept of the lineage of the material; the premises and growing crops are regularly inspected by SASA inspectors during the growing season; growing crops are subject to at least two official inspections by SASA inspectors and must be free from diseases, rogues, and off types; and mini-tubers are stored in a dedicated store with dedicated handling equipment (SASA, 2004a). Harvested mini-tubers are inspected by SASA inspectors and must be free from pests and diseases and have minimal defects in accordance with the requirements of the Scottish Seed Potato Classification Scheme (Table 1).

Mini-tubers meeting the official tolerances during growing crop and tuber inspections (Table 1) are classified as Pre-basic TC class seed as specified in the Scottish Seed Potato Classification Scheme (SASA, 2004a). Samples of all marketed mini-tubers are planted at SASA to check for variety and trueness-to-type. Our analysis of risk is based on consistent, efficacious pathogen testing and application of phytosanitary measures to ensure that potato micro-propagative material is free from pathogens. Per SASA (2010), potato mini-tubers for export to the United States must be produced in facilities that meet the requirements of pest-free places of production

[1] We consider these *Erwinia* species as synonyms of *Pectobacterium chrysanthemi*, *Pectobacterium atrosepticum*, and *P. carotovorum* subsp. *carotovorum*.

or pest-free production sites as defined in ISPM 33 (IPPC, 2010) to ensure that clear nuclear stock does not become infected during the propagation process.

Table 1. Tolerances for diseases, pests, damage, and defects at tuber inspection of Pre-basic TC seed class within the Seed Potato Classification Scheme (from SASA, 2004a).

Diseases, pests, damage and defects	**Individual tolerances**
Wart disease (*Synchytrium endobioticum*)	0%
Potato tuber eelworm (*Ditylenchus destructor*)	0%
Potato cyst nematode (*Globodera* species infesting potatoes)	0%
Ring rot (*Clavibacter michiganensis* subsp. *sepedonicus*)	0%
Brown rot (*Ralstonia solanacearum*)	0%
Potato tuber moth (*Phthorimea operculella*)	0%
Potato spindle tuber viroid	0%
Colorado beetle (*Leptinotarsa decemlineata*)	0%
Blight (*Phytophthora infestans*)	0%
Blackleg (*Erwinia carotovora* subsp. *atroseptica* or *E. chrysanthemi* or both)	0%
Gangrene/dry rot/wet rot	0%
Frost damaged tubers	0%
Skin spot (*Polyscytalum pustulans*)	0%
Black scurf (*Rhizoctonia solani*)	0%
Common scab (*Streptomyces* spp.)	0%
Powdery scab (*Spongospora subterranea*)	0%
External blemishes or tubers other than diseased tubers whose shape is atypical for the variety	3%
Dirt or other extraneous matter	1%

1.4.2. Post-harvest procedures in the exporting area

Post-harvest procedures in the exporting area have not been specified and are not being considered as part of the assessment.

1.4.3. Shipping and storage conditions

Shipping and storage conditions have not been specified and are not being considered as part of the assessment.

1.4.4. Summary of the pathway

Specific production practices outlined above were taken into consideration when creating this pest list. Insects are not associated with mini-tubers and therefore were not included in this list; the presence of any insect on commercially produced mini-tubers from the United Kingdom would represent a failure of the production environment and indicate a need to suspend imports.

2. Pest List and Pest Categorization

In this section, we identify the pests with actionable regulatory status for the United States that could become established in the United States as a result of the importation of potato micro-tubers from the United Kingdom, and we determine which of these pests meet the criteria for further analysis. Pests are considered to be of regulatory significance if they are actionable at U.S. ports-of-entry. Actionable pests include quarantine pests, pests considered for or under official control, and pests that require evaluation for regulatory action.

2.1. Pests considered but not included on the pest list

2.1.1. Organisms with non-actionable regulatory status

Appendix A lists those pests that are both associated with potato and present in the United Kingdom; however, because these organisms have non-actionable regulatory status for the United States, we did not include them in this risk assessment.

2.2. Pest list

In Table 2, we list the actionable pests associated with potato mini-tubers produced for propagation that occur in the United Kingdom. The list comprises those actionable pests that occur in the United Kingdom on any host and are reported to be associated with potato whether in the United Kingdom or elsewhere in the world. For each pest, we indicate 1) the part of the imported plant species with which the pest is generally associated, and 2) whether the pest has a reasonable likelihood of being associated, in viable form, with the potato mini-tubers produced under the system outlined by SASA. We developed this pest list based on the scientific literature, port-of-entry pest interception data, and information provided by the government of the United Kingdom.

Specific production practices outlined above were taken into consideration when creating this pest list. Insects are not associated with mini-tubers and therefore were not included in this list; the presence of any insect on commercially produced mini-tubers from the United Kingdom would represent a failure of the production environment and indicate a need to suspend imports.

Table 2. Actionable pathogens and nematodes reported on *Solanum tuberosum* (in any country) and present in the United Kingdom (on any host). Specific production practices outlined above were considered when determining whether a pest would be associated with the commodity at the time of export. Insects and mollusks are not expected to be present in the mini-tuber production system and presence of any species, regardless of regulatory status in the United States, is indicative of overall system failure and would constitute grounds for immediate suspension of market access. The one highlighted pests is of quarantine significance to the United States and is not explicitly considered in production practices as described by SASA.

Pest name	Evidence of presence in the United Kingdom	Host status	Plant part(s) association[2]	Present on mini-tubers?[3]	Remarks
BACTERIA					
'Dickeya solani'	Toth et al., 2011; Van Vaerenbergh et al., 2012; Elphinstone, 2012	Czajkowski et al., 2012; Van Vaerenbergh et al., 2012; Elphinstone, 2012	Tuber (Czajkowski et al., 2012; Czajkowski et al., 2011; Van Vaerenbergh et al., 2012; Elphinstone, 2012)	Yes	Documentation does not include testing for *Dickeya* spp. In Europe, isolates of *Erwinia chrysanthemi* (Syn: *Pectobacterium chrysanthemi*) biovar 1 and biovar 7 are now classified in *Dickeya dianthicola*. However, in the past few years, a new *Dickeya* biovar 3 variant, tentatively named '*Dickeya solani*,' was reported infecting potato plants.
Ralstonia solanacearum (Smith) Yabuuchi et al. R3 B2	EPPO, 1997	CABI, 2013	Root, stem, tubers (EPPO, 1997; CABI, 2013)	No (SASA, 2010)	Tolerance levels for certification for pre-basic seeds is 0 percent (SASA, 2004a) and testing is done to produce pathogen-free nuclear stock (SASA, 2010).

[2] The plant part(s) listed are those for the plant species under analysis. If the information is extrapolated, such as from plant part association on other plant species, this is noted.

[3] "Yes" indicates that the pest has a reasonable likelihood of being associated with the harvested commodity; the level of pest prevalence on the harvested commodity (low, medium, or high) is qualitatively assessed in risk element A1 as part of the likelihood of introduction assessment (section 3).

Pest name	Evidence of presence in the United Kingdom	Host status	Plant part(s) association[2]	Present on mini-tubers?[3]	Remarks
FUNGI					
Boeremia foveata (Foister) Aveskamp, Gruyter & Verkley Syn. ≡*Phoma exigua var. foveata* (Foister) Boerema	Aveskamp et al., 2010; CABI, 2013; Farr and Rossman, 2013	CABI, 2013; Smith et al., 1988	Root and tuber (CABI, 2013; Farr and Rossman, 2013)	No (SASA, 2010)	Tolerance levels for certification for pre-basic seeds is 0 percent (SASA, 2004a).
Synchytrium endobioticum (Schilb.) Percival	CABI, 2013	CABI, 2013; Farr and Rossman, 2013; SASA, 2004a, 2010	Tubers (SASA, 2004a, 2010)	No (SASA, 2004a, 2010)	Tolerance levels for certification for pre-basic seeds is 0 percent (SASA, 2004a). Potato tubers will be grown on soil-less media at sites where this pest has never been found.
NEMATODE					
Globodera pallida (Stone) Behrens	CABI, 2013	CABI, 2013	Roots, tuber, soil (CABI, 203)	No (SASA, 2004a, 2010)	Peat is tested for freedom from *G. pallida.* Potato tubers will be grown on soil-less media at sites where this pest has never been found. Tolerance levels for certification for pre-basic seeds is 0 percent (SASA, 2004a).
Globodera rostochiensis (Wollenweber) Behrens	CABI, 2013	CABI, 2013	Roots, tuber, soil (CABI, 203)	No (SASA, 2004a, 2010)	Peat is tested for freedom from *G. rostochiensis.* Peat is tested for freedom from *G. rostochiensis.* Potato tubers will be grown on soil-less media at sites where this pest has never been found. Tolerance levels for certification for pre-basic seeds is 0 percent (SASA, 2004a).

Pest name	Evidence of presence in the United Kingdom	Host status	Plant part(s) association[2]	Present on mini-tubers?[3]	Remarks
Meloidogyne minor Karssen et al.	CABI, 2013	Karssen et al., 2004	Roots, tuber, soil (CABI, 2013)	No (SASA, 2004a, 2010)	Present in the United States (WA) (McClure et al., 2012), but is considered actionable (PestID, 2013). Potato tubers will be grown on soil-less media at sites where this pest has never been found.
Ditylenchus destructor Thorne	CABI, 2013	CABI, 2013	Tuber, foliage (CABI, 2013)	No (SASA, 2010)	Present in the United States, but is considered actionable on commodities for planting (PestID, 2013). Potato tubers will be grown on soil-less media at sites where this pest has never been found. Tolerance levels for certification for pre-basic seeds is 0 percent (SASA, 2004a).
Ditylenchus dipsaci (Kühn) Filip'ev	CABI, 2013	CABI, 2013	Tuber, foliage (CABI, 2013)	No (SASA, 2010)	Present in the United States, but is considered actionable on commodities for planting (PestID, 2013). Potato tubers will be grown on soil-less media at sites where this pest has never been found.
VIRUSES					
Potato virus V (PVV)	Brunt et al., 1996	Brunt et al., 1996	Whole plant (Brunt et al., 1996)	No (SASA, 2010)	SASA (2010) confirmed that testing for PVV is done in the production of pathogen-free nuclear stock potato in the United Kingdom.

Pest name	**Evidence of presence in the United Kingdom**	**Host status**	**Plant part(s) association[2]**	**Present on mini-tubers?[3]**	**Remarks**
Tomato black ring virus (TBRV)	Brunt et al., 1996	Brunt et al., 1996	Whole plant (Brunt et al., 1996)	No (SASA, 2010)	SASA (2010) confirmed that TBRV testing is done in the production of pathogen-free nuclear stock potato in the United Kingdom.

3. Summary and Conclusions of Risk Assessment

Of the pests associated with potato mini-tubers worldwide and reported in the United Kingdom, we did not identify any that are actionable pests for the United States and have a reasonable likelihood of being associated with the commodity following harvesting from the field and prior to any post-harvest processing. Thus, we did not further evaluate any organisms for their likelihood and potential consequences of introduction. The results of this risk assessment represent a baseline estimate of the risks associated with the import commodity pathway as described in section 1.4.

Seed certification and specific production practices were taken into consideration when creating this pest list and conducting this analysis. If applied consistently and efficaciously, these factors will mitigate pest risks associated with this commodity. Insects are not associated with mini-tubers and therefore were not included in this analysis; as noted throughout this document, the presence of any insect on commercially produced mini-tubers from the United Kingdom would represent a failure of the production environment and indicate a need to suspend imports.

4. Acknowledgements

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6. Appendix A. Pests with non-actionable regulatory status

There is evidence of the below listed organisms being associated with potato and being present in the United Kingdom; however, because these organisms have non-actionable regulatory status for the United States, they are not included on the pest list (Table 2).

Below we list these organisms along with the references supporting their potential association with potato, their potential presence in the United Kingdom, their presence in the United States (if applicable), and their regulatory status for the United States. For organisms *not* present in the United States, we also provide justification for their non-actionable status.

Organism	**Evidence**
BACTERIA and PHYTOPLASMAS	
Burkholderia cepacia	CABI, 2013; present in the United States.
Clavibacter michiganensis subsp. *sepedonicus*	CABI, 2013; PestID, 2013
Dickeya chrysanthemi	CABI, 2013; PestID, 2013 as *Erwinia chrysanthemi.*
Dickeya dianthicola	CABI, 2013; present in the United States.
Dickeya zeae	CABI, 2013; present in the United States.
Pectobacterium atrosepticum	CABI, 2013; PestID, 2013 as *Erwinia atroseptica.*
Pectobacterium carotovorum subsp. *carotovorum*	CABI, 2013; PestID, 2013 as *Erwinia carotovora.*
Pseudomonas marginalis pv. *marginalis*	CABI, 2013; PestID, 2013
Pseudomonas syringae	CABI, 2013; PestID, 2013
Ralstonia solanacearum	CABI, 2013; PestID, 2013
Rhizobium radiobacter	CABI, 2013; PestID, 2013 as *Agrobacterium rhizogenes.*
FUNGI	
Alternaria radicina	CABI, 2013; PestID, 2013
Aspergillus niger	CABI, 2013; PestID, 2013
Botryotinia fuckeliana	CABI, 2013; PestID, 2013 as *Sclerotinia fuckeliana*.
Chalara elegans	CABI, 2013; PestID, 2013 as *Thielaviopsis basicola*.
Cochliobolus lunatus	CABI, 2013; PestID, 2013
Didymella lycopersici	CABI, 2013; PestID, 2013 as *Boeremia lycopersici*.
Fusarium culmorum	CABI, 2013; PestID, 2013
Fusarium oxysporum	CABI, 2013; PestID, 2013
Gibberella avenacea	CABI, 2013; PestID, 2013

Gibberella zeae	CABI, 2013; PestID, 2013
Glomerella cingulata	CABI, 2013; PestID, 2013
Golovinomyces orontii	CABI, 2013; present in the United States.
Haematonectria haematococca	CABI, 2013; PestID, 2013
Helminthosporium solani	CABI, 2013; PestID, 2013
Leveillula taurica	CABI, 2013: PestID, 2013
Macrophomina phaseolina	CABI, 2013: PestID, 2013
Olpidium brassicae	CABI, 2013; present in the United States.
Phytophthora citrophthora	CABI, 2013; PestID, 2013
Phytophthora cryptogea	CABI, 2013; present in the United States.
Phytophthora erythroseptica var. *erythroseptica*	CABI, 2013; PestID, 2013
Phytophthora infestans	CABI, 2013; PestID, 2013
Phytophthora megasperma	CABI, 2013; present in the United States.
Polyscytalum pustulans	CABI, 2013; PestID, 2013
Pythium aphanidermatum	CABI, 2013; PestID, 2013
Pythium vexans	CABI, 2013; present in the United States.
Rosellinia necatrix	CABI, 2013; present in the United States.
Sclerotinia sclerotiorum	CABI, 2013; PestID, 2013
Spongospora subterranea f.sp. *subterranea*	CABI, 2013; PestID, 2013
Streptomyces scabiei	CABI, 2013; PestID, 2013
Thanatephorus cucumeris	CABI, 2013; PestID, 2013
Ulocladium atrum	CABI, 2013; present in the United States.
Verticillium albo-atrum	CABI, 2013, PestID, 2013
Verticillium dahliae	CABI, 2013; PestID, 2013
INSECTS	
Coleoptera	
Araecerus fasciculatus (Anthribidae)	CABI, 2013; PestID, 2013
Hypera postica (Curculionidae)	CABI, 2013; PestID, 2013
Alphitobius laevigatus (Tenebrionidae)	CABI, 2013; PestID, 2013
Diptera	
Delia platura (Anthomyiidae)	CABI, 2013; PestID, 2013
Liriomyza sativae (Agromyzidae)	CABI, 2013; PestID, 2013
Liriomyza trifolii (Agromyzidae)	CABI, 2013; PestID, 2013
Hemiptera	
Adelphocoris lineolatus (Miridae)	CABI, 2013; PestID, 2013
Aphis craccivora (Aphididae)	CABI, 2013; PestID, 2013

Aphis fabae (Aphididae)	CABI, 2013; PestID, 2013
Aphis frangulae (Aphididae)	Panayotou and Katis, 1986; PestID, 2013
Aphis gossypii (Aphididae)	CABI, 2013; PestID, 2013
Aphis spiraecola (Aphididae)	CABI, 2013; PestID, 2013
Aulacorthum solani (Aphididae)	CABI, 2013; PestID, 2013
Bemisia tabaci (Aleyrodidae)	CABI, 2013; PestID, 2013
Hyalopterus pruni (Aphididae)	CABI, 2013; PestID, 2013
Hyperomyzus lactucae (Aphididae)	CABI, 2013; PestID, 2013
Macrosiphum euphorbiae (Aphididae)	CABI, 2013; PestID, 2013
Myzus persicae (Aphididae)	CABI, 2013; PestID, 2013
Nezara viridula (Pentatomidae)	CABI, 2013 (host genus); PestID, 2013
Nipaecoccus nipae (Pseudococcidae)	CABI, 2013; PestID, 2013
Philaenus spumarius (Cercopidae)	CABI, 2013; PestID, 2013
Planococcus citri (Pseudococcidae)	CABI, 2013; PestID, 2013
Pseudococcus calceolariae (Pseudococcidae)	CABI, 2013; PestID, 2013
Pseudococcus jackbeardsleyi (Pseudococcidae)	CABI, 2013; PestID, 2013
Pseudococcus longispinus (Pseudococcidae)	CABI, 2013; PestID, 2013
Rhopalosiphum maidis (Aphididae)	CABI, 2013; PestID, 2013
Trialeurodes vaporariorum (Aleyrodidae)	CABI, 2013; PestID, 2013
Lepidoptera	
Ephestia kuehniella (Pyralidae)	CABI, 2013; PestID, 2013
Hydraecia micacea (Noctuidae)	CABI, 2013; PestID, 2013
Mythimna unipuncta (Noctuidae)	CABI, 2013; PestID, 2013
Noctua pronuba (Noctuidae)	CABI, 2013; PestID, 2013
Ostrinia nubilalis (Pyralidae)	CABI, 2013; PestID, 2013
Peridroma saucia (Noctuidae)	CABI, 2013; PestID, 2013
Phthorimaea operculella (Gelechiidae)	CABI, 2013; PestID, 2013
Spodoptera exigua (Noctuidae)	CABI, 2013; PestID, 2013
Trichoplusia ni (Noctuidae)	CABI, 2013; PestID, 2013
Xestia c-nigrum (Noctuidae)	CABI, 2013; PestID, 2013
Orthoptera	
Gryllotalpa gryllotalpa (Gryllotalpidae)	CABI, 2013; PestID, 2013
Thysanoptera	
Thrips tabaci (Thripidae)	CABI, 2013; PestID, 2013
MITES	
Aculops lycopersici (Eriophyidae)	CABI, 2013; PestID, 2013
Polyphagotarsonemus latus (Tarsonemidae)	CABI, 2013; PestID, 2013
Tetranychus cinnabarinus (Tetranychidae)	CABI, 2013; PestID, 2013
MOLLUSKS	
Arion hortensis	CABI, 2013; Airey, 1987;

	PestID, 2013 (HI, PR)
Deroceras reticulatum	CABI, 2013; Airey, 1987; PestID, 2013
NEMATODES	
Ditylenchus destructor	CABI, 2013; PestID, 2013
Ditylenchus dipsaci	CABI, 2013; PestID, 2013
Helicotylenchus dihystera	CABI, 2013; PestID, 2013
Helicotylenchus pseudorobustus	CABI, 2013; PestID, 2013
Meloidogyne arenaria	CABI, 2013; PestID, 2013
Meloidogyne hapla	CABI, 2013; PestID, 2013
Meloidogyne incognita	CABI, 2013; PestID, 2013
Pratylenchus penetrans	CABI, 2013; PestID, 2013
Pratylenchus thornei	CABI, 2013; PestID, 2013
Trichodorus viruliferus	CABI, 2013; present in the United States.
Tylenchorhynchus claytoni	CABI, 2013; PestID, 2013
Xiphinema americanum	CABI, 2013; PestID, 2013
Xiphinema diversicaudatum	CABI, 2013; present the United States.
Zygotylenchus guevarai	CABI, 2013; present the United States.
VIRUSES AND VIROIDS	
Alfalfa mosaic virus	CABI, 2013; present in the United States (Brunt et al., 1996).
Cucumber mosaic virus	CABI, 2013; PestID, 2013
Impatiens necrotic spot virus (TSWV-I)	CABI, 2013; present in the United States (Brunt et al., 1996).
Potato leafroll virus	CABI, 2013; present in the United States.
Potato mop-top virus	CABI, 2013; present in the United States..
Potato spindle tuber viroid	CABI, 2013; present in the United States.
Potato virus M	CABI, 2013; present in the United States.
Potato virus Y	CABI, 2013; present in the United States.
Strawberry latent ringspot virus	CABI, 2013; present in the United States. (Brunt et al., 1996).
Tobacco necrosis virus	CABI, 2013; present in the United States.

Tobacco rattle virus	CABI, 2013; present in the United States (Brunt et al., 1996).
Tobacco ringspot virus	CABI, 2013; present in the United States (Brunt et al., 1996).
Tobacco streak virus	CABI, 2013; present in the United States (Brunt et al., 1996).
Tomato spotted wilt virus	CABI, 2013; present in the United States (Brunt et al., 1996).
Pepino mosaic virus	CABI, 2013; present in the United States.