Importation of Fresh Pepper Fruit with Stems (*Capsicum annuum* L., *C. frutescens* L., *C. baccatum* L., *C. pubescens* Ruiz & Pav., and *C. chinense* Jacq.) from Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua into the United States

A Qualitative, Pathway-Initiated 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 qualitative pest risk assessment to examine plant pest risks associated with the importation of fresh pepper fruit with stems, specifically the domesticated species *C. annuum* L., *C. frutescens* L., *C. baccatum* L., *C. pubescens* Ruiz & Pav., and *C. chinense* Jacq., from Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua into the United States.

A list of pests that attack peppers and were present in one or more of the exporting countries was developed by searching scientific literature, previous APHIS commodity risk assessments for peppers, U.S. port interception records, and information provided by the exporting countries. Two hundred and twenty nine pests were identified in this document, and 71 of them were determined to be quarantine pests of the United States. Twelve of the 71 quarantine pests were deemed likely to follow the pathway, which is any means that allows the entry and spread of a pest. The twelve pests deemed likely to follow the pathway and analyzed in this document include two fruit flies (Diptera: Tephritidae), *Anastrepha ludens* and *Ceratitis capitata*, one weevil (Coleoptera: Curculionidae), *Faustinus ovatipennis*, one leaf mining fly (Diptera: Agromyzidae), *Liriomyza huidobrensis*, one snout moth (Lepidoptera: Pyralidae), *Neoleucinodes elegantalis*, one fungus moth (Lepidoptera: Tineidae), *Opogona sacchari*, two mealybugs (Hemiptera: Pseudococcidae), *Phenacoccus parvus* and *Planococcus minor*, one thrips (Thysanoptera: Thripidae), *Thrips palmi*, one rust fungus (Uredinales: Pucciniaceae), *Puccinia pampeana*, one comovirus (Comoviridae), Andean potato mottle virus and one geminivirus (Geminiviridae), Tomato yellow mosaic virus.

All of the organisms analyzed in this document pose phytosanitary risks to American agriculture and/or ecosystems. Pest Risk Potentials, which are summations of the Consequences of Introduction and Likelihood of Introduction values, were estimated as High for *Anastrepha ludens*, *Ceratitis capitata*, *Liriomyza huidobrensis*, *Neoluecinodes elegantalis*, *Opogona sacchari*, *Phenacoccus parvus*, *Planococcus minor*, *Thrips palmi* and *Puccinia pampeana*. *Thrips palmi* is established in the United States and is not under official control, thus the Pest Risk Potential has been down rated from a High to a Medium in this document. The remaining pests, *Faustinus ovatipennis*, Andean potato mottle virus and Tomato yellow mosaic virus were assigned Medium Pest Risk Potentials. Consequences of Introduction values were estimated by assessing the climate/host interaction, the host range, the dispersal potential, the economic impact, and the environmental impact of each pest. Likelihood of Introduction values were estimated by considering the quantity of commodity that would be imported annually and the potential for pest introduction and establishment. Details of the methods and criteria used to analyze these pests can be found in *Guidelines for Pathway-Initiated Pest Risk Assessment, version 5.02* (USDA 2000).

Specific phytosanitary measures may be necessary for pests with Medium Pest Risk Potentials and are strongly recommended for those with High Pest Risk Potentials. The choice of appropriate measures to mitigate risk is part of Risk Management and is not addressed in this document.

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I. Introduction

The Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) prepared this pest risk assessment to examine plant pest risks associated with the importation of fresh pepper fruit with stems (*Capsicum* spp., specifically the domesticated species *C. annuum* L., *C. frutescens* L., *C. baccatum* L., *C. pubescens* Ruiz & Pav., and *C. chinense* Jacq.) from Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua into the United States. This is a qualitative risk assessment, where estimates of risk are expressed by the terms "high", "medium" or "low", rather than probabilities or frequencies. Details of the methods and criteria used to analyze these pests can be found in the *Guidelines for Pathway-Initiated Pest Risk Assessments, version 5.02* (USDA 2000).

Regional and international plant protection organizations such as the North American Plant Protection Organization (NAPPO) and the International Plant Protection Convention (IPPC) administered by the Food and Agriculture Organization (FAO) of the United Nations, provide guidance for conducting pest risk assessments. The methods used to initiate, conduct and report plant pest risk in this assessment are consistent with the guidelines provided by FAO and NAPPO. The use of biological and phytosanitary terms conforms with the Definitions and Abbreviations (Introduction Section) in *International Standards for Phytosanitary Measures, Section 1-Import Regulations: Guidelines for Pest Risk Analysis* (IPPC 1996), and the *Glossary of Phytosanitary Terms* (IPPC 2001). These guidelines describe three stages of pest risk analysis: Stage 1 (initiation), Stage 2 (risk assessment) and Stage 3 (risk management). This document satisfies the requirements of FAO Stages 1 and 2.

Cultivated peppers are indigenous to Latin America, and most botanists believe that *C. annuum* originated in Mexico, while the other four cultivated species were developed in South America (CABI 2003; Pernezny, Roberts et al. 2003). Two of the domesticated species, *C. annuum* and *C. frutescens*, are grown on every continent; the three remaining species, *C. baccatum*, *C. pubescens* and *C. chinense*, are rarely found outside of South America (CABI 2003). Peppers are an important economic crop in many parts of the world (Pernezny, Roberts et al. 2003), and world production of fresh pepper fruit was estimated at 14 million metric tons in 1996 (CABI 2003). Asian countries produce the majority of these peppers, but the United States and Mexico are principal producers in the Americas (CABI 2003). Peppers are harvested with their stems intact to prevent bacterial infection (Schooley 2003). Stems were considered as a potential pathway for the introduction of exotic pests in this document.

II. Risk Assessment

A. Initiating Event: Proposed Action

This commodity-based, pathway-initiated risk assessment was conducted in response to a request by the governments of Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua for USDA authorization to allow importation of fresh fruits of pepper (*Capsicum* spp.). Importation into the United States of fresh pepper fruits with stems (*Capsicum* spp.) that were grown in Costa

Rica, El Salvador, Guatemala, Honduras and Nicaragua presents a potential pathway for the introduction of plant pests. Title 7, Section 319, Part 56 of the U.S. Code of Federal Regulations (7CFR §319.56) provides regulatory authority for the importation of fruits and vegetables from foreign sources into the United States.

B. Assessment of the Weed Potential of Peppers, *Capsicum* spp.

The potential of the commodity to become a weed after it enters the United States was examined in this step, and a pest-initiated risk assessment was not conducted because the analysis did not indicate that the commodity had significant weed potential (**Table 1**).

Table 1. Assessment of the Weed Potential of *Capsicum annuum* L., *C. baccatum* L., *C. chinense* Jacq., *C. frutescens* L., and *C. pubescens* Ruiz & Pav. (Solanaceae).

Table 1a. Process for determining the weed potential of *Capsicum annuum* Linnaeus (Solanaceae)	
	Common Names: Bell pepper, sweet pepper, chili pepper, green pepper, paprika, cayenne pepper, aji, chiltepines. Synonyms: *Capsicum cordiforme* Mill (USDA-ARS 2004; USDA-NRCS 2004)
Phase 1:	Distribution in the USA: *Capsicum annuum* is an important commodity that is widely cultivated throughout the world including in the United States (CABI 2003). Its fruit is used as a condiment in many foods, while the plants are used decoratively in home landscapes.
Phase 2:	Invasive / Weed Status: Listing as weed
No	(Holm, Plucknett et al. 1977; Reed 1977; Gunn and Ritchie 1982; Holm, Doll et al. 1997; Swearingen 2003; Weber 2003; ISSG 2004; Skinner, Smith et al. 2004; USDA 2004; WSSA 2004).
Yes	Geographical Atlas of World Weeds (Holm, Pancho et al. 1991).
Yes	A Global Compendium of Weeds (Randall 2002).
Yes	Alien Plant Invaders of Natural Areas (Swearingen 2003)

Table 1a. Process for determining the weed potential of *Capsicum annuum* Linnaeus (Solanaceae)	
Phase 3:	Summary and Conclusions: Although *C. annuum* has been listed as a weed and a naturalized species for some countries (Holm, Pancho et al. 1991; Randall 2002), it does not appear to be particularly invasive in either natural or agricultural systems. It is recommended that this species be considered for import following an appropriate pest risk assessment for the exporting country. However, because there is still some taxonomic uncertainty regarding its species status (Walsh and Hoot 2001) and because wild populations of *C. annuum* integrate with that of *C. frutescens* and *C. chinense (Eshbaugh 1993)*, all pest risk assessments for *C. annuum* should also include *C. frutescens* and *C. chinense*. Furthermore, because of the wide overlap of common name usage among all domesticated *Capsicum* species (Bosland 1996), the other two cultivated species (*C. pubescens* and *C. baccatum*) should also be included, especially if the exporting country is in South or Central America where these species are locally cultivated. Conclusion: Proceed with the pest risk assessment.

Table 1b. Process for determining the weediness potential of *Capsicum baccatum* L. (Solanaceae)	
	Common Names: Aji; Yellow Aji; Aji limon; Aji mono; Aji norteno; Aji ayucllo; Locoto. Synonyms: None: (USDA-ARS 2004; USDA-NRCS 2004)
Phase 1:	Distribution in the USA: *Capsicum baccatum* fruits are an important commodity in South America where they are used as a condiment in many foods (Eshbaugh 1993). Although, it is not officially grown in the United States, it may occur in private gardens of Chile-pepper enthusiasts.
Phase 2:	Invasive / Weed Status: Listing as weed
No	(Holm, Plucknett et al. 1977; Reed 1977; Gunn and Ritchie 1982; Holm, Doll et al. 1997; Swearingen 2003; Weber 2003; ISSG 2004; Skinner, Smith et al. 2004; USDA 2004; WSSA 2004).
Yes	Geographical Atlas of World Weeds (Holm, Pancho et al. 1991).
Yes	A Global Compendium of Weeds (Randall 2002).

Table 1b. Process for determining the weediness potential of *Capsicum baccatum* L. (Solanaceae)	
Phase 3:	Summary and Conclusions: Although *C. baccatum* has been listed as a weed in two countries (Holm, Pancho et al. 1991; Randall 2002), it does not appear to be particularly invasive. It is recommended that this species be considered for import following completion of this pest risk assessment for the exporting country. However, because of the wide overlap of common name usage among all domesticated *Capsicum* species (Bosland 1996), and because of some similarities in fruit morphologies among the five domesticated species (Eshbaugh 1993), all pest risk assessments for *C. baccatum* should also include the other four domesticated species of *Capsicum* (*C. annuum*, *C. frutescens*, *C. chinense* and *C. pubescens*). Conclusion: Proceed with the pest risk assessment.

Table 1c. Process for determining the weediness potential of *Capsicum chinense* Jacq. (Solanaceae)	
	Common Names: Bonnet pepper; Datil pepper; Habanero pepper; Piripiri pepper; Squash pepper; Yellow squash pepper; Rocotillo Synonyms: (USDA-ARS 2004; USDA-NRCS 2004)
Phase 1:	Distribution in the USA: Native to the American tropics, *C. chinense* is a popular pepper species that is cultivated in Brazil and throughout the Caribbean (Bosland and Votava. 2000). Though not commercially grown in the United States (USDA-NASS 2003), it is grown in the private backyards of Chile-pepper enthusiasts (World Wide Web, personal observation).
Phase 2:	Invasive / Weed Status: Listing as weed
<u>No</u>	(Holm, Plucknett et al. 1977; Reed 1977; Gunn and Ritchie 1982; Holm, Pancho et al. 1991; Holm, Doll et al. 1997; Randall 2002; Swearingen 2003; Weber 2003; ISSG 2004; Skinner, Smith et al. 2004; USDA 2004; WSSA 2004).

Table 1c. Process for determining the weediness potential of *Capsicum chinense* Jacq. (Solanaceae)	
Phase 3:	Summary and Conclusions: *Capsicum chinense* has not been listed as a weed or naturalized species. It is recommended that this species be considered for import following an appropriate pest risk assessment for the exporting country. However, because there is still some taxonomic uncertainty regarding its species status (Walsh and Hoot 2001) and because wild populations of *C. chinense* integrate with that of *C. annuum* and *C. frutescens* (Eshbaugh 1993), all pest risk assessments for *C. chinense* should also include *C. annuum* and *C. frutescens*. Furthermore, because of the wide overlap of common name usage among all domesticated *Capsicum* species (Bosland 1996), the other two cultivated species (*C. pubescens* and *C. baccatum*) should also be included, especially if the exporting country is in South or Central America where these species are locally cultivated. Conclusion: Proceed with the pest risk assessment.

Table 1d. Process for determining the weediness potential of *Capsicum frutescens* Linnaeus (Solanaceae)	
	Common Names: Bird pepper; Cayenne pepper; Chili pepper; Tabasco pepper; Aji; Chile Synonyms: *Capsicum fastigiatum* Blume; *Capsicum annuum* L. var. *frutescens* (L.) Kuntze; *Capsicum minimum* (USDA-ARS 2004; USDA-NRCS 2004)
Phase 1:	Distribution in the USA: *Capsicum frutescens* fruits are an important commodity that are used as a condiment in many foods and have been widely distributed and cultivated, including in the Untied States (USDA-NASS 2003).
Phase 2:	Invasive / Weed Status: Listing as weed
<u>No</u>	(Holm, Plucknett et al. 1977; Reed 1977; Gunn and Ritchie 1982; Holm, Doll et al. 1997; Swearingen 2003; Weber 2003; ISSG 2004; Skinner, Smith et al. 2004; USDA 2004; WSSA 2004)..
<u>Yes</u>	Geographical Atlas of World Weeds (Holm, Pancho et al. 1991).
<u>Yes</u>	A Global Compendium of Weeds (Randall 2002).

Table 1d. Process for determining the weediness potential of *Capsicum frutescens* Linnaeus (Solanaceae)	
Phase 3:	Summary and Conclusions: Although *Capsicum frutescens* has been listed as a weed and a naturalized species for about a dozen countries (Holm, Pancho et al. 1991; Randall 2002), it does not appear to be particularly invasive in either natural or agricultural systems. It is recommended that this species be considered for import following an appropriate pest risk assessment for the exporting country. However, because there is still some taxonomic uncertainty regarding its species status (Walsh and Hoot 2001) and because wild populations of *C. frutescens* integrate with that of *C. annuum* and *C. chinense* (Eshbaugh 1993), all pest risk assessments for *C. frutescens* should also include *C. annuum* and *C. chinense*. Furthermore, because of the wide overlap of common name usage among all domesticated *Capsicum* species (Bosland 1996), the other two cultivated species (*C. pubescens* and *C. baccatum*) should also be included, especially if the exporting country is in South or Central America where these species are locally cultivated. Conclusion: Proceed with the pest risk assessment.

Table 1e. Process for determining the weediness potential of *Capsicum pubescens* Ruiz. & Pav (Solanaceae)	
	Common Names: Apple chile; Rocoto; Lacoto; Chile caballo. Synonyms: *Brachistus lanceaefolius* Miers; *Capsicum guatemalense* Bitter; *C. lanceaefolium* (Miers) Kuntze; *C. violaceum* Kunth. (USDA-ARS 2004; USDA-NRCS 2004)
Phase 1:	Distribution in the USA: *Capsicum pubescens* is native to and cultivated in South America (Bosland and Votava. 2000). It is probably cultivated in U. S. private gardens by chile-pepper enthusiasts.
Phase 2:	Invasive / Weed Status: Listing as weed
<u>No</u>	(Holm, Plucknett et al. 1977; Reed 1977; Gunn and Ritchie 1982; Holm, Pancho et al. 1991; Holm, Doll et al. 1997; Randall 2002; Swearingen 2003; Weber 2003; ISSG 2004; Skinner, Smith et al. 2004; USDA 2004; WSSA 2004).

Table 1e. Process for determining the weediness potential of *Capsicum pubescens* Ruiz. & Pav (Solanaceae)	
Phase 3:	Summary and Conclusions: *Capsicum pubescens* is unlikely to become a problematic species in the United States. It is recommended that this species be considered for import following an appropriate pest risk assessment for the exporting country. However, because of the wide overlap of common name usage among all domesticated *Capsicum* species (Bosland 1996), and because of some similarities in fruit morphologies among the five domesticated species (Eshbaugh 1993), all pest risk assessments for *C. baccatum* should also include the other four domesticated species of *Capsicum* (*C. annuum*, *C. frutescens*, *C. chinense* and *C. pubescens*). Conclusion: Proceed with the pest risk assessment.

C. Previous Risk Assessments, Current Status and Pest Interceptions

Previous Risk Assessments

No pest risk assessments have been completed for *Capsicum* spp. from Central America. Below are risk assessments completed on *Capsicum* spp. or other Solanaceous species from Central and South America (http://www.aphis.usda.gov/ppq/pra/).

1996 – Importation of fresh pepper fruit, *Capsicum annuum* from Chile into the continental United States. USDA-APHIS-PPQ, Riverdale, MD (contacts: Russell D. Stewart, Scott C. Redlin, and Edward V. Podleckis)
1996 – Importation of *Solanum melongena* (eggplant) fruits for consumption from El Salvador and Nicaragua into the United States. USDA-APHIS-PPQ, Riverdale MD (contact: John Lightfield)

Decision History for *Capsicum* spp. from Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua

Costa Rica

1936 – Approved entry of fresh *Capsicum* spp. into all ports of entry
1971 – Deny entry of *Capsicum* spp. into the ports requested (New York ports of entry)
1994 – Deny entry of *Capsicum* spp. (no approved treatment for *Ceratitis capitata*)
1996 – Deny entry of *Capsicum* spp. (no approved treatments available)
1997 – Approve entry of *Capsicum* spp. from the Almeria Province only, registered/inspect

El Salvador

No decision history reports on file for El Salvador.

Guatemala

1981 – Deny entry of fresh *Capsicum* spp. (no acceptable treatment available for *Ceratitis capitata*)

1988 – Deny entry of fresh *Capsicum* spp. (no acceptable treatment)

Honduras

1984 – Deny entry of fresh *Capsicum* spp. (no approved treatment available for *Ceratitis capitata* in peppers)

Nicaragua

1971 – Deny entry of fresh *Capsicum* spp. (lack of effective treatment for *Ceratitis capitata*)

Decision history for *Capsicum* spp. from neighboring countries:

Panama

1981 – Deny entry of fresh *Capsicum* spp. (lack of effective treatment for *Ceratitis capitata*)

Current Status

Title 7, Section 319, Part 56 of the U.S. Code of Federal Regulations (7 CFR §319.56) does not currently permit importation of fresh fruits of *Capsicum* spp. from Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua.

Appendix 1 lists pest interceptions on peppers from Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua since 1985 (PIN309 query September 10, 2003).

D. Pest Categorization

Plant Protection and Quarantine (PPQ) adheres to the accepted international definition(s) of a quarantine pest, a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (IPPC 1996; IPPC 2001). The first step in identifying quarantine pests is to develop a comprehensive list of pests that are associated with the parent species of the proposed export and are known to occur in the country or region from which the commodity is to be exported. All pests on such a list are considered to be "of potential economic importance" because they are associated with the plant species (IPPC 1996).

Table 2 shows the pest list for *Capsicum* spp. from Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua. This list identifies: (1) the geographic distribution of the pests with respect to the exporting countries and the United States, (2) the generally affected plant part or parts, (3) the quarantine status of each pest with respect to the United States, (4) whether the pest is likely to follow the pathway and enter the United States on commercially exported *Capsicum*

spp. fruit, and (5) pertinent citations for the distribution and biology of the pest. Many of the organisms in **Table 2** were eliminated from further consideration as sources of phytosanitary risk because they do not satisfy the definition of a quarantine pest and/or they were unlikely to follow the pathway.

Quarantine pests that were reasonably expected to follow the pathway, *i.e.*, be included in commercial shipments of *Capsicum* spp. fruit, were analyzed in detail (USDA 2000). Other plant pests in this assessment, not chosen for further scrutiny, may be potentially detrimental to the agricultural production systems and/or ecosystems of the United States; however, there were a variety of reasons for not subjecting them to further analysis. For example, they were associated mainly with plant parts other than the commodity; they may be associated with the commodity, but it was not considered reasonable to expect these pests to remain with the commodity during processing; they have been intercepted as biological contaminants of these commodities during inspection at ports-of-entry but would not be expected to be present with every shipment. Pest risk analyses, by necessity, must focus on organisms for which biological information is available; therefore, none of the pests listed at the level of genus or higher were selected for further analyses because specific information was lacking. Lack of specific information or identification to the specific level does not indicate that a pest does not pose a serious phytosanitary risk to agriculture in the United States. It may simply indicate the quality of the specimen or the limits of current taxonomic knowledge. If pests identified to higher taxa are intercepted in the future, a reevaluation of their risk may occur.

Table 2. Pests reported on peppers (*Capsicum annuum, C. baccatum, C. chinense, C. frutescens, C. pubescens*) and reported as present in Costa Rica, El Salvador, Guatemala, Honduras and/or Nicaragua.

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
ARTHROPODS						
ACARI						
Eriophyidae						
Aculops lycopersici (Tryon)	EL, US	A, F	F, I, L	No	Yes	(Armine and Stansy 1994; Baker, Kono et al. 1996; Saninet 2002; CABI 2003; Castillo 2003)
Tarsonemidae						
Phytonemus pallidus (Banks)	CR, US	A, S	I, L	No	No	(Chinchilla and Ujueta 2002; CABI 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Polyphagotarsonemus latus Banks	CR, EL, HO, NI, US	A, F, S	F, I, L, S	No	Yes	(Jeppson, Keifer et al. 1975; Chinchilla and Ujueta 2002; Saninet 2002; CABI 2003)
Tetranychidae						
Tetranychus cinnabarinus (Boisduval)	CR, US	S	F, L, S	No	Yes	(Jeppson, Keifer et al. 1975; Saninet 2002; CABI 2003)
Tetranychus ludeni Zacher	CR, EL, HO, NI, US	S	L	No	No	(Jeppson, Keifer et al. 1975; Bolland, Gutierrex et al. 1998; CABI 2003)
Tetranychus marianae McGregor	CR, HO, NI, US	A	L	No	No	(Jeppson, Keifer et al. 1975; Cole and Jackman 1997; Bolland, Gutierrex et al. 1998; CABI 2003)
Tetranychus neocaledonicus André	CR, HO, US	A	L	No	No	(Jeppson, Keifer et al. 1975; Bolland, Gutierrex et al. 1998; CABI 2003)
Tetranychus urticae Koch	CR, EL, GU, HO, US	A, S	F, L, S	No	Yes	(Jeppson, Keifer et al. 1975; Bolland, Gutierrex et al. 1998; Chinchilla and Ujueta 2002; Saninet 2002; CABI 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Tenuipalpidae						
Brevipalpus obovatus Donnadieu	CR, US	S	L, S	No	Yes [4]	(Jeppson, Keifer et al. 1975; Chinchilla and Ujueta 2002; CABI 2003)
COLEOPTERA						
Anobiidae						
Lasioderma serricorne Fabricius	GU, US	S	L, R, Sd	No	No [14]	(Padwal Desai, Sharma et al. 1987; Pedersen 1992; CABI 2003)
Bostrichidae						
Rhyzopertha dominica (Fabricius)	HO, NI, US	F	F, Sd	No	No [14]	(Padwal Desai, Sharma et al. 1987; CABI 2003)
Chrysomelidae						
Cerotoma atrofaciata Jacoby	EL	A	L	Yes	No	(Castillo 2003)
Cerotoma ruficornis (Olivier) (= *Andrector ruficornis* (Olivier))	CR, EL, EU, GU, HO, NI	A	L	Yes	No	(Blackwelder 1944; Hobbs 1981; Saninet 2002; CABI 2003)
Diabrotica balteata Leconte	CR, EL, GU, HO, NI, US	A	F, I, L, R	No	No [5]	(Granardos 2001; Saninet 2002; CABI 2003; Castillo 2003)
Diabrotica sp.	CR, HO	S	F, I, L, R, S	Yes	No [5]	(Granardos 2001; Chinchilla and Ujueta 2002; Puerto 2003)
Diabrotica speciosa Germar	CR	S	F, I, L, R, S	Yes	No [5]	(CABI 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Diabrotica undecimpunctata Mannerheim	EL, GU, NI, US	A, S	F, I, L, R, S	No	No [5]	(Antonious and Byers 1994; CABI 2003)
Disonycha eximia Harold (= *D. laevigata* (Jacoby))	CR	A	L, R [7]	Yes	No	(Virkki, Santiago-Blay et al. 1991; Bechyne 1997; Saninet 2002; CABI 2003)
Epitrix cucumeris (Harris)	EL, HO, US	A	L	No	No	(CABI 2003; Castillo 2003; Puerto 2003)
Epitrix sp.	CR	S	L, R	Yes	No	(Borror, Triplehorn et al. 1989; Chinchilla and Ujueta 2002)
Curculionidae						
Anthonomus eugenii Cano	CR, EL, GU, HO, NI, US	A, B, F, S	F, I, L	No	Yes	(O'Brien and Wibmer 1982; Mau and Kessing 1994; Chinchilla and Ujueta 2002; CABI 2003)
Diaprepes abbreviatus (Linnaeus)	CR, HO, US (FL, MS)	A	I, L, R	Yes	No	(CABI 2003; Puerto 2003)
Faustinus ovatipennis (Champion)	GU, HO	S	F, I, L, S [8]	Yes	Yes [8]	(Blackwelder 1944; O'Brien and Wibmer 1982; USDA 2003)
Geraeus sp.	HO	A, F	F	Yes	No [9]	(Caballero-Munoz and Toro-Restrepo 1994; Nearctica 2003; Puerto 2003)
Metamasius callizona (Chevrolat)	GU, US (FL)	S	R, S	[Yes] [22]	No [10]	(Blackwelder 1944; Larson and Frank 2000)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Phyrdenus muriceus Germar	CR	S	L, R	Yes	No	(Alcázar and Cisneros 1999; Chinchilla and Ujueta 2002)
Rhynchophorus palmarum (Linnaeus)	CR, EL, GU, HO, NI, US (CA, TX)	S	F, S	Yes	No [11]	(CABI 2003)
Elateridae						
Aeolus mellillus (Say)	EL, US	A	R, Sd	No	No	(Ingerson-Mahar, Huffaker et al. 1997; CABI 2003; Castillo 2003)
Meloidae						
Epicauta carmelita (Haag)	HO, NI	A, F	I, L [12]	Yes	No	(Champion 1892; Blackwelder 1944; Maes 1989; Maes and Chandler 1994; Maes 2003; Puerto 2003)
Scarabaeidae						
Macrodactylus sp.	CR, GU	S	F, L, R	Yes	No [6]	(Arce and Moron 2000; Arnett, Thomas et al. 2002; Chinchilla and Ujueta 2002; CABI 2003; Nearctica 2003)
Phyllophaga menetriesii (Blanchard)	CR, EL, HO, NI	A	F, L, R	Yes	No [6]	(King 1984; King 1985; Abarca and Quesada 1997; CABI 2003; Castillo 2003)
Phyllophaga sp.	CR, GU	A, S	F, L, R	Yes	No [6]	(Chinchilla and Ujueta 2002; CABI 2003; Nearctica 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Tenebrionidae						
Tribolium castaneum Herbst	CR, EL, GU, HO, NI, US	A	F, Sd	No	No [14]	(CABI 2003)
DIPTERA						
Agromyzidae						
Liriomyza huidobrensis (Blanchard)	CR, EL, GU, HO, NI	A	F, I, L, S	Yes	Yes	(Poe 1982; Spencer 1983; Spencer and Steyskal 1986; Steck 1999; Scheffer and Lewis 2001; Saninet 2002; CABI 2003; EPPO 2003)
Liriomyza sativae Blanchard	CR, EL, HO, NI, US	A, S	F, I, L	No	Yes	(Spencer 1983; CABI 2003; Castillo 2003; Puerto 2003)
Liriomyza sp.	CR, HO, NI	S	F, I, L	Yes	No [9]	(Chinchilla and Ujueta 2002; Saninet 2002; CABI 2003; Nearctica 2003; Puerto 2003; USDA 2003)
Liriomyza trifolii Burgess	CR, GU, HO, US	A	F, L	No	Yes	(Spencer 1983; CABI 2003; Puerto 2003; USDA 2003)
Cecidomyiidae						
Clinodiplosis capsici Gagne	CR	S	I, L, S	Yes	No [13]	(Gagne, Blanco-Metzler et al. 2000)
Lonchaeidae						
Neosilba certa (Walker)	CR	S	I (Bud), F, S	Yes	No [15]	(McAlpine and Steyskal 1982; Chinchilla and Ujueta 2002)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Neosilba pendula (Bezzi) (= *N. glaberrima* (Wiedemann) and *Silba pendula* (Bezzi))	CR, EL, GU, HO, NI	A	I (Bud), F, S	Yes	No [15]	(McAlpine and Steyskal 1982; Hill 1983; Silva, Uramoto et al. 1998; Aguiar-Menezes, Menezes et al. 2002; CABI 2003; Castillo 2003; Maes 2003)
Neosilba sp.	CR	S	I (Bud), F, S	Yes	No [9, 15]	(Chinchilla and Ujueta 2002)
Muscidae						
Atherigona orientalis Schiner	EL, US	A, F	F, L, S	No	No [16]	(CABI 2003)
Tephritidae						
Anastrepha ludens (Loew)	CR, EL, GU, HO, NI, US (TX)	A [27], P	F	Yes	Yes	(Norrbom and Kim 1988; CABI 2003; Steck 2003; Norrbom 2004)
Anastrepha sp.	EL	S	F	Yes	Yes [9]	(USDA 2003)
Ceratitis capitata Wiedemann	CR, EL, GU, HO, NI, US (HI)	A, F	F	Yes	Yes	(Avidov and Harpaz 1969; Weems 1981; Mau and Martin 1992; White and Elson-Harris 1992; Vera, Rodriguez et al. 2002; CABI 2003)
HEMIPTERA						
Aleyrodidae						
Aleurodicus dispersus Russell	CR, US (FL, HI)	S	L	Yes	No	(CABI 2003)
Aleurotrachelus trachoides (Back)	NI, US	A, S	L	No	No	(CABI 2003; Maes 2003; USDA 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Bemisia tabaci (Gennadius)	CR, EL, GU, HO, NI, US	A	L	No	No	(Chinchilla and Ujueta 2002; Saninet 2002; CABI 2003; Castillo 2003; Maes 2003)
Bemisia tabaci Gennadius (Biotype B)	CR, GU, HO, NI	A	L	No	No	(CABI 2003)
Trialeurodes vaporariorum Westwood	CR, US	A	L	No	No	(CABI 2003; Puerto 2003)
Trialeurodes sp.	CR	S	L	Yes	No	(Chinchilla and Ujueta 2002; CABI 2003)
Aphididae						
Aphis craccivora Koch	NI, US	A, S	L, S	No	No [17]	(Saninet 2002; CABI 2003)
Aphis gossypii Glover	CR, GU, HO, NI, US	A, F	L, S	No	No [17]	(Blackman and Eastop 2000; CABI 2002; Chinchilla and Ujueta 2002; Saninet 2002; Castillo 2003)
Aphis spiraecola Patch	CR, EL, HO, US	A	I, L, S	No	No [17]	(CABI 2003)
Aulacorthum solani Kaltenbach	CR, EL, GU, HO, NI, US	A	L, S	No	No [17]	(Blackman and Eastop 2000; CABI 2003; Puerto 2003)
Myzus persicae Sulzer	CR, EL, GU, HO, US	A, S	L, S	No	No [17]	(Blackman and Eastop 2000; Chinchilla and Ujueta 2002; Saninet 2002; CABI 2003)
Coccidae						
Coccus hesperidum Linnaeus	CR, EL, GU, HO, NI, US	F, S	L, S	No	Yes [4]	(Quezada, Cornejo et al. 1972; CABI 2003; Scalenet 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Parasaissetia nigra (Nietner)	CR, EL, GU, HO, NI, US	F, S	L, S	No	Yes [4]	(Quezada, Cornejo et al. 1972; CABI 2003; Scalenet 2003)
Pulvinaria psidii Maskell	CR, GU, US	A, F	F, I, L, S	No	Yes	(Ben-Dov 1993; Jansen 1995; CABI 2003; Scalenet 2003)
Pulvinaria urbicola Cockerell	NI, US	A, F, S	F, L, S	No	Yes	(Ben-Dov 1993; Halbert 1996; CABI 2003; Maes 2003; Scalenet 2003)
Saissetia coffeae (Walker)	CR, EL, GU, HO, US	A, F, S	L, S	No	Yes [4]	(Quezada, Cornejo et al. 1972; CABI 2003; Scalenet 2003)
Coreidae						
Anasa sp.	HO	S	L	Yes	No [9]	(Puerto 2003)
Diaspididae						
Aspidiotus destructor Signoret	CR, GU, HO, NI, US	S	F, L, S	No	Yes	(CIE 1966; Beardsley 1969; CABI 2003)
Lepidosaphes tokionis (Kuwana)	CR, GU, US (HI)	S	F, L, S	Yes	No [18]	(Scalenet 2003)
Pinnaspis strachani (Cooley)	EL, HO, US	A, F, S	F, L, S	No	Yes	(Merrill 1953; Dekle 1976; Gill 1997; CABI 2003; Puerto 2003; Scalenet 2003)
Pseudaulacaspis pentagona (Targioni Tozzetti)	CR, HO, US	A, S	F, L, S, R	No	Yes	(CABI 2003; Scalenet 2003)
Unaspis citri (Comstock)	EL, HO, US	S	F, L, S	No	Yes	(CIE 1962; CABI 2003; EPPO 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Membracidae						
Antianthe expansa (Germar)	CR, GU, HO, NI, US	S	S	No	No [20]	(Schuster 1981; Chinchilla and Ujueta 2002; Castillo 2003; Maes 2003)
Miridae						
Creontiades sp.	NI	S	L, S	Yes	No [9]	(Maes 2003)
Halticus bractatus (Say)	EL, NI, US	S	L, S	No	No [20]	(Capinera 1999; CABI 2003; Maes 2003)
Ortheziidae						
Orthezia insignis Browne	CR, EL, GU, HO, US	S	I, L, S	No	Yes [4]	(CABI 2003; Scalenet 2003)
Orthezia pseudinsignis Morrison	GU, US	S	L, S	Yes	No [28]	(Beingola 1969; Scalenet 2003)
Pentatomidae						
Acrosternum marginatum (Palisot de Beauvois)	CR, EL, GU, HO, NI, US	A	F, I	No	No [19]	(Rodriguez, Madrinan et al. 1985; Hallman, Morales et al. 1992; Schaefer and Panizzi 2000; CABI 2003)
Nezara viridula (Linnaeus)	CR, EL, GU, HO, NI, US	A	F, I, L, S	No	No [19]	(CABI 2003; Puerto 2003)
Piezodorus guildinii (Westwood)	CR, US	A	F, I, L, Sd	No	No [19]	(Chinchilla and Ujueta 2002; CABI 2003)
Pseudococcidae						
Dysmicoccus brevipes (Cockerell)	CR, EL, GU, HO, NI, US	S	F, L, S, R	No	Yes	(Ben-Dov 1994; CABI 2003; Scalenet 2003)
Ferrisia virgata (Cockerell)	CR, GU, HO, NI, US	S	F, L, S, P	No	Yes	(Hill 1987; CABI 2003; Scalenet 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Geococcus coffeae Green	CR, EL, GU, HO, US (FL)	A	R	Yes	No	(Hambleton 1946; Williams 1969; Williams and Granara de Willink 1992; Ben-Dov 1994; CABI 2003; Scalenet 2003)
Paracoccus marginatus Williams and Granara de Willink	CR, GU, US (FL, MT)	A	F, I, L, S	[Yes] [22]	No [29]	(Williams and Granara de Willink 1992; Pollard 1999; CABI/EPPO 2000; Watson and Chandler 2000; CABI 2003; EPPO 2003; Scalenet 2003)
Phenacoccus madeirensis Green	CR, GU, US	A	L, S	No	Yes [4]	(CABI 2003; Scalenet 2003)
Phenacoccus parvus Morrison	CR, NI, US (FL)	A, F, S	L, S	[Yes] [22]	Yes [4]	(Williams and Cox 1984; Williams and Granara de Willink 1992; Ben-Dov 1994; CABI 2003; Fletcher 2003; Scalenet 2003)
Planococcus minor (Maskell)	CR, GU, HO, US (Virgin Isls., American Samoa)	A, F	F, I, R, S	Yes	Yes	(Williams and Cox 1984; Williams and Granara de Willink 1992; Ben-Dov 1994; Peña, Sharp et al. 2002; CABI 2003; Scalenet 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Pseudococcus jackbeardsleyi Gimpel and Miller	CR, EL, GU, HO, NI, US	F, S	F, L, S	No	Yes	(CABI 2003; Scalenet 2003)
Pseudococcus longispinus Targioni Tozzetti	CR, GU, HO, US	A	F, I, L, S	No	Yes	(Williams and Granara de Willink 1992; Ben-Dov 1994; CABI 2003; Scalenet 2003)
Tingidae						
Corythucha gossypii (Fabricius)	CO, HO, NI, US	S	L	No	No	(Peña and Waddill 1982; Mead 1989; Chinchilla and Ujueta 2002; CABI 2003; Maes 2003)
LEPIDOPTERA						
Arctiidae						
Estigmene acraea Drury	CR, EL, GU, HO, NI, US	S	L	No	No	(Capinera 2001; Chinchilla and Ujueta 2002; CABI 2003)
Cosmopterigidae						
Pyroderces rileyi (Walsingham)	EL, HO, US	A, S	F	No	Yes	(CABI 2003; Maes 2003; Robinson, Ackery et al. 2003)
Gelechiidae						
Keiferia lycopersicella Walsingham	CR, NI, US	A	F, I, L	No	Yes	(CABI 2003; Maes 2003; Robinson, Ackery et al. 2003)
Phthorimaea operculella (Zeller)	CR, GU, NI, US	A, S	L, R	No	No	(CABI 2003; Maes 2003; Robinson, Ackery et al. 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Symmetrischema capsica (Bradley and Povolny)	HO, US	A	I (Buds)	No	No	(Bennett 1995; Robinson, Ackery et al. 2003)
Lycaenidae						
Tmolus echion (Linnaeus) (= *Ministrymon echion* (Linnaeus))	CR, EL, GU, HO, NI, US	A	F, I, L	No	Yes	(CABI 2003; Robinson, Ackery et al. 2003; Struttmann 2003)
Noctuidae						
Agrotis ipsilon (Hufnagel)	HO, US	A	F, L, S	No	No [21]	(Zhang 1994; CABI 2003; Robinson, Ackery et al. 2003)
Agrotis malefida Guenée (= *Rhizagrotis malefida* (Guenée))	HO, NI, US	A	F, L, S	No	No [21]	(Zhang 1994; CABI 2003; Maes 2003; Robinson, Ackery et al. 2003)
Agrotis repleta Walker	CR, EL, GU, HO, NI, US	A	F, L, S	No	No [21]	(Zagatti, Lalanne-Cassou et al. 1995; Saninet 2002; CABI 2003; Nearctica 2003)
Agrotis sp.	CR	S	F, L, S	Yes	No [9, 21]	(Chinchilla and Ujueta 2002)
Chrysodeixis includens (Walker) (= *Pseudoplusia includens* (Walker))	HO, NI, US	A	F, I, L, S, Sd	No	Yes	(Saninet 2002; CABI 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Feltia subterranea (Fabricius) (= *Agrotis subterranea* (Fabricius))	CR, EL, HO, NI, US	A	F, L, S	No	No [21]	(Navarro 2000; Saninet 2002; CABI 2003; Castillo 2003; Maes 2003; Robinson, Ackery et al. 2003)
Helicoverpa zea (Boddie) (= *Chloridea obsoleta* Fabricius)	CR, EL, GU, HO, NI, US	A, S	F, I, L, S, Sd	No	Yes	(Zhang 1994; Chinchilla and Ujueta 2002; Saninet 2002; CABI 2003; Maes 2003; Robinson, Ackery et al. 2003)
Heliothis virescens (Fabricius) (= *Chloridea virescens* (Fabricius))	CR, EL, GU, HO, NI, US	A, S	F, I, L, S, Sd	No	Yes	(Chinchilla and Ujueta 2002; Saninet 2002; CABI 2003; Maes 2003; Robinson, Ackery et al. 2003)
Heliothis sp.	CR	S	F, I, L, S, Sd	Yes	No [9]	(Chinchilla and Ujueta 2002; USDA 2003)
Mythimna unipuncta Haworth (= *Pseudaletia unipuncta* (Haworth))	CR, GU, US	A, S	L, S, Sd	No	No [21]	(CABI 2003; Robinson, Ackery et al. 2003)
Peridroma saucia (Hübner)	CR, GU, HO, US	A	F, I, L, S, Sd	No	No [21]	(Zhang 1994; CABI 2003; Puerto 2003; Robinson, Ackery et al. 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Spodoptera albula (Walker) (=*S. sunia* Guenée)	CR, EL, HO, NI, US	A	F, L	No	No [21]	(Teixeira, Novo et al. 2000; Chinchilla and Ujueta 2002; CABI 2003; Castillo 2003; Maes 2003; Nearctica 2003; Puerto 2003)
Spodoptera eridania Stoll	CR, HO, NI, US	A, F	F, L	No	No [21]	(Chinchilla and Ujueta 2002; Saninet 2002; CABI 2003; EPPO 2003; Robinson, Ackery et al. 2003)
Spodoptera exigua (Hübner)	CR, EL, HO, NI, US	A, S	F, I, L, S	No	No [21]	(Chinchilla and Ujueta 2002; Saninet 2002; CABI 2003; Maes 2003; Robinson, Ackery et al. 2003)
Spodoptera frugiperda J.E. Smith (= *Laphygma frugiperda* Guenée)	CR, EL, GU, HO, NI, US	A, F	F, I, L, S	No	No [21]	(Saninet 2002; CABI 2003; Maes 2003; Robinson, Ackery et al. 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Spodoptera latifascia (Walker)	CR, EL, GU, HO, NI, US	A	L, S	No	No [21]	(Zagatti, Lalanne-Cassou et al. 1995; Chinchilla and Ujueta 2002; CABI 2003; Maes 2003; Nearctica 2003; Puerto 2003; Robinson, Ackery et al. 2003)
Spodoptera ornithogalli (Guenée) (= *Prodenia ornithogalli* Guenée)	CR, GU, NI, US	A, F	F, L	No	Yes	(Zagatti, Lalanne-Cassou et al. 1995; Capinera 2001; Saninet 2002; CABI 2003; Maes 2003; Robinson, Ackery et al. 2003)
Spodoptera sp.	CR	S	F, I, L, S	Yes	No [9]	(Chinchilla and Ujueta 2002; USDA 2003)
Trichoplusia ni (Hübner)	CR, HO, NI, US	A, S	L	No	No	(Chinchilla and Ujueta 2002; CABI 2003; Maes 2003)
Nymphalidae						
Ithomia celemia (Hewitson)	CR	S	L	Yes	No	(DeVries 1989; Haber 2001; Robinson, Ackery et al. 2003)
Pteronymia notilla Butler and Druce	CR	S	L	Yes	No	(Young 1974; Haber 2001; Robinson, Ackery et al. 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Psychidae						
Oiketicus kirbyi Guilding	CR	A	L	Yes	No	(Saninet 2002; CABI 2003)
Pyralidae						
Cadra cautella Walker	CR, EL, GU, NI, HO, US	S	F, R, Sd	No	No [14]	(CABI 2003; Maes 2003; Robinson, Ackery et al. 2003)
Elasmopalpus lignosellus (Zeller)	CR, EL, GU, NI, US	S	L, S, R	No	No [23]	(CABI 2003; Maes 2003)
Ephestia elutella Hübner	NI, US	S	F, Sd	No	No [14]	(CABI 2003; Maes 2003; Robinson, Ackery et al. 2003)
Ephestia kuehniella Zeller	CR, EL, GU, NI, HO, US	S	F, R, Sd	No	No [14]	(CABI 2003; Maes 2003; Robinson, Ackery et al. 2003)
Etiella zinckenella (Treitschke)	EL, HO, NI, US	A	F, Sd	No	Yes	(CABI 2003; Maes 2003; Robinson, Ackery et al. 2003)
Herpetogramma bipunctalis (Fabricius) (= *Psara bipunctalis* (Fabricius))	NI, US	F	L	No	No	(Kalita, Devroy et al. 1997; CABI 2003; Maes 2003; Nearctica 2003; Robinson, Ackery et al. 2003)
Lineodes integra (Zeller)	NI, US	A, S	L	No	No	(Maes 2003; Nearctica 2003; Robinson, Ackery et al. 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Neoleucinodes elegantalis (Guenée)	CR, EL, GU, HO, NI	A, S	F	Yes	Yes	(McGuire 1967; Marcano 1991; Alvaro and Blackmer 2003; CABI 2003; Eiras and Blackmer 2003; Robinson, Ackery et al. 2003)
Plodia interpunctella (Hübner)	NI, US	F, S	F, Sd	No	No [14]	(CABI 2003; Maes 2003; Robinson, Ackery et al. 2003)
Sphingidae						
Manduca sexta (Linnaeus)	CR, GU, HO, NI, US	A	L	No	No	(Blackman and Eastop 2000; Chinchilla and Ujueta 2002; Saninet 2002; CABI 2003; Robinson, Ackery et al. 2003)
Tineidae						
Opogona sacchari Bojer	HO, US (FL, HI)	S	I, L, S, R	[Yes] [22]	Yes	(Davis and Pena 1990; CABI/EPPO 1999; CABI 2003)
Tortricidae						
Lorita scarificata (Meyrick)	CR, EL, GU, HO, NI, US (CA, FL, HI)	S	F	No	Yes	(Pogue 1988)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Platynota rostrana Walker	GU, HO, NI, US	A, F	L	No	No	(Rajapakse 1989; CABI 2003; Maes 2003; Nearctica 2003; Robinson, Ackery et al. 2003)
ORTHOPTERA						
Gryllidae						
Gryllus assimilis (Fabricius) (= *Acheta assimilis* Fabricius)	CR, GU, NI, US	A	L	No	No	(Saninet 2002; CABI 2003; Maes 2003)
Gryllotalpidae						
Gryllotalpa gryllotalpa Linnaeus	EL, US	A	R	No	No	(CABI 2003; Castillo 2003)
Neocurtilla hexadactyla (Perty) (= *Gryllotalpa hexadactyla* Perty)	CR, NI, US	A	R	Yes	No	(Saninet 2002; CABI 2003; Maes 2003)
THYSANOPTERA						
Thripidae						
Frankliniella occidentalis (Pergande)	CR, GU, HO, US	A	F, I, L	No	Yes	(Shipp, Binns et al. 1998; CABI 2003; Puerto 2003)
Thrips palmi Karny	GU, US (FL, HI)	A, S	F, I, L	[Yes] [22]	Yes	(Saninet 2002; CABI 2003)
Thrips tabaci Lindeman	CR, US	S	L, I	No	No	(Hill 1987; CABI 2003)
PLANT PATHOGENS						
BACTERIA						
Actinomycetales						
Clavibacter michiganensis subsp. *michiganensis* Smith and Davis, et. al	CR, US	A	F, L, S	No	Yes	(CABI 2003)
Enterobacteriales						
Erwinia carotovora subsp. *carotovora* Jones, Bergey et. al.	CR, HO, US	A	L, S, R	No	No [26]	(CABI 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Erwinia chrysanthemi (Burkh.) Young et al.	CR, GR, HO, US	A	F, I, L, R, S	No	Yes	(CABI 2003)
Erwinia chrysanthemi pv. *paradisiaca* (Victoria & Barros) Dickey & Victoria	HO, GU	A	F, I, L, R, S	Yes	No [25]	(Bradbury 1986; CABI 2003; Puerto 2003)
Burkholderiales						
Ralstonia solanacearum race 1 (Smith) Yabuuchi *et. al*	CR, EL, GU, HO, NI, US	A	F, S, R	No	Yes	(CABI 2003)
Ralstonia solanacearum race 3 biovar 2 (Smith) Yabuuchi *et. al*	CR, GU	A, S	R, S, L	Yes	No	(USDA-APHIS-PPQ-PDMP 2004)
Pseudomonadales						
Pseudomonas cichorii (Swingle) Stapp	CR, US	A	L	No	No	(Calderón and Díaz 2002; CABI 2003)
Pseudomonas syringae pv. *syringae* van Hall	EL, GU, HO, US	A	F, I, L, R, S, Sd	No	Yes	(CABI 2003)
Xanthomonadales						
Xanthomonas vesicatoria (Doidge) Dowson	CR, EL, GU, HO, NI, US	A	F, L, S	No	Yes	(Calderón and Díaz 2002; CABI 2003)
FUNGI						
ASCOMYCETES						
Erysiphales						
Erysiphe betae (Vaňha) Weltzien (syn. *E. polygoni*)	CR, US	A	L	No	No	(Calderón and Díaz 2002)
Leveillula taurica (Lév.) G. Arnaud	CR, HO, NI, US	A	F, I, L, S (shoot)	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Oidium sp.	CR, GU	A	F, I, L, S	Yes	No [9]	(Farr, Bills et al. 1989; Calderón and Díaz 2002)
Incertae sedis						
Glomerella cingulata (Stonem.) Spauld.and Schrenk	CR, GU, HO, NI, US	A	F, I, L, S	No	Yes	(CABI 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Leotiales						
Botrytis cinerea (de Bary) Whetzel	CR, EL, GU, HO, NI, US	S	F, I, L, S	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Sclerotinia sclerotiorum (Lib.) de Bary	CR, GU, US	A, F	F, I, L, R, S, Sd	No	Yes	(Calderón and Díaz 2002; Aldana 2003; CABI 2003)
Saccharomycetales						
Geotrichum candidum Link (anamorph)	CR, US	A	F	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Xylariales						
Lasiodiplodia theobromae (Pat.) Griffiths & Maubl.	CR, EL, HO, NI, US	A	F, I, L, R, S, Sd	No	Yes	(CABI 2003)
BASIDIOMYCETES						
Uredinales						
Puccinia pampeana [synonyms = *Dicaeoma pampeana* (Speg.) Kuntz., *P. araucana* Dietel & Neger, *P. capsici* Mayor, *P. capsicicola* Kern & Thurston, *P. gonzalezii* Mayor, *P. paulensis* Rangel, *P. solanina* Speg.] [anamorph = *Endophyllum pampeanum* (Speg.) J.C. Lindquest (synonyms = *Aecidium pampeanum* Speg., *A. capsici* Kern & Whetzel, *A. solaninum* Speg., *A. solaninum* var. *laevis*)]	CR, GU	A, B, F, S	F, L, S	Yes	Yes	(Watson 1971; Figueiredo 2000; Calderón and Díaz 2002; Hernandez and Hennen 2003)
Puccinia psidii G. Winter	CR, EL, GU, US	A	F, I, L, S	No	Yes	(CABI 2003)
Ceratobasidiales						
Thanatephorus cucumeris (anamorph=*Rhizoctonia solani*) (Frank) Donk	CR, EL, HO, US	A	F, I, L, R, S, Sd	No	Yes	(Calderón and Díaz 2002; CABI 2003; Castillo 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
MITOSPORIC FUNGI						
Coelomycetes						
Colletotrichum gloeosporioides (Penz.) Sacc. (teleomorph=*Glomerella cingulata*)	CR, GU, HO, NI, US	A	F, L	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Colletotrichum acutatum Simmonds ex Simmonds (teleomorph=*Glomerella*)	CR, US	S	F, I, L, R, S	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Colletotrichum capsici (Syd.) E.J. Butler & Bisby (teleomorph=*Glomerella*)	EL, US	A	F, L	No	Yes	(Calderón and Díaz 2002; CABI 2003; Castillo 2003)
Macrophomina phaseolina (Tassi) Goid	CR, EL, HO, US	A	F, I, L, R, S (shoot), Sd	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Pestalotiopsis sp.	CR	A	F	Yes	No [9]	(Calderón and Díaz 2002)
Phoma destructiva Plowr.	CR, US	A	F, L	No	Yes	(Calderón and Díaz 2002)
Phomopsis vexans Gratz	CR, US	A	F	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Hyphomycetes						
Alternaria alternata (Fr.:Fr.) Keissl.	CR, HO, US	A	F, L	No	Yes	(Calderón and Díaz 2002; CABI 2003; Puerto 2003)
Alternaria solani Sorauer	CR, EL, GU, HO, US	A	F, L	No	Yes	(Calderón and Díaz 2002; Aldana 2003; CABI 2003; Castillo 2003; Puerto 2003)
Aspergillus sp.	CR	A	F	Yes	No [9]	(Calderón and Díaz 2002; CABI 2003)
Cercospora sp.	CR	A	L	Yes	No	(Calderón and Díaz 2002)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Cercospora capsici Heald and Wolf	CR, HO, GU, US	A	F, L	No	Yes	(Calderón and Díaz 2002; Aldana 2003; Puerto 2003)
Corynespora casiicola (Berk. & Curtis) Weir	CR, US	S	L	No	No	(Calderón and Díaz 2002; CABI 2003)
Curvularia lunata (Wakker) Boedjin (teleomorph=*Cochliobolus lunatus* R.R. Nelson & Haasis)	CR, US	F, S	I, L, Sd	No	No	(Calderón and Díaz 2002; CABI 2003)
Fulvia fulva (Cooke) Arx	CR, GU, HO, NI, US	A	F, L	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Fusarium oxysporum Schlechtendahl	CR, US	A	F, L, S	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Fusarium oxysporum f.sp. *radicislycopersici* Jarvis & Shoemaker	CR, US	A	F, L, S	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Fusarium oxysporum f.sp. *vasinfectum* (G.F. Atk.) W.C. Snyder & H.N. Hansen	EL, GU, NI, US	A	L, R, S	No	No	(CABI 2003)
Fusarium solani (Wollenw.) Gerlach	worldwide	A	R, S	No	Yes	(CABI 2003)
Fusarium sp.	CR	A	F, R	Yes	No [9]	(Calderón and Díaz 2002; CABI 2003)
Penicillium sp.	CR	A	F	Yes	No [9]	(Calderón and Díaz 2002; CABI 2003)
Phaeoramularia capsicicola (Vassilj.) Deighton	HO, US	A	L	No	No	(Deighton 1976; CABI 2003; Puerto 2003)
Sclerotium rolfsii Sacc.	CR, EL, US	A	F, L, R, S, Sd	No	Yes	(Calderón and Díaz 2002; CABI 2003; Castillo 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Stemphylium solani Weber	Cosmopolitan	A	F, L	No	Yes	(Calderón and Díaz 2002)
Thielaviopsis basicola (Berk. & Broome) Ferraris	CR, US	S	R	No	No	(CABI 2003)
Verticillium dahliae Kleb.	NI, US	A	F, I, L, R, S, Sd	No	Yes	(CABI 2003)
OOMYCETES						
Peronosporales						
Peronospora hyoscyami f.sp. *tabacina* (syn. *P. tabacina*) (D.B. Adam) Skalicky	CR, EL, GU, HO, NI, US	A	I, L, R, S	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Pythiales						
Pythium aphanidermatum (Edson) Fitzp.	CR, US	A, S	F, R, S	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Phytophthora capsici Leonian	CR, EL, GU, HO, US	A, F	F, L, R, S	No	Yes	(Calderón and Díaz 2002; CABI 2003; Puerto 2003)
Pythium debaryanum Hesse	CR, US	A	R	No	No	(CABI 2003)
Phytophthora infestans (Mont.) de Bary	CR, EL, GU, HO, NI, US	A	F, L, R, S	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Pythium sp.	CR	A	R	Yes	No	(Calderón and Díaz 2002)
Phytophthora nicotianae Breda de Haan	CR, EL, GU, HO, NI, US	S	F, L, R, S	No	Yes	(CABI 2003)
Phytophthora nicotianae var. *parasitica*	CR, EL, GU, HO, NI, US	A	F, S (shoot)	No	Yes	(Calderón and Díaz 2002; CABI 2003)
ZYGOMYCETES						
Mucorales						
Rhizopus stolonifer (Ehrenb.) Lind	CR, US	A	F	No	Yes	(Calderón and Díaz 2002; CABI 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
NEMATODES						
Aphelenchidae						
Aphelenchus sp. (Bastian)	HO	A, F	S, R	Yes	No	(Shurtleff and Averre 2000; CABI 2003; Puerto 2003)
Belonolaimidae						
Belonolaimus longicaudatus Rau	CR, US	A	R	No	No	(CABI 2003)
Criconematinae						
Criconemella sp. De Grisse & Loof	CR, EL	A	R	Yes	No	(Solano, Rojas et al. 2002; CABI 2003)
Hemicycliophora sp.	CR	A	R	Yes	No	(Solano, Rojas et al. 2002; CABI 2003)
Hoplolaimidae						
Helicotylenchus dihystera (Cobb) Sher	CR, EL, GU, US	A	R	No	No	(CABI 2003)
Helicotylenchus sp.	CR	A	R	Yes	No	(Solano, Rojas et al. 2002; CABI 2003)
Hoplolaimus seinhorsti Luc	GU	S	R	Yes	No	(CABI 2003)
Rotylenchulus reniformis Linford & Oliveira	HO, US, EL	A	R	No	No	(Pinochet and Guzmán 1987; CABI 2003)
Longidoridae						
Longidorus sp. Micoletzky (Filipjev)	CR	A	R	Yes	No	(CABI 2003)
Meloidogynidae						
Meloidogyne arenaria (Neal) Chitwood	CR, US	F	R	No	No	(CABI 2003)
Meloidogyne exigua Goeldi	CR, EL, GU, HO, NI	A	R	Yes	No	(CABI 2003)
Meloidogyne hapla Chitwood	CR, US	A	R	No	No	(CABI 2003)
Meloidogyne incognita (Kofoid & White)	CR, EL, GU, HO, NI, US	A	R	No	No	(Solano, Rojas et al. 2002; CABI 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Meloidogyne javanica (Treub) Chitwood	CR, EL, GU, HO, NI, US	A	R	No	No	(CABI 2003)
Meloidogyne sp.	CR	A	R	Yes	No	(Solano, Rojas et al. 2002)
Pratylenchidae						
Pratylenchus penetrans (Cobb) Filipjev & Schuurmans Stekhoven	CR, EL, US	A, F	R	No	No	(CABI 2003; Castillo 2003)
Pratylenchus sp.	CR	A	R	Yes	No	(Solano, Rojas et al. 2002)
Pratylenchus zeae Graham	CR, EL, US	A	R	No	No	(CABI 2003)
Trichodoridae						
Trichodorus sp.	CR, EL, NI	A	R	Yes	No	(Solano, Rojas et al. 2002; CABI 2003)
Tylenchindae						
Tylenchus sp.	HO	A, F	R	Yes	No	(CABI 2003; Puerto 2003)
VIRUSES						
Bromoviridae						
Cucumber mosaic virus	CR, HO, US	A	F, L	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Bunyaviridae						
Potato Y potyvirus	CR, EL, US	A	F	No	Yes	(Calderón and Díaz 2002; CABI 2003; Castillo 2003)
Tomato spotted wilt virus	CR, US	A	F, L	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Comoviridae						
Andean potato mottle virus	CR, HO, NI	A, F	F, I, L, S	Yes	Yes	(Valverde, Black et al. 1995; CABI/EPPO 1999; CABI 2003; Pernezny, Roberts et al. 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Geminiviridae						
Beet curly top virus	CR, US	A, F	L, R, S	No	Yes	(CABI 2003)
Texas pepper geminivirus [synonym = pepper golden mosaic virus]	CR, US	S	L, R	No	No	(Brunt, Crabtree et al. 1996 (onwards); Lotrakul, Valverde et al. 2000; Pernezny, Roberts et al. 2003)
Tomato yellow leaf curl virus	CR, US	A	W	No	Yes	(Momol 2001; CABI 2003)
Tomato yellow mosaic virus [synonym = tomato golden mosaic bigeminivirus, potato yellow mosaic virus]	EL	A	F, L, S, R	Yes	Yes	(Brunt, Crabtree et al. 1996 (onwards); Morales, Lastra et al. 2001; Castillo 2003)
Luteoviridae						
Potato leafroll luteovirus	CR, US	A	F, I, L, S, Sd	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Potexvirus						
Potato X Potexvirus [synonyms = potato latent virus, potato mild mosaic virus]	CR, US	A	W	No	Yes	(Brunt, Crabtree et al. 1996 (onwards); Calderón and Díaz 2002; CABI 2003)
Potyviridae						
Pepper mottle potyvirus	EL, GU, US	A	F, L, S	No	Yes	(Verhoeven, Willemen et al. 2002; CABI 2003)
Tobacco etch virus	CR, EL, HO, US	A	F, I, L, R, S	No	Yes	(Calderón and Díaz 2002; CABI 2003; Puerto 2003)
Tobamovirus						
Pepper mild mottle virus	HO, US	A, F	F, L	No	Yes	(CABI 2003)

Pest	Geographic Distribution [1]	Host [2]	Plant Part Affected [3]	Quarantine Pest	Likely to Follow Pathway	References
Tobacco mosaic virus	CR, US	A	W	No	Yes	(Calderón and Díaz 2002; CABI 2003)
Tospovirus						
Impatiens necrotic spot virus	CR, US	A	I, L, S	No	Yes	(CABI 2003)

[1] CR = Costa Rica; EL = El Salvador; GU = Guatemala; HO = Honduras; NI = Nicaragua; US = United States (specific states are listed for those pests that have limited distribution and are considered quarantine pests: CA = California; FL = Florida; GA = Georgia; HI = Hawaii; LS = Louisiana; MS = Mississippi; MT = Montana; TX = Texas)

[2] A = *Capsicum annuum*; B = *Capsicum baccatum*; F = *Capsicum frutescens*; P = *Capsicum pubesecnes*; S = *Capsicum* sp.

[3] F = Fruit; I = Inflorescence; L = Leaf; R = Root; S = Stem; Sd = Seed; W = Systemic

[4] Species was considered likely to follow the pathway because it feeds on stems and peppers are harvested with their stems intact to prevent soft rot (Schooley 2003).

[5] *Diabrotica* species were considered unlikely to follow the pathway because adults, which are capable of flight and feed externally on fruit (MAG 1991; Granardos 2001; CABI 2003; UAQ 2003) are likely to be removed by minimal processing of the commodity.

[6] Scarab larvae in the genera *Macrodactylus* and *Phyllophaga* feed on roots, but the adults feed on foliage and fruit (CABI, 2003; Borer et al., 1989). Fruit feeding adults are not expected to stay with the commodity during post-harvest processing because they are capable of flight (CABI, 2003). Species in these genera were therefore considered unlikely to follow the pathway on fresh pepper fruits.

[7] An exhaustive literature search for *Disonycha eximia* yielded no specific information. The species was therefore assumed to behave similar to other members of the subfamily Alticinae, which feed on foliage as adults and roots as larvae (Borror, Triplehorn et al. 1989).

[8] An exhaustive literature search for *Faustinus ovatipennis* and its synonyms *Euxenus ovatipennis* and *Collabismodes ornatipennis* (O'Brien and Wibmer 1982) yielded no specific information. The species was therefore assumed to behave similar to other members of the genus *Faustinus*, which feed externally on flowers, foliage, fruit and stems as adults and bore into stems and fruit as larvae (Marsh 1982; Davis 1996; Capinera 2002). *Faustinus ovatipennis* was considered likely to follow the pathway because members of the genus *Faustinus* have been intercepted 45 times on fresh fruit of *Capsicum* by PPQ officers (USDA 2003).

[9] Pest not identified to the specific level in this document belong to genera that are present in the U.S. (CABI 2003; Farr *et al* 1989; Nearctica 2003). These pests may or may not be quarantine pests. They were not analyzed because their risk is reasonable encompassed in the analysis of another pest in the same taxon or there was no evidence of other pests in the taxon being

associated with the commodity in the region examined. Pest risk analyses, by necessity, must focus on organisms for which biological information is available. Lack of specific information or identification to the specific level does not indicate that a pest is not a phytosanitary risk to U.S. agriculture. It may simply indicate the quality of the specimen or the limits of current taxonomic knowledge. If pests identified to higher taxa are intercepted in the future, APHIS may take action at the port of entry and a reevaluation of their risk may occur.

[10] *Metamasius callizona* was considered unlikely to follow the pathway because they typically attack bromeliads, adults feed on leaves, and larvae, which bore into stems, are usually found near the base of the plant (Larson and Frank 2000).

[11] *Rhynchophorus palmarum* was considered unlikely to follow the pathway because it is primarily a pest of palms; reports on other hosts are typically of highly mobile adults feeding on ripe fruit (CABI 2003).

[12] An exhaustive literature search for *Epicauta carmelita* and its synonym *Lytta carmelita* (Maes 2003) yielded no specific information. The species was therefore assumed to behave similar to other members of the genus *Epicauta*, which feed on foliage and flowers as adults and bee or grasshopper eggs as larvae (Borror, Triplehorn et al. 1989).

[13] Although *C. capsici* forms galls at the base of flowers (Gagné et al., 2000), it was considered ulikely to follow the pathway on stems of pepper fruit because it has never been detected in commercial pepper plantations (Gagné et al., 2000). Gagné et al. (2000) hypothesized that insecticides used in commercial pepper plantations for control of the pepper weevil, *A. eugenii*, excludes *C. Capsici* from these areas.

[14] Species was considered unlikely to follow the pathway because it is a stored product pest that is associated with dry commodities (CABI 2003).

[15] *Neosilba* species were considered unlikely to follow the pathway because they are secondary pests that attack hosts previously damaged by primary invaders, particularly fruit flies (McAlpine and Steyskal 1982; White and Elson-Harris 1992). If damaged fruit are culled and fruit fly mitigation is undertaken, then *Neosilba* species are removed from the commodity (Franco, Bernal et al. 2002).

[16] *Atherigona orientalis* was considered unlikely to follow the pathway because no member of the subgenus *Acrotochaeta* is known to be an obligate phytophage (CABI 2003). Most are saprophages that develop in rotting or damaged fruit (CABI 2003), which is likely to be culled during post-harvest treatment.

[17] Soft bodied insects are not expected to survive minimal post harvest treatments, so are not expected to follow the pathway.

[18] *Lepidosaphes tokionis* was considered unlikely to follow the pathway because its primary host is croton, *Codiaeum* sp. (Nakahara, 1982; Zimmerman, 1948), and it has never been intercepted on *Capsicum* sp. by PPQ officers (USDA, 2003b).

[19] Large arthropods that feed externally on stems and fruit were considered unlikely to follow the pathway because minimal processing of the commodity would remove these pests prior to shipment.

[20] Pest is associated with stems but is highly mobile and unlikely to remain with the commodity during processing.

[21] Species is unlikely to be associated with the commodity during harvest because it spends the day below ground and feeds on plant material at night (Navarro 2000; Teixeira, Novo et al. 2000; CABI 2003).

[22] Species with a limited distribution in the United States and deemed actionable by APHIS because it is being considered for an official control program (personal communication, USDA APHIS National Identification Services, contact: Paul Courneya, Entomologist).

[23] *Elasmopalpus lignosellus* was considered unlikely to follow the pathway because its larvae bore into the stem "at, or just below, soil level" (CABI 2003).

[24] Pepper was artificially inoculated with *Erwinia chrysanthemi* pv. *paradisiaca* (Bradbury 1986) and a search of the literature and databases resulted in no records of the bacteria naturally infecting pepper.

[25] *Capsicum annuum* is susceptible to *Erwinia chrysanthemi* pv. *paradisiaca* when artificially inoculated (Bradbury 1986), however after a search of the literature and various databases, no confirmed report was found documenting that this bacterium naturally infects *Capsicum* sp. *Erwinia chrysanthemi* pv. *paradisiaca* is reported to occur in Honduras on *Musa* sp., but has not reported on *Capsicum* sp. (Puerto 2003). This pathogen was excluded from further analysis.

[26] The pathogen is reported to occur on stems but is not considered to follow the pathway either because it is not suspected to occur on the section of stem attached to fruit, or the stem is not important for the movement of the pathogen.

[27] *Capsicum annuum* is a host of *A. ludens* only under laboratory conditions (Norrbom and Kim 1988; Norrbom 2004). The only know field host of *A. ludens* is *C. pubescens* (Steck 2003).

[28] The fruit of *Capsicum* species have been imported into the U.S. from Mexico, a country where *O. pseudinsignis* is known to occur (Morrison 1952; Scalenet 2003), for over 70 years. During this time, *O. pseudinsignis* has only been intercepted once in passenger baggage (USDA 2003). *Orthezia pseudinsignis* is therefore considered unlikely to follow the pathway on commercially produced *Capsicum* fruit.

[29] *Capsicum annuum* is a secondary host of *P. marginatus* (CABI 2003). The fruit of *Capsicum* species have been imported into the U.S. from Mexico, a country where *P. marginatus* is known to occur (CABI 2003; Scalenet 2003), for over 70 years. During this time, *O. pseudinsignis* has only been intercepted once in passenger baggage (USDA 2003). *Paracoccus marginatus* is therefore considered unlikely to follow the pathway on commercially produced *Capsicum* fruit.

Pests listed in **Table 3** were selected for further analyses because they are quarantine pests with respect to the United States, and they were considered likely to follow the pathway (*i.e.* accompany shipments of peppers). Justifications for considering these pests as reasonably likely to follow the pathway are presented below.

Table 3. Quarantine pests selected for further analysis.

Arthropods
Anastrepha ludens (Tephritidae: Diptera)
Faustinus ovatipennis (Curculionidae: Coleoptera)
Liriomyza huidobrensis (Agromyzidae: Diptera)
Ceratitis capitata (Tephritidae: Diptera)
Opogona sacchari (Tineidae: Lepidoptera)
Phenacoccus parvus (Pseudococcidae: Hemiptera)
Planococcus minor (Pseudococcidae: Hemiptera)
Neoleucinodes elegantalis (Pyralidae: Lepidoptera)
Thrips palmi (Thripidae: Thysanoptera)
Fungi
Puccinia pampeana (Uredinales: Basidiomycetes)
Viruses
Andean Potato Mottle Virus (Comoviridae)
Tomato Yellow Mosaic Virus (Geminiviridae)

The fruit flies, *A. ludens* and *C. capitata*, were considered likely to follow the pathway because they lay eggs in or on, and can develop inside fruit (Weems 1981; CABI 2003). Both species have been intercepted on fresh fruit of *Capsicum* by USDA agriculture inspectors (USDA 2003).

Although information on the weevil, *F. ovatipennis* was scarce, it was considered likely to follow the pathway because it has been reported as a pest of *Capsicum* (USDA-APHIS-PPQ 1984), and members of the genus *Faustinus* have been intercepted 45 times on fresh fruit of *Capsicum* by USDA agriculture inspectors (USDA 2003).

The leafmining fly, *L. huidobrensis*, was considered likely to follow the pathway because females oviposit in plant tissue, and larvae can develop inside the mesocarp of fruit (Steck 1999; CABI 2003). Genetic analysis of North and Latin American flies identified as *L. huidobrensis* has confirmed that the North American flies are a cryptic species within the *L. huidobrensis* complex that should be referred to as *L. langei* Frick (Scheffer and Lewis 2001); therefore, reports indicating that *L. huidobrensis* is established in the United States are erroneous. *Liriomyza huidobrensis* has been intercepted by USDA agriculture inspectors on a variety of

fresh fruits, and flies identified only as *Liriomyza* sp. have been intercepted 49 times on *Capsicum* fruit (USDA 2003).

The tineid moth, *O. sacchari*, was considered likely to follow the payhway because its larvae are stem borers that are know to infest peduncles, it occasionally attacks peppers, and early instars are difficult to detect in woody or fleshy stems (CABI/EPPO 1997; CABI 2003).

The mealybugs, *P. parvus* and *P. minor*, were considered likely to follow the pathway because all life stages are minute (Peña, Sharp et al. 2002), they feed on fruit (Ben-Dov 1994; Peña, Sharp et al. 2002; USDA 2003), and they have been intercepted by PPQ officers on *Capsicum* sp. (USDA 2003).

The Pyralid moth, *N. elegantalis*, was considered likely to follow the pathway because it is reported to feed on *Capsicum* (Robinson, Ackery et al. 2003), its larvae develop inside fruit (Marcano 1991; Eiras and Blackmer 2003), and it has been intercepted 29 times on fresh fruit of *Capsicum* by PPQ officers (USDA 2003).

Thrips palmi was considered likely to follow the pathway because all life stages are minute, and they can occur on fruit (Lewis 1997; CABI 2003). Lewis (1997) indicated that thrips are a major barrier to exportation because fruit is often contaminated with eggs, larvae and adults. This species has been intercepted 79 times on fresh fruit of *Capsicum* by PPQ officers (USDA 2003), and it was analyzed here because it is under consideration by APHIS for official control (Payne 2003).

The fungus *P. pampeana* is considered likely to follow the pathway because it is reported as a disease of *Capsicum* leaves and fruit from Costa Rica (Calderón and Díaz 2002) and is also reported to occur in Guatemala (Hernandez and Hennen 2003). Subepidermal hyphae and spores may be associated with the fruit and stems (Figueiredo, Pimentel et al. 1987; Agrios 1997).

The viruses, Andean potato mottle virus and tomato yellow mosaic virus, were considered likely to follow the pathway because both can become systemic (Lastra and Gil 1981; Brunt, Crabtree et al. 1996 (onwards); CABI 2003; Pernezny, Roberts et al. 2003).

E. Analysis of Quarantine Pests

The undesirable consequences that may occur from the introduction of quarantine pests are assessed within this section. For each quarantine pest, the potential consequences of introduction and likelihood of introduction are assessed. The pest risk potential is determined by summing the consequences of introduction and likelihood of introduction risk values. These ratings are determined using the criteria in the *Guidelines for Pathway-Initiated Pest Risk Assessments, Version 5.02* (USDA 2000).

The major sources of uncertainty present in this risk assessment are similar to those in other risk assessments. They include the use of a developing or evolving process (Orr, Cohen et al.

1993), the approach used to combine risk elements (Morgan and Henrion 1990; Bier 1999), and the evaluation of risk using the list of factors provided in guidelines (Kaplan 1992; Orr, Cohen et al. 1993). To address this last source of uncertainty, the list of factors is interpreted as illustrative and not exhaustive. Additional biological information, even if not explicitly part of the risk rating criteria, can be used when relevant to the rating. Other sources of uncertainty are the quality or lack of biological information. Inherent biological variation within a population of organisms also introduces uncertainty (Morgan and Henrion 1990).

Consequences of Introduction—Economic/Environmental Importance

The potential consequences of introduction are rated using five risk elements: climate-host interaction, host range, dispersal potential, economic impact, and environmental impact. These elements reflect the biology, host ranges and climatic/geographic distributions of the pests. For each risk element, pests are assigned a rating of Low (1 point), Medium (2 points) or High (3 points) (USDA 2000). The following is a description of how each of these ratings is determined for each risk element and results are summarized in **Table 4**.

Risk Element #1: Climate—Host Interaction

When introduced to new areas, pests can be expected to behave as they do in their native areas if host plants and climates are similar. Ecological zonation and the interactions of the pests and their biotic and abiotic environments are considered in the element. Estimates are based on the availability of both host material and suitable climate conditions. To rate this risk element, the U.S. "Plant Hardiness Zones" map (USDA 1990) is used (**Figure 1**). Due to the availability of both suitable host plants and suitable climate, the risk of a pest to establish a breeding colony is rated as: Low (1) in a single plant hardiness zone; Medium (2) in two or three plant hardiness zones; or High (3) in four or more plant hardiness zones.

Risk Element #2: Host Range

The risk posed by a plant pest depends on both its ability to establish a viable, reproductive population and its potential for causing plant damage. For arthropods, risk is assumed to be correlated positively with host range. For pathogens, risk is more complex and is assumed to depend on host range, aggressiveness, virulence and pathogenicity; for simplicity, risk is rated as a function of host range and is as follows: Low (1) when the pest attacks a single species or multiple species within a single genus; Medium (2) when the pest attacks multiple species within a single plant family; High (3) when the pest attacks multiple species among multiple plant families.

Risk Element #3: Dispersal Potential

A pest may disperse after introduction to a new area. The following items are considered: reproductive patterns of the pest (*e.g.* voltinism, biotic potential); inherent powers of movement; factors facilitating dispersal, wind, water, presence of vectors, human, *etc*. Pests are rated as follows: Low (1) when the pest has neither high reproductive potential nor rapid dispersal capability; Medium (2) when the pest has either high reproductive potential *OR* the species is capable of rapid dispersal; or High (3) when the pest has high biotic potential, *e.g.*, many

generations per year, many offspring per reproduction ("r-selected" species), *AND* evidence exists that the pest is capable of rapid dispersal, *e.g.*, over 10 km/year under its own power; via natural forces, wind, water, vectors, *etc*., or human-assistance.

Risk Element #4: Economic Impact

Introduced pests are capable of causing a variety of direct and indirect economic impacts. These are divided into three primary categories (other types of impacts may occur): lower yield of the host crop, *e.g.*, by causing plant mortality, or by acting as a disease vector; lower value of the commodity, *e.g.*, by increasing costs of production, lowering market price, or a combination; loss of foreign or domestic markets due to presence of new quarantine pest. The risk ratings are described as follows: Low (1) when the pest causes any one or none of the above impacts; Medium (2) when the pest causes any two of the above impacts; or High (3) when the pest causes all three of the above impacts.

Risk Element #5: Environmental Impact

The assessment of the potential of each pest to cause environmental damage (IPPC 1996) proceeds by considering the following factors: introduction of the pest is expected to cause significant, direct environmental impacts, *e.g.*, ecological disruptions, reduced biodiversity. When used within the context of the National Environmental Policy Act (NEPA) (7CFR §372), significance is qualitative and encompasses both the likelihood and severity of an environmental impact; pest is expected to have direct impacts on species listed by Federal Agencies as endangered or threatened (50CFR §17.11 and §17.12), by infesting/infecting a listed plant. If the pest attacks other species within the genus or other genera within the family, and preference/no preference tests have not been conducted with the listed plant and the pest, then the plant is assumed to be a host; pest is expected to have indirect impacts on species listed by Federal Agencies as endangered or threatened by disrupting sensitive, critical habitat; introduction of the pest would stimulate chemical and/or biological control programs. The risk ratings are described as follows: Low (1) when none of the above would occur; it is assumed that introduction of a non-indigenous pest will have some environmental impact (by definition, introduction of a non-indigenous species affects biodiversity); Medium (2) when one of the above would occur; or High (3) when two or more of the above would occur.

Consequences of Introduction: *Anastrepha ludens* (Loew) (Diptera: Tephritidae)	**Risk Value**
Risk Element 1: Climate-Host Interaction *Anastrepha ludens* is a native Mexican fruit fly that migrates annually into the southern tip of Texas (Foote, Blanc et al. 1993). It has been reported from Texas south to Costa Rica (Foote, Blanc et al. 1993; CABI 2003). Based on this distribution, it is estimated that *A. ludens* could become established in the United States in USDA Hardiness Zones 9-11 (**Figure 1**). One or more of its potential hosts occur in these zones (USDA-NRCS 2003).	Medium (2)
Risk Element 2: Host Range *Anastrepha ludens* is extremely polyphagous attacking plants in the families Anacardiaceae, Annonaceae, Apocynaceae, Cactaceae, Caricaceae, Clusiaceae, Cucurbitaceae, Ebenaceae, Fabaceae, Juglandaceae, Lauraceae, Moraceae, Musaceae, Myrtaceae, Punicaceae, Rosaceae, Rubiaceae, Rutaceae, Solanaceae (Norrbom and Kim 1988; Steck 2003; Norrbom 2004).	High (3)
Risk Element 3: Dispersal Potential Female *A. ludens* can mature and deposit up to 1597 eggs during their life, and several overlapping generations occur each year (Díaz-Fleisher and Aluja 2003). Adult *A. ludens* can fly up to 135km during their life, and larvae can be transported over long distances in infested fruit (CABI 2003).	High (3)
Risk Element 4: Economic Impact It has been estimated that *A. ludens* destroys 25% of the citrus, mango and guava crops each year in Mexico (Steck 2003). In addition to reducing yields, *A. ludens* lowers crop values by requiring controls, and widespread establishment in the United States would cause foreign and domestic markets to be lost. *Anastrepha ludens* is listed by the European and Mediterranean Plant Protection Organization (EPPO) as an A1 quarantine pest for Europe (CABI/EPPO 1997), and the United States enacted Federal Quarantine Number 64 to prevent shipment of certain fruits from infested areas of Texas to other parts of the country (Weems and Heppner 2001).	High (3)
Risk Element 5: Environmental Impact *Anastrepha ludens* is extremely polyphagous and could potentially attack plants listed as Threatened or Endangered in Title 50, Part 17, Section 12 of the United States Code of Federal Regulations (50 CFR §17.12) (*e.g. Cucurbita okeechobeensis* ssp. *okeechobeensis* and *Prunus geniculata*). It would undoubtedly initiate chemical or biological control programs if introduced into the United States because it is a pest of numerous economic crops (*e.g.* citrus, peach and peppers).	High (3)

Consequences of Introduction: ***Ceratitis capitata* (Wiedmann) (Diptera: Tephritidae)**	**Risk Value**
Risk Element 1: Climate-Host Interaction *Ceratitis capitata* is widely distributed in the Mediterranean, South and Central America, west Asia (CABI 2003) and northern Australia (Hassan 1977). Based on this distribution and the geographic range predicted by Vera *et al*. (2002), it is estimated that *C. capitata* could become established in the United States in USDA Hardiness Zones 8-11. One or more of its potential hosts occur in these Zones (USDA-NRCS 2003).	High (3)
Risk Element 2: Host Range *Ceratitis capitata* has been recorded on hosts from numerous plant families, including Anacardiaceae, Arecaceae, Chrysobalanaceae, Cucurbitaceae, Ebanaceae, Longaniaceae, Malpighiaceae, Meliaceae, Moraceae, Myrtaceae, Oleaceae, Podocarpaceae, Rosaceae, Rubiaceae, Rutaceae, Sapotaceae, Solanaceae and Sterculiaceae (Weems 1981; White and Elson-Harris 1992; CABI 2003).	High (3)
Risk Element 3: Dispersal Potential Female *C. capitata* can mature and deposit up to 800 eggs during their life (Weems 1981), and several overlapping generations occur each year (Hassan 1977). Adult *C. capitata* can fly up to 20km during their two month life, and larvae can be transported over long distances in infested fruit (CABI 2003).	High (3)
Risk Element 4: Economic Impact In some Mediterranean countries, *C. capitata* infestation of stone fruits hovers near 100% (Weems 1981). In addition to substantial yield reductions, *C. capitata* lowers crop values by requiring controls, and its presence in the United States would cause foreign and domestic markets to be lost (Weems 1981). *Ceratitis capitata* is listed by EPPO as an A2 quarantine pest for Europe (CABI/EPPO 1997).	High (3)
Risk Element 5: Environmental Impact *Ceratitis capitata* is extremely polyphagous and could potentially attack plants listed as Threatened or Endangered in 50 CFR §17.12 (*e.g. Opuntia treleasei* and *Prunus geniculata*). It would undoubtedly initiate chemical or biological control programs if introduced into the United States because it is a major pest of numerous economic crops (*e.g.* apple, citrus, fig and peach).	High (3)

Consequences of Introduction: *Faustinus ovatipennis* (Champion) (Curculionidae: Coleoptera)	**Risk Value**
Risk Element 1: Climate-Host Interaction *Faustinus ovatipennis* is a Central American species that occurs in Guatemala, Honduras and Mexico (O'Brien and Wibmer 1982). Based on this distribution, it is estimated that *F. ovatipennis* could become established in the United States in USDA Hardiness Zones 10 and 11 (**Figure 1**). One or more of its potential hosts occur in these zones (USDA-NRCS 2003).	Medium (2)
Risk Element 2: Host Range *Faustinus ovatipennis* has only been reported as a pest of *Capsicum* (Solanaceae) (USDA-APHIS-PPQ 1984). Other species in the genus *Faustinus* appear to be monophagous or oligophagous on solanaceous plants (Marsh 1982; Gordon, Gonzalez et al. 1988; Giraldo 1993; Davis 1996; CABI 2003)	Low (1)
Risk Element 3: Dispersal Potential No information was available on reproductive and dispersal potentials of *F. ovatipennis*, or any member of the genus *Faustinus*. The genus *Faustinus* is part of the subfamily Cryptorhynchinae (O'Brien and Wibmer 1982), and most Cryptorhynchinae are apterous (Lyal 1993), which makes them incapable of long distance dispersal under their own power. However, members of the genus can be transported over long distances via anthropogenic activities, as evidenced by 45 PPQ interceptions of *Faustinus* sp. on *Capsicum* fruit (USDA 2003). The pest risk potential was estimated as high because of uncertainty in reproductive potential.	High (3)
Risk Element 4: Economic Impact Yield losses have not been reported in the literature for *F. ovatipennis* and are therefore assumed to be minimal. Establishment of this pest in the United States is however likely to cause foreign and domestic markets to be lost, as *F. ovatipennis* has a very limited distribution and would be considered a quarantine pest by most governments.	Low (1)
Risk Element 5: Environmental Impact *Faustinus ovatipennis* does not appear to be a threat to plants listed as Threatened or Endangered in 50 CFR §17.12 because it has only been reported as a pest of *Capsicum* (Solanaceae) (USDA-APHIS-PPQ 1984), and no species of *Capsicum* are listed as Threatened or Endangered in the United States. Introduction may stimulate chemical or biological control programs, but this is not certain.	Low (1)

Consequences of Introduction: *Liriomyza huidobrensis* (Blanchard) (Agromyzidae: Diptera)	**Risk Value**
Risk Element 1: Climate-Host Interaction *Liriomyza huidobrensis* is more cold-tolerant than other closely related leafmining flies (CABI 2003). It can survive an average winter in the Netherlands, and it has been shown to survive freezing at -18.7°C (CABI 2003). *Liriomyza huidobrensis* is presumably a native of Latin America, but it has been widely distributed by trade (Steck 1999; CABI 2003). It now occurs in southwest Africa, southern Asia, Canada, Europe, Hawaii and the Middle East, (Steck 1999; CABI 2003). Based on this information, it is estimated that *L. huidobrensis* could become established in the United States in USDA Hardiness Zones 7-11 (**Figure 1**). One or more of its potential hosts occur in these zones (USDA-NRCS 2003).	High (3)
Risk Element 2: Host Range *Liriomyza huidobrensis* is extremely polyphagous attacking plants in the families Amaranthaceae, Apiaceae, Asteraceae, Brassicaceae, Caryophyllaceae, Chenopodiaceae, Cucurbitaceae, Fabaceae, Liliaceae, Linaceae, Oxalidaceae, Polemoniaceae, Portulacaceae, Solanaceae, Tropaeolaceae, Valerianaceae, Verbenaceae, Violaceae (Steck 1999; CABI 2003).	High (3)
Risk Element 3: Dispersal Potential Female *L. huidobrensis* can mature and deposit up to 161 eggs during their life, and a generation can be completed in 13-26 days, so several generations per year are possible (Steck 1999; CABI 2003). Adult *L. huidobrensis* are capable of flight, and they can be transported over long distances in shipments of infested commodities (CABI 2003).	High (3)
Risk Element 4: Economic Impact Adult *L. huidobrensis* puncture plant tissues to feed and oviposit, while larvae feed within plant tissues (Steck 1999; CABI 2003). Feeding and oviposition on young plants reduces photosynthesis and can lead to plant mortality, which ultimately reduces yield (Steck 1999; CABI 2003). Plants that are attacked latter in their development do not die, but their value is reduced by unattractive punctures and larval mines (Steck 1999; CABI 2003). Establishment of *L. huidobrensis* in the continental United States is likely to cause a loss of foreign and domestic markets, as it is an important quarantine pest (CABI 2003). *Liriomyza huidobrensis* is listed by the European and Mediterranean Plant Protection Organization (EPPO) as an A2 quarantine pest for Europe (CABI/EPPO 1997).	High (3)
Risk Element 5: Environmental Impact *Liriomyza huidobrensis* is extremely polyphagous and could potentially attack plants listed as Threatened or Endangered in 50 CFR §17.12 (*e.g. Allium munzii* and *Cucurbita okeechobeensis* ssp. *okeechobeensis*). Chemical or biological control programs would undoubtedly be initiate if introduced into the United States because it is a major pest of vegetable and ornamental plants (Steck 1999; CABI 2003).	High (3)

Consequences of Introduction: *Neoleucinodes elegantalis* (Guenée) (Pyralidae: Lepidoptera)	**Risk Value**
Risk Element 1: Climate-Host Interaction *Neoleucinodes elegantalis* is a Latin American species that occurs from southern Mexico to northern Argentina (Marcano 1991). Based on this distribution, it is estimated that *N. elegantalis* could become established in the United States in USDA Hardiness Zones 9-11 (**Figure 1**). One or more of its potential hosts occur in these zones (USDA-NRCS 2003).	Medium (2)
Risk Element 2: Host Range *Neoleucinodes elegantalis* has only been recorded as a pest of solanaceous plants, including the economically important species: eggplant (*Solanum melongena*), tomato (*Lycopersicon esculentum*) and peppers (*Capsicum annuum*) (Marcano 1991; CABI 2003; Robinson, Ackery et al. 2003).	Medium (2)
Risk Element 3: Dispersal Potential Female *N. elegantalis* can mature and deposit up to 160 eggs during their life, and eggs are typically deposited on maturing fruit (Eiras and Blackmer 2003). No information was available on voltinism, but a mean generation time of 39.16 days was reported by Marcano (1991) on eggplant held at a constant 25ºC, so multiple generations per year are possible. Larvae of *N. elegantalis* can be transported over long distances in infested fruit, as evidenced by 29 USDA interceptions on *Capsicum* fruit (USDA 2003).	High (3)
Risk Element 4: Economic Impact *Neoleucinodes elegantalis* is the principal pest of tomato in Brazil, Colombia and Venezuela (Marcano 1991; Eiras and Blackmer 2003). Picanço *et al*. (1998) reported that nearly 2% of Brazilian tomatoes that were sprayed weekly with an insecticide were still infested by *N. elegantalis*. Other authors have indicated that even more frequent applications (every 2-3 days) do not offer sufficient control (Marcano, 1991). *Neoleucinodes elegantalis* can have a tremendous impact on tomato production because fruit infested by a single larvae is not marketable (Eiras and Blackmer 2003), and frequent insecticide applications increase production costs, which ultimately lowers the value of the commodity. In addition to reducing yield and lowering the value of the commodity, establishment of *N. elegantalis* in the United States is likely to cause foreign and domestic markets to be lost, as this pest is not widely distributed and would be considered a quarantine pest by most governments.	High (3)
Risk Element 5: Environmental Impact *Neoleucinodes elegantalis* could potentially attack plants listed as Threatened or Endangered in 50 CFR §17.12 (*e.g. Solanum incompletum* and *S. sandwicense*), and chemical or biological control programs would undoubtedly be initiated if it were introduced into the United States because it is a major pest of some economically important crops (*e.g.* eggplant, peppers and tomato).	High (3)

Consequences of Introduction: *Opogona sacchari* Bojer (Lepidoptera: Tineidae)	**Risk Value**
Risk Element 1: Climate-Host Interaction *Opogona sacchari* is a native African tineid that has been introduced into the Americas and Europe (CABI/EPPO, 1997). It has been reported as widespread in sub-Saharan Africa and Central America, present in Brazil, the Guangdong and Hebei provinces of China, Peru, the Russian Federation and Venezuela, and as having a restricted distribution in Italy, the Netherlands, Portugal, Spain, Switzerland and the United States (*i.e*. present in Florida and Hawaii) (CABI, 2003; CABI/EPPO, 1997). Reports from cool temperate regions (*e.g*. the Hebei province of China and Switzerland, which represent USDA Hardiness Zones 5-7) are believed to be either greenhouse infestations or interception records because *O. sacchari* is not known to survive outdoor winter temperatures that occur over most of the EPPO region (CABI/EPPO, 1997). Based on this information, it is estimated that *O. sacchari* could potentially establish in the United States in USDA Hardiness Zones 8-11 (**Figure 1**). One or more of its potential hosts occur in these zones (USDA-NRCS 2003).	High (3)
Risk Element 2: Host Range *Opogona sacchari* has a wide host range that includes both living and dead plant material (CABI/EPPO, 1997). Its primary hosts are in the families Bromeliaceae (*e.g*. pineapple), Cactaceae (*e.g*. cacti), Musaceae (*e.g*. banana), Poaceae (*e.g*. bamboo, corn and sugarcane), Liliaceae (*e.g*. *Dracaena*) and Agavaceae (*e.g*. yucca), but it will attack ornamentals in the families Araceae (*e.g*. *Dieffenbachia* and *Philodendron*), Arecaceae (*e.g*. *Chamaedorea*), Begoniaceae (*e.g*. *Begonia*), Euphorbiaceae (*e.g*. poinsettia), Heliconiaceae (*e.g*. *Heliconia*), Marantaceae (*e.g*. arrowroot), Nyctaginaceae (*e.g*. *Bougainvillea*), Zingiberaceae (*e.g*. *Alpinia*), and crops in the families Dioscoreaceae (*e.g*. yam), Moraceae (*e.g*. fig) and Solanaceae (*e.g*. eggplant and peppers) (CABI/EPPO, 1997).	High (3)
Risk Element 3: Dispersal Potential Female *O. sacchari* can mature and deposit up to 200 eggs during their life, and up to eight generations per year are possible under favorable conditions (CABI, 2003). The moth can only fly short distances, but larvae can be transported over long distances in shipments of infested commodities (CABI/EPPO, 1997).	High (3)

Consequences of Introduction: *Opogona sacchari* Bojer (Lepidoptera: Tineidae)	**Risk Value**
Risk Element 4: Economic Impact *Opogona sacchari* mines plant stems causing leaf fall and allowing pathogens to colonize and destroy affected plants (DEFRA, 2002). It is an important pest of banana that causes annual average yield losses of 5-10% in the Canary Islands (Perez and Carnero, 1984). It also affects ornamental plants, such as *Dracaena fragrans*, and up to 61% of *D. fragrans* grown in Sao Paulo, Brazil may be damaged by *O. sacchari* (Bergmann et al., 1995). In addition to substantial yield reductions, *O. sacchari* lowers crop values by requiring controls, and its wide spread establishment in the United States would cause foreign and domestic markets to be lost, as *O. sacchari* is listed by EPPO as an A2 quarantine pest for Europe (CABI/EPPO 1997).	High (3)
Risk Element 5: Environmental Impact *Opogona sacchari* could potentially attack plants listed as Threatened or Endangered in 50 CFR §17.12 (*e.g. Solanum incompletum* and *S. sandwicense*), and chemical or biological control programs would undoubtedly be initiated if it were introduced into new areas of the United States because it is a troublesome quarantine pest (CABI/EPPO, 1997).	High (3)

Consequences of Introduction: *Phenacoccus parvus* Morrison (Hemiptera: Pseudococcidae)	**Risk Value**
Risk Element 1: Climate-Host Interaction *Phenacoccus parvus* reportedly occurs in Africa (*i.e.* Congo, Gabon and Senegal), Australia, Central America (*i.e.* Belize, Costa Rica, Nicaragua and Panama), North America (*i.e.* Florida and Mexico) and South America (*i.e.* Argentina, Chile, Guyana, Paraguay and Uruguay) (CABI, 2003; Scalenet, 2003). Williams and Granara de Willink (1992) suggested that it may be a common mealybug throughout Cental and South America. Based on this information, it is estimated that *P. parvus* could potentially establish in the United States in USDA Hardiness Zones 8-11 (**Figure 1**). One or more of its potential hosts occur in these zones (USDA-NRCS 2003).	High (3)
Risk Element 2: Host Range *Phenacoccus parvus* is extremely polyphagous attacking plants in the families Actinidiaceae, Amaranthaceae, Apocynaceae, Asclepiadaceae, Compositae, Convolvulaceae, Euphorbiaceae, Gramineae, Lamiaceae, Leguminosae, Malvaceae, Musaceae, Myrtaceae, Piperaceae, Solanaceae and Verbenaceae (Scalenet, 2003).	High (3)

Consequences of Introduction: *Phenacoccus parvus* Morrison (Hemiptera: Pseudococcidae)	**Risk Value**
Risk Element 3: Dispersal Potential Fecundity and generation times vary with host, but *P. parvus*, which is facultatively parthenogenetic, can produce an average of 337 crawlers during their life when reared on tomato plants, and generation times generally fall within the range of 25-33 days under laboratory conditions (Marohasy, 1997). Based on this information, it is reasonable to assume that *P. parvus* has a high biotic potential (*e.g.* many offspring per reproduction and many generations per year). Although mealybugs have limited powers of natural dispersal, *P. parvus* can be transported over long distances in shipments of infested commodities, as evidenced by the 36 PPQ interceptions on a variety of different commodities (USDA, 2003b).	High (3)
Risk Element 4: Economic Impact *Phenacoccus parvus* has wrongly been labeled as a pest because it could potentially attack numerous crop species (Marohasy, 1994, 1997). It has never actually caused economic damage to any plant anywhere that it occurs (Marohasy, 1994, 1997). Classifying *P. parvus* as a pest has prevented it from being used to control the weed, *Lantana camara*, which it preferentially attacks (Marohasy, 1994, 1997).	Low (1)
Risk Element 5: Environmental Impact *Phenacoccus parvus* could potentially attack plants listed as Threatened or Endangered in 50 CFR §17.12 (*e.g. Solanum incompletum* and *S. sandwicense*). Introduction into new areas of the United States could initiate chemical and/or biological control programs because *P. parvus* can survive and reproduce on some economically important crops, like peppers and eggplant (Marohasy, 1997).	High (3)

Consequences of Introduction: *Planococcus minor* (Maskell) (Pseudococcidae: Hemiptera)	**Risk Value**
Risk Element 1: Climate-Host Interaction *Planococcus minor* is widely distributed in Argentina, Australia, Bangladesh, Barbados, Bermuda, Burma, Borneo, Brazil, Colombia, Costa Rica, Cuba, Dominica, Fiji, the Galapagos Islands, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, India, Jamaica, Madagascar, Mexico, Papua New Guinea, the Philippines, Singapore, Sumatra, Malaysia, Taiwan, Thailand and the Virgin Islands (Ben-Dov 1994). Based on this distribution, it is estimated that *P. minor* could become established in the United States in USDA Hardiness Zones 8-11 (**Figure 1**). One or more of its potential hosts occur in these zones (USDA-NRCS 2003).	High (3)

Consequences of Introduction: *Planococcus minor* (Maskell) (Pseudococcidae: Hemiptera)	**Risk Value**
Risk Element 2: Host Range *Planococcus minor* is extremely polyphagous attacking plants in the families Acanthaceae, Amaranthaceae, Anacardiaceae, Annonaceae, Apiaceae, Apocynaceae, Araceae, Araliaceae, Asclepiadaceae, Balsaminaceae, Barringtoniaceae, Bischofiaceae, Burseraceae, Bromeliaceae, Burseraceae, Cactaceae, Casuarinaceae, Combretaceae, Commelinaceae, Compositae, Convolvulaceae, Corynocarpaceae, Cruciferae, Cucurbitaceae, Cyperaceae, Dioscoreaceae, Euphorbiaceae, Fabaceae, Gramineae, Guttiferae, Heliconiaceae, Iridaceae, Labiatae, Lamiaceae, Lauraceae, Loganiaceae, Lythraceae, Magnoliaceae, Malavaceae, Marantaceae, Moraceae, Musaceae, Myristicaceae, Myrtaceae, Onagraceae, Orchidaceae, Palmae, Pandanaceae, Passifloraceae, Piperaceae, Proteaceae, Rhamnaceae, Rosaceae, Rubiaceae, Rutaceae, Sapotaceae, Scrophulariaceae, Solanaceae, Sterculiaceae, Theaceae, Tiliaceae, Urticaceae, Verbenaceae, Vitidaceae and Zingiberaceae (Ben-Dov 1994).	High (3)
Risk Element 3: Dispersal Potential Female *P. minor* are highly fecund depositing up to 800 eggs in a 14 day period (Peña *et al*. 2002), and they can complete 10 generations in a year, with generation times varying from 28-45 days depending on season (Sahoo *et al*. 1999). Although mealybugs have limited powers of natural dispersal, they can be transported over long distances in shipments of infested fruits and vegetables (CABI 2003).	High (3)
Risk Element 4: Economic Impact According to Peña *et al*. (2002), *P. minor* feeds on inflorescences, stems and fruit; its feeding stunts plant growth, covers foliage with sooty mold, and lowers the quality of fruit. Fruit that has been attacked by *P. minor* is not marketable (Peña *et al*. 2002). In addition to reducing marketable yield and the value of the commodity by requiring controls, its presence in the United States could cause foreign and domestic markets to be lost.	High (3)
Risk Element 5: Environmental Impact *Planococcus minor* is extremely polyphagous and could potentially attack plants listed as Threatened or Endangered in 50 CFR §17.12 (*e.g. Cucurbita okeechobeensis* subsp. *okeechobeensis*). Its presence in the United States would likely stimulate chemical and/or biological control programs because it is a pest of numerous economic crops (*e.g.* citrus, potato, peppers and melon).	High (3)

Consequences of Introduction: *Thrips palmi* Karny (Thripidae: Thysanoptera)	**Risk Value**
Risk Element 1: Climate-Host Interaction *Thrips palmi* is a tropical to subtropical species that cannot survive subzero temperatures for more than a few days (Lewis 1997). However, populations exist in temperate climates by overwintering in greenhouses and interior landscapes (CABI 2003). It is present in Africa, Asia, Australia, the United States, Japan, Latin America, the Caribbean and Pacific Islands (CABI 2003). United States populations are restricted to American Samoa, Florida, Guam, Hawaii and Puerto Rico (CABI 2003). Based on this distribution, it is estimated that *T. palmi* could establish permanent outside populations in the United States in USDA Hardiness Zones 9-11 (**Figure 1**). One or more of its potential hosts occur in these zones (USDA-NRCS 2003).	Medium (2)
Risk Element 2: Host Range *Thrips palmi* is a polyphagous pest that attacks plants in the families Anacardiaceae, Asteraceae, Cucurbitaceae, Fabaceae, Lauraceae, Liliaceae, Malvaceae, Orchidaceae, Pedaliaceae, Poaceae and Solanaceae (CABI 2003).	High (3)
Risk Element 3: Dispersal Potential Female *T. palmi* can mature and deposit up to 204 eggs during their life, and generation times range from 11.5-20 days depending on temperature and host plant (Capinera 2000; CABI 2003); so several generations per year are possible. Adults are capable of flight, and their small size and fringed wings allow long distance dispersal via wind or as passengers in commercial commodities (Lewis 1997).	High (3)
Risk Element 4: Economic Impact Feeding by *T. palmi* may cause leaves to yellow and die, terminal growth to be arrested and fruits to be scarred or deformed (Capinera 2000). *Thrips palmi* can severely reduce tomato yields by spreading tomato spotted wilt disease, and even low population densities (4.5 adults per sticky trap per day) may reduce the yield of greenhouse grown peppers (CABI 2003). Yield reductions in excess of 30% have been reported for numerous vegetables crops attacked by *T. palmi* (CABI 2003). In addition to substantial yield reductions, *T. palmi* lowers crop values by requiring controls, and its wide spread establishment in the United States would cause foreign and domestic markets to be lost. *Thrips palmi* is listed by EPPO as an A1 quarantine pest for Europe (CABI/EPPO 1997).	High (3)
Risk Element 5: Environmental Impact *Thrips palmi* could potentially attack plants listed as Threatened or Endangered in 50 CFR §17.12 (*e.g. Allium munzii*), and control programs would undoubtedly be initiated if it were to be introduced into new areas of the United States.	High (3)

Consequences of Introduction: *Puccinia pampeana* Mayor (Uredinales: Basidiomycetes)	**Risk Value**
Risk Element 1: Climate-Host Interaction *Puccinia pampeana* has been reported to occur in sub-tropical and tropical regions of the western hemisphere, including Argentina (Figueiredo, Carvalho et al. 1994; Hernandez and Hennen 2003), Bolivia (Hernandez and Hennen 2003), Brazil (Watson 1971; Gomez and Varon-de-Agudelo 1993; Calderón and Díaz 2002; Hernandez and Hennen 2003), Chile (Hernandez and Hennen 2003), Columbia (Watson 1971; Gomez and Varon-de-Agudelo 1993; Calderón and Díaz 2002), Costa Rica (Watson 1971; Gomez and Varon-de-Agudelo 1993; Calderón and Díaz 2002), Ecuador (Hernandez and Hennen 2003), Guatemala (Hernandez and Hennen 2003), Mexico (Romero Cova 1990; Hernandez and Hennen 2003), Peru (Hernandez and Hennen 2003), and Uruguay (Hernandez and Hennen 2003). Based on its distribution, *P. pampeana* would be able to establish populations in USDA Hardiness Zones 8-11 (**Figure 1**) (USDA 1990; Anonymous 2004).	High (3)
Risk Element 2: Host Range Rust fungi are generally host-specific, often causing disease on certain genera or even on certain cultivars (Agrios 1997). *Puccinia pampeana* has been reported on genera in the Solanaceae family, including *Acnistus arborescens* (L.) Schltdl., *A. breviflorus* Sendtn., *A. parviflorus* Griseb., *Acnistus* sp., *Capsicum annuum* L., *C. baccatum* L., *C. ciliatum* (Kunth) Kuntze, *C. frutescens* L., *C. microcarpum* DC., *C. pendulum* Willd. (Hernandez and Hennen 2003); *Capsicum* sp. (Watson 1971; Gomez and Varon-de-Agudelo 1993; Calderón and Díaz 2002; Hernandez and Hennen 2003); *Cestrum* sp., *Dunalia breviflora* (Sendtn.) Sleumer, *D. lycioides* Miers, *Salpichroa diffusa* Miers, *S. origanifolia* (Lam.) Baill., *S. rhomboidea* (Hook.) Miers, *Salpichroa* sp., *Solanum cyrtopodium* Dunal, *S. lycioides* L., *S. valdiviense* Dunal, *Solanum* sp. (Hernandez and Hennen 2003).	Medium (2)
Risk Element 3: Dispersal Potential *Puccinia pampeana* is autoecious (Figueiredo, Carvalho et al. 1994) and microcyclic (Ono 2002). Aecia/aeciospores and uredinia/urediniospores are not seen (Figueiredo 2000; Hernandez and Hennen 2003). The fungus has a dimorphic telial state, producing *Endophyllum*-type and a *Puccinia*-type teliospores, both of which germinate to produce basidiospores (Ono 2002; Hernandez and Hennen 2003). *Endophyllum*-type teliospores germinate without dormancy, forming basidiospores within 4-5 hours and are responsible for rapid dissemination and increase in fungal population (Figueiredo, Pimentel et al. 1987; Figueiredo 2000). Multiple generations can occur in a year. The *Puccinia*-type teliospores become dormant, functioning as over-seasoning spores and may be the source for initial infection in field conditions (Figueiredo, Pimentel et al. 1987; Figueiredo 2000). There was no information regarding spore dispersal potential for this species.	High (3)

Consequences of Introduction: *Puccinia pampeana* Mayor (Uredinales: Basidiomycetes)	**Risk Value**
Spores of other *Puccinia* species have the capability to be dispersed by rain splash, dew run-off, insects, and wind (Alexopoulos, Mims et al. 1996; Agrios 1997), and can disperse long distances in air currents, as seen with basidiospores of a related *Puccinia* sp. that dispersed a few hundred kilometers (Agrios 1997).	
Risk Element 4: Economic Impact The economic impact *P. pampeana* is unknown or not reported in the literature. Related *Puccinia* species cause significant reductions in yield and product quality (Wiese 1987; Alexopoulos, Mims et al. 1996; Agrios 1997), and require control through removal of alternate hosts, host resistance and/or chemical control (Agrios 1997). The presence of *P. pampeana* in the United States would most likely require chemical and cultural control, and may result foreign and domestic markets to be lost.	High (3)
Risk Element 5: Environmental Impact *Puccinia pampeana* could potentially attack plants listed as Threatened or Endangered in 50 CFR §17.12 (*e.g.* plants in the Solanaceae family, including: *Goetzea elegans* (Puerto Rico); *Nothocestrum breviflorum* and *N. peltatum* (Hawaii); *Solanum drymophilum* (Puerto Rico); and *S. incompletum* and *S. sandwicense* (Hawaii)), and control programs would undoubtedly be initiated if it were to be introduced into new areas of the United States, because it is a major pathogen of at least one economically important crop (*Capsicum* sp.).	High (3)

Consequences of Introduction: Andean potato mottle virus (Comovirus)	**Risk Value**
Risk Element 1: Climate-Host Interaction Andean potato mottle virus (APMoV) is reported to occur in South and Central America, including Brazil (Avila, Salazar et al. 1984), Bolivia, Costa Rica, Ecuador (CABI 2003), Honduras (Valverde, Black et al. 1995), Nicaragua (CABI 2003) and Peru (Fribourg, Jones et al. 1977). Based on the distribution, APMoV could potentially establish in USDA Hardiness Zones 8-12 (USDA 1990; Anonymous 2004). One or more of its potential hosts lives within this range (USDA-NRCS 2003).	High (3)
Risk Element 2: Host Range The host range of APMoV is restricted to the Solanaceae family including: *Capsicum annuum*, *C. frutescens* (CABI 2003; Pernezny, Roberts et al. 2003), *Lycopersicon chilense*, *Nicandra physaloides* (Valverde and Fulton 1996), *Nicotiana bigelovii* (Fribourg et al. 1977), *N. clevelandii* (Valverde and Fulton 1996), *Solanum melongena*, and *S. tuberosum* (CABI 2003; Pernezny et al. 2003).	Medium (2)

Consequences of Introduction: Andean potato mottle virus (Comovirus)	Risk Value
Risk Element 3: Dispersal Potential APMoV is vectored by the polyphageous beetles, *Diabrotica balteata* Leconte and *D. viridula* Fabricius (Chrysomelidae, Coleoptera), found in Central America, Caribbean, Mexico and southern states of the United States (Valverde, Black et al. 1995; Valverde and Fulton 1996). Other species of *Diabrotica* are also suspected to be vectors (Valverde and Fulton 1996). *Diabrotica* sp. would most likely not arrive with the commodity since adults are capable of flight and feed externally on fruit (MAG 1991; Granardos 2001; CABI 2003; UAQ 2003) and are likely to be removed by minimal processing of the commodity, thus populations already present within the United States would be responsible for the movement of the virus into the environment. APMoV is also transmitted through mechanical means and plant-to-plant contact (Fribourg, Jones et al. 1977; Pernezny, Roberts et al. 2003), but not through seed (Brunt, Crabtree et al. 1996 (onwards); CABI 2003; Pernezny, Roberts et al. 2003).	Low (1)
Risk Element 4: Economic Impact Economic losses caused by APMoV infection in solanaceous crops has not been specifically reported in the literature. APMoV is highly virulent, and is a concern for potato seed production regions (Avila, Salazar et al. 1984). Its presence in the United States may cause foreign and domestic markets to be lost.	High (3)
Risk Element 5: Environmental Impact APMoV could potentially attack plants listed as Threatened or Endangered in 50 CFR §17.12 (*e.g*. plants in the Solanaceae family, including: *Goetzea elegans* (Puerto Rico); *Nothocestrum breviflorum* and *N. peltatum* (Hawaii); *Solanum drymophilum* (Puerto Rico) and *S. incompletum* and *S. sandwicense* (Hawaii)), and control programs would undoubtedly be initiated if it were to be introduced into new areas of the United States, because it is a major pathogen of several economic crops (*e.g*. peppers, potatoes, and tomatoes).	High (3)

Consequences of Introduction: Tomato yellow mosaic virus (Geminivirus)	Risk Value
Risk Element 1: Climate-Host Interaction Tomato yellow mosaic virus (ToYMV) has been reported in Venezuela (CABI 2003) and El Salvador (Castillo 2003). Based on this distribution, ToYMV could potentially become established in USDA Hardiness Zones 9-13 (USDA 1990). One or more of its potential hosts live within this range (USDA-NRCS 2003).	High (3)

Consequences of Introduction: Tomato yellow mosaic virus (Geminivirus)	Risk Value
Risk Element 2: Host Range Mainly solanaceous crops are infected by the virus: *Lycopersicon esculentum* (CABI 2003), *L. hirsutum*, *L. pimpinellifolium* (Brunt, Crabtree et al. 1996 (onwards)), *Nicotiana glutinosa*, *Nicotiana tabacum* (Lastra and Gil 1981), *Solanum tuberosum* (CABI 2003), and *Solanum quitoense* (CABI 2003) (Solanaceae).	Medium (2)
Risk Element 3: Dispersal Potential ToYMV is transmitted by *Bemisia tabaci* (Gennadius) but is typically not mechanical transmitted (de Uzcátegui and Lastra 1978; Lastra and Gil 1981). The virus is not transmitted by contact between plants, by seed or by pollen (Lastra and Uzcategui 1975; de Uzcátegui and Lastra 1978)	Low (1)
Risk Element 4: Economic Impact ToYMV has caused serious losses, up to 90% in some cases, in Venezuela on tomato (de Uzcátegui and Lastra 1978; Piven, Uzcategui et al. 1995). Tomato plants infected in the early stages of development may remain fruitless (Piven, Uzcategui et al. 1995). Its presence in the United States could cause foreign and domestic markets to be lost.	High (3)
Risk Element 5: Environmental Impact ToYMV could potentially attack plants listed as Threatened or Endangered in 50 CFR §17.12 (*e.g*. plants in the Solanaceae family, including: *Goetzea elegans* (Puerto Rico); *Nothocestrum breviflorum* and *N. peltatum* (Hawaii); *Solanum drymophilum* (Puerto Rico) and *S. incompletum* and *S. sandwicense* (Hawaii)), and control programs would undoubtedly be initiated if it were to be introduced into new areas of the United States, because it is a major pathogen of several economic crops (*e.g*. peppers and tomatoes).	High (3)

Table 4. Risk Rating for Consequences of Introduction.

Pest	Climate-Host Interaction	Host Range	Dispersal Potential	Economic Impact	Environmental Impact	Cumulative Risk Rating[1]
Anastrepha ludens	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Ceratitis capitata	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (14)
Faustinus ovatipennis	Medium (2)	Low (1)	High (3)	Low (1)	Low (1)	Low (8)
Liriomyza huidobrensis	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Neoleucinodes elegantalis	Medium (2)	Medium (2)	High (3)	High (3)	High (3)	High (13)
Opogona sacchai	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Phenacoccus parvus	High (3)	High (3)	High (3)	Low (1)	High (3)	High (13)
Planococcus minor	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Thrips palmi	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Puccinia pampeana	High (3)	Medium (2)	High (3)	High (3)	High (3)	High (14)
Andean potato mottle virus	High (3)	Medium (2)	Low (1)	High (3)	High (3)	Medium (12)
Tomato Yellow Mosaic Virus	High (3)	Medium (2)	Low (1)	High (3)	High (3)	Medium (12)

[1]Cumulative risk rating value is defined as Low (5-8 points); Medium (9-12 points); or High (13-15 points) (USDA 2000).

Likelihood of Introduction—Quantity Imported and Pest Opportunity

Each pest is rated with respect to likelihood of introduction, which is a function of the quantity to be imported and the pest opportunity (**Table 6**). First, an estimate is made concerning the amount of commodity likely to be imported. Second, pest opportunity is estimated using five biological features: ability of the pest to survive post harvest treatment; ability of the pest to survive shipment; ability of the pest to be detected at the port of entry; ability of the pest to move

to an area with an environment suitable for survival, and the chance that the pest would come in contact with host material (USDA 2000). The biological features should be considered as a series of independent events that must all take place before a pest outbreak can occur, *i.e.*, the estimates for one element should not affect estimates for other elements. The following scale is used to interpret the summation between the amount to be imported and pest opportunity: Low is 6-9 points, Medium is 10-14 points, and High is 15-18 points.

Quantity of commodity imported annually

The government of Costa Rica estimates that the export volume of fresh pepper fruit for consumption to the United States would average 6,000 metric tons per year (Gonzalez 2003), which equates to 300 40-ft. containers based on the conversion factor of 20 metric tons per 40-foot shipping container (**Table 5**) (Cargo Systems 2001).

The government of El Salvador estimates that the export of pepper fruit (*C. annuum*) for consumption to the United States would total 450 metric tons/month, or 5,400 metric tons/year (**Table 5**) (Castillo 2003). This translates into 270 40-foot shipping containers per year based on a conversion factor of 20 metric tons per 40-foot shipping container (Cargo Systems 2001).

The government of Guatemala estimates that the export of peppers (*C. annuum*, *C. frutescens*, and *Capsicum* spp. with sepals, peduncles and shafts) to the United States for consumption would total 11,240 metric tons per year packed in cardboard boxes or wooden crates (**Table 5**) (Aldana 2003). This converts into a predicted volume of approximately 562 standard 40-foot shipping containers per year based on the above conversion factor.

The government of Honduras estimates that the export of peppers (*C. annuum*) to the United States for consumption would total 3,000 metric tons per year (250 metric tons/month) packed in cardboard boxes (**Table 5**) (Puerto 2003). This converts into a predicted volume of approximately 150 standard 40-foot shipping containers per year (12.5 containers/month) based on the above conversion factor.

The government of Nicaragua estimates that the export of peppers (about 88% as *Capsicum annuum* and 12% as *C. frutescens*) for consumption to the United States would total 5,400 metric tons per year (450 metric tons/month) packed in cardboard boxes enclosed with at least a 17 net mesh (**Table 5**) (Fonseca 2003; Fonseca 2003). This translates into a predicted volume of approximately 270 standard 40-foot shipping containers a year based on the above conversion.

The cumulative total for the quantity to be imported from these Central American countries was assigned a risk rating of High in accordance with the template document, *Guidelines for Pathway-Initiated Pest Risk Assessment, Version 5.02* (USDA 2000).

Table 5. Estimated volume of *Capsicum* fruit to be exported to the U.S. for consumption.

Country	Volume per month (metric tons) [6, 7]	Volume per year (metric tons) [6]	40-ft shipping containers per month [6, 7]	40-ft shipping containers per year [6]	Reference
Costa Rica[1]	500	6,000	25	300	(Gonzalez 2003)
El Salvador[2]	450	5,400	22.5	270	(Castillo 2003)
Guatemala[3]	936	11,240	46.8	562	(Aldana 2003)
Honduras[4]	250	3,000	12.5	150	(Puerto 2003)
Nicaragua[5]	450	5,400	22.5	270	(Fonseca 2003)
Total	2,586	31,040	129	1552	

[1] Costa Rica provided the estimated metric tons to be exported per year.
[2] El Salvador provided the estimated monthly weight to be exported.
[3] Guatemala provided an estimate of the number of boxes (a box holds 12.8 kg of pepper, except for the Holandés-type pepper where a box holds 5 kg) to be exported per year for 4 types of pepper. These volumes were summed and converted to metric tons.
[4] Honduras provided the monthy weight to be exported.
[5] Nicaragua provided a monthly weight to be exported.
[6] The following formulas were used to convert volume per month to volume per year and vice versa; and to convert volume to the number of 40-ft. shipping containers. Metric tons per month = (metric tons per year / 12 months per year); Metric tons per year = (metric tons per month * 12 months per year); Shipping containers per month = (metric tons per month / 20 metric tons per 40 ft. shipping container) (Cargo Systems 2001); Shipping containers per year = (metric tons per year / 20 metric tons per 40-ft. shipping container) (Cargo Systems 2001).
[7] The monthly volume is an estimate since production volume will have seasonal fluctuations.

Survive post-harvest treatment: For this sub-element, post-harvest treatment refers to any manipulation, handling or specific phytosanitary treatment to which the commodity is subjected. Examples of post-harvest treatments include culling, washing, chemical treatment, cold storage, etc.

Arthropods that feed internally were expected to survive minimal post-harvest treatments, such as washing and culling. The flies, *A. ludens*, *C. capitata* and *L. huidobrensis*, the moths, *N. elegantalis* and *O. sacchari*,, and the weevil, *F. ovatipennis*, were therefore rated High for this sub-element.

External feeding arthropods would have a lower probability of surviving postharvest treatment than internal feeding arthropods. However, minute arthropods like mealybugs and thrips may survive post-harvest treatment by hiding in recesses on the fruit (*e.g.* the calyx) (Lewis 1997; CABI 2003). For these reasons, the mealybugs, *P. parvus* and *P. minor*, and the thrips, *T. palmi*, were given a risk rating of Medium.

Puccinia pampeana produces subepidermal fungal structures (Figueiredo, Pimentel et al. 1987; Figueiredo 2000) which are expected to survival minimal post-harvest treatments. The *Puccinia*-type teliospores can remain viable for a long time (Figueiredo, Pimentel et al. 1987). While washing or other debris removal may occur, there is no evidence suggesting that this will eliminate latent infection. *Puccinia pampeana* was given a risk rating of High for this sub-element.

Both the APMoV and ToYMV cause systemic infection (Lastra and Gil 1981; CABI 2003) and would survive post-harvest treatments on the commodity (Matthews 1992; Agrios 1997). Both viruses were given a risk rating of High.

Survive shipment: Fresh peppers are typically stored at 4ºC and 95% relative humidity (CABI 2003). If these conditions were maintained while transporting the commodity via a modern cargo ship, which should take about 2.5 days to travel from Costa Rica to Miami, Florida, assuming fair weather, a distance of 1,118 miles and a constant speed of 16 knots, some individuals of each pest would likely survive. For example, the USDA currently recommends that fruit be stored at 0ºC for 12 days to kill all *C. capitata* larvae (USDA 2002). The fungal pathogen *P. pampeana* and the two viruses APMoV and ToYMV can be found in the sub-epidermal layers or become systemic (Lastra and Gil 1981; Figueiredo, Pimentel et al. 1987; Hernandez and Hennen 2003; Pernezny, Roberts et al. 2003), surviving shipment within the tissue of pepper fruit and stems. In addition, *Puccinia*-type teliospores of *P. pampeana* may survive shipping conditions in a dormant state (Figueiredo 2000). All species were therefore assigned a High risk rating for this sub-element.

Not be detected at the port of entry: The probability that an arthropod pest is detected at the port of entry is a function of their size and degree of concealment. Because internal feeders are well concealed, they have a high probability of escaping detection. *Anastrepha ludens*, *C. capitata*, *F. ovatipennis*, *L. huidobrensis* and *N. elegantalis* and *O. sacchari* were therefore given high risk ratings for this sub-element. Although external feeders are more likely to be detected at the port of entry than internal feeders, minute pests, especially if hidden in the calyx of fruit or in packing material, are unlikely to be noticed. *Planococcus minor*, *P. parvus* and *T. palmi* were therefore also given a pest risk rating of High.

Infection sites with signs of sporulation, leaf and stem lesions and rotting fruit are easily identified (Agrios, 1997) at the port of entry, but latent infections and the presence of spores adhering to the fruit or packing materials are likely to go undetected. The spores of *P. pampeana*, if present, are likely to remain viable, and the *Puccinia*-type teliospores can remain dormant (Figueiredo, Pimentel et al. 1987; Figueiredo 2000). Under the circumstances, the rating for this risk element is Medium.

APMoV and ToYMV symptoms vary depending on the host and cultivar infected (Piven, Uzcategui et al. 1995; Pernezny, Roberts et al. 2003). On pepper, APMoV causes mottling (CABI 2003; Pernezny, Roberts et al. 2003), and ToYMV causes mosaic-type symptoms on several hosts (de Uzcátegui and Lastra 1978; Roberts, Buck et al. 1986). APMoV can reach a high titer in the plant which can remain symptomless (Pernezny, Roberts et al. 2003). ToYMV can also be present

in a symptomless plant (Piven, Uzcategui et al. 1995). Symptoms can sometimes be mistaken for abiotic problems, such as natural genetic variation, nutritional deficiency, temperature or other environmental factor. Diagnosis can be confirmed through serological testing (Matthews 1992; Agrios 1997; Pernezny, Roberts et al. 2003). Both viruses were given a risk rating of Medium.

Imported or moved subsequently to an area with an environment suitable for survival: Peppers have widespread acceptance among consumers in the United States, which means that markets exist in all parts of the United States, and infested or infected fruits are likely to arrive in areas that are suitable for pest survival. Risk ratings for this sub-element were therefore based on the area of the United States in which each pest could potentially establish.

Liriomyza huidobrensis was rated High because it could potentially establish in USDA Hardiness Zones 7-11, which represents an estimated 50% of the United States. *Anastrepha ludens*, *C. capitata*, *N. elegantalis*, *O. sacchari*, *P. minor*, *P. parvus* and *T. palmi* were rated Medium because they could potentially establish in USDA Hardiness Zones 8-11 or 9-11, which represent less than an estimated 33% of the United States. *Faustinus ovatipennis* was rated Low because it could potentially establish in USDA Hardiness Zones 10-11, which represent an estimated 10% of the United States.

Puccinia pampeana could potentially survive in US Plant Hardiness Zones 8-11 (USDA 1990), which represents less than an estimated 33% of the US. Under these circumstances the rating for this risk element is Medium.

The viruses APMoV and ToYMV were rated Medium because they could potentially establish in U.S. Plant Hardiness Zones 8-12 and 9-13, respectively, which represents less than an estimated 33% of the US.

Come into contact with host material suitable for reproduction: Even if the final destination of infested commodities is conducive for pest survival, suitable hosts must be available in order for the pest to survive.

Polyphagous pests or those that utilize very common hosts and were capable of long distance aerial dispersal (*i.e. A. ludens*, *C. capitata*, *L. huidobrensis*, *N. elegantalis*, *O. sacchari* and *T. palmi*) were considered likely to come into contact with suitable hosts and were assigned a pest risk rating of High for this sub-element. The remaining pests (*i.e. F. ovatipennis*, *P. parvus* and *P. minor*) were given pest risk ratings of Medium because they were not capable of long distance aerial dispersal.

The dispersal potential for *P. pampeana* is not known, however related *Puccinia* species are capable of long distance aerial dispersal (Alexopoulos, Mims et al. 1996; Agrios 1997). Rust fungi are generally host-specific, causing disease which is limited to certain host genera, species or even cultivars (Agrios 1997). *Puccinia pampeana* is reported to occur on 6 genera and 17 species within the Solanaceae family. Four of the host species occur in the United States, two limited to the southern tier states (*S. origanifolia* and *S. rhomboidea*), one found in Puerto Rico

and Hawaii (*A. arborescens*) and one that is widespread (*C. annuum*) (USDA 2004). The fungus was given a risk rating of Medium under these circumstances.

APMoV is vectored by species of *Diabrotica* and is mechanically transmitted but is not transmitted by seed (Pernezny, Roberts et al. 2003). *Diabrotica* spp. would have to come in contact with infected fruit when it arrives in the United States (since it would most likely not arrive with the commodity), acquire the virus by feeding on infected fruit and then disperse to a host in the environment (CABI 2003; Pernezny, Roberts et al. 2003). ToYMV is vector transmitted (*Bemisia tabaci*), not easily mechanically transmitted and is not transmitted through seed (de Uzcátegui and Lastra 1978; Piven, Uzcategui et al. 1995). Both viruses have a limited host range, affecting mostly plants within the Solanaceae family. These viruses were given a risk rating of Low.

Table 6. Summary of the ratings for the quantity imported annually, the pest opportunity, and the value for the Likelihood of Introduction.

Pest	Quantity Imported Annually	Ratings for Pest Opportunity					Likelihood of Introduction Value
		Survive Post-harvest Treatment	Survive Shipment	Not Detected at Port of Entry	Moved to Suitable Habitat	Contact with Host Material	
Anastrepha ludens	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (17)
Ceratitis capitata	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (17)
Faustinus ovatipennis	High (3)	High (3)	High (3)	High (3)	Low (1)	Medium (2)	High (15)
Liriomyza huidobrensis	High (3)	High (3)	High (3)	High (3)	High (3)	High (3)	High (18)
Neoleucinodes elegantalis	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (17)
Opogona sacchari	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (17)
Phenacoccus parvus	High (3)	Medium (2)	High (3)	High (3)	Medium (2)	Medium (2)	High (15)
Planococcus minor	High (3)	Medium (2)	High (3)	High (3)	Medium (2)	Medium (2)	High (15)
Thrips palmi	High (3)	Medium (2)	High (3)	High (3)	Medium (2)	High (3)	High (16)
Puccinia pampeana	High (3)	High (3)	High (3)	Medium (2)	Medium (2)	Medium (2)	High (15)
Andean Potato Mottle Virus	High (3)	High (3)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (14)
Tomato Yellow Mosaic Virus	High (3)	High (3)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (14)

F. Conclusion: Pest Risk Potential

Pest Risk Potentials, which are summations of the Consequences of Introduction and Likelihood of Introduction values, are recorded in **Table 7**. Pest Risk Potential is an estimation of the risk associated with importation of the commodity in the absence of any mitigative measures. The summation results in the following Pest Risk Potential ratings: Low (11-18 points); Medium (19-26 points); and High (27-33 points). According to the template document, *Guidelines for Pathway-Initiated Pest Risk Assessments, Version 5.02* (USDA 2000), port of entry inspection provides sufficient phytosanitary security for pests assigned low pest risk potentials, while specific phytosanitary measures may be necessary for pests assigned medium pest risk potentials and are strongly recommended for pests assigned high pest risk potentials.

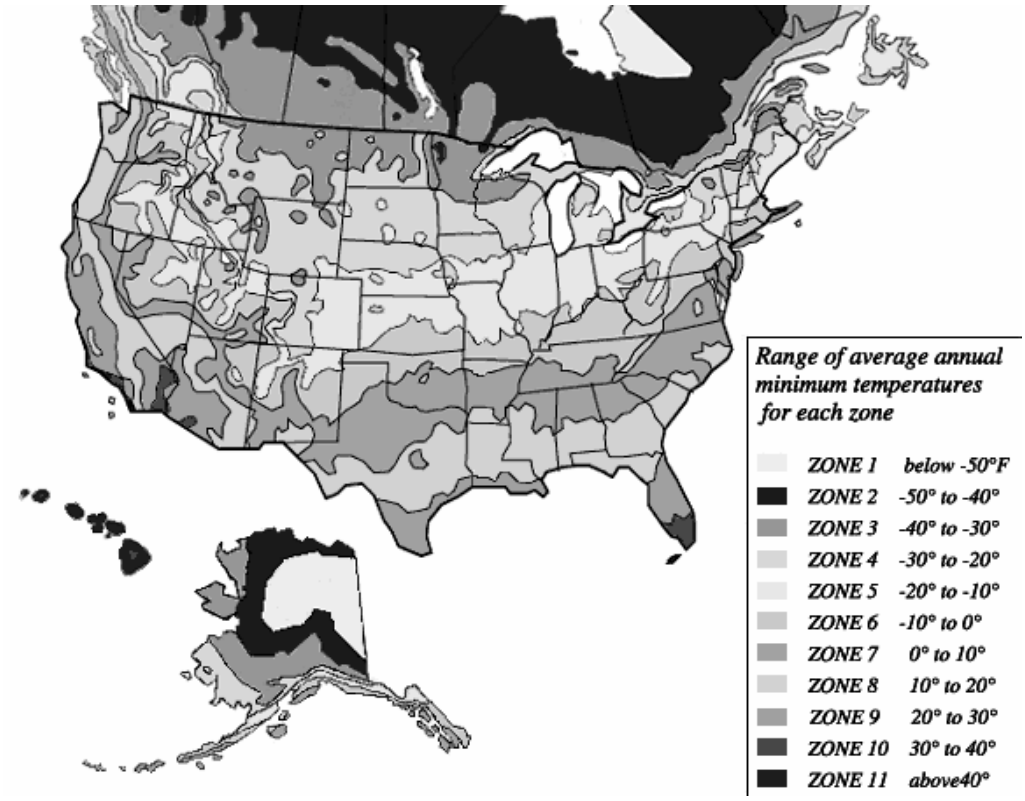
Table 7. Pest Risk Potential.

Pest	Consequences of Introduction	Likelihood of Introduction	Pest Risk Potential[1]
Anastrepha ludens	High (14)	High (17)	High (31)
Ceratitis capitata	High (15)	High (17)	High (32)
Faustinus ovatipennis	Low (8)	High (15)	Medium (23)
Liriomyza huidobrensis	High (15)	High (18)	High (33)
Neoleucinodes elegantalis	High (13)	High (17)	High (30)
Opogona sacchari	High (15)	High (17)	High (32)
Phenacoccus parvus	High (13)	High (15)	High (28)
Planococcus minor	High (15)	High (15)	High (30)
Thrips palmi [2]	High (14)	High (16)	High (30)
Puccinia pampeana	High (14)	High (15)	High (29)
Andean potato mottle virus	Medium (12)	Medium (14)	Medium (26)
Tomato yellow mosaic virus	Medium (12)	Medium (14)	Medium (26)

[1] Pest Risk Potential rating is defined as Low (11-18 points); Medium (19-26 points); or High (27-33 points) (USDA 2000).
[2] *Thrips palmi* is established in the United States and is not under official control, thus the Pest Risk Potential has been down rated from a High to a Medium in this document

The choice of appropriate measures to mitigate risks is part of the Risk Management within APHIS and is not addressed in this document. However, mitigation should only be developed for *Anastrepha ludens* on *Capsicum pubescens* because records of *A. ludens* using the fruit of other *Capsicum* species as hosts are artificial (*i.e.* forced laboratory infestations).

Figure 1: Climatic Zones Map (USDA 1990).



Appendix 1. Pest interceptions on *Capsicum* spp. from Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua at U.S. ports of entry between January 1, 1985 and September, 10, 2003.

Organism	Host (plant part affected)	Location of interception	Number of interceptions [1]
Costa Rica			
Agromyzidae, species of	*Capsicum annuum*	Stores	1
Anthomyiidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Anthonomus sp.	*Capsicum* sp. (fruit)	Baggage	4
Anthonomus sp.	*Capsicum* sp. (fruit)	Stores	1
Coleoptera, species of	*Capsicum* sp. (fruit)	Baggage	1
Curculionidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Gelechiidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Lonchaeidae, species of	*Capsicum* sp. (fruit)	Baggage	3
Neoleucinodes elegantalis	*Capsicum* sp. (fruit)	Stores	1
Olethreutinae, species of	*Capsicum* sp.	Baggage	1
Pentatomidae, species of	*Capsicum* sp. (fruit)	Permit cargo	1
Pseudococcidae, species of	*Capsicum* sp. (fruit)	Permit cargo	1
Solenopsis sp.	*Capsicum* sp. (fruit)	Baggage	1
El Salvador			
Agromyzidae, species of	*Capsicum* sp. (leaf)	Baggage	2
Amorbia sp.	*Capsicum* sp. (fruit)	Baggage	1
Anastrepha sp.	*Capsicum annuum* (fruit)	Baggage	1
Anthonomus sp.	*Capsicum* sp. (fruit)	Baggage	7
Anthonomus sp.	*Capsicum* sp.	Baggage	1
Aphididae, species of	*Capsicum* sp. (fruit)	Baggage	1
Aphididae, species of	*Capsicum* sp. (fruit)	Baggage	1
Asphondylia sp.	*Capsicum* sp. (fruit)	Baggage	1
Ceratitis capitata	*Capsicum* sp. (fruit)	Baggage	1
Contarinia sp.	*Capsicum* sp.	Baggage	1
Curculionidae, species of	*Capsicum annuum* (fruit)	Stores	1
Curculionidae, species of	*Capsicum* sp. (fruit)	Baggage	3
Curculionidae, species of	*Capsicum* sp.	Baggage	1
Diptera, species of	*Capsicum* sp. (fruit)	Baggage	5
Diptera, species of	*Capsicum* sp.	Baggage	1
Ecdytolopha sp.	*Capsicum* sp. (fruit)	Baggage	1
Gelechiidae, species of	*Capsicum annuum* (fruit)	Baggage	1
Gelechiidae, species of	*Capsicum* sp. (fruit)	Baggage	3
Gelechiidae, species of	*Capsicum* sp. (fruit)	Stores	1
Gnorimoschema sp.	*Capsicum* sp. (fruit)	Baggage	1
Gracillariidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Insecta, species of	*Capsicum* sp. (leaf)	Baggage	1
Lepidoptera, species of	*Capsicum* sp. (fruit)	Baggage	1
Lonchaeidae, species of	*Capsicum* sp. (fruit)	Baggage	2

Membracidae, species of	*Capsicum* sp.	Baggage	1
Neoleucinodes elegantalis	*Capsicum* sp. (leaf)	Baggage	1
Noctuidae, species of	*Capsicum annuum*	Baggage	1
Noctuidae, species of	*Capsicum* sp.	Baggage	1
Phlaeothripidae, species of	*Capsicum* sp. (leaf)	Baggage	1
Pseudococcidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Pseudococcidae, species of	*Capsicum* sp.	Baggage	1
Schizomyia sp.	*Capsicum* sp. (leaf)	Baggage	1
Tephritidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Thripidae, species of	*Capsicum* sp. (fruit)	Baggage	3
Tortricidae, species of	*Capsicum* sp.	Baggage	1
Guatemala			
Altica sp.	*Capsicum* sp. (fruit)	Baggage	1
Amorbia sp.	*Capsicum* sp. (fruit)	Baggage	1
Anastrepha sp.	*Capsicum* sp.	Baggage	1
Anastrepha sp.	*Capsicum* sp.	Baggage	1
Anthonomus sp.	*Capsicum annuum* (fruit)	Stores	1
Anthonomus sp.	*Capsicum* sp. (fruit)	Baggage	24
Anthonomus sp.	*Capsicum* sp. (fruit)	Stores	2
Anthonomus sp.	*Capsicum* sp.	Stores	1
Aphididae, species of	*Capsicum pubescens*	Baggage	1
Aphididae, species of	*Capsicum* sp. (fruit)	Baggage	4
Aphididae, species of	*Capsicum* sp. (fruit)	Baggage	1
Aphididae, species of	*Capsicum* sp.	Baggage	2
Asphondylia sp.	*Capsicum* sp. (fruit)	Baggage	3
Atherigona sp.	*Capsicum* sp.	Baggage	1
Cecidomyiidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Cicadellidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Cladosporium sp.	*Capsicum annuum*	Baggage	2
Coccidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Contarinia sp.	*Capsicum* sp. (fruit)	Baggage	2
Copitarsia sp.	*Capsicum* sp. (fruit)	Stores	1
Curculionidae, species of	*Capsicum* sp. (fruit)	Baggage	8
Dasineura sp.	*Capsicum* sp. (fruit)	Baggage	1
Diaspididae,species of	*Capsicum* sp. (fruit)	Baggage	1
Diptera, species of	*Capsicum* sp. (fruit)	Baggage	2
Ecdytolopha sp.	*Capsicum* sp. (fruit)	Baggage	1
Eurytoma sp.	*Capsicum* sp. (fruit)	Baggage	1
Frankliniella sp.	*Capsicum* sp. (fruit)	Baggage	1
Gelechiidae, species of	*Capsicum annuum*	Baggage	2
Gelechiidae, species of	*Capsicum frutescens* (fruit)	Baggage	1
Gelechiidae, species of	*Capsicum frutescens*	Baggage	1
Gelechiidae, species of	*Capsicum* sp. (fruit)	Baggage	26
Gelechiidae, species of	*Capsicum* sp.	Baggage	1
Gnorimoschema sp.	*Capsicum* sp. (fruit)	Baggage	4
Heteroptera, species of	*Capsicum* sp.	Baggage	1

Lepidoptera, species of	*Capsicum* sp. (fruit)	Baggage	2
Leucinodes orbonalis	*Capsicum* sp.	Baggage	1
Lonchaeidae, species of	*Capsicum* sp. (fruit)	Baggage	19
Lonchaeidae, species of	*Capsicum* sp. (fruit)	Stores	1
Miridae, species of	*Capsicum* sp. (fruit)	Baggage	1
Neoleucinodes elegantalis	*Capsicum* sp. (fruit)	Baggage	1
Neoleucinodes elegantalis	*Capsicum* sp.	Baggage	1
Noctuidae, species of	*Capsicum annuum* (fruit)	Baggage	1
Noctuidae, species of	*Capsicum* sp. (fruit)	Stores	1
Oecophoridae, species of	*Capsicum* sp.	Baggage	1
Orphulella punctata	*Capsicum* sp. (fruit)	General cargo	1
Pentatomidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Pentatomidae, species of	*Capsicum* sp. (fruit)	Permit cargo	1
Phycitinae, species of	*Capsicum* sp. (fruit)	Baggage	1
Pseudococcidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Pyralidae, species of	*Capsicum* sp. (fruit)	Baggage	2
Pyralidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Pyraustinae, species of	*Capsicum* sp. (fruit)	Baggage	1
Pyraustinae, species of	*Capsicum* sp.	Baggage	1
Symmetrischema sp.	*Capsicum* sp.	Baggage	1
Tettigoniidae, species of	*Capsicum* sp. (leaf)	Permit cargo	1
Tortricidae, species of	*Capsicum* sp. (fruit)	Baggage	2
Tortricidae, species of	*Capsicum* sp.	Baggage	1
Tortricidae, species of	*Capsicum* sp. (fruit)	Baggage	2
Honduras			
Anthonomus sp.	*Capsicum annuum* (fruit)	Baggage	2
Anthonomus sp.	*Capsicum annuum* (fruit)	Stores	1
Anthonomus sp.	*Capsicum frutescens* (fruit)	Stores	2
Anthonomus sp.	*Capsicum* sp. (fruit)	Baggage	2
Anthonomus sp.	*Capsicum* sp. (fruit)	Stores	3
Anthonomus sp.	*Capsicum* sp.	Stores	1
Aphididae, species of	*Capsicum* sp. (leaf)	Baggage	1
Blapstinus sp.	*Capsicum* sp. (fruit)	Permit cargo	1
Cecidomyiidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Conocephalus sp.	*Capsicum* sp.	Permit cargo	1
Curculionidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Curculionidae, species of	*Capsicum* sp. (fruit)	Stores	1
Diptera, species of	*Capsicum* sp. (fruit)	Baggage	4
Gelechiidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Geometridae, species of	*Capsicum* sp. (fruit)	Baggage	1
Geometridae, species of	*Capsicum* sp. (fruit)	Permit cargo	1
Ips sp.	*Capsicum* sp. (crating)	General cargo	1
Listronotus sp.	*Capsicum* sp.	General	1

		cargo	
Lonchaeidae, species of	*Capsicum* sp. (fruit)	Baggage	2
Noctuidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Noctuidae, species of	*Capsicum* sp. (fruit)	Stores	1
Pulvinaria sp.	*Capsicum* sp. (fruit)	Baggage	1
Pyralidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Tetranychus sp.	*Capsicum* sp. (fruit)	Baggage	1
Tortricidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Nicaragua			
Anthomyiidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Anthonomus sp.	*Capsicum annuum* (fruit)	Stores	1
Anthonomus sp.	*Capsicum* sp. (fruit)	Baggage	1
Chrysomelidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Diptera, species of	*Capsicum annuum* (fruit)	Baggage	1
Gelechiidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Lonchaeidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Lonchaeidae, species of	*Capsicum* sp.	Baggage	1
Neoleucinodes elegantalis	*Capsicum annuum* (fruit)	Baggage	1
Pentatomidae, species of	*Capsicum* sp. (fruit)	Baggage	1
Pterophoridae, species of	*Capsicum* sp. (fruit)	Baggage	1
Pyraustinae, species of	*Capsicum* sp.	Permit cargo	1

[1] Interception records obtained from the PIN309 Data System (USDA 2003)

Appendix II. Weed Evaluations for *Capsicum annuum* L., *C. baccatum* L., *C. chinense* Jacq., *C. frutescens* L. and *C. pubescens* Ruiz & Pav.

Capsicum annuum Linnaeus
Pepper

Taxonomy
Class: Dicotyledonae
Order: Solanales
Family: Solanaceae
Species: *Capsicum annuum* Linnaeus

Introduction

C. annuum is an important commodity that is widely cultivated throughout the world including in the United States (CABI 2003). Its fruit is used as a condiment in many foods, while the plants are used decoratively in home landscapes. Because of *C. annuum*'s long history of domestication (Eshbaugh 1993), many different varieties, with varying pod shape, pod size, fruit color and pungency have been developed, including pungent and nonpungent types. Several ancestral or wild type varieties also occur throughout its native range in the western hemisphere (Tewksbury, Nabhan et al. 1999).

Of the five domesticated species of *Capsicum* (*C. annuum*, *C. frutescens*, *C. chinense*, *C. baccatum* and *C. pubescens*), *C. annuum* is the most widely cultivated species. Together, production of all five species exceeds that of any other spice (Pernezny, Roberts et al. 2003). After his discovery of *C. annuum* on his first voyage, Columbus distributed it around the world where it was rapidly incorporated into local foods (Bosland 1996). The genus *Capsicum* is named after the compound capsaicin which gives the plants their peppery–spicy taste. This compound has been used as a pain reliever (Bosland and Votava. 2000; Frerick, Keitel et al. 2003) and an antibiotic (Chichewicz and Thorpe 1996).

Weed Status and Invasiveness

C. annuum is native to Central and South America, as well as the southern portions of the United States. In Florida, the native variety is *C. annuum* var. *glabriusculum* (bird pepper), while in Arizona it is *C. annuum* var. *aviculare* (bird pepper, chiltepines). Due to their increasing rarity in Arizona, wild populations have been designated as a species of special status (Tewksbury, Nabhan et al. 1999). *Capsicum annuum* has been reported as a weed and naturalized species in Australia, India, Indonesia, Finland and New Zealand (Holm, Pancho et al. 1991; Randall 2002). It is believed that it may have been introduced to Puerto Rico by Indians prior to Columbus' discovery of the New World (Francis No Date). The only report of *C. annuum* potentially being a significant weed is from Puerto Rico where it is reported as "common but scattered in early secondary forests" and occasionally forming small thickets (Francis No Date). Nevertheless, aside from this single report, nonnative cultivated populations of *C. annuum* may still represent a significant threat to native wild populations through

introgression and hybridization. Conservation of local genetic diversity is not only important to maintain the adaptive fitness of local populations, but is also important for genetic improvement of domesticated forms of crops (Tewksbury, Nabhan et al. 1999). Two other species in the genus *Capsicum* have been described as weedy species (Randall 2002).

Relevant Biology / Ecology

There are a plethora of varieties of *C. annuum*. Flowers range from greenish-white or yellowish-white, with blue, violate or yellow anthers (Francis No Date). Fruits vary tremendously in size, color and shape. Birds, which are insensitive to the pungent chemicals of *Capsicum* will readily eat the fruits and disperse the seeds, of at least the wild (Francis No Date) and perhaps some of the small fruited cultivated forms. In the arid southwestern U.S., birds are important in directed dispersal of seeds to favorable recruitment sites underneath nurse plants (Tewksbury, Nabhan et al. 1999).

Many taxonomic issues plague the genus *Capsicum*, including concerns regarding species delineation (Walsh and Hoot 2001). Muddling these issues even further is that five species have been domesticated to a lesser or greater extent and then moved about Central and South America. Cultivars of different species have been selected for similar traits within regions, but different traits among regions (Eshbaugh 1993). Furthermore, multiple common names are shared among the different cultivars and species (Bosland 1996). Previous studies have established that of the five domesticated species, two of them are clearly distinct species: *C. baccatum* and *C. pubescens*. However the other three species, *C. frutescens*, *C. annuum* and *C. chinense* may or may not be distinct species. The cultivars of these three taxa are easily distinguished, but the wild ancestral populations are similar and hybridize (Eshbaugh 1993). The ease with which these species hybridize has been confirmed with plant crossing trials (Eshbaugh 1993). A recent phylogenetic study using DNA sequences established that these three taxa can be distinguished based on molecular markers and warrant species status (Walsh and Hoot 2001).

Current and Potential Distribution in the United States

C. annuum is a tropical species of the American tropics that is intolerant of freezing temperatures (Francis No Date). Non-domesticated forms of *C. annuum* are native to the southern U.S., including Florida and Arizona. Escapees of cultivated forms of *C. annuum* from private gardens and commercial plantings have likely increased the species' overall distribution in the U.S. *Capsicum annuum* is unlikely to establish and persist in most of the U.S., unless it starts behaving as an annual species with an over wintering seed bank.

Potential Impact of Importation

Associated with the importation of commodities and products, there is some risk of simultaneously importing pests and pathogens with those commodities. These pests and pathogens may pose a threat to closely related native species or to U.S. agriculture, forestry and/or environment if similar or suitable hosts occur in the U.S. As of February 2004, there were no species of *Capsicum* listed as federally endangered or threatened, listed as candidate species or proposed for listing (USFWS 2004). The following sources are good sources for information on the pests and pathogens of *C. annuum*: (Peet 2003; Pernezny, Roberts et al. 2003).

The genetic composition of native populations and varieties of *C. annuum* may be altered if imported *C. annuum* establishes near native populations and interbreeds with native plants. Introgression of foreign genes (*i.e.*, genetic invasion) has the potential to disrupt locally adapted gene complexes of native populations of *C. annuum* and lead to a loss of local fitness. Introgression and hybridization associated with biological invasions have been recognized as a significant threat to native species (Rhymer and Simberloff 1996; Sakai, Allendorf et al. 2001).

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Capsicum baccatum
Aji

Taxonomy
Class: Dicotyledonae
Order: Solanales
Family: Solanaceae
Species: *Capsicum baccatum* L.

Introduction

Capsicum baccatum is an important commodity in South America, especially in Peru, Bolivia, Ecuador and Chile. Ranging from coast to coast, its center of diversity appears to be in Bolivia (Eshbaugh 1993). The cultivated variety, *C. baccatum* var. *pendulum* is very similar to its wild type *C. baccatum* var. *baccatum*. Although *C. baccatum* may have as many different pod types and flavors as the more common *C. annuum*, it probably never reached global popularity as *C. annuum* due to the latter's earlier distribution by the Spanish (Eshbaugh 1993). Of the approximately 20-27 species in the *Capsicum* genus (Walsh and Hoot 2001), five have been domesticated: *C. frutescens*, *C. annuum*, *C. chinense*, *C. baccatum* and *C. pubescens* (CABI 2003). *Capsicum baccatum* can be distinguished from other *Capsicum* species by its creamed colored flowers that have gold, green or tan corolla markings.

The genus *Capsicum* is named after the compound capsaicin which gives the plants their peppery–spicy taste. This compound has been used as a pain reliever (Bosland and Votava. 2000; Frerick, Keitel et al. 2003) and an antibiotic (Chichewicz and Thorpe 1996). It is also the main ingredient in mace pepper sprays (Francis No Date). Together, the five cultivated species of *Capsicum* represent an important agricultural commodity (CABI 2003), with production exceeding that of any other spice (Pernezny, Roberts et al. 2003).

Weed Status and Invasiveness

Although *C. baccatum* is listed as a weed in Trinidad and Brazil (Holm, Pancho et al. 1991; Randall 2002) and present in natural areas of the Galapagos Islands, it has not been reported as an aggressive invader of either natural- or agroecosystems. Two other species in the genus *Capsicum* have been described as weedy species (Randall 2002).

Relevant Biology / Ecology

Many taxonomic issues plague the genus *Capsicum*, including concerns regarding species delineation (Walsh and Hoot 2001). Muddling these issues even further is that five species have been domesticated to a lesser or greater extent and then moved about Central and South America. Cultivars of different species have been selected for similar traits within regions, but different traits among regions (Eshbaugh 1993). Furthermore, multiple common names are shared among the different cultivars and species (Bosland 1996). Previous studies have established that of the five domesticated species, two of them are clearly distinct species: *C. baccatum* and *C. pubescens*. However the other three species, *C. frutescens*, *C. annuum* and *C. chinense* may or may not be distinct species.

Current and Potential Distribution in the United States

C. baccatum is a lowland to mid-elevational species of the South American tropics and is intolerant of freezing temperatures. It can be grown as a warm season crop in colder regions. *Capsicum baccatum* is unlikely to become a weed in most of the U.S because of its cold sensitivity. Potential areas where it could establish include Florida, the extreme southwest, Hawaii and Puerto Rico.

Potential Impact of Importation

Associated with the importation of commodities and products, there is some risk of simultaneously importing pests and pathogens with those commodities. These pests and pathogens may pose a threat to closely related native species or to U.S. agriculture, forestry and/or environment if similar or suitable hosts occur in the U.S. As of February 2004, there were no species of *Capsicum* listed as federally endangered or threatened, listed as candidate species or proposed for listing (USFWS 2004). The following sources are good sources for information on the pests and pathogens of *C. baccatum*: (Pernezny, Roberts et al. 2003).

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Capsicum chinense
Pepper

Taxonomy
Class: Dicotyledonae
Order: Solanales
Family: Solanaceae
Species: *Capsicum chinense* Jacq.

Introduction

Capsicum chinense is one of the five commonly cultivated species of *Capsicum*: *C. frutescens*, *C. annuum*, *C. chinense*, *C. baccatum* and *C. pubescens* (CABI 2003). The genus *Capsicum* is named after the compound capsaicin which gives the plants their peppery–spicy taste. This compound has been used as a pain reliever (Bosland and Votava. 2000; Frerick, Keitel et al. 2003) and an antibiotic (Chichewicz and Thorpe 1996). It is also the main ingredient in mace pepper sprays (Francis No Date). Together, production of all five species exceeds that of any other spice (Pernezny, Roberts et al. 2003).

Native to and domesticated in South America, *C. chinense* is popular in many tropical areas, especially in Brazil and the Caribbean. A popular cultivar of this species is the Habenero pepper which is particularly hot (Bosland and Votava. 2000).

Weed Status and Invasiveness

C. chinense has not been listed as a weed by any authority (see **Table 1**). However, three other species of *Capsicum* have been described as weedy species: *C. frutescens*, *C. baccatum* and *C. annuum* (Randall 2002).

Relevant Biology / Ecology

Many taxonomic issues plague the genus *Capsicum*, including concerns regarding species delineation (Walsh and Hoot 2001). Muddling these issues even further is that five species have been domesticated to a lesser or greater extent and then moved about Central and South America. Cultivars of different species have been selected for similar traits within regions, but different traits among regions (Eshbaugh 1993). Furthermore, multiple common names are shared among the different cultivars and species (Bosland 1996). Previous studies have established that of the five domesticated species, two of them are clearly distinct species: *C. baccatum* and *C. pubescens*. However the other three species, *C. frutescens*, *C. annuum* and *C. chinense* may or may not be distinct species. The cultivars of these three taxa are easily distinguished, but the wild ancestral populations are similar and hybridize (Eshbaugh 1993). The ease with which these species hybridize has been confirmed with plant crossing trials (Eshbaugh 1993). A recent phylogenetic study using DNA sequences established that these three taxa can be distinguished based on molecular markers, and therefore, warrant species status (Walsh and Hoot 2001).

Current and Potential Distribution in the United States

The distribution of *C. chinense* in the United States is unknown, however it is grown by Chile-pepper enthusiasts in private gardens (see World Wide Web). *C. chinense* is a lowland- to mid-elevational species of South America that is intolerant of freezing temperatures. It can only be grown in colder areas as a warm season crop. It is unlikely to establish in most of the U.S. due to sensitivity to cold temperature. Potential areas of establishment include Florida, the extreme southwest, Hawaii and Puerto Rico.

Potential Impact of Importation

Associated with the importation of commodities and products, there is some risk of simultaneously importing pests and pathogens with those commodities. These pests and pathogens may pose a threat to closely related native species or to U.S. agriculture and forestry if similar or suitable hosts occur in the U.S. As of February 2004, there were no species of *Capsicum* listed as federally endangered or threatened, listed as candidate species or proposed for listing (USFWS 2004). Native and ornamental populations of *Capsicum* in the southern U.S. may serve as a reservoir for pests and pathogens of agricultural forms of *Capsicum*. The following source is a good reference for information on the pests and pathogens of *Capsicum* species: (Pernezny, Roberts et al. 2003).

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Capsicum frutescens Linnaeus
Cayenne pepper

Taxonomy

Class: Dicotyledonae
Order: Solanales
Family: Solanaceae
Species: *Capsicum frutescens* Linnaeus

Introduction

Capsicum frutescens Linnaeus is a widely cultivated species of pepper that is native to South and Central America. Of the approximately 20-27 species in the genus (Walsh and Hoot 2001), five have been domesticated: *C. frutescens*, *C. annuum*, *C. chinense*, *C. baccatum* and *C. pubescens* (CABI 2003). The genus *Capsicum* is named after the compound capsaicin which gives the plants their peppery–spicy taste. This compound has been used as a pain reliever (Bosland and Votava. 2000; Frerick, Keitel et al. 2003) and an antibiotic (Chichewicz and Thorpe 1996). It is also the main ingredient in mace pepper sprays (Francis No Date). Together,

the five cultivated species of *Capsicum* represent an important agricultural commodity (CABI 2003), with production exceeding that of any other spice (Pernezny, Roberts et al. 2003). *Capsicum frutescens* is the main ingredient in Tabasco sauce.

Weed Status and Invasiveness

Capsicum frutescens is a short-lived shrub that can grow as high as 1.5 meters (Francis No Date). Because of its importance as a condiment it has been distributed around the world and has naturalized in several areas (Bosland and Votava. 2000). *Capsicum frutescens* is listed as a weed in India, Jamaica, West Polynesia, Trinidad, (Holm, Pancho et al. 1991) and as a naturalized species in the Galapagos (Tye No Date). The Global Compendium of Weeds (Randall 2002) also lists it as a weed in Japan, South Africa, Micronesia and Puerto Rico. However, despite these multiple occurrences, none of the sources describe *C. frutescens* as an aggressive invader of either natural- or agroecosystems. Two other species in the genus *Capsicum* have been described as weedy species (Randall 2002).

Relevant Biology / Ecology

There are relatively few varieties of *C. frutescens*. Flowers are greenish-white, while fruits start out green and mature to orange / red. Fruits are relatively elongate, measuring approximately 1 x 5 cm (CABI 2003). Birds, which eat the fruits and disperse the seeds, are not sensitive to the pungent chemicals of *Capsicum* (Francis No Date).

Many taxonomic issues plague the genus *Capsicum*, including concerns regarding species delineation (Walsh and Hoot 2001). Muddling these issues even further is that five species have been domesticated to a lesser or greater extent and then moved about Central and South America. Cultivars of different species have been selected for similar traits within regions, but different traits among regions (Eshbaugh 1993). Furthermore, multiple common names are shared among the different cultivars and species (Bosland 1996). Previous studies have established that of the five domesticated species, two of them are clearly distinct species: *C. baccatum* and *C. pubescens*. However the other three species, *C. frutescens*, *C. annuum* and *C. chinense* may or may not be distinct species. The cultivars of these three taxa are easily distinguished, but the wild ancestral populations are similar and hybridize (Eshbaugh 1993). The ease with which these species hybridize has been confirmed with plant crossing trials (Eshbaugh 1993). A recent phylogenetic study using DNA sequences established that these three taxa can be distinguished based on molecular markers, and therefore, warrant species status (Walsh and Hoot 2001).

Current and Potential Distribution in the United States

C. frutescens is a lowland to mid-elevational species of the American tropics that is intolerant of freezing temperatures. In other areas, it can be grown as a warm season crop. Specific data on its worldwide distribution is not readily available and is obscured through the use of common names. However, peppers (*C. frutescens* and *C. annuum*) are widely cultivated in the U.S., especially in the southeast and southwest (USDA-NASS 2003). *Capsicum frutescens* is unlikely to become a weed in most of the U.S since it is sensitive to cold temperatures. Potential weedy areas include Florida, the extreme southwest, Hawaii and Puerto Rico. It has been reported to have established in southern Florida (Gann, Bradley et al. 2001; Fairchild Tropical Garden

2003), but it seems that some of those records may have been in error (Gann, Bradley et al. 2001).

Potential Impact of Importation

Associated with the importation of commodities and products, there is some risk of simultaneously importing pests and pathogens with those commodities. These pests and pathogens may pose a threat to closely related native species or to U.S. agriculture and forestry if similar or suitable hosts occur in the U.S. As of February 2004, there were no species of *Capsicum* listed as federally endangered or threatened, listed as candidate species or proposed for listing (USFWS 2004). The following sources are good sources for information on the pests and pathogens of *Capsicum*: (Pernezny, Roberts et al. 2003)

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Capsicum pubescens Ruiz. & Pav
Chile

Taxonomy

Class: Dicotyledonae
Order: Solanales
Family: Solanaceae
Species: *Capsicum pubescens* Ruiz. & Pav

Introduction

Capsicum pubescens Ruiz & Pav is one of five species of peppers that have been domesticated: *C. frutescens*, *C. annuum*, *C. chinense*, *C. baccatum* and *C. pubescens* (CPC 2003). The genus *Capsicum* is named after the compound capsaicin which gives the plants their peppery–spicy taste. This compound has been used as a pain reliever (Bosland and Votava. 2000; Frerick, Keitel et al. 2003) and an antibiotic (Chichewicz and Thorpe 1996). It is also the main ingredient in mace pepper sprays (Francis No Date). Together, the five cultivated species of *Capsicum* represent an important agricultural commodity (CABI 2003), with production exceeding that of any other spice (Pernezny, Roberts et al. 2003). *Capsicum pubescens* is readily distinguished from the other four domesticated pepper species by its purple flowers (vs. white) and brown / black seeds (Bosland and Votava. 2000). Of the five domesticated species, it is probably the least known.

Weed Status and Invasiveness

Capsicum pubescens is native to Boliva, Ecuador and Peru. It was probably domesticated in Bolivia, after which it was distributed to other regions. Currently it is grown from Mexico to Peru in highland areas (Bosland and Votava. 2000). It has not been listed as a weed by any authority. Three species in the genus *Capsicum* have been described as weedy species (Randall 2002): *C. frutescens*, *C. baccatum* and *C. annuum*.

Relevant Biology / Ecology

Many taxonomic issues plague the genus *Capsicum*, including concerns regarding species delineation (Walsh and Hoot 2001). Muddling these issues even further is that five species have been domesticated to a lesser or greater extent and then moved about Central and South America. Cultivars of different species have been selected for similar traits within regions, but different traits among regions (Eshbaugh 1993). Furthermore, multiple common names are shared among the different cultivars and species (Bosland 1996). Previous studies have established that of the five domesticated species, two of them are clearly distinct species: *C. baccatum* and *C. pubescens*. However the other three species, *C. frutescens*, *C. annuum* and *C. chinense* may or may not be distinct species.

Current and Potential Distribution in the United States

Capsicum pubescens is a mid-elevational species of the American tropics that is intolerant of freezing temperatures. It can be grown in other areas as a warm season crop. Outside of South and Central America it is grown on a very limited basis (Bosland and Votava. 2000). Specific data on its worldwide distribution is not readily available. It is likely being grown in the U.S. by Chile-pepper enthusiasts. *Capsicum pubescens* is unlikely to establish in most areas of the U.S. due to sensitivity to cold temperatures.

Potential Impact of Importation

Associated with the importation of commodities and products, there is some risk of simultaneously importing pests and pathogens with those commodities. These pests and pathogens may pose a threat to closely related native species or to U.S. agriculture and forestry if similar or suitable hosts occur in the U.S. As of February 2004, there were no species of *Capsicum* listed as federally endangered or threatened, listed as candidate species or proposed for listing (USFWS 2004). The following reference is a good source for information on the pests and pathogens of *Capsicum*: (Pernezny, Roberts et al. 2003).

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