Importation of Fresh Paprika Pepper Fruit (*Capsicum annuum* L. var. *annuum*) from the Republic of Korea into the Continental United States

A Pathway-Initiated Risk Assessment

United States Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine
Center for Plant Health Science and Technology
Plant Epidemiology and Risk Analysis Laboratory
1017 Main Campus Drive, Suite 1550
Raleigh, North Carolina 27606 USA
Agency Contact: Michael K. Hennessey, michael.k.hennessey@aphis.usda.gov

Executive Summary

The Republic of Korea requested to export fresh hydroponically, greenhouse-grown fruit of pepper (*Capsicum annuum* L. var. *annuum*) into the continental United States. The commodity has not been imported into the mainland from Korea before, so a pathway-initiated risk assessment was done. A list of pepper pests in Korea was prepared based on (1) documents submitted by the Republic of Korea, (2) United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) records of intercepted pests, and (3) scientific literature. The commodity was not found to be a potential weed. Quarantine pests that were identified to the species level, and found likely to follow the pathway, were qualitatively analyzed using the methodology described in the USDA-APHIS Guidelines 5.02; this information allowed APHIS to determine the Consequences of Introduction and the Likelihood of Introduction, in addition to estimating the Baseline Pest Risk Potential of each pest before mitigation. Mitigations to reduce pest populations could include pre-harvest use of screens, hygienic practices, disease-free stock selection, sticky trap monitoring, systemic insecticides or biocontrol, and post-harvest washing, brushing, inspection, culling, and fumigation.

Pests with high unmitigated pest risk potential:
Agrotis segetum (Lepidoptera: Noctuidae)
Helicoverpa armigera (Lepidoptera: Noctuidae)
Helicoverpa assulta (Lepidoptera: Noctuidae)
Mamestra brassicae (Lepidoptera: Noctuidae)
Monilinia fructigena (Helotiales: Sclerotiniaceae)
Ostrinia furnacalis (Lepidoptera: Pyralidae)
Scirtothrips dorsalis (Thysanoptera: Thripidae)
Spodoptera litura (Lepidoptera: Noctuidae)
Thrips palmi (Thysanoptera: Thripidae)

Ralstonia solanacearum race 3 (Burkholderiales: Ralstoniaceae)---A separate PPQ-CPHST-PERAL Ad Hoc report, "*Ralstonia solanacearum* Race 3 Biovar 2 Likelihood of Entry, Introduction, and Establishment, and Mitigation Recommendations: Supplement to the USDA-APHIS Pest Risk Assessment Importation of fresh paprika pepper fruit (*Capsicum annuum* L. var. *annuum*) from the Republic of South Korea into the continental United States" addressed this pest and is included as an addendum to this PRA.

Table of Contents

I. Introduction

This risk assessment was prepared by the Animal and Plant Health Inspection Service (APHIS), United States Department of Agriculture (USDA) to examine potential pest risks associated with the importation of fresh pepper fruit (*Capsicum annuum* L. var. *annuum*) into the continental United States from the Republic of Korea.

The peppers are hydroponically greenhouse-grown throughout the exporting country. Red varieties, or cultivars, ('Spirit', 'Special', 'Jubilee') will comprise 60-70% of the Korean pepper commodity that will be exported to the United States (Park, 2002). Yellow pepper cultivars or varieties ('Fiesta', 'Romeca') will make up 20-25% of exports, and orange ('Nassau', 'Emily', 'Boogie') pepper cultivars will comprise 5-10% of the paprika commodity shipped to the United States (Park, 2002). Holland is the seed source for the paprika peppers grown in Korea (Kang, 2002). Abamectin insecticide is used to target thrips and *Liriomyza trifolii* during production; acephate, methomyl, and bifenthrin for aphids; dicofol for *Polyphagotarsonemus latus;* and acephate, methomyl, diazinon, fenvalerate, and chlorpyrifos for *Helicoverpa assulta, Spodoptera exigua* and *S. litura* (Park, 2003). No treatment information is available for pathogens.

Pepper fruit colored more than 80% are manually harvested using cutting knives, which are exclusively used for paprika harvesting (Park, 2002). Harvesting will occur between November and July. Fruit are hand-harvested, the pedicel is cut and the calyx is left on the fruit, which is followed by its being transported to the packing facility. Post-harvest procedures include cleaning the peppers with brushes and using compressed air; following this, peppers are graded by size and then sorted culled (removal of damaged and deformed fruit), graded by quality, packed, inspected by plant quarantine inspection, and then transported to the port for shipping (Kang 2002; Park, 2002). During post–harvest handling, no chemical treatments are applied to the fruit in order to prolong freshness, *etc*. (Park, 2002).

The pepper fruits ready for export are packed in standardard boxes (usually 5kg/CTN package) and stored under low temperature conditions (Park, 2002). During distribution, temperatures are maintained at 8-10°C (Park, 2002). The paprika commodity is then transported from Korea by ship, using refrigerated containers, to Western parts of the United States, and via air containers to Eastern parts of the United States (Park, 2002).

Korea expects to export about 250 metric tons of peppers per month, making about 3,000,000 kg annually. At 5 kg per carton, that would be about 600,000 cartons per year, or about 600 40-ft container loads (if each holds 1,000 cartons) annually in aggregate (Park, 2002).

Peppers that are used for food are commercially grown throughout the continental United States; at least 12 states produced a crop worth over $420 million in 2001. California and Florida annually produce over 75% of the United States crop (NASS, 2002). Additionally, *Capsicum* spp. are widely grown in home and botanical gardens throughout the United States.

Ornamental peppers are an important minor crop in the United States. They have the highest per unit value of any pepper product and have become an innovative way for small farmers to produce a high-value alternative crop (Griesbach, 2003). Individual statistics on ornamental pepper production and value are not available (NASS, 2002); however, last year the USDA reported that nearly half of the wholesale value of bedding plants ($730 million dollars) was in minor crops, which included pepper. Floral crop sales comprise one of the fastest growing segments of United States agriculture, forming a $4.739 billion industry for 2000 (Griesbach, 2003). Growth of the floral industry requires the introduction of new minor crops like pepper, while the market share is maintained by the introduction of genetically improved standard crops, like petunia. During the last five years, the number and type of ornamental cultivars introduced into the market place has dramatically increased. Commercial ornamental pepper cultivars are now available as bedding and potted plants, cut stems, and foliage plant production (Griesbach, 2003).

II. Risk Assessment

This pest risk assessment is based on the risks that may be associated with the importation pathway of peppers. It is qualitative, and the risk is expressed in descriptive terms, such as high, medium, and low, rather than in probabilities or frequencies. The international plant protection organizations, such as the North American Plant Protection Organization (NAPPO) and the International Plant Protection Convention (IPPC) of the United Nations Food and Agriculture Organization (FAO), provide guidance for conducting pest risk analyses. The methods used in this plant pest risk assessment are consistent with these guidelines, as they are based on the Guidelines of Version 5.02 (USDA, 2000), and they are in accordance to the Guidelines for pest risk analysis, Section 2 of the International Standards for Phytosanitary Measures (FAO, 1996). Biological and phytosanitary terms are in accordance with those in the Glossary of Phytosanitary Terms, Section 5 of the International Standards for Phytosanitary Measures (FAO, 1999). The cited guidelines describe three stages of pest risk analysis: Stage 1 (initiation), Stage 2 (risk assessment), and Stage 3 (risk management). The present document satisfies the requirements of Stages 1 and 2.

The first five Risk Elements considered are combined to form an assessment of the risk associated with the Consequences of Introduction. The value for the Consequences of Introduction is interpreted by using those guidelines. The six Sub-Elements are the evaluated and combined for the sixth Risk Element, as described in the guidelines, to give a value for the risk associated with the Likelihood of Introduction. Together, the Consequences of Introduction and the Likelihood of Introduction values form an evaluation of the Pest Risk Potential. These science-based evaluations of the risks associated with this importation are designed to inform decision-makers.

A. Initiating Event: Proposed Action

This commodity-based, pathway-initiated assessment is in response to two separate requests for USDA authorization to allow importation of a particular commodity presenting a potential plant pest risk (Kang, 2000). The USDA received import requests from the Republic of Korea to export fresh pepper fruit of *C. annuum* L. var. *annuum* into the continental United States. The importation into the Continental United States of fresh pepper fruit, grown in Korea, is a potential pathway for plant pest introduction. The 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 Weediness Potential of *Capsicum annuum* var. *annuum*.

The results of the weediness screening for peppers (Table 1) indicate that there is no need for a weed pest-initiated risk assessment.

Table 1. Assessment of Weediness Potential of *Capsicum annuum* var. *annuum*
Commodity: *Capsicum annuum* L. var. *annuum* (ARS, 2001a) **Plant family:** Solanaceae **Common names for *C. annuum* var. *annuum*:** bell pepper, capsicum pepper, Cayenne pepper, cherry pepper, chili pepper, cone pepper, green pepper, long pepper, paprika, red cone pepper, red pepper, sweet pepper, green capsicum, piment doux, poivron doux, poivre d'Espagne, Poivre de Cayenne, Gemüsepaprika, spanishcher Pfeffer, Cayennepfeffer, peperone, pimentão, ají, chile, guindilla, pimiento (ARS, 2001a).
Phase 1: The genus *Capsicum* is widely cultivated in the United States as a commercial crop, as well as in dooryard gardens (Wiersema and León, 1999).
Phase 2: Is the species listed in: YES Geographical Atlas of World Weeds (Holm, *et al*., 1991a). YES Global Compendium of Weeds (Randall, 2002). NO World's Worst Weeds (Holm, *et al*., 1991b). NO Report of the Technical Committee to Evaluate Noxious Weeds; Exotic Weeds for the Federal Noxious Weed Act (Gunn and Ritchie, 1982). NO Economically Important Foreign Weeds (Reed, 1977). NO Composite List of Weeds (WSSA, 1989). NO AGRICOLA, CAB, AGRIS. NO World Economic Plants (Wiersema and León, 1999). NO Noxious Weeds of Australia (Parsons and Cuthbertson, 2001). NO Florida's Invasive Species List, Florida Exotic Pest Plant Council (FLEPPC, 2001).
Phase 3: Two of the above sources suggest it may be a weed outside the United States. Commercial fresh peppers are currently imported from many countries and the commodity is widely cultivated in the United States. Imports from Korea are unlikely to present any increased weed potential. **Conclusion:** This commodity is not likely to be a weed in the PRA area; therefore, a weed pest-initiated PRA is not required.

C. Current Status, Decision History, Previous Risk Assessments and Pest Interceptions

Pepper fruits are able to enter from Korea into Guam and the Northern Marianas (USDA, 2003b). There have been no previous risk assessment written under USDA Guidelines (USDA, 2000) regarding peppers from Korea; however decision sheets for Korean *Capsicum* exports to Guam, as noted in Table 2, were prepared.

Table 2. Approved ports and conditions of entry for peppers from Korea into the United States

Date	**Approved Port-of-entry**	**Conditions of Entry and Notes**
1988	Guam	Port requested in application, Guam. Pepper (*Capsicum* sp.) "leaves" requested. *Capsicum* sp. "leaves" approved with inspection and treatment (USDA, 1988).
1992	Guam	USDA (1992) recommended permitting entry of bell pepper (*Capsicum* sp.) fruit into Guam, subject to inspection.
Date not indicated	Northern Marianas	Pepper "fruit" and "leaf" specified (USDA, 2003b).

Table 3 summarizes PPQ pest interceptions since 1985 (PIN 309, 2003). Because *Capsicum* sp. could include the commodity, those interceptions are included in Table 3. Also, because some interceptions did not specify plant part, or the plant part was reported to possibly include fruit and other parts, those interceptions were included in Table 3. The species that are reported as being intercepted are all quarantine pests, as they are assumed to be in the fruit's pathway.

Table 3. USDA Pest Interceptions on *Capsicum* sp. from the Republic of Korea (1985-2003; PIN 309, 2003)

Pest	Host	Plant Part	Where Found	Frequency
Agrotis spp.	*Capsicum* sp.	Fruit	Baggage	3
Aphididae spp.	*Capsicum* sp.	Fruit or none specified	Baggage	2
Cladosporium spp.	*Capsicum annuum* or sp.	Fruit	Baggage and Stores	4
Diptera sp.	*Capsicum* sp.	Fruit	Baggage	1
Hadeninae spp.	*Capsicum* sp.	Fruit or none specified	Baggage	2
Helicoverpa armigera	*Capsicum* sp.	Fruit or none specified	Baggage	2
Helicoverpa spp.	*Capsicum annuum, C. frutescens,* or *Capsicum* sp.	Fruit or none specified	Baggage	61
Heliothinae sp.	*Capsicum* sp.	Fruit	Baggage	1
Heliothis spp.	*Capsicum* sp.	Fruit	Baggage	21
Noctuidae spp.	*Capsicum annuum, C. frutescens,* or *Capsicum* sp.	Fruit, Leaf, or none specified	Baggage, Permit Cargo, and Stores	12
Olethreutinae sp.	*Capsicum* sp.	Fruit	Baggage	1
Phoma spp.	*Capsicum* sp.	Fruit	Baggage and Stores	2
Pyraustinae sp.	*Capsicum* sp.	Fruit	Baggage	1
Spodoptera litura	*Capsicum* sp.	Fruit	Baggage	1
Tephritidae sp.	*Capsicum* sp.	Fruit	Baggage	1
Thripidae spp.	*Capsicum* sp.	Fruit	Baggage	3
Tortricinae sp.	*Capsicum* sp.	Fruit	Baggage	1
Total Arthropod Interceptions				**113**
Total Pathogen Interceptions				**6**
Grand Total				**119**

D. Pest Categorization

Table 4 (a, b) presents information about geographic distribution, host associations and regulatory data for red peppers from Korea; it serves as a basis for selecting pests for risk assessment. Pests listed as occurring on *Capsicum* spp. (or *C. fructigena*) are included because these pests are generally common to all species of the genus (Hill, 1993). Table 4 includes: (1) the presence of pests in Korea relative to presence in the United States, (2) the generally affected plant part or parts, (3) the quarantine status of the pest in the United States, (4) whether the pest is likely to follow the pathway into the United States on red peppers, and (5) pertinent citations for either the distribution, quarantine status, pathway status, or the biology of the pest. Many organisms have been eliminated from further consideration because the sources of phytosanitary risk on peppers from Korea do not satisfy the definition of a quarantine pest (FAO, 1999). A quarantine pest is defined as, "A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled" (FAO, 1999).

Table 4a. Arthropod pests of *Capsicum* spp. in the Republic of Korea

Pest Scientific Name and Taxonomic Classification	Geographic Distribution [1]	*Capsicum* Species Reported	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Arthropods						
Agrotis ipsilon (Hufnagel) (Lepidoptera: Noctuidae)	KR, US	*C. annuum* *Capsicum* sp.	Fruit	No	Yes	PIN 309, 2003; NPQS, 2000; Zhang, 1994
Agrotis segetum (Denis and Schiffermuller) (Lepidoptera: Noctuidae)	KR	*C. annuum* *Capsicum* sp.	Fruit	Yes	Yes (larvae in fruit)	PIN 309, 2003; NPQS, 2000; Zhang, 1994
***Agrotis* sp.** (Lepidoptera: Noctuidae)	KR	*Capsicum* sp.	Fruit	Yes	Yes	PIN 309, 2003

Table 4a. Arthropod pests of *Capsicum* spp. in the Republic of Korea						
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution [1]**	***Capsicum* Species Reported**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Aphis fabae Scopoli (Homoptera: Aphididae)	KR, US	*Capsicum* sp.	Bud, Fruit, Leaf	No	No	Blackman and Eastop, 2000; CIE, 1963; CPC, 2002
Aphis gossypii Glover (Homoptera: Aphididae)	KR, US	*C. annuum*	Bud, Fruit, Leaf	No	No	Blackman and Eastop, 2000; CIE, 1968; Hill, 1993; Hong, 1993; NPQS, 2000; Park, 2002
Aphis horii Takahashi **(Homoptera: Aphididae)**	KR	*C. annuum*	Bud, Fruit, Leaf	Yes	No	Blackman and Eastop, 1994; KSPP, 1972
Aphis nerii Boyer de Fonscolombe **(Homoptera: Aphididae)**	KR; US (PR)	*C. annuum*	Bud, Fruit, Leaf	Yes	No	Blackman and Eastop, 2000; CPC, 2002
Aphis spiraecola Patch (Homoptera: Aphididae)	KR, US	*Capsicum* sp.	Bud, Fruit, Leaf	No	No	Blackman and Eastop, 2000; CIE, 1969; CPC, 2002
Aphididae sp. (Homoptera)	KR	*Capsicum* sp.	Fruit	Yes	No*	PIN 309, 2003
Arge nipponensis Rohwer (Hymenoptera: Argidae)	KR	*Capsicum annuum.*	Leaf	Yes	No (larvae on leaf)	Arnett, 1997; KSPP, 1972
Bemisia argentifolii Bellows and Perring (Homoptera: Aleyrodidae)	KR, US	*Capsicum* sp.	Flower, Fruit, Leaf	No	Yes (Possibly pepper virus vector)	Ahn *et al.*, 2001

Table 4a. Arthropod pests of *Capsicum* spp. in the Republic of Korea						
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution** [1]	***Capsicum* Species Reported**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Bemisia tabaci (Gennadius) (Homoptera: Aleyrodidae)	KR, US	*Capsicum* sp.	Flower, Fruit, Leaf	No	Yes (Possibly pepper virus vector)	CIE, 1986; CPC, 2002; Mound and Halsey, 1978
Bourletiella hortensis (Fitch) (Collembola: Sminthuridae)	KR, US	*Capsicum* sp.	Flower, Fruit, Leaf, Seedling	No	No (nymphs and adults on surface easily dislodged and unlikely to remain on commodity)	Arnett, 1997; NPQS, 2000
Chrysodeixis eriosoma Doubleday (Lepidoptera: Noctuidae)	KR, US (HI)	*Capsicum* sp.	Bud, Fruit, Leaf	Yes	No (reportable from HI; larvae on fruit surface large and unlikely to remain with commodity)	CPC, 2002; Mau and Messing, 1991; PIN 309, 2003; Zhang, 1994
Coccus hesperidum Linnaeus (Homoptera: Coccidae)	KR, US	*Capsicum* sp.	Flower, Fruit, Leaf	No	Yes	Ben-Dov, 1993; CPC, 2002
Diptera sp.	KR	*Capsicum* sp.	Fruit	Yes	Yes	PIN 309, 2003

Table 4a. Arthropod pests of *Capsicum* spp. in the Republic of Korea						
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution [1]**	***Capsicum* Species Reported**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Epilachna vigintioctomaculata Motschulsky (Coleoptera: Coccinellidae)	KR, US (American Samoa)	*C. annuum*.	Leaf	Yes	No (all stages external on leaf)	CPC, 2002; KSPP, 1972; Metcalf *et al.,* 1962
Epilachna vigintioctopunctata (Fabricius) (Coleoptera: Coccinellidae)	KR, US (American Samoa)	*C. annuum*.	Leaf	Yes	No (all stages external on leaf)	CPC, 2002; KSPP, 1972; Metcalf *et al.,* 1962
Eudocima fullonia Clerck (Lepidoptera: Noctuidae)	KR, US (HI)	*Capsicum* sp.	Fruit	Yes	No (only adults feed on fruit, not likely to remain on commodity)	CPC, 2002; Zhang, 1994
Frankliniella intonsa **(Trybom) (Thysanoptera: Thripidae)**	KR, US (WA)	*C. annuum*	Flower, Fruit, Leaf	No	Yes (eggs in fruit tissue; other stages under calyces)	PIN 309, 2005; Park, 2002; CPC, 2002; NPQS, 2000
Frankliniella occidentalis (Pergande) (Thysanoptera: Thripidae)	KR, US	*C. annuum*	Flower, Fruit, Leaf	No	Yes (eggs in fruit tissue; other stages under calyces)	Park, 2002; CABI/EPPO, 1998; CPC, 2002; EPPO, 1997; NPQS, 2000

Table 4a. Arthropod pests of *Capsicum* spp. in the Republic of Korea						
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution [1]**	***Capsicum* Species Reported**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
***Gonocephalum* sp.** (Coleoptera: Tenebrionidae)	KR	*Capsicum* sp.	Leaf	Yes	No	CPC, 2002
Hadeninae sp. (Lepidoptera: Noctuidae)	KR	*Capsicum* sp.	Fruit	Yes	Yes	PIN 309, 2003
Helicoverpa armigera (Hubner) (Lepidoptera: Noctuidae)	KR, US (American Samoa, Guam, Northern Marianas)	*C. annuum*	Fruit	Yes	Yes (larvae in fruit)	CABI/EPPO, 1998; CPC, 2002; EPPO, 1997; PIN 309, 2003; Zhang, 1994
Helicoverpa assulta (Guenee) (Lepidoptera: Noctuidae)	KR, US (American Samoa, Northern Marianas)	*Capsicum sp.* *C. annuum*	Fruit	Yes	Yes (larvae in fruit)	Park, 2002; CPC, 2002; Hong, 1993; NPQS, 2000; Zhang, 1994
***Helicoverpa* spp.** (Lepidoptera: Noctuidae)	KR	*C. annuum*, *C. frutescens*, *Capsicum* sp.	Fruit, Leaf, or None specified	Yes	Yes	PIN 309, 2003
Heliothinae spp. (Lepidoptera: Noctuidae)	KR	*Capsicum* sp.	Fruit	Yes	Yes	PIN 309, 2003
***Heliothis* spp.** (Lepidoptera: Noctuidae)	KR	*Capsicum* sp.	Fruit	Yes	Yes	PIN 309, 2003
Indomegoura indica (van der Goot) (Homoptera: Aphididae)	KR	***C. annuum.***	Fruit, Leaf, Shoot	Yes	No*	Blackman and Eastop, 1994; KSPP, 1972
Liromyza trifolii (Burgess) (Diptera: Agromyzidae)	KR, US	*C. annuum*	Fruit, Leaf	No	Yes (larvae mine under leaf or fruit surface)	CABI/EPPO, 1998; Park, 2002; NPQS, 2000

Table 4a. Arthropod pests of *Capsicum* spp. in the Republic of Korea

Pest Scientific Name and Taxonomic Classification	Geographic Distribution [1]	*Capsicum* Species Reported	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Listroderes costirostris Schonherr (Coleoptera: Curculionidae)	KR, US	*C. annuum*	Leaf, Stem	No	No	CPC, 2003[a]
Macrosiphum euphorbiae (Thomas) (Homoptera: Aphididae)	KR, US	*Capsicum* sp.	Fruit, Leaf	No	Yes (possibly pepper virus vector)	Blackman and Eastop, 2000; CPC, 2002; NPQS, 2000
Mamestra brassicae (Linnaeus) (Lepidoptera: Noctuidae)	KR	*C. annuum*, *Capsicum* sp.	Fruit	Yes	Yes (larvae in fruit)	CPC, 2002; NPQS, 2000; Zhang, 1994
Myzus persicae (Sulzer) (Homoptera: Aphididae)	KR, US	*C. annuum*	Leaf	No	No*	Blackman and Eastop, 2000; CPC, 2002; Hill, 1993; NPQS, 2000; Park, 2002
Nezara viridula (Linnaeus) (Heteroptera: Pentatomidae)	KR, US	*C. annuum*	Fruit	No	Yes	CPC, 2002; NPQS, 2000

Table 4a. Arthropod pests of *Capsicum* spp. in the Republic of Korea

Pest Scientific Name and Taxonomic Classification	Geographic Distribution [1]	*Capsicum* Species Reported	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Noctuidae sp. (Lepidoptera)	KR	*C. annuum*, *C. frutescens*, *Capsicum* sp.	Fruit, Leaf, or None specified	Yes	Yes	PIN 309, 2003
Olethreutinae sp. (Lepidoptera: Tortricidae)	KR	*Capsicum* sp.	Fruit	Yes	Yes	PIN 309, 2003
Ostrinia furnacalis (Guenee) (Lepidoptera: Pyralidae)	KR, US (Guam, Northern Marianas)	*C. annuum*	Leaf; probable fruit, stem borer	Yes	Yes (larvae in fruit)	Park, 2002; CPC, 2002; NPQS, 2000; Zhang, 1994
Phthorimaea operculella (Zeller) (Lepidoptera: Gelechiidae)	KR, US	*C. annuum*	Flower, Fruit, Leaf, Stem	No	Yes (larvae in fruit)	CPC, 2002; NPQS, 2000; Godfrey and Haviland, 2003; Zhang, 1994
***Phyllophaga* sp.** (Coleoptera: Scarabaeidae)	KR	*Capsicum* sp.	Fruit	Yes	No (adult on fruit, easily dislodged not likely to be with commodity)	CPC, 2002
Phytonemus pallidus (Banks) (Acari: Tarsonemidae)	KR, US	*Capsicum* sp.	Fruit, Leaf, Stem	No	Yes (all stages)	CPC, 2003a
Pinnaspis strachani (Cooley) (Homoptera: Diaspididae)	KR, US	*Capsicum* sp.	Fruit, Leaf, Stem	No	Yes	CPC, 2002; Nakahara, 1982

Table 4a. Arthropod pests of *Capsicum* spp. in the Republic of Korea						
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution [1]**	***Capsicum* Species Reported**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Polyphagotarsonemus latus (Banks) (Acari: Tarsonemidae)	KR, US	*C. annuum*	Fruit, Leaf, Stem	No	Yes	CIE, 1986a; CPC, 2002; Hill, 1993; Park, 2002
Pseudalacaspis pentagona (Targioni-Tozzetti) (Homoptera: *Diaspididae)	KR, US	*Capsicum* sp.	Flower, Fruit, Leaf, Seedling	No	Yes	CIE, 1988; CPC, 2002
Pyraustinae sp. (Lepidoptera: Pyralidae)	KR	*Capsicum* sp.	Fruit	Yes	Yes	PIN 309, 2003
Saissetia coffeae (Walker) (Homoptera: Coccidae)	KR, US	*Capsicum* sp.	Flower, Fruit, Leaf, Stem	No	Yes	Ben-Dov, 1993; CPC, 2002
Scirtothrips dorsalis Hood (Thysanoptera: Thripidae)	KR, US (FL, HI)	*Capsicum* sp.	Flower, growing point, immature Fruit, Seedling	Yes (Limited mainland distribution and PPQ actionable)	Yes (nymphs, adults, and pupae under calyces)	CIE, 1986b; Courneya, 2003; CPC, 2002; EPPO, 1997; Thomas, 2000
Spodoptera exigua (Hubner) (Lepidoptera: Noctuidae)	KR, US	*C. annuum*, *Capsicum* sp.	Fruit, Stem	No	Yes (larvae in fruit)	Park, 2002; CPC, 2002; NPQS, 2000; Zhang, 1994
Spodoptera litura (Fabricius) (Lepidoptera: Noctuidae)	KR, US (American Samoa, Guam, HI, Northern Marianas)	*Capsicum* sp.	Fruit, Stem	Yes	Yes (larvae in fruit)	EPPO, 1997; NPQS, 2000; PIN 309, 2003; Zhang, 1994
Tephritidae sp. (Diptera)	KR	*Capsicum* sp.	Fruit	Yes	Yes (eggs, larvae in fruit)	PIN 309, 2003

Table 4a. Arthropod pests of *Capsicum* spp. in the Republic of Korea						
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution [1]**	***Capsicum* Species Reported**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Tetranychus kanzawai Kishida (Acari: Tetranychidae)	KR, US	*C. annuum*, *Capsicum* sp.	Fruit, Leaf	No	Yes (all stages on fruit)	Bolland *et al*., 1998; Navajas *et al*., 1999
Tetranychus urticae Koch (Acari: Tetranychidae)	KR, US	*C. annuum*, *Capsicum* sp.	Fruit, Leaf	No	Yes (all stages in cracks or under calyces)	Hong, 1993; NPQS, 2000
Thrips hawaiiensis (Morgan) (Thysanoptera: Thripidae)	KR, US	*C. annuum*	Flower, Fruit, Leaf	No	Yes (all stages in cracks or under calyces)	~~Park, 2002;~~ CPC, 2002; Nakahara, 1994; NPQS, 2000; Park, 2002
Thrips palmi Karny (Thysanoptera: Thripidae)	KR, US (American Samoa, FL, Guam, HI, PR)	*C. annuum*	Flower, Fruit, Leaf	Yes (Limited mainland distribution and PPQ actionable)	Yes (all stages in cracks or under calyces)	Courneya, 2003; CPC, 2002; Martin and Mau, 1992; Nakahara, 1994; NPQS, 2000; Park, 2002
Thrips tabaci Lind. (Thysanoptera: Thripidae)	KR, US	*Capsicum* spp.	Flower, Fruit, Leaf	No	Yes (all stages in cracks or under calyces)	Hill, 1993
Thripidae sp. (Thysanoptera)	KR	*Capsicum* sp.	Fruit	Yes	Yes	PIN 309, 2003
Trialeurodes vaporariorum (Westwood) (Homoptera: Aleyrodidae)	KR, US	*C. annuum*, *Capsicum* sp.	Leaf	No	Yes	Mound and Halsey, 1978; NPQS, 2000; Park, 2002

Table 4a. Arthropod pests of *Capsicum* spp. in the Republic of Korea

Pest Scientific Name and Taxonomic Classification	Geographic Distribution [1]	*Capsicum* Species Reported	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Tribolium castaneum Herbst (Coleoptera: Tenebrionidae)	KR, US	*Capsicum* sp.	Fruit	No	Yes (all stages in fruit)	CPC, 2003a; PIN 309, 2003
Trichoplusia ni (Hubner) (Lepidoptera: Noctuidae)	KR, US	*Capsicum* sp.	Fruit	No	Yes (larvae in fruit)	CPC, 2003a; PIN 309, 2003
Tortricinae sp. (Lepidoptera: Tortricidae)	KR	*Capsicum* sp.	Fruit	Yes	Yes (larvae in fruit)	PIN 309, 2003

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea

Pest Scientific Name and Taxonomic Classification	Geographic Distribution[1]	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Fungi[2]					
Alternaria alternata (Fr.: Fr.) Keissl. =*Alternaria fasciculate* (Cooke and Ellis) L. Jones and Grout =*Alternaria tenuis* Nees =*Macrosporium fasciculatum* Cooke and Ellis (Anamorphic fungi)	KR, US, worldwide	Flower, Fruit, Leaf, Seed	No	Yes	Anonymous, 1986; Anonymous, 1997; Anonymous, 1998; Park, 2002; CPC, 2003b; Farr *et al*., 1989; Holliday, 1980; Sherf and MacNab, 1986
***Alternaria* longipes** (Ellis and Everh.) E. Mason (Anamorphic fungi)	KR, US	Leaf, Stem	No	No	CPC, 2003b; Farr *et al*., 1989
Alternaria solani Sorauer =*Macrosporium solani* Ellis and G. Martin (Anamorphic fungi)	KR, US, worldwide	Fruit, Leaf, Stem	No	Yes	Alfieri *et al.*, 1994; Anonymous, 1986; Anonymous, 1997; Anonymous, 1998; CPC, 2003b; Dixon *et al*., 1995; Farr *et al*., 1989; Weber, 1973
***Alternaria* sp.** (Anamorphic fungi)	KR	Leaf	Yes	No	Anonymous, 1998
Ascochyta capsici Bond.-Mont (Anamorphic fungi)	KR, US	Leaf	No	No	Alfieri *et al*., 1994; Anonymous, 1986

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Ascochyta sp. (Anamorphic fungi)	KR	Leaf	Yes	No	Anonymous, 1998
Aspergillus flavus Link:Fr. =*Belonidium parksii* Cash =*Belonium parksii* (Cash) Seaver =*Nipterella parksii* (Cash) Dennis (Anamorphic fungi)	KR, US, worldwide	Fruit, Seed	No	Yes	CPC, 2003b; Farr *et al*., 1989
Aspergillus fumigatus Fres. (Anamorphic fungi)	KR, US, worldwide	Fruit, Seed	No	Yes	CPC, 2003b; Farr *et al*., 1989
Aspergillus niger Tiegh. =*Sterigmatocytis nigra* Tiegh. (Anamorphic fungi)	KR, US, worldwide	Fruit, Seed	No	Yes	CPC, 2003b; Farr *et al*., 1989
Botryotinia fuckeliana (de Bary) Whetzel =*Sclerotinia fuckeliana* (de Bary) Fuckel =*Botrytis cinerea* Pers. : Fr. (Helotiales: Sclerotiniaceae)	KR, US, widespread	Flower, Fruit, Leaf, Seed, Stem	No	Yes	Alfieri *et al.*,1994; Anonymous, 1986; Anonymous, 1997; Anonymous, 1998; Black *et al*., 1991; CPC, 2003b; Park, 2002; Dixon *et al*., 1995; Farr *et al*., 1989; Holliday, 1980; Kim and Cho, 1996; Pernezny *et al.*, 2003; Sherf and MacNab, 1986; Weber, 1973

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea

Pest Scientific Name and Taxonomic Classification	Geographic Distribution[1]	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Cercospora capsici Heald and F.A. Wolf =*Cercospora capsicicola* Vassil. =*Cercospora unamunoi* E. Castell =*Phaeoramularia unamunoi* (Cast.) Muntanola (Anamorphic fungi)	KR, US	Fruit, Leaf, Seed, Stem	No	Yes	Alfieri *et al.*, 1994; Anonymous, 1986; Anonymous, 1998; ARS, 2001b; Black *et al*., 1991; CPC, 2003b; Farr *et al*., 1989; Kranz *et al*., 1977; Park, 2002; Pernezny *et al.*, 2003; Sherf and MacNab, 1986; Shin and Braun, 1993; USDA, 1959; Weber, 1973
Choanephora cucurbitarum (Berk. and Ravenel) Thaxt. =*Choanephora americana* A. Moller (Mucorales: Choanephoraceae)	KR, US, worldwide	Flower, Fruit, Leaf, Seed, Stem	No	Yes	Alfieri *et al.*, 1994; Anonymous, 1986; CPC, 2003b; Farr *et al*., 1989; Holliday, 1980; Kranz *et al*., 1977; Pernezny *et al*., 2003; Sherf and MacNab, 1986; Weber, 1973
Cladosporium herbarum (Pers. :Fr.) Link =*Cladosporium epiphyllum* (Pers.:Fr.) Fr. =*Cladosporium graminum* (Pers.Fr.) Link =*Helminthosporium flexuosum* Corda (Anamorphic fungi)	KR, US, worldwide	Fruit, Leaf	No	Yes	Anonymous, 1986; Anonymous, 1997; Anonymous, 1998; CPC, 2003b; Dixon *et al.*, 1995; Farr *et al*., 1989; Sherf and MacNab, 1986
***Cladosporium* sp.** (Anamorphic fungi)	KR	None specified	Yes	Yes	PIN 309, 2002

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Cochliobolus lunatus R.R. Nelson and Haasis =*Pseudocochliobolus lunatus* (R.R. Nelson and Haasis) Tsuda, Ueyama and Nishihara =*Acrothecium lunatum* Wakker =*Curvularia lunata* (Wakker) Boedjin (Pleosporales: Pleosporaceae)	KR, US, worldwide	Flower, Leaf, Seed, Stem	No	Yes	CPC, 2003b; Farr *et al*., 1989
Colletotrichum acutatum J.H. Simmonds ex Simmonds (Anamorphic fungi)	KR, US	Fruit, Leaf, Seed, Stem	No	Yes	Black *et al*., 1991; CPC, 2003b; Spizes, 2002
Colletotrichum capsici (Syd. E.J. Butler and Bisby =*Colleotrichum indicum* Dastur =*Vermicularia capsici* Syd. (Anamorphic fungi)	KR, US, worldwide	Flower, Fruit, Leaf, Seed, Stem	No	Yes	Alfieri *et al*., 1994; Black *et al*., 1991; CPC, 2003b; Dixon *et al*., 1995; Farr *et al*., 1989; Holliday, 1980; Pernezny *et al*., 2003; Sherf and MacNab, 1986; Spizes, 2002

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Colletotrichum coccodes (Wallr.) S.J. Hughes =*Colletrotrichum atramentarium* (Berk. and Broome) Taubenhaus =*Colletotrichum piperatum* Ellis and Everh. **=***Gloeosporium piperatum* (Anamorphic fungi)	KR, US, worldwide	Flower, Fruit, Leaf, Root, Seed, Stem	No	Yes	Anonymous, 1998; Black *et al*., 1991; CPC, 2003b; Farr *et al*., 1989; Holliday, 1980; Park, 1958; Park, 2002; Pernezny *et al*., 2003; Sherf and MacNab, 1986; Spizes, 2002; USDA, 1959
Colletotrichum dematium (Pers.:Fr.) Grove =*Vermicularia compacta* Cooke and Ellis =*Vermicularia dematium* (Pers.) Fr. =*Vermicularia dianthi* Westend. in Kickx (Anamorphic fungi)	KR, US, worldwide	Flower, Fruit, Leaf, Seed , Stem	No	Yes	Anonymous, 1998; Chung and Chang, 1984; CPC, 2003b; Farr *et al*., 1989; Holliday, 1980; Sherf and MacNab, 1986
Colletotrichum dematium f. sp**. *capsicum*** =*Colletotrichum dematium* (Pers.:Fr.) Grove (Anamorphic fungi)	KR, US	Flower, Fruit, Leaf, Seed , Stem	No	Yes	Anonymous, 1986; Anonymous, 1998; Chung and Chang, 1984; CPC, 2003b; Park, 2002

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea

Pest Scientific Name and Taxonomic Classification	Geographic Distribution[1]	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Colletotrichum nigrum Ellis and Halsted (Anamorphic fungi)	KR, US	Flower, Fruit, Leaf, Seed , Stem	No	Yes	Anonymous, 1986; Anonymous, 1998; Farr *et al*., 1989; Park, 1958; Sherf and MacNab, 1986; USDA, 1959
Colletotrichum truncatum (Schwein.) Andrus and W.D. Moore =*Colletotrichum dematium* f. *truncatum* (Schwein.) Arx =*Vermicularia truncate* Schwein. (Anamorphic fungi)	KR, US	Fruit, Leaf, Seed, Stem	No	Yes	CPC, 2003b Farr *et al*., 1989; Kim *et al*., 1989
Corticium rolfsii Curzi *=Athelia rolfsii* (Curzi) Tu and Kimbrough *=Pellicularia rolfsii* E. West *=Sclerotium rolfsii* Sacc. (Polyporales: Corticiaceae)	KR, US, worldwide	Flower, Fruit, Leaf, Seed, Stem, Root, Whole plant wilt	No	No	Alfieri *et al.,* 1994; Anonymous, 1998; CPC, 2003b; Farr *et al*., 1989; Pernezny *et al*., 2003; Weber, 1973

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea

Pest Scientific Name and Taxonomic Classification	Geographic Distribution[1]	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Corynespora cassiicola (Berk. and M.A. Curtis) C.T. Weir =*Cercospora vinicola* E. Kawamura =*Helminthosporium cassiicola* Berk. and M.A. Curtis =*Helminthosporium vignae* Olive in Olive, Bain and Lefebvre (Anamorphic fungi)	KR, US, worldwide	Flower, Fruit, Leaf, Root, Stem	No	Yes	Alfieri *et al.,* 1994; CPC, 2003b; Farr *et al.,* 1989; Kwon *et al*., 2001
Diaporthe phaseolorum (Cooke and Ellis) Sacc. =*Diaporthe batatis* Harter and E.C. Field =*Diaporthe phaseolorum* var. *batatis* (Harter and E.C. Field) Wehmeyer =*Diaporthe sojae* S.G. Lehman (Diaporthales: Valsaceae)	KR, US, worldwide	Fruit, Leaf, Stem	No	Yes	Anonymous, 1997; Anonymous, 1998; Farr *et al*., 1989; Park, 2002; Sherf and MacNab, 1986; Weber, 1973

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Erysiphe cichoracearum DC. =*Erysiphe asterum* Schwein. =*Oidium asteris punicei* Peck (Erysiphales: Erysiphaceae)	KR, US, worldwide	Leaf, Stem	No	No	Alfieri *et al.*, 1994; CPC, 2003b; Farr *et al*., 1989; Shin, 1988; Shin and Lee, 1999
Erysiphe orontii Castagne emend. U. Braun =*Erysiphe cucurbitacearum* Zheng and Chen =*Erysiphe polyphaga* Hammarlund, nom. nud. =*Erysiphe tabaci* Sawada =*Oidium begoniae* Braun =*Oidium violae* Whipps et al. (Erysiphales: Erysiphaceae)	KR, US	Leaf, Stem	No	No	CPC, 2003b; Hahm *et al.,* 1988

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Fusarium oxysporum Schlechtend.:Fr. =*Fusarium angustum* Sherb. =*Fusarium auantiacum* (Link) Sacc =*Fusarium oxysporum* var. *aurantiacum* (Link) Wollenweb. (Anamorphic fungi)	KR, US, worldwide	Fruit, Root, Stem, Whole plant wilt	No	Yes	Alfieri *et al.,*1994; Anonymous, 1986; Anonymous, 1997; CPC, 2003b; Farr *et al*., 1989; Pernezny *et al.,* 2003
Fusarium oxysporum* f. sp. *vasinfectum (Atk.) W.C. Snyder and H.N. Hans. =*Fusarium vasinfectum* Atk. (Anamorphic fungi)	KR, US, worldwide	Fruit, Leaf, Seed, Stem, Root, Whole plant wilt	No	Yes	CPC, 2003b; Farr *et al*., 1989; Pernezny *et al.,* 2003; Sherf and MacNab, 1986; Weber, 1973
***Fusarium* spp.** (Anamorphic fungi)	KR	Fruit	Yes	Yes	Anonymous, 1998
Geotrichum candidum Link (Anamorphic fungi)	KR, US, worldwide	Fruit	No	No	CPC, 2003b; Pernezny *et al*., 2003

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Gibberella intricans Wollenw. =*Fusarium equiseti* (Corda) Sacc. =*Fusarium equiseti* var. *bullatum* Wollenweb. *Fusarium scirpi* Lambotte and Fautrey *Fusarium scripi* var. *compactum* Wollemweb. (Hypocreales: Nectriaceae)	KR, US, worldwide	Leaf, Root, Stem	No	No	Anonymous, 1998; CPC, 2003b; Farr *et al*., 1989
Glomerella graminicola Politis =*Colletotrichum cereale* Manns =*Colletotrichum graminicola* (Ces.) G.W. Wilson =*Dicladium graminicola* Ces. =*Dicladium graminicolum* Ces. (Anamorphic fungi)	KR, US	Flower, Fruit, Leaf, Seed , Stem	No	Yes	Anonymous, 1998; CPC, 2003b; Farr *et al*., 1989; Sherf and MacNab, 1986
Lasiodiplodia theobromae (Pat.) Griffiths and Maubl. (Anamorphic fungi)	KR, US, worldwide	Flower, Fruit, Leaf, Seed, Stem	No	Yes	CPC, 2003b; Farr *et al*., 1989

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Macrophomina phaseolina (Tassi) Goidanich = *Dothiorella phaseoli* (Maubl.) Petr. and Syd. = *Macrophoma phaseoli* Maubl. =*Macrophoma phaseolina* Tassi (Anamorphic fungi)	KR, US, worldwide	Leaf, Root, Seed, Stem	No	Yes	Alfieri *et al*., 1994; CPC, 2003b; Farr *et al*., 1989; Pernezney *et al.,* 2003; Weber, 1973
Monilinia fructigena Honey in Whetzel =*Sclerotinia fructigena* Aderhold ex Sacc. (Helotiales: Sclerotiniaceae)	KR	Fruit, Leaf, Stem	Yes	Yes	Batra, 1991; CPC, 2003b
Myrothecium verrucaria (Albertini and Schwein) Ditmar:Fr. =*Gliocladium fibriatum* Gilman and E. Abbott =*Metarhizium glutinosum* S. Pope =*Starkeyomyces koochalomoides* Agnihothrudu (Anamorphic fungi)	KR, US, worldwide	Fruit, Leaf	No	Yes	CPC, 2003b; Farr *et al*., 1989

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Nectria haematococca (Wollenw.) Gerlach =*Fusarium solani* (Mart.) Sacc. =*Fusarium lathyri* Taubenhaus (Hypocreales: Nectriaceae)	KR, US, worldwide	Root, Stem, Whole plant wilt	No	Yes	Alfieri *et al*., 1994; CPC, 2003b; Pernezny *et al.,* 2003
Oidiopsis sicula Scalia =*Leveillula taurica* (Lév.) G. Arnaud =*Erysiphe taurica* Lév. =*Leveillula leguminosarum* Golovin, nom. inval. = *Ramularia richardiae* =*Oidiopsis taurica* (Lév.) Salmon (Erysiphales: Erysiphaceae)	KR, US, worldwide in temperate, semi-arid and tropical zones	Flower, Fruit, Leaf, Stem	No	Yes	Anonymous, 1986; Anonymous, 1997; Anonymous, 1998; Black *et al*., 1991; Park, 2002; CPC, 2003b; Farr *et al.,* 1989; Holliday, 1980; Hong, 1993; Kranz *et al*., 1977; Pernezny *et al.,* 2003; Shin, 1988
Oidiopsis **sp.** (Erysiphaceae)	KR	Fruit, Leaf	Yes	Yes	Shin, 1988
Peronospora hyoscyami **f. sp. *tabacina*** (D.B. Adam) Skalicky =*Peronospora tabacina* D.B. Adam (Peronosporales: Peronosporaceae)	KR, US, worldwide in temperate regions	Flower, Leaf, Stem, Whole plant	No	No	Alfieri *et al*., 1994; CPC, 2003b; Farr *et al*., 1989; Sherf and MacNab, 1986; Weber, 1973

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Phoma destructiva Plowr. =*Diplodina destructive* (Plowr.) Petr. =*Phyllosticta lycopersici* Peck (Diaporthales: Valsaceae)	KR, US, worldwide	Fruit, Leaf, Stem	No	Yes	Alfieri *et al*., 1994; Anonymous, 1972; Anonymous, 1986; Anonymous, 1998; CPC, 2003b; Dixon *et al*., 1995; Farr *et al*., 1989; Park, 1958; Weber, 1973
Phoma exigua* var. *exigua Desmaz. **=***Phoma solanicola* Prill. and Delacr. *=Phyllosticta destructiva* Desmaz. (Diaporthales: Valsaceae)	KR, US, worldwide	Leaf, Root, Stem	No	No	Alfieri *et al*., 1994; Anonymous, 1998; CPC, 2003b; Farr *et al.,* 1989
***Phoma* sp.** (Valsaceae)	KR	Fruit	Yes	Yes	PIN 309, 2002
Phomopsis longicolla T.W. Hobbs (Anamorphic fungi)	KR, US	Fruit, Stem	No	Yes	CPC, 2003b; Farr *et al*., 1989

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea

Pest Scientific Name and Taxonomic Classification	Geographic Distribution[1]	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Phytophthora capsici Leonian (Pythiales: Pythiaceae)	KR, US	Fruit, Leaf, Seed, Stem, Root, Whole plant wilt	No	Yes	Alfieri *et al.*, 1994; Anonymous, 1972; Anonymous, 1986; Anonymous, 1997; Anonymous, 1998; ARS, 2001b; Black *et al*., 1989; Park, 2002; CPC, 2003b; Dixon *et al*., 1995; Farr *et al*., 1989; Holliday, 1980; Hong, 1993; Hwang and Kim, 1995; Pernezny *et al.*, 2003; Sherf and MacNab, 1986; USDA, 1959; Weber, 1973
Phytophthora cryptogea Pethybr. and Lafferty (Pythiales: Pythiaceae)	KR, US	Leaf, Root, Stem	No	No	CPC, 2003b; Farr *et al*., 1989
Phytophthora infestans (Mont.) de Bary (Pythiales: Pythiaceae)	KR, US	Fruit, Leaf, Root, Stem	No	Yes	CPC, 2003b; Farr *et al*., 1989

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea

Pest Scientific Name and Taxonomic Classification	Geographic Distribution[1]	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Phytophthora nicotianae Breda de Haan =*P. parasitica* var. *nicotianae* (Brenda de Haan) Tucker =*Phytophthora parasitica* var. *rhei* Godfrey =*Phytophthora terrestris* Sherb. =*Phytophthora nicotianae* var. *parasitica* (Dastur) G.M. Waterhouse (Pythiales: Pythiaceae)	KR, US, worldwide	Fruit, Leaf, Root, Stem	No	Yes	Alfieri *et al.*, 1994; Anonymous, 1997; Anonymous, 1998; CPC, 2003b; Dixon *et al*., 1995; Farr *et al*., 1989; Park, 2002
Pleospora herbarum **(Fr.)** Rabenh. =*Stemphylium botryosum* Wallr. =*Macrosporium commune* Rabenh. (Pleosporales: Pleosporaceae)	KR, US, worldwide	Fruit, Leaf, Seed, Stem	No	Yes	Alfieri *et al.*, 1994; Anonymous, 1972; Anonymous, 1997; CPC, 2003b; Farr *et al*., 1989; Holliday, 1980; Park, 1958; Pernezny *et al.*, 2003

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Pythium aphanidermatum (Edson) Fitzp. = *Nematosporangium aphanidermatum* (Edson) Fitzp. =*Pythium butleri* L. Subramanian =*Rheosporangium aphanidermatum* Edson (Saprolegniales: Incertae sedis)	KR, US, worldwide	Fruit, Root, Stem	No	Yes	Alfieri *et al.,* 1994; CPC, 2003b; Farr *et al*., 1989; Pernezny *et al.,* 2003; Weber, 1973
Pythium debaryanum Auct. non R. Hesse (Saprolegniales: Incertae sedis)	KR, US, widespread	Fruit, Root, Stem	No	Yes	CPC, 2003b; Farr *et al*., 1989; Sherf and MacNab, 1986; Weber, 1973
Pythium irregulare Buisman *=Pythium dactyliferum* Drechs. in Rands =*Pythium fabae* G. Cheney (Saprolegniales: Incertae sedis)	KR, US, worldwide	Root, Stem	No	No	CPC, 2003b; Farr *et al*., 1989
Pythium myriotylum Drechs. (Saprolegniales: Incertae sedis)	KR, US, worldwide	Root, Stem	No	No	Alfieri *et al.,* 1994; CPC, 2003b; Pernezny *et al.,* 2003
Pythium spinosum Sawada (Saprolegniales: Incertae sedis)	KR, US, worldwide	Root	No	No	Alfieri *et al.,* 1994; CPC, 2003b

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Pythium ultimum Trow (Saprolegniales: Incertae sedis)	KR, US, worldwide	Root, Stem	No	No	Anonymous, 1986; Anonymous, 1998; CPC, 2003b; Farr *et al*., 1989; Pernezny *et al*., 2003
Pythium vexans de Bary *=Pythium ascophallon* Sideris *=Pythium complectens* H. Braun*)* (Saprolegniales: Incertae sedis)	KR, US, worldwide	Root	No	No	CPC, 2003b; Farr *et al*., 1989
Rhizopus stolonifer (Ehrenb. : Fr.) Vuill. =*Rhizopus nigricans* Ehrenb. (Mucorales: Mucoraceae)	KR, US, worldwide	Fruit	No	Yes	Alfieri *et al*., 1994; Anonymous, 1998; Park, 2002; Farr *et al*., 1989; Holliday, 1980; Pernezny *et al*., 2003
Sclerotinia minor Jagger =*Sclerotinia intermedia* Ramsey =*Sclerotinia sativa* Drayton and Groves (Helotiales: Sclerotiniaceae)	KR, US, worldwide	Fruit,Leaf, Root, Stem	No	Yes	Anonymous, 1998; CPC, 2003b; Pernezny *et al*., 2003

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Sclerotinia sclerotiorum (Lib.) de Bary =*Sclerotinia libertiana* Fuckel =*Whetzelinia sclerotiorum* (Lib. Korf and Dumont =*Sclerotium varium* Pers.:Fr. (Helotiales: Sclerotiniaceae)	KR, US, worldwide	Fruit, Root, Stem, Whole plant wilt	No	Yes	Alfieri *et al.*,1994; Anonymous, 1986; Anonymous, 1997; Anonymous, 1998; CPC, 2003b; Dixon *et al.*, 1995; Farr *et al.*, 1989; Pernezny *et al.*, 2003; Weber, 1973
Septoria lycopersici Speg. (Anamorphic fungi)	KR, US, worldwide	Leaf	No	No	Anonymous, 1998; CPC, 2003b; Farr *et al.*, 1989; Park, 1958; Shin *et al.*, 2001.
Sphaeropsis lappae Ellis and Everh. =*Glomerella cingulata* (Stoneman) Spauld. and H. Schrenk =*Physalospora anthurii* R. Fischer =*P. cattleyae* Maubl. and Lasnier =*Colletotrichum gloesporioides* (Penz.) Penz. and Sacc. in Penz. (Anamorphic fungi)	KR, US, worldwide	Flower, Fruit, Leaf, Seed, Stem	No	Yes	Alfieri *et al.*, 1994; Anonymous, 1986; Anonymous, 1998; Black *et al.*, 1991; CPC, 2003b; Farr *et al.*, 1989; Hong, 1993; Park, 2002; Pernezny *et al.*, 2003; Weber, 1973

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Stemphylium botryosum Wallr. =*Macrosporium commune* Rabenh. (Anamorphic fungi)	KR, US, worldwide	Leaf	No	No	Anonymous, 1986; Farr *et al*., 1989
Stemphylium lycopersici (Enjoji) W. Yamamoto =*S. floridanum* Hannon and G.F. Weber (Anamorphic fungi)	KR, US, widespread	Flower, Leaf, Stem	No	No	Alfieri *et al*., 1994; Anonymous, 1998; Black *et al*., 1991; CPC, 2003b; Farr *et al*., 1989; Pernezny *et al*., 2003; Sherf and MacNab, 1986; Weber, 1973
Stemphylium solani G.F. Weber (Anamorphic fungi)	KR, US, worldwide	Flower, Leaf, Stem	No	No	Alfieri *et al*., 1994; Anonymous, 1998; CPC, 2003b; Farr *et al*., 1989; Holliday, 1980; Pernezny *et al*., 2003; Sherf and MacNab, 1986; Weber, 1973
***Stemphylium* sp.** (Anamorphic fungi)	KR	Leaf	Yes	No	Anonymous, 1998
Thanatephorus cucumeris (A.B. Frank) Donk =*Rhizoctonia solani* Kühn (Ceratobasidiales: Ceratobasidiaceae)	KR, US, worldwide	Fruit, Seed, Stem, Root	No	Yes	Anonymous, 1997; Anonymous, 1998; Black *et al*., 1991; CPC, 2003b; Farr *et al*., 1989; Holliday, 1980; Park, 2002; Pernezny *et al*., 2003; Spizes, 2002; USDA, 1959; Weber, 1973

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Verticillium albo-atrum Reinke and Berthold (Anamorphic fungi)	KR, US, worldwide	Fruit, Leaf, Root, Seed, Stem, Whole-plant wilt	No	Yes	Alfieri *et al.*, 1994; Anonymous, 1998; CPC, 2003b; Farr *et al*., 1989; Kranz *et al.*, 1977; Pernezny *et al.*, 2003; Sherf and MacNab, 1986; Spizes, 2002; Weber, 1973
Verticillium dahliae Kleb. (Anamorphic fungi)	KR, US, worldwide	Fruit, Leaf, Root, Seed, Stem, Whole-Plant wilt	No	Yes	Anonymous, 1997; Anonymous, 1998; Black *et al.*, 1991; CPC, 2003b; Holliday, 1980; Kranz *et al.*, 1977; Pernezny *et al.*, 2003; Spizes, 2002
Bacteria[3]					
Clavibacter michiganensis* subsp. *michiganensis (Smith) Davis *et al.* (Actinomycetales: Microbacteriaceae)	KR, US	Fruit, Leaf, Seed, Stem	No	Yes	Alfieri *et al.*, 1994; Anonymous, 1997; Anonymous, 1998; Bradbury, 1986; CPC, 2003b; Park, 2002; Pernezny *et al.*, 2003
Erwinia carotovora* subsp. *atroseptica (van Hall) Dye (Enterobacteriales: Enterobacteriaceae)	KR, US, worldwide	Fruit, Stem	No	Yes	CPC, 2003b; Pernezny *et al*. 2003

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Erwinia carotovora* subsp. *carotovora (Jones) Bergey *et al.* = *Bacillus carotovorus* Jones =*Erwinia aroideae* (Town.) Holland =*Pectobacterium carotovorum* (Jones) Waldee (Enterobacteriales: Enterobacteriaceae)	KR, US, worldwide	Fruit, Leaf, Stem, Root	No	Yes	Alfieri *et al*., 1994; Anonymous, 1972; Anonymous, 1986; Anonymous, 1997; Anonymous, 1998; Black *et al*.; Bradbury, 1986; CPC, 2003b; Park, 2002; Pernezny *et al*. 2003; Sherf and MacNab, 1986; Weber, 1973
Erwinia chrysanthemi (Burkh.) Young *et al*. (Enterobacteriales: Enterobacteriaceae)	KR, US, worldwide	Fruit, Leaf, Root, Stem	No	No	Alfieri *et al*., 1994; Bradbury, 1986; CPC, 2003b; Pernezny *et al*. 2003
Pseudomonas cichorii (Swingle) Stapp (Pseudomonadales: Pseudomonadaceae)	KR, US	Leaf, Stem	No	No	Alfieri *et al*., 1994; Bradbury, 1986; CPC, 2003b
Pseudomonas marginalis (Brown) Stevens =*Pseudomonas fluorescens* biovar II (Trevisan) Migula (Pseudomonadales: Pseudomonadaceae)	KR, US	Fruit	No	Yes	CPC, 2003; Pernezny *et al*., 2003; Yi and Seo, 2000

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea

Pest Scientific Name and Taxonomic Classification	Geographic Distribution[1]	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Pseudomonas marginalis* pv. *marginalis (Brown) Stevens (Pseudomonadales: Pseudomonadaceae)	KR, US	Fruit, Leaf, Root, Stem	No	Yes	Bradbury, 1986; CPC, 2003b
Pseudomonas syringae van Hall (Pseudomonadales: Pseudomonadaceae)	KR, US	Flower, Fruit, Leaf, Stem	No	Yes	Bradbury, 1986; CPC, 2003b
Pseudomonas syringae* pv. *aptata (Brown and Jamieson) Young et al. (Pseudomonadales: Pseudomonadaceae)	KR, US	Fruit, Leaf	No	Yes	Bradbury, 1986; CPC, 2003b
Pseudomonas syringae* pv. *syringae van Hall (Pseudomonadales: Pseudomonadaceae)	KR, US	Flower, Fruit, Leaf, Root, Seed, Stem	No	Yes	Alfieri *et al*., 1994; Bradbury, 1986; CPC, 2003b
Pseudomonas syringae* pv. *tabaci (Wolf and Foster) Young et al. (Pseudomonadales: Pseudomonadaceae)	KR, US	Fruit, Leaf, Seed	No	Yes	Bradbury, 1986; CPC, 2003b; Kranz *et al.*, 1977

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Pseudomonas viridiflava (Burkholder) Dowson (Pseudomonadales: Pseudomonadaceae)	KR, US, worldwide	Flower, Fruit, Leaf, Root, Seed, Stem	No	Yes	Bradbury, 1986; CPC, 2003b
Ralstonia solanacearum race 1 (Smith) Yabuuchi *et al.* =*Pseudomonas solanacearum* (Smith) Smith (Burkholderiales: Ralstoniaceae)	KR, US, widespread	Fruit, Leaf, Seed, Stem, Root , Whole plant wilt	No	Yes	Alfieri *et al*., 1994; Anonymous, 1972; Anonymous, 1986; Anonymous, 1998; Black *et al*., 1991; Bradbury, 1986; CPC, 2003b; Hong, 1993; Kranz *et al.*, 1977; NIAST, 2002; Park, 2002; Weber, 1973
Ralstonia solanacearum race 3 (Smith) Yabuuchi *et al.* =*Pseudomonas solanacearum* (Smith) Smith (Burkholderiales: Ralstoniaceae)	KR	Fruit, Leaf, Seed, Stem, Root, Whole plant wilt	Yes	Yes**	Alfieri *et al*., 1994; Anonymous, 1972; Anonymous, 1986; Anonymous, 1998; Black *et al*., 1991; Bradbury, 1986; Hong, 1993; Kranz *et al.,* 1977; NIAST, 2002; Park, 2002; Weber, 1973
Rhizobium radiobacter (Beijerinck and van Delden) Young et al. =*Agrobacterium tumefaciens* (Smith and Towns.) Conn (Rhizobiales: Rhizobiaceae)	KR, US, widespread	Stem, Root	No	No	Anonymous, 1998; CPC, 2003b; Bradbury, 1986; Kang *et al*., 1997

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Xanthomonas campestris* pv. *vesicatoria (Doidge) Dye (Xanthomonadales: Xanthomonadaceae)	KR, US	Fruit, Leaf, Seed, Stem	No	Yes	Alfieri *et al*.,1994; Anonymous, 1972; Anonymous, 1986; Anonymous, 1997; Anonymous, 1998; Black *et al*., 1991; Bradbury, 1986; CPC, 2003b; Hong, 1993; Pernezny *et al*., 2003; Sherf and MacNab, 1986; USDA, 1959; Weber, 1973
Xanthomonas vesicatoria (ex Doidge) Vauterin *et al.* (Xanthomonadales: Xanthomonadaceae)	KR, US	Fruit, Leaf, Seed, Stem	No	Yes	CPC, 2003b; Pernezny *et al.*, 2003
Nematodes[4]					
Ditylenchus destructor Thorne (Anguinidae)	KR, US	Root	No	No	CPC, 2003b
Meloidogyne arenaria (Neal) Chitwood (Meloidogynidae)	KR, US, worldwide	Root	No	No	Anonymous, 1998; Black *et al.*, 1991; Choi, 1981; CPC, 2003b; Pernezny *et al.*, 2003
Meloidogyne hapla Chitwood (Meloidogynidae)	KR, US, worldwide	Root	No	No	Anonymous, 1998; Black *et al.*, 1991; Choi, 1981; CPC, 2003b; Pernezny *et al.*, 2003

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Meloidogyne incognita (Kofoid and White) Chitwood (Meloidogynidae)	KR, US, worldwide	Root	No	No	Anonymous, 1998; Black *et al.,* 1991; Choi, 1981; CPC, 2003b; Pernezny *et al.,* 2003; Spizes, 2002
Meloidogyne javanica (Treub) Chitwood (Meloidogynidae)	KR, US, worldwide	Root	No	No	Anonymous, 1998; Choi, 1981; CPC, 2003b; Pernezny *et al.,* 2003
Paratrichodorus minor (Colbran) Siddiqi. = *Paratrichodorus christiei (*Allen) Siddiqi. =*Trichodorus christiei* Allen (Trichodoridae)	KR, US, worldwide	Root	No	No	CPC, 2003b; Pernezny *et al.,* 2003; Sherf and MacNab, 1986
Pratylenchus neglectus (Rensch) Filipjev and S. Stekhoven =*Pratylenchus minyus* Sher and Allen (Pratylenchidae)	KR	Root	Yes	No	Anonymous, 1998; CPC, 2003b
Pratylenchus penetrans (Cobb) Filipjev and S. Stekhoven *(*Pratylenchidae)	KR, US	Root	No	No	CPC, 2003b; Pernezny *et al.,* 2003; Sherf and MacNab, 1986
Viruses[5]					

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Alfalfa mosaic virus =*Lucerne mosaic virus* =*Potato calico virus* (Bromoviridae: *Alfamovirus*)	KR, US	Fruit, Leaf, Seed, Stem	No	Yes	Anonymous, 1972; Anonymous, 1986; Anonymous, 1997; Anonymous, 1998; Black *et al.*, 1991; Brunt *et al.*, 2002; CPC, 2003b; Kim *et al.*, 1990; Pernezny *et al.*, 2003; Spizes, 2002; van Regenmortel *et al*., 2000
Beet curly top virus (Geminiviridae: *Curtovirus*)	KR, US	Fruit, Leaf, Stem	No	Yes	Anonymous, 1997; Black *et al*., 1991; CPC, 2003b; Pernezny *et al*., 2003; Spizes, 2002; USDA, 1959; van Regenmortel *et al*., 2000
Broad bean wilt virus (Comoviridae: *Fabavirus*)	KR, US	Fruit, Leaf, Seed, Stem	No	Yes	Anonymous, 1998; CPC, 2003b; Park, 2002; Pernezny *et al.*, 2003; van Regenmortel *et al*., 2000
Chilli veinal mottle virus = Pepper vein banding mosaic virus (Potyviridae:*Potyvirus*)	KR	Fruit, Leaf	Yes	No***	Black *et al*., 1991; Brunt *et al.*, 2002; CPC, 2003b; Pernezny *et al*., 2003; van Regenmortel *et al*., 2000

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Cucumber mosaic virus (Bromoviridae*: Cucumovirus*)	KR, US, worldwide	Fruit, Leaf, Stem	No	Yes	Alfieri *et al*., 1994; Anonymous, 1972; Anonymous, 1986; Anonymous, 1997; Black *et al*., 1991; Brunt *et al.,* 2002; CPC, 2003b; Hong, 1993; Kim *et al.,* 2002; Park, 2002; Pernezny *et al*., 2003; Spizes, 2002; USDA, 1959; van Regenmortel *et al*., 2000
Peanut stunt virus *(*Bromoviridae*: Cucumovirus)*	KR, US	Leaf, Seed	No	Yes	Brunt *et al.,* 2002; CPC, 2003b; Pernezny *et al*., 2003; van Regenmortel *et al*., 2000
Pepper vein chlorosis virus (Unknown)	KR	Leaf, Stem, Whole plant	Yes	Yes	Anonymous, 1998; Kim *et al.,* 1990; Park, 2003
Potato virus X (*Potexvirus*)	KR, US, worldwide	Leaf	No	No	Anonymous, 1972; Anonymous, 1986; Anonymous, 1997 Brunt *et al.,* 2002; CPC, 2003b; Kim *et al.,* 1990; Pernezny *et al*., 2003; van Regenmortel *et al*., 2000

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Potato virus Y (Potyviridae: *Potyvirus*)	KR, US, worldwide	Fruit, Leaf, Stem	No	No	Alfieri *et al*., 1994; Anonymous, 1986; Anonymous, 1997; Anonymous, 1998; Black *et al*., 1991; Brunt *et al.,* 2002; CPC, 2003b; Kim *et al.,* 1990; Park, 2002; Pernezny *et al*., 2003; van Regenmortel *et al*., 2000
Tobacco mosaic satellite virus (Subviral agent – satellite virus: Subgroup 2: Tobacco necrosis satellite virus-like)	KR, US	Leaf	No	No	Anonymous, 1998; Brunt *et al.,* 2002; CPC, 2003b; van Regenmortel *et al*., 2000
Tobacco mosaic virus (*Tobamovirus*)	KR, US, worldwide	Fruit, Leaf, Seed, Stem, Root	No	Yes	Alfieri *et al*., 1994; Anonymous, 1972; Anonymous, 1986; Anonymous, 1997; Black *et al*., 1991; Brunt *et al.,* 2002; CPC, 2003b; Hong, 1993; Park, 2002; Pernezny *et al*., 2003; Spizes, 2002; USDA, 1959; van Regenmortel *et al*., 2000
Tobacco rattle virus (*Tobravirus*)	KR, US	Leaf, Seed, Stem	No	Yes	Alfieri *et al*., 1994; Anonymous, 1997; Brunt *et al.,* 2002; CPC, 2003b; Pernezny *et al*., 2003; van Regenmortel *et al*., 2000

Table 4b. Pathogen pests of *Capsicum* spp. in the Republic of Korea					
Pest Scientific Name and Taxonomic Classification	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest**	**Follow Pathway**	**References**
Tobacco ringspot virus (Comoviriidae: *Nepovirus*)	KR, US	Fruit, Leaf, Seed, Stem	No	Yes	Brunt *et al.,* 2002; CPC, 2003b; Pernezny *et al*., 2003; van Regenmortel *et al*., 2000
Tomato mosaic virus (*Tobamovirus*)	KR, US, worldwide	Fruit, Leaf, Seed, Stem Root	No	Yes	Brunt *et al.,* 2002; CPC, 2003b; Kim *et al.,* 1990; Pernezny *et al*., 2003; van Regenmortel *et al*., 2000
Tomato spotted wilt (Bunyaviridae*:* *Tospovirus*)	KR, US, worldwide	Fruit, Leaf, Stem	No	No	Alfieri *et al*., 1994; Anonymous, 1997; Black *et al.,* 1991; Brunt *et al.,* 2002; CPC, 2003b; Kranz *et al.,* 1977; Spizes, 2002; Pernezny *et al*., 2003; van Regenmortel *et al*., 2000

[1] Geographic Distribution: FL=Florida; HI=Hawaii; KR = Korea; PR=Puerto Rico; US = United States; WA=Washington

[2] Fungal Nomenclature as in ARS (2001b); Fungal Taxonomic Classification as in CAB (2001).

[3] Bacterial nomenclature and taxonomy as in Euzéby (2002).

[4] Nematode nomenclature and taxonomy as in CPC (2003b).

[5] Virus nomenclature and taxonomy as in van Regenmortel et al. (2000).

* Even though intercepted twice on peppers in baggage, aphids are not considered likely to remain with the commodity after even minimal commercial processing.

**See CPHST-PERAL Ad Hoc Report "*Ralstonia solanacearum* Race 3 Biovar 2 Likelihood of Entry, Introduction, and Establishment, and Mitigation Recommendations: Supplement to the USDA-APHIS Pest Risk Assessment Importation of fresh paprika pepper fruit (*Capsicum annuum* L. var. *annuum*) from the Republic of South Korea into the continental United States" in Addendum p. 90 which concludes that although the pathogen can enter with the commodity, it is not likely to become established.

*** It is vectored by several aphid species in a non-persistent manner and is not transmitted in seed; therefore, propagation from seeds would not be likely to yield infected plants (Brunt *et al.,* 2003; CPC, 2003b). The aphid vectors in Korea are not likely to remain in the shipping pathway. Additional vectors, such as *Aphis gossypii* and *Myzus persicae* are present in the United States (CPC, 2003b), but they feed on live plants and it is not likely that they will come into contact with the commodity. Therefore, although the virus can enter in the fruit, it is not likely that the virus will become established, the pathway stops at entry and the virus is not analyzed further.

E. Quarantine Pests Likely to Follow the Pathway

Table 5. Quarantine Pests Likely to Follow the Pathway
Agrotis segetum (Lepidoptera: Noctuidae)
Helicoverpa armigera (Lepidoptera: Noctuidae)
Helicoverpa assulta (Lepidoptera: Noctuidae)
Mamestra brassicae (Lepidoptera: Noctuidae)
Monilinia fructigena (Helotiales*:* Sclerotiniaceae)
Ostrinia furnacalis (Lepidoptera: Pyralidae)
Ralstonia solanacearum race 3 (Burkholderiales*:* Ralstoniaceae)*
Scirtothrips dorsalis (Thysanoptera: Thripidae)
Spodoptera litura (Lepidoptera: Noctuidae)
Thrips palmi (Lepidoptera: Noctuidae)

*See Addendum p. 90 for conclusive analysis of risk of entry and establishment. Pathogen is not likely to become established, therefore pathway ends at entry.

Other plant pests in this assessment, not chosen for further scrutiny, may be potentially detrimental to the agricultural production systems of the United States; however, there were a variety of reasons for not subjecting them to further analysis:

1. The primary association is with plant parts other than the pepper fruit. Should any of the pests be intercepted in shipments of pepper fruit, quarantine action may be taken at the port-of-entry, where additional risk analyses may be conducted.

2. Pests are associated with the pepper fruit, but it is not considered reasonable to expect these pests to remain with the fruit in a viable form during harvesting, culling, selection, grading, post-harvest treatment, packaging and shipping procedures. This pertains to highly mobile species not attached to the fruit. It is very unlikely that some external feeders, which may be on the fruit during the harvest, even if they are of quarantine significance, will remain with the fruit after this manipulation.

3. Organisms identified to the genus, or higher taxonomic level, are not analyzed further, even though individual species within those taxonomic groups are potential pests that may or may not occur within the United States. The IPPC guidelines do not require risk assessment of pests identified only by genus name (FAO, 1996). By necessity, pest risk assessments focus on those organisms for which adequate biological and taxonomic information is available. Often, there are many species within a genus, and it is not reasonable to assume that the biology of all organisms within a genus is identical. Lack of species identification may indicate the limits of the current taxonomic knowledge, the life stage or the quality of the specimen submitted for identification. The lack of identification at the species level does not rule out the possibility that a high risk quarantine pest was intercepted or that the intercepted pest was not a quarantine pest. By developing detailed assessments for known pests that inhabit a variety of niches on the parent commodity, for example, on the surface of, within the stem or fruit, on the flowers, *etc*., effective mitigation measures may be developed to eliminate the known pests, and any similar unknown ones that inhabit the same niches. Lack of biological information on any given insect

or pathogen should not be equated with a low risk.

Some pests may be intercepted during inspection by Plant Protection and Quarantine Officers as biological contaminants (hitchhikers) of the pepper fruit, however, these are not expected to be present with every shipment.

In 1990, pepper vein chlorosis virus was reported as a new virus of red pepper in Korea, causing stem necrosis and vein chlorosis, with an abundant presence of virus particle in phloem tissue (Kim *et al*., 1990). In transmission studies, the virus was transmitted by the green peach aphid, *Myzus persicae,* in a non-persistent manner. Due to this report in the literature, pepper vein chlorosis virus was included in Table 4b and is listed as a quarantine pest following the pathway; however, this virus was not selected for further analysis because a personal communication by Chong-Seo Park (2003) notes that since the initial report in 1990, pepper vein chlorosis virus has not been observed again on *Capsicum* sp. in Korea. Currently, this virus is not considered a disease of *Capsicum* sp. in Korea by various virus disease experts at Youngnam University, and by the experts at the Korea's Agricultural Science and Technology and Horticultural Research Insitutes of the Rural Development Administration (Park, 2003).

F. Consequences of Introduction and Likelihood of Introduction

For each of the quarantine pests in the pathway listed in Table 5, the potential Consequences of Introduction are rated using five risk elements, as the Likelihood of Introduction is rated by six risk elements. 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). A cumulative Risk Rating is then calculated by summing all risk element values. For Consequences of Introduction: Low = 5-8 points, Medium = 9-12 points, High = 13-15 points. For Likelihood of Introduction: Low = 6-9 points, Medium = 10-14 points, High = 15-18 points. An overall Pest Risk Potential for each pest is then calculated: Low = 11-18 points, Medium = 19-26 points, High = 27-33 points.

Agrotis segetum	
Consequences of Introduction	**Risk Rating**
Climate/Host Interaction The climatic conditions are suitable for the survival and establishment of this pest in over 4 Plant Hardiness Zones of the United States (7 – 11) (ARS, 1990; Carter, 1984).	3
Host Range *Agrotis segetum* has a wide host range consisting of more than 20 different families, including Brassicaceae, Cucurbitaceae, and Solanaceae, as well as cereals, citrus and cotton (Carter, 1984; CPC, 2002).	3
Dispersal Potential *Agrotis segetum*, like many cutworms, is capable of long distance flight; it has been documented to migrate among European countries. The species can complete up to four generations in a season, while the female can lay several hundred eggs per week (Carter, 1984; CPC, 2003a).	3
Economic Impact The pest is capable of causing major potato yield losses in Africa (Rhoades *et al*., 2002), and is a major European pest of seedlings (Carter, 1984). In the United Kingdom, up to 34% of the beet leaf crop has been damaged.	3
Environmental Impact The pest infests species of *Cucurbita, Solanum, Helianthus, Allium, etc.* (Zhang, 1994). If an outbreak should occur in one of these crops within the United States, chemical control programs would need to be established. There are eight endangered species representing the above genera that could be directly affected by the pest should it become established (50 CFR 1 17.12, 2001).	3
Consequences of Introduction Risk Rating	15 High

Agrotis segetum	
Likelihood of Introduction	**Risk Rating**
Quantity Annually Imported Korea plans to export about 600 40-ft container loads in aggregate per year (Park, 2002).	3
Survive Post-harvest Treatment There are no mandatory post-harvest treatments likely to affect larvae in fruits.	3
Survive Shipment Fruits are likely to be shipped under environmental conditions favorable for the survival of the pest, Commodity preservation and surface treatments are unlikely to affect the larvae in fruits.	3
Not Detected at Port-of-entry Some entrance holes on the outside of fruits may be detected by visual inspection. Other entrance holes, under calyces, and larvae in fruits will be more difficult to detect (CPC, 2002).	2
Moved to Suitable Habitat The climate throughout most of the United States is similar to that in the range of the pest (Carter, 1984; Zhang, 1994).	3
Contact with Host Material Due to the broad host and climate range (Carter, 1984; Zhang, 1994), there is likely to be agricultural or non-crop host material near most ports-of-entry.	3
Likelihood of Introduction Risk Rating	17 High
Pest Risk Potential = Likelihood of Introduction Rating + Consequences of Introduction Risk Rating	32 High

Helicoverpa armigera	
Consequences of Introduction	**Risk Rating**
Climate/Host Interaction The pest is distributed from France to the Phillipines (EPPO, 1997). Climatic conditions in over four USDA Plant Hardiness Zones of the United States (6 – 11) (ARS, 1990; Carter, 1984) would be suitable for establishment of this pest.	3
Host Range The pest infests crop and non-crop hosts representing over 10 genera and over four families (Carter, 1984; Zhang, 1994).	3
Dispersal Potential As with other noctuids, the pest is capable of flying long distances of many miles to disperse. Internal larvae may be dispersed long distances in fruits (CPC, 2003a; EPPO, 1997). Females may lay over 700 eggs during their lifetime and there may be up to six generations per year (CPC, 2003a).	3
Economic Impact Larvae are major pests of tomato, maize, cotton, and other crops (Carter, 1984; CPC, 2002), becoming major pests if they establish. For example, in India, losses of up to 50% of the potato crop have been recorded (CPC, 2003a). As an A2 pest for Europe, establishment in the US will lead to loss of export markets (EPPO, 1997).	3
Environmental Impact Larvae feed on genera, including *Amaranthus, Silene*, *Solanum*, *Carthamus, Gossypium, Hibiscus, etc*. The above genera include at least 10 species on the endangered list (50 CFR 1 17.12, 2001) that occur in the PRA area. If an outbreak occurs in a crop, new chemical treatments similar to those used on other major lepidopteran pests could occur.	3
Consequences of Introduction Risk Rating	15 High

Helicoverpa armigera	
Likelihood of Introduction	**Risk Rating**
Quantity Annually Imported Korea plans to export about 600 40-ft container loads in aggregate per year (Park, 2002).	3
Survive Post-harvest Treatment There are no mandatory post-harvest treatments; surface treatments are unlikely to affect larvae in fruits.	3
Survive Shipment Fruits are shipped under environmental conditions favorable for survival of the pest, as well as commodity preservation (Park, 2002).	3
Not Detected at Port-of-entry Some entrance holes on the outside of fruits may be detected by visual inspection. Other entrance holes, under calyces, and larvae in fruits will be more difficult to detect (CPC, 2002; EPPO, 1997).	2
Moved to Suitable Habitat The pest may infect numerous hosts that range over the area that may be affected (CPC, 2002).	3
Contact with Host Material Due to the broad host and climate range (Carter, 1984; Zhang, 1994), there is likely to be agricultural or non-crop host material near most ports-of-entry.	3
Likelihood of Introduction Risk Rating	17 High
Pest Risk Potential = Likelihood of Introduction Rating + Consequences of Introduction Risk Rating	32 High

Helicoverpa assulta	
Consequences of Introduction	**Risk Rating**
Climate/Host Interaction The pest is distributed in the subtropics and tropics. The climatic conditions are suitable for the survival and establishment of this insect in four USDA Plant Hardiness Zones of the United States (8 – 11) (ARS, 1990; Zhang, 1994).	3
Host Range The pest feeds on at least six genera in four families (CPC, 2003a).	3
Dispersal Potential *Helicoverpa* spp., such as the corn earworm, disperse many miles by flight (Metalf, *et al*., 1962). The species may have up to four generations annually, and females can each lay several hundred eggs in a lifetime (CPC, 2003a). Larvae of this pest can be dispersed in shipped peppers (NPQS, 2000).	3
Economic Impact In Korea, this pest has been known to reach levels requiring treatment (NPQS, 2000), and is reputed as a serious pest of peppers (CPC, 2003a). It could be expected to cause yield, quality, and quarantine losses.	3
Environmental Impact This pest eats plants in the genera *Lactuca, Solanum, Argemone. Corchora, Datura, Piper, Perilla, Lycopersicon,* and *Capsicum* (CPC, 2002; Zhang, 1994). The above genera contain at least four endangered species (50 CFR 1 17.12, 2001) that occur in the PRA area. Outbreaks on crops in the PRA area would likely trigger increased chemical control, as is currently used on related species.	3
Consequences of Introduction Risk Rating	15 High

Helicoverpa assulta	
Likelihood of Introduction	**Risk Rating**
Quantity Annually Imported Korea plans to export about 600 40-ft container loads in aggregate per year (Park, 2002).	3
Survive Post-harvest Treatment There are no mandatory post-harvest treatments; surface treatments are unlikely to affect larvae in fruits.	3
Survive Shipment Fruits are likely to be shipped under environmental conditions favorable for survival of the pest, as well as commodity preservation (Park, 2002).	3
Not Detected at Port-of-entry Some entrance holes on the outside of fruits may be detected by visual inspection. Other entrance holes, under calyces, and larvae in fruits will be more difficult to detect (CPC, 2002).	2
Moved to Suitable Habitat The pest may infest hosts that range widely over the PRA area (CPC, 2002).	3
Contact with Host Material Due to the host range (Carter, 1984; Zhang, 1994), there is likely to be agricultural or non-crop host material near most subtropical or tropical ports-of-entry.	3
Likelihood of Introduction Risk Rating	17 High
Pest Risk Potential = Likelihood of Introduction Rating + Consequences of Introduction Risk Rating	32 High

Mamestra brassicae	
Consequences of Introduction	**Risk Rating**
Climate/Host Interaction The pest occurs throughout Europe and subtropical Asia (Carter, 1984); this area which corresponds to more than four USDA Plant Hardiness Zones of the United States (6 – 11) (ARS, 1990; Carter, 1984).	3
Host Range This pest prefers Brassicaceae, but will attack crops in at least five other families, especially in greenhouses (CPC, 2002; Zhang, 1994).	3
Dispersal Potential Noctuid pests are strong fliers and can fly long distances after mating (Metcalf *et al.,* 1962). Larvae may spread inside fruits. There may be up to three generations per year, with females laying up to several thousand eggs each year (CPC, 2003a).	3
Economic Impact Up to an 80% yield loss in cabbage in Moldavia and a 98% loss in Germany has been reported (CPC, 2003a). Similar losses in cabbage and other crops could occur in the PRA area; this could include quality, yield, and quarantine losses.	3
Environmental Impact The pest feeds on *Lactuca, Solanum, Brassica, Quercus, Allium, Chrysanthemum*, *etc*. The above genera contain six endangered species that could be at risk in the PRA area (50 CFR 1 17.12, 2001). Outbreaks in crops in the PRA area would likely trigger chemical control programs, in addition to those now in use for other caterpillars.	3
Consequences of Introduction Risk Rating	15 High

Mamestra brassicae	
Likelihood of Introduction	**Risk Rating**
Quantity Annually Imported Korea plans to export about 600 40-ft container loads in aggregate per year (Park, 2002).	3
Survive Post-harvest Treatment There are no mandatory post-harvest treatments; surface treatments are unlikely to affect larvae in fruits.	3
Survive Shipment Fruits are likely to be shipped under environmental conditions favorable for the survival of the pest, as well as commodity preservation (Park, 2002).	3
Not Detected at Port-of-entry Some entrance holes on the outside of fruits may be detected by visual inspection. Other entrance holes, under calyces, and larvae in fruits will be more difficult to detect (CPC, 2002).	2
Moved to Suitable Habitat The pest may infest numerous hosts that range over the suitable climatic area (CPC, 2002).	3
Contact with Host Material Due to the broad host range (Carter, 1984; Zhang, 1994), there is likely to be agricultural or non-crop host material near most ports-of-entry.	3
Likelihood of Introduction Risk Rating	17 High
Pest Risk Potential = Likelihood of Introduction Rating + Consequences of Introduction Risk Rating	32 High

Monilinia fructigena	
Consequences of Introduction	**Risk Rating**
Climate/Host Interaction *Monilinia fructigena* is found throughout western and southern Europe, extending into the Scandinavian countries, eastern Europe, the former Soviet Union, the Middle and Far East, India, North Africa and South America (CPC, 2003b). Because *M. fructigena* is capable of surviving a wide range of climatic conditions, as evidenced by its presence in countries that experience cold winters, as well as subtropical to tropical conditions, the fungus would be able to survive in a large area of the United States. Cultivated host species, such as *Capsicum* spp. and *Malus* spp., are grown in more than six plant hardiness zones of the United States (NASS, 2002; NRCS, 2002). Cultivated, native and weedy species of *Corylus*, *Diospyros*, *Vitis*, *Berberis*, *Cornus*, *Vaccinium* and *Rhododendron* are potential hosts that occupy most of the United States (Abrams, 1940; Bailey, 1976; Harlow *et al.,* 1996; Hickman, 1993; Small, 1913). Climatic conditions and distribution of potential hosts are suitable for the survival and establishment of this fungal pathogen in at least 4 Plant Hardiness Zones of the United States (ARS, 1990; CPC 2003b).	3
Host Range The plant pathogenic fungus, *M. fructigena*, infects multiple species of at least ten plant families, including those shown below (Batra, 1991; Chang, 1986; CPC, 2003b). The combined distribution of the native and cultivated species within the host genera extends over most of the United States (Abrams, 1940; Bailey, 1976; Hickman, 1993; NRCS, 2002; Small, 1913; Sutherst *et al*., 1999). Berberidaceae: *Berberis* (Barberries) Betulaceae: *Corylus avellana* (European filbert) Cornaceae: *Cornus mas* (Cornelian cherry) Ebenaceae: *Diospyros kaki* (Oriental persimmon) Ericaceae: *Rhododendron* (*Azalea*), *Vaccinium* (Blueberries) Menispermaceae: *Ficus carica* (Common fig) Myrtaceae: *Psidium guajava* (Common guava) Rosaceae: *Amelanchier canadensis* (Downy serviceberry), *Chaenomeles japonica* (Flowering quince), *Cotoneaster, Crataegus laevigata* (English hawthorn), *Cydonia oblonga* (Common quince), *Eriobotrya japonica* (Loquat), *Fragaria*, *Fragaria* x *ananassa* (Cultivated strawberry), *Malus pumila* (Paradise apple), *Malus* spp. (Apples), *Mespilus germanica* (Medlar), *Prunus* (Stone fruit), *Prunus armeniaca* (Apricot), *Prunus avium* (Sweet cherry), *Prunus cerasus* (Sour cherry), *Prunus domestica* (Plum), *Prunus dulcis* (Almond), *Prunus persica* (Peach), *Prunus spinosa* (Blackthorn), *Prunus* spp. (Cherries, Peaches, Plums), *Pyrus communis* (European pear), *Pyrus* spp. (Pears), *Rosa* spp. (Roses),	3

Rubus (Blackberry, Raspberry), *Rubus occidentalis* (Black raspberry), *Sorbus aucuparia* (Mountain ash). Solanaceae: *Capsicum* (Peppers), *Lycopersicon esculentum* (Tomato) Vitaceae: *Vitis vinifera* (Grapevine)	
Dispersal Potential Conidia of *Monilinia fructigena* are produced on conidiophores that are elevated above infected plant tissues where they are exposed to air currents. Sporogenous hyphae produces a large number of relatively long-lived conidia that are air and wind disseminated (Batra, 1991, Byrde and Willets, 1977; Chang, 1986; CPC, 2003b). Aerial dispersal of conidia is responsible for the spread of spores over a wide range, while water splash dispersal may spread spores short distances, mainly to other parts of the same plant, or, in some cases, between adjacent plants (CPC, 2003b; Byrde and Willets, 1977). Animals are important vectors of *M. fructigena*, including birds, wasps (*Vespula* spp.), beetles (especially Nitidulidae), Diptera (particularly *Drosophila* spp.) and some Lepidoptera (Byrde and Willets, 1977; CPC, 2003b). Because fruits infected with the pest may serve as primary inocula, long distance spread of the pathogen may occur with the commodity. At harvest, apparently healthy fruit can be contaminated with spores, and decay may occur during storage and marketing (CPC, 2003b).	3
Economic Impact *Monilinia fructigena* causes significant yield losses both pre and post-harvest , according to Batra (1991) it is not easy to assess the overall loss to a country or worldwide. Brown rot losses reported in European apple orchards have ranged from 7-36%, with damage to stored fruit in the range of 0.2-1.5% (CPC, 2003b). Fungicides used for the routine control of foliar diseases that may occur in the field simultaneously with *M. fructigena*, provide incidental control of *M. fructigena* (CPC, 2003b). The sanitation and control of insects that serve as vectors and/or provide wounds for infection is essential for effective control of *M. fructigena* (CPC, 2003b). In the United Kingdom, average commercial losses in apples, due to fungal rots, have been maintained at less than 2% by the use of post-harvest fungicide treatments (Berrie, 1993). Fruit may appear healthy at the time of harvest, but, in reality be latently infected or contaminated with spores of *M. fructigena* (Batra, 1991; CPC, 2003b). Rotted fruit that develops in transit, storage or at the market, has reduced quality that impacts foreign market availability (Batra, 1991; CPC, 2003b; NZNPPO, 2000). *Monilinia fructigena* is a Quarantine Risk group 2 pathogen for Australian *Capsicum annuum* shipped to New Zealand (NZNPPO, 2000). New Zealand defines a Risk group 2 pathogen as a regulated pest, which, on entry into New Zealand, would cause a major disruption to market access and/or have significant economic impacts on the production of a particular commodity/commodities and/or the environment.	3
Environmental Impact The host list for *M. fructigena* includes host families and genera containing Threatened and Endangered species listed by the United States Fish Wildlife Service (USFWS) (50 CFR § 17.11-12) (CPC, 2003b). The host families Berberidacea, Ericaceae, Myrtaceae, Rosaceae, and Solanaceae are listed on the	

USFWS T & E list (50 CFR § 17.11-12). Within Berberidacea, there are two species of *Berberis* (*B. nevinii* and *B. pinnata* ssp. *insularis*) that are potential hosts of *M. fructigena* (50 CFR § 17.11-12). In the plant family Ericaceae, *Arctostaphylos confertiflora*, *A. glandulosa* ssp. *crassifolia*, *A. hookeri* var. *ravenii*, *A. morroensis, A. myrtifolia*, *A. pallida*, *Lyonia truncata* var. *proctorii,* and *Rhododendron chapmanii,* are listed T & E species (50 CFR § 17.11-12). Three genera containing five species are listed T & E (50 CFR § 17.11-12) for the plant family Myrtaceae: *Calyptranthes thomasiana, Eugenia haematocarpa, E. koolauensis, E. woodburyana* and *Myrcia paganii.* Within the Rosaceae, there are several species that are potential hosts of *M. fructigena*: *Acaena exigua, Cercocarpus traskiae, Geum radiatum, Ivesia kingii* var. *eremica, Potentilla hickmanii, Prunus geniculata, Purshia (=Cowania) subintegra,* and *Spiraea virginiana* (50 CFR § 17.11-12). Solanaceous plants in three genera, *Goetzea elegans, Nothocestrum breviflorum, N. peltatum, Solanum drymophilum, S. incompletum* and *S. sandwicense* are potential hosts of *M. frucigena*, and are considered T & E species (50 CFR § 17.11-12). Populations of the aforementioned species may be at risk if this fungal disease enters and becomes established in the United States. Adverse effects to hosts found in mesic to wet habitats could cause negative impacts to watershed function and riparian corridors. Chemical control programs for these pests are likely to be needed if pest populations become established, but such programs are not likely to be feasible or economically practicable outside of managed agroecosystems.	3
Consequences of Introduction Risk Rating	15 High

Monilinia fructigena	
Likelihood of Introduction	**Risk Rating**
Quantity Annually Imported Korea plans to export about 600 40-ft container loads in aggregate per year (Park, 2002).	3
Survive Post-harvest Treatment No treatments targeting the pest are mandatory for the commodity. Initial infection by *M. fructigena* is via wounds and subsequent spread can occur by contact between adjacent fruit (CPC, 2003b). Fruits that have been physically damaged by mechanical means, birds and vectors, can easily be culled at the time of harvest, or at the packing house. Mycelia may grow within host tissue and can be resistant to surface treatments. Tiryaki *et al*. (1994) found that gamma-ray doses of 1,2,3, and 3.5 kGy did not completely control post-harvest decay of apple, quince, onion, and peach, but did delay the growth of post-harvest pathogens, including *M. fructigena*. Mycelial growth stops at 30-35°, and mycelia are killed at approximately 50°C (CPC, 2003b).	3
Survive Shipment Mycelia of *M. fructigena* survive long periods of adverse conditions within infected tissue (CPC, 2003b). There have been more than 500 interceptions of *M. fructigena* on commodities entering the United States from several dozen countries; this demonstrates that this pathogen can survive shipment on imported fruit (USDA, 1964-1991). At harvest, apparently healthy fruit can be contaminated with spores, and decay may occur during storage and marketing (CPC, 2003b). Growth of *M. fructigena* is slowed, but the pathogen is not eliminated when fruit is chilled below about 5°C in transit and storage (CPC, 2003b).	3
Not Detected at Port-of-entry Obviously damaged and rotted fruit may be detected during standard inspection protocols conducted at ports-of-entry (Park, 2002). Because asymptomatic fruit may harbor latent infections (when the host is infected, but does not yet show symptoms), pepper fruit infected with *M. fructigena* may escape detection at the port (CPC, 2003b). Nursery stock is required to be indexed for *M. fructigena* (7 CFR §319.37-5).	3

Moved to Suitable Habitat *Monilinia fructigena* is a pathogen of numerous hosts that range over most of the United States (CPC, 2003b). Batra (1991 noted the ability of this fungus to invade new hosts. The extensive cultivation of fruit trees in temperate regions. and their long life span, ensures that hosts are readily available (CPC, 2003b). *Monilinia fructigena* was transported and became established outside of its native European and Asian range (CPC, 2000 *listing* Chile and Paraguay as areas of recent establishment by propagative material from Western Europe). This is rated high.	3
Contact with Host Material Movement of infected fruits or nursery stock could introduce this pathogen into new areas (Chang, 1986). Mycelia and spores may survive for a long time in infected fruits after disposal. Disposal of exposed material near agricultural areas, or unmanaged ecosystems, could open pathways to other crops or hosts. Because of wind and spore-splash dispersal (Agrios, 1997; CPC, 2003b) infected material may infect neighboring plants.	3
Likelihood of Introduction Risk Rating	18 High
Pest Risk Potential = Likelihood of Introduction Rating + Consequences of Introduction Risk Rating	33 High

Ostrinia furnacalis	
Consequences of Introduction	**Risk Rating**
Climate/Host Interaction This species occurs in the subtropics and tropics (CPC, 2002) corresponding to over four USDA Plant Hardiness Zones of the United States (7b – 11) (ARS, 1990).	3
Host Range The pest feeds mainly on grasses, but can also attack *Artemesia* and other plant families (CPC, 2002).	3
Dispersal Potential Typical for pest pyralids, this pest can be widely dispersed by flight in its adult stage (Metcalf *et al*., 1962). Larvae may also be spread in fruits (CPC, 2002). Females may lay up to 600 eggs, and several generations may occur annually (CPC, 2003a).	3
Economic Impact Up to 30% yield loss in maize in the Philippines was attributed to this pest, although in most areas the loss was closer to 5% (CPC, 2002). Losses include yield, quality, or quarantine.	3
Environmental Impact The pest feeds on *Polygonum, Coix, Artemisia, Setaria, Zingiber*, *etc*. (CPC, 2002; NPQS, 2000). The above genera do not contain endangered species that may be at risk in the PRA area, but there are numerous species of grasses that are endangered in the PRA area (*e.g.*, *Xyris tennesseensis, Zizania texana*) that may be at risk (50 CFR 1 17.12, 2001). Outbreaks in crops in the PRA area may be expected to trigger chemical treatments.	3
Consequences of Introduction Risk Rating	15 High

Ostrinia furnacalis	
Likelihood of Introduction	**Risk Rating**
Quantity Annually Imported Korea plans to export about 600 40-ft container loads in aggregate per year (Park, 2002).	3
Survive Post-harvest Treatment There are no mandatory post-harvest treatments; surface treatments are unlikely to affect larvae in fruits.	3
Survive Shipment Fruits are likely to be shipped under environmental conditions favorable for the survival of the pest, as well as commodity preservation (Park, 2002).	3
Not Detected at Port-of-entry Some entrance holes on the outside of fruits may be detected by visual inspection. Other entrance holes, under calyces, and larvae in fruits will be more difficult to detect (CPC, 2002).	2
Moved to Suitable Habitat The pest may infect numerous hosts that range over the climate zones 7-11 (CPC, 2002).	3
Contact with Host Material Due to the broad host range (Carter, 1984; Zhang, 1994), there is likely to be agricultural or non-crop host material near most ports-of-entry.	3
Likelihood of Introduction Risk Rating	17 High
Pest Risk Potential = Likelihood of Introduction Rating + Consequences of Introduction Risk Rating	32 High

***Ralstonia solanacearum* race 3**	
Consequences of Introduction	**Risk Rating**
Climate/Host Interaction *R. solanacearum* race 3 is widely distributed thoughout Europe, Asia, Central America and the Caribbean (CPC, 2003b). Cultivated host species of *R. solanacearum* race 3, such as *Capsicum* spp, are grown in more than six plant hardiness zones of the United States (NASS, 2002; NRCS, 2002). The climatic conditions and host range are suitable for the survival and establishment of this pest in at least 4 Plant Hardiness Zones of the United States (ARS, 1990).	3
Host Range The natural host range of *R. solanacearum* race 3 includes both solanaceous crops and weeds, as well as non-solanaceous host plants (CPC, 2003b; Denny and Hayward, 2001; Janse *et al*., In press): Chenopodiaceae: *Chenopodium* spp., *Melampodium perfoliatum* (perfoliate blackfoot) Cruciferae: *Brassica rapa* (bird rape, field mustard, turnip) Cucurbitaceae: *Mormordica chararantia* (bitter gourd) Geraniaceae: *Pelargonium zonale* (=*P*. x *hortorum*) (geranium) Lamiaceae: *Salvia reflexa* (lanceleaf sage) Leguminosae: *Phaseolus vulgaris* (garden bean) Portulacaceae: *Portulaca oleracea* (common purlane) Solanaceae: *Capsicum annuum* (pepper), *Cyphomandra betaceae* (tree tomato) *Lycopersicon esculentum* (tomato), *Physalis angulata* (cutleaf groundcherry),*Solanum cinereum* (Narrawa burr), *S. dulcamara* (bittersweet nightshade), *S. melongena* (eggplant), *S. nigrum* (black nightshade), *S. tuberosum* (potato). Natural latent hosts of *R. solanacearum* race 3 include (Janse *et al*., 2003): Capparadidaceae: *Cleome monophylla* Compositae: *Galinsoga ciliata* (shaggy-soldier) Solanaceae: *Nicotiana glutinosa* (tobacco), *N. rustica*(Aztec tobacco), *Solanum sisymbriifolium* (sticky nightshade) Polygonaceae: *Polygonum capitatum* (pinkhead smartweed) Urticacea: *Urtica dioica* (stinging nettle) Compositae: *Zinnia elegans* (garden zinnia)	3

Dispersal Potential *Ralstonia solanacearum* can be transmitted through soil, contaminated irrigation water, equipment, or personnel. It may also be spread by transplanting and propagating infected plants, cutting infected portions of plants and moving to the next plant without disinfecting cutting blades, and particularly in contaminated subirrigation water (USDA 2003a). The pathogen does not readlily spread from plant-to-plant through the splashing of water, causal contact or aerially (USDA, 2003a). Because infected fruit and other plant parts may be transported long distances, long distance dispersal may occur (CPC, 2003b) and systemically infected seed may be dispersed into the environment (Bradbury, 1986; CPC, 2003b). *R. solanacearum* may survive in soil for relatively short periods of time (Sequeira, 1994). Long term survival in perennial hosts, followed by surface water dispersal is the most likely dispersal strategy for the bacterium (Olsson, 1976).	2
Economic Impact *Ralstonia solanacearum* race 3 causes high yield loss in infected hosts, including several valuable agricultural crops and ornamental species (USDA, 2003a). *R. solanacearum* on potato has been described as one of the world's most destructive plant bacterial diseases. It may affect up to 3.75 milllion acres of potatoes in more than 80 countries, with estimated annual losses of more than $950 million (DEFRA, 2003). Financial losses to the US geranium industry in 2003 were significant (USDA, 2003b). The loss of world markets due to *R. solanacearum* race 3, biovar 2 status as a Select Agent (USDA, 2003a) would have a major negative economic impact.	3
Environmental Impact Several member of both cultivated and wild Solanaceae are affected by this bacterial pathogen. Solanaceous plants in three genera, *Goetzea elegans, Nothocestrum breviflorum, N. peltatum, Solanum drymophilum, S. incompletum* and *S. sandwicense* are potential host of *M. frucigena* and are considered T & E species (50 CFR § 17.11-12). Populations of the aforementioned T & E species may be at risk if this fungal disease enters and becomes established in the United States. Adverse effects to hosts found in mesic to wet habitats could cause negative impacts to watershed function and riparian corridors. Chemical control programs for these pests will be needed if pest populations become established; such programs are not feasible or economically practicable outside of managed agroecosystems.	3
Consequences of Introduction Risk Rating	14 High

Ralstonia solanacearum race 3	
Likelihood of Introduction (See ADDENDUM p. 90 for conclusive analysis of entry and establishment)	**Risk Rating**
Quantity Annually Imported Korea plans to export about 600 40-ft container loads in aggregate per year (Park, 2002).	3
Survive Post-harvest Treatment There are no mandatory post-harvest treatments likely to affect the pest in fruits.	3
Survive Shipment This bacterium has been shown to survive long distances transport to the United States within infected geranium cuttings from Kenya and Guatemala (USDA, 2003a).	3
Not Detected at Port-of-entry Because asymptomatic fruit may harbor latent infections (when the host is infected, but does not yet show symptoms), the bacterium may escape detection (Kaplan, 2003). No port-of-entry detection method has been found to be effective for geranium cuttings.	3
Moved to Suitable Habitat Since the early 1990's, evidence has been accumulating that *R. solanacearum* race 3, biovar 2 may have established itself in the ecosystems of several European countries (Van Elsas *et al*., 2000). This pathogen has long been thought to be adapted to tropical climates, however, recent outbreaks of potato brown rot in the temperate climates of western Europe have also been attributed to *R. solanacearum* race 3, biovar 2 (Janse, 1996). *Ralstonia solanacearum* race 3 may infect several major commercial hosts (potato, tomato, pepper, geranium) that range over most of the United States in field or greenhouse locations (CPC, 2003b). The bacterium is also known to infect numerous weed hosts in which it can survive season to season until cultivated crops or ornamental hosts become available (Janse *et al*., In press).	3
Contact with Host Material Disposal of exposed host material near agricultural areas, greenhouses, or unmanaged ecosystems could open pathway(s) to other crops, such as cultivated potato, tomato, and pepper or weed hosts. Survival of *R. solanacearum* race 3, biovar 2 in the soil for long periods of time in the absence of host plants can be attributed to its association with plant debris or with several weed hosts which are symptomless carriers (Hayward, 1991); or due to it's ability to enter a dormant-like "viable but not culturable" state, like many soil microbes (Grey and Steck, 2001). In geranium production, ebb and flow irrigation systems in greenhouses are conducive to disease (NAPPO, 2001). The main path for international spread is by latently infected plant parts. *Ralstonia* can easily be spread by water in field and greenhouse settings (Daughtry, 2003).	3

Likelihood of Introduction Risk Rating	18 High
Pest Risk Potential = Likelihood of Introduction Rating + Consequences of Introduction Risk Rating	32 High

Scirtothrips dorsalis	
Consequences of Introduction	**Risk Rating**
Climate/Host Interaction The distribution of *S. dorsalis* is largely subtropical to tropical, although its occurrence in Korea and Honshu, Japan suggests that it can survive in cold temperate regions. Its range extends in Asia from Pakistan to Japan, south to the Philippines, and through parts of Melanesia to Australia (CPC, 2002). The pest has a restricted distribution in Africa. It is conservatively estimated that *S. dorsalis* could become established in the United States' Plant Hardiness Zones 8-11 (ARS, 1990).	3
Host Range *Scirtothrips dorsalis* has been recorded on hosts in several families, including *Allium cepa* (Liliaceae), *Mangifera indica* (Anacardiaceae), *Arachis hypogaea* (Fabaceae), *Camellia sinensis* (Theaceae), *Citrus* spp. (Rutaceae), *Gossypium* sp. (Malvaceae), *Lycopersicon esculentum* (Solanaceae), *Ricinus communis* (Euphorbiaceae), *Nelumbo* sp. (Nelumbonaceae), *Vitis vinifera* (Vitaceae) (CPC, 2002).	3
Dispersal Potential Fecundity ranges from 40-68 eggs per female; a female:male sex ratio of 6:1 has been reported (CPC, 2002). The potential of *Scirtothrips* spp. for natural spread appears to be limited (EPPO, 1997). In international trade, *S. dorsalis* could be carried on plant materials; however, interceptions have been rare. For example, over the last 13 years, the species has been intercepted at U.S. ports on only 43 occasions (PIN 309, 2003).	1
Economic Impact In chili pepper, heavy infestation causes premature leaf drop; yield losses of 25-55% may occur (CPC, 2002). In India, the thrips is routinely controlled on this crop with various insecticides, which increases production costs. As *S. dorsalis* is listed as an A1 quarantine pest for Europe (EPPO, 1997), its establishment in the United States could result in the loss of foreign markets for various agricultural commodities.	3
Environmental Impact This pest has the potential to attack vulnerable native plants in the United States, such as *Allium munzii* and *Ziziphus celata*. Its introduction could spur the initiation of biological control programs.	3
Consequences of Introduction Risk Rating	13 High

Scirtothrips dorsalis	
Likelihood of Introduction	**Risk Rating**
Quantity Annually Imported Korea plans to export about 600 40-ft container loads in aggregate per year (Park, 2002).	3
Survive Post-harvest Treatment There are no mandatory post-harvest treatments; handling is unlikely to affect stages under calyces.	3
Survive Shipment Fruits are likely to be shipped under environmental conditions favorable for the survival of the pest, as well as commodity preservation (Park, 2002).	3
Not Detected at Port-of-entry Adults and damage would be likely to be detected externally, but hidden stages under calyces would be likely to go undetected (CPC, 2002).	2
Moved to Suitable Habitat This pest may infect numerous hosts that occur over most of the warmer parts of the United States.	2
Contact with Host Material Due to the broad host range, there is likely to be agricultural or non-crop host material near most ports-of-entry.	3
Likelihood of Introduction Risk Rating	16 High
Pest Risk Potential = Likelihood of Introduction Rating + Consequences of Introduction Risk Rating	29 High

Spodoptera litura	
Consequences of Introduction	**Risk Rating**
Climate/Host Interaction This species is widely distributed over several subtropical and tropical countries (EPPO, 1997) corresponding to four Plant Hardiness Zones of the PRA area (8 – 11) (ARS, 1990).	3
Host Range The pest uses hosts representing at least six families, including Rosaceae, Solanaceae, Compositae, and Fabaceae (CABI/EPPO, 1998).	3
Dispersal Potential Adults can fly about 2 km in 4 hours. Larvae may be spread while in fruits (CABI/EPPO, 1998). Fecundity may be as high as 2,600 eggs per female, with up to 12 generations annually (CPC, 2003a).	3
Economic Impact In India, crop yield loss was estimated at over 40% due to this pest. In Japanese greenhouses, a 10% yield loss in peppers was found (CABI/EPPO, 1998). Similar losses may be expected on crops in the PRA area. EPPO (1997) records this as an A1 pest; as a result, its establishment in the United States may lead to the loss of export markets.	3
Environmental Impact Hosts include species of *Coccinea, Vigna, Ricinus, Citrus, Colocasia, Leucaena, Trifolium, etc*. (CABI/EPPO, 1998; Zhang, 1994). The above genera include four endangered species in the PRA area (50 CFR 1 17.12, 2001). Outbreaks in crops in the PRA area would likely trigger increased chemical control programs similar to those now in effect for other caterpillars.	3
Consequences of Introduction Risk Rating	15 High

Spodoptera litura	
Likelihood of Introduction	**Risk Rating**
Quantity Annually Imported Korea plans to export about 600 40-ft container loads in aggregate per year (Park, 2002).	3
Survive Post-harvest Treatment There are no mandatory post-harvest treatments; surface treatments are unlikely to affect larvae in fruits.	3
Survive Shipment Fruits are likely to be shipped under environmental conditions favorable for survival of the pest, as well as commodity preservation (Park, 2002).	3
Not Detected at Port-of-entry Some entrance holes on the outside of fruits may be detected by visual inspection. Other entrance holes, under calyces, and larvae in fruits will be more difficult to detect (CPC, 2002).	2
Moved to Suitable Habitat The pest may infest numerous hosts that range over a large portion of the United States (CPC, 2002).	3
Contact with Host Material Due to the broad host range (Carter, 1984; Zhang, 1994), there is likely to be agricultural or non-crop host material near most ports-of-entry for the pest to spread into.	3
Likelihood of Introduction Risk Rating	17 High
Pest Risk Potential = Likelihood of Introduction Rating + Consequences of Introduction Risk Rating	32 High

Thrips palmi	
Consequences of Introduction	**Risk Rating**
Climate/Host Interaction *Thrips palmi* is subtropical to tropical in distribution; populations in temperate climates are able to overwinter in greenhouses or other artificial situations (CPC, 2002). This thrips occurs in Asia, from Pakistan to Indonesia, in parts of the tropical Pacific and Africa, and, most recently, in the Caribbean and northern South America. It is estimated that the species could establish permanent populations only in the southern United States, in areas corresponding to Plant Hardiness Zones 9-11.	2
Host Range Among primary hosts are species of Cucurbitaceae and Solanaceae, including *Cucurbita pepo* and *Solanum melongena*. The thrips also has been recorded on *Allium cepa* (Liliaceae), *Helianthus annuus* (Asteraceae), *Citrus* spp. (Rutaceae), *Glycine max* (Fabaceae), *Gossypium* sp. (Malvaceae), *Mangifera indica* (Anacardiaceae), *Oryza sativa* (Poaceae), *Persea americana* (Lauraceae), and *Sesamum indicum* (Pedaliaceae) (CPC, 2002).	3
Dispersal Potential Fecundity may exceed 200 eggs per female. Originally restricted to South and Southeast Asia, over the past 25 years, *T. palmi* has spread rapidly to Australia, Africa, and the western hemisphere (CPC, 2002). The species has been intercepted over 8,100 times at US ports during the last 20 years (PIN 309, 2003); this pest exhibits high reproductive and dispersal capacities.	3
Economic Impact *Thrips palmi* is a serious pest of cucurbits and eggplant. Losses of 50-90% in these crops have been reported (CPC, 2002). The species is a vector of tomato spotted wilt tospovirus (CPC, 2002). As it is listed as an A1 quarantine pest for Europe (EPPO, 1997), its establishment in the United States could result in the loss of foreign markets for various agricultural commodities.	3
Environmental Impact This pest has the potential to attack plants listed as Endangered or Threatened in the United States (*e.g., Allium munzii*, *Cucurbita okeechobeensis* ssp. *okeechobeensis*, *Helianthus* spp., *Solanum* spp.).	2
Consequences of Introduction Risk Rating	13 High

Thrips palmi	
Likelihood of Introduction	**Risk Rating**
Quantity Annually Imported Korea plans to export about 600 40-ft container loads in aggregate per year (Park, 2002).	3
Survive Post-harvest Treatment There are no mandatory post-harvest treatments; surface treatments are unlikely to affect most stages on fruits.	2
Survive Shipment Fruits are likely to be shipped under favorable environmental conditions, although the conditions are not optimum for the survival of the pest, as well as commodity preservation (Park, 2002).	2
Not Detected at Port-of-entry Large infestations are likely to be detected, but small ones under calyces will likely to go unnoticed (CPC, 2002).	2
Moved to Suitable Habitat The pest infests hosts that range over the warmer parts of the United States (CPC, 2002).	2
Contact with Host Material Due to the broad host range, there is likely to be agricultural or non-crop host material in fields and greenhouses near most ports-of-entry for the pest to spread into.	3
Likelihood of Introduction Risk Rating	14 Medium
Pest Risk Potential = Likelihood of Introduction Rating + Consequences of Introduction Risk Rating	27 High

Table 6. Baseline Pest Risk Potential for Pepper Pests from Republic of Korea			
Pest	**Consequences of Introduction**	**Likelihood of Introduction**	**Pest Risk Potential**
Agrotis segetum	High (15)	High (17)	High (32)
Helicoverpa armigera	High (15)	High (17)	High (32)
Helicoverpa assulta	High (15)	High (17)	High (32)
Mamestra brassicae	High (15)	High (17)	High (32)
Monilinia fructigena	High (15)	High (18)	High (33)
Ostrinia furnacalis	High (15)	High (17)	High (32)
Ralstonia solanacearum race 3	High (14)	High (18)*	High (32)
Scirtothrips dorsalis	High (13)	High (16)	High (29)
Spodoptera litura	High (15)	High (17)	High (32)
Thrips palmi	High (13)	High (14)	High (27)

***See Addendum p. 90 for conclusive analysis of entry and establishment. This pathogen has low likelihood of establishment.**

G. Conclusions

Port-of-entry inspection is not considered sufficient to provide phytosanitary security against the identified high risk pests, and specific phytosanitary measures are strongly recommended. Identification and selection of appropriate phytosanitary measures to mitigate the risk of pests with high pest risk potential ratings is undertaken as part of the risk management phase, and is not finalized in this document. The appropriate risk management strategy for a particular pest depends on the appropriate level of protection decided upon. *Chilli veinal mottle virus* and *Ralstonia solanacearum* Race 3 can enter but are not likely to remain in the pathway of establishment. Therefore, mitigation will not be required for *Chilli veinal mottle virus*. Measures for *Ralstonia solanacearum* Race 3 are discussed in the Addendum on p. 76.

The Treatment Manual (PPQ, 2002) lists post-harvest methyl bromide treatment which could be an option for mitigating some of the above pests. Post-harvest measures, including brushing and washing, could reduce risk of surface pests. Inspection and culling processes could reduce the risk of exporting internal borers, thrips under calyces, and fruits with visible disease symptoms. These and other methods are reported by Vierbergen (1995).

The following are suggestions for pre-harvest mitigations that may be considered. Because the commodity is supposed to originate from hydroponic, soil-less greenhouse production, most of the high risk insect pests can be excluded from the greenhouse with screening, proper doors, monitoring, hygienic measures, and eradication measures including pesticides (Roosjen *et al.*, 1999) or biocontrol (Jacobson, 1995; 1997). Thrips, especially *Thrips palmi*, are a major pest of quarantine concern in this system. This concern is relevent because the thrips sometimes thrive under greenhouse conditions, and, because they can pass through screens of larger mesh than 0.35x0.35 mm (Roosjen *et al*., 1999), they are then difficult to detect. Their small size and their likelihood to hide under the calyces of harvested fruit also make them difficult to detect, remove, or treat. Monitoring the crop for pests, especially thrips, by sticky trapping (yellow and blue) may be a useful component of the mitigation system (Shipp, 1995; Roosjen *et al*., 1999). Appropriate systemic pesticides introduced into the medium have been effective in eradicating thrips from plants (Roosjen *et al*., 1999). The introduction of pest-free stock could reduce the risk of disease transmission and insect introduction into the greenhouses (Roosjen *et al*., 1999).

III. LITERATURE CITED

Abrams, L. 1940. Illustrated flora of the Pacific states. Stanford University Press, Stanford, California. 2039 pp.

Agrios, G.N. 1978. Plant pathology. 2nd Edition. Academic Press, San Diego, California. 703 pp.

Agrios, G.N. 1997. Plant pathology, 4th Edition. Academic Press, San Diego, California. 635 pp.

Ahn, K.-S., Lee, K.-Y., Choi, M.-H., Kim, J.-W., and Kim, G.H. 2001. Effect of temperature and host plant on development and reproduction of the sweetpotato whitefly, *Bemisia tabaci* (Homoptera: Aleyrodidae). Korean Journal of Applied Entomology 40: 203-209.

Alfieri, S.A., Jr, Langdon, K.R., Kimbrough, J.W., El-Gholl, N.E., and Wehlburg, C. 1994. Diseases and disorders of plants in Florida. Florida Dept. of Agric. and Consumer Serv., Div. of Plant Industry, Gainesville, Florida. 1114 pp.

Anonymous. 1972. A list of plant diseases, insect pests, and weeds in Korea. The Korean Society of Plant Protection. 424 pp.

Anonymous. 1986. A List of Plant Diseases, Insect Pests, and Weeds in Korea. The Korean Society of Plant Protection. 633 pp.

Anonymous. 1997. California Pest List. Pepper list supplied by the California Department of Agriculture. (On file with USDA-APHIS-PPQ).

Anonymous. 1998. List of Plant Diseases in Korea. 3rd Edition. Korean Society of Plant Pathology. 436 pp

Arnett, Jr., R.H. 1997. American insects. Sandhill Crane Press, Gainesville. 850 pp.

ARS. 1990. USDA plant hardiness zone map. USDA, Agric. Research Serv. Misc. Publ. No. 1475. Washington, DC. <http://usna.usda.gov/Hardzone/ushzmap.html>, *Last accessed*, 6 August 2003.

ARS. 2001a. GRIN. Online Database. USDA-ARS, National Genetic Resources Program, Germplasm Resources Information Network. Washington, DC. <http://ars-grin.gov/cgi-bin/npgs/html/rare.pl> *Last accessed*, 6 August 2003.

ARS. 2001b. U.S. National Fungus Collections. Systematic Botany and Mycology Laboratory, Fungal Databases. USDA, Agricultural Research Service, Beltsville, MD.

<http://nt.ars-grin.gov/fungaldatabases/databaseframe.cfm> *Last accessed*, 1 June 2002.

Batra, L.R. 1991. World species of *Monilinia* (fungi) their ecology, biosystematics, and control. Mycologia Memoir No. 16. J. Cramer, Delaware. 246 pp.

Bailey, L.H. and Bailey, E.Z. (Revised by L.H. Bailey, Hortorium staff). 1976. Hortus 3rd. Macmillan General Reference, NY. 1290 pp.

Ben-Dov, Y. 1993. A systematic catalogue of the soft scale insects of the world. Flora and Fauna Handbook 9. Sandhill Crane Press, Gainesville. 536 pp.

Berrie, A.M. 1993. Progress towards integrated control of post-harvest rots of cox apples in the United Kingdom. Acta Horticulturae, 347: 107-114.

Black, L.L, Green, S.K., Hartman, G.L., and Poulos, J.M. 1991. Pepper Diseases: A Field Guide. Asian Vegetable Research and Development Center, AVRDC Publication No. 91-347. Taipei, Taiwan. 98 pp.

Blackman, R.L. and Eastop, V.F. 1994. Aphids on the world's trees. CABI, Wallingford. 987 pp.

Blackman, R.L. and Eastop, V.F. 2000. Aphids on the world's crops. John Wiley and Sons, West Sussex, England. 466 pp.

Bolland, H.R.,Guitierrez, J., and Flechtmann, C.H.W. 1998. World catalogue of the spider mite family (Acari: Tetranychidae). Brill, Leiden. 392 pp.

Bradbury, J.F. 1986. Guide to Plant Pathogenic Bacteria. CAB International Mycological Institute. Kew, Surrey, England. 332 pp.

Brunt, A.A., Crabtree, K., Dallwitz, M.J., Gibbs, A.J., Watson, L., and Zurcher, E.J. 2002. Plant Viruses Online: Descriptions and Lists from the VIDE Database. Version: 20th August 1996. < http://biology.anu.edu.au/Groups/MES/vide/> *Last accessed*, 6 August 2003.

Byrde, R.J.W. and Willets, H.J. 1977. The brown rot fungi of fruit: their biology and control. Pergamon Press, New York, New York.

CAB. 2001. Dictonary of the Fungi. 9th Edition. Online Database. <http:/1194.131.255.3/cabipages/Names/fundic.asp> *Last accessed*, 15 August 2003.

CABI/EPPO. 1998. Distribution maps of quarantine pests for Europe. CABI, Wallingford, United Kingdom. 353 maps, index.

Carter, D.J. 1984. Pest Lepidoptera of Europe. Junk, Dordrecht. 431 pp.

Chang, L.W.H. 1986. Fruit brown rot. PNKTO Pests not known to occur in the United States or of limited distribution No. 76, 81-49. USDA-APHIS-PPQ, Hyattsville, MD, 14 pp.

Choi, Y.E., 1981. The root-knot nematodes, *Meloidogyne* spp., in Korea. Proceedings of the 3rd Research Planning Conference on root-knot nematodes, *Meloidogyne* spp., Region VI, 20-24 July 1981, Jakarta, Indonesia. Raleigh, NC USA: North Carolina State University, 20-30.

Chung, B.K. and Chang, S.H. 1984. An etiological study on the anthracnose fungus of pepper caused by *Colletotrichum dematium* in Korea. Korean J. Mycol. 12: 153-157.

CIE. 1963. Distribution map 174, *Aphis fabae*. CIE, London. 2 pp.

CIE. 1968. Distribution map 18, *Aphis gossypii*. CIE, London. 3 pp.

CIE. 1969. Distribution map 256, *Aphis spiraecola*. CIE, London. 2 pp.

CIE. 1986. Distribution map 284, *Bemisia tabaci*. CIE, London. 3 pp.

CIE. 1986a. Distribution map 191, *Polyphagotarsonemus latus*. CIE, London. 3 pp.

CIE. 1986b. Distribution map 475, *Scirtothrips dorsalis*. CIE, London. 2 pp.

CIE. 1988. Distribution map 58, *Pseudalacaspis pentagona*. CIE, London. 3 pp.

Courneya, P. 2003. Personal communication (August 4, 2003) from P. Courneya, USDA-APHIS-PPQ-NIS-PIN 309 database, to L. Millar, USDA-APHIS-PPQ-CPHST-PERAL (Subject: Organisms currently in PIN 309 as reportable will continue to maintain quarantine status until USDA develops procedures for official control of pests with limited distributions in the United States. On file with USDA-APHIS-PPQ-CPHST-PERAL).

CPC. 2000. Crop Protection Compendium. Commonwealth Agricultural Bureau International. Wallingford, United Kingdom. Computer online database.

CPC. 2002. Crop Protection Compendium. Commonwealth Agricultural Bureau International. Wallingford, United Kingdom. CD database.

CPC. 2003a. Crop Protection Compendium. Commonwealth Agricultural Bureau International. Wallingford, United Kingdom. CD database.

CPC. 2003b. Crop Protection Compendium. Commonwealth Agricultural Bureau International. Wallingford, United Kingdom. Online database.

Daughtry, M. 2003. Southern bacterial wilt, caused by *Ralstonia solanacearum*. Fact Sheet. Available from the author at Cornell University, Long Island Horticultural Research & Extension Center, Riverhead, NY .

DEFRA. 2003. Department for Environment, Food and Rural Affairs. United Kingdom. Plant Pathology.<http: www.defra.gov.uk/planth>, *Last accessed*, 15 March 2003.

Denny, T.P. and Hayward, A.C. 2001. *Ralstonia* :151-174. In Schadd, N.W. Laboratory guide for the identification of plant pathogenic bacteria, 3rd edition. APS Press, St. Paul, Minnesota. 373 pp.

Dixon, W.N., Schubert, T.S., Thomas, M.C., and Lehman, P.S. 1995. Pest Circular. Bureau of Entomology, Nematology, Botany, and Plant Pathology. Division of Plant Industry. Florida Department of Agriculture and Consumer Services, Gainesville, Florida. 3pp.

EPPO. 1997. Quarantine pests for Europe. CAB International, Wallingford. 1425 pp.

Euzéby, J.P. 2002. List of bacterial names with standing in nomenclature. <http://www.bacteriio.cict.fr/introduction.html> *Last accessed*, 6 August 2003.

FAO. 1996. International Standards for Phytosanitary Measures. Section 1 - Import Regulations. Guidelines for Pest Risk Analysis. Secretariat of the International Plant Protection Convention of the Food and Agriculture Organization of the United Nations. Rome, Italy. <http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGP/AGPP/PQ/En/Publ/ISPM/ispms.htm> *Last accessed*, 27 Febuary 2002.

FAO. 1999. International Standards for Phytosanitary Measures. Glossary of Phytosanitary Terms, Publication No. 5. UN-FAO-IPPC, Italy.

Farr, D.F., Bills, G.F., Chamuris, G.P. and, Rossman, A.Y. 1989. Fungi on Plants and Plant Products in the United States. American Phytopathological Society, St. Paul, MN. 1252 pp.

FLEPPC. 2001. List of Florida's Invasive Species. Florida Exotic Pest Plant Council. <http://www.fleppc.org/01list.htm> *Last accessed*, 6 December 2001.

Godfrey, L. D. and Haviland, D.R. 2003. Potato tuberworm. University of California pest management guidelines 3463.<www.ipm.ucdavis.edu> *Last accessed*, 10 July 2003.

Grey, B.E. and Steck, T.R. 2001. The Viable but Nonculturable State of *Ralstonia solanacearum* May be Involved in Long-term Survival and Plant Infection. Appl. Environ. Microbiol. 67, 3866-3872.

Griesbach, R. 2003. Personal Communication from Rob Griesbach, Ph.D. Genetics, Floral and Nursery Plants Research, U.S. National Arboretum,USDA, ARS, Beltsville, MD to Lynn Evans-Goldner, Plant Pathologist/Assistant Staff Officer, Pest Detection and Management Programs, USDA, APHIS, PPQ. (Subject: Ornamental pepper production in the United States. On file with USDA-APHIS-PPQ-PDMP).

Gunn, C.R. and Ritchie, C.A. 1982. 1982 Report of the Technical Committee to Evaluate Noxious Weeds; Exotic Weeds for the Federal Noxious Weed Act. (unpublished). 335 pp.

Hahm Y.I., Kwon M., Kim J.S., Seo H.W., and Ahn, J.H. 1988. Surveys on disease occurrence in major horticultural crops in Kangwon alpine areas. Korean Journal of Plant Pathology, 14(6):668-675.

Harlow, W.M., Harrar, E.S., Hardin, J.W., and White, F.M. 1996. Textbook of dendrology. McGraw-Hill, Inc, NY. 534 pp.

Hayward, A.C. 1991. Biology and epidemiology of bacterial wilt caused by *Pseudomonas solanacearum*. Annual Rev. Phytopathology 29:65-87.

Hickman, J.C. (ed). 1993. Jepson manual, higher plants of California. Univ. of California Press, Berkeley, CA. 1400 pp.

Hill, D. S. 1993. Agricultural insect pests of the tropics and their control. Cambridge University Press, United Kingdom. 746 pp.

Holliday, P. 1980. Fungus Diseases of Tropical Crops. Cambridge University Press, Cambridge, England. 607 pp.

Holm, L.G., Pancho, J.V., Herberger, J.P., and Plucknett, D.L. 1991a. A Geographical Atlas of World Weeds. Krieger Publishing, Malabar. 391pp.

Holm, L.G., Plucknett, D.L., Pancho, J.V., and Herberger, J.P. 1991b. World's worst weeds: distribution and biology. Krieger Publishing, Malabar. 609 pp.

Hong, I.-S. 1993. Letter and pest list from Director General Hong of Korea NPQS to PPQ Deputy Administrator Lee. Unpublished. 3 pp. (On file with USDA-APHIS-PPQ-CPHST-PERAL).

Hwang, B.K. and Kim, C.H. 1995. *Phytophthora* blight of pepper and its control in Korea. Pl. Dis. 79:221-227.

Jacobson, R.J. 1995. Resources to implement biological control in greenhouses : 211-219. In Parker, B. L., Skinner, M. and T. Lewis (eds.). Thrips biology and management. Plenum, New York, New York. 636 pp.

Jacobson, R.J. 1997. Integrated pest management (IPM) in glasshouses : 639-670. In Lewis, T. (ed.). Thrips as crop pests. CABI, Wallingford, United Kingdom. 740 pp.

Janse, J.D. 1996. Potato Brown Rot in Western Europe – History, Present Occurrence and some remarks on Possible Origin, Epidemiology and Control Strategies. Bull. OEPP, 26, 679-695.

Janse, J.D., Van Den Beld, H.E., Elphinstone, J., Simpkins, S., Tijoi-Tam-Sin, N., and A.Van Vaerenbergh. In press. Introduction to Europe of *Ralstonia solanacearum* biovar 2/race 3 in *Pelargonium zonale* Cuttings. American Phytopathological Society.

Kang, I. 2000. Letter from Nonghyup America, Inc. to D. Knott of PPQ. Unpublished. 1 pp. (On file with USDA-APHIS-PPQ-CPHST-PERAL).

Kang, I. 2002. Personal Communication Inho Kang, Manager, Export Office, Nonghyup, The National Agricultural Cooperative Federation, Korea to Lynn Evans-Goldner, Plant Pathologist, USDA, APHIS, PPQ. (Subject: Confirmation of scientific name of Sweet pepper for export to the United States from Korea. On file with USDA APHIS-PPQ-PDMP).

Kang, S.W., Kwon, J.H., Kim, D.K., and Kim H.K. 1997. New epidemic of crown gall on sweet pepper (*Capsicum annuum* L. var. *grossum* Bailey) in greenhouse. Korean Journal of Plant Pathology, Vol. 13, No. 5, pp. 367-369.

Kaplan, D. 2003. Personal communication with Dr. David Kaplan, plant pathologist, National Science Program Leader, USDA-APHIS-PPQ-CPHST. Member of USDA *Ralstonia* Response Team and major contributor to USDA-APHIS *Ralstonia* Action Plan.

Kim, B.S., Park, H.K., and Lee, W.S. 1989. Resistance to anthracnose (*Colletotrichum* spp.) in pepper. Tomato and pepper production in the tropics. Proceedings of the international symposium on integrated management practices, Tainan, Taiwan, 21-26 March 1988., 184-199; [AVRDC Publication No. 89-317].

Kim, J.H., Choi, G.S. and Choi, J.Y. 2002. Characterization of cucumber mosaic virus subgroup II isolated from paprika (*Capsicum annuum* var. *grossum*) in Korea. Plant Pathology Journal, Vol. 18, No. 1, pp. 6-11.

Kim, J.S., Kim, S.K., Lee, S.H., and Lee. M.W. 1990. A pepper vein chlorosis virus causing stem necrosis and vein chlorosis on red pepper in Korea. Korean J. Plant Pathol. 6(3): 376-381.

Kim, W.G. and Cho, W.D. 1996. Developmental characteristics of grey mold in pepper. RDA Journal of Agricultural Science, Crop Protection, Vol. 38, No. 1, pp. 466-472.

Kranz, J., Schmutterer, H., and Koch, W. (eds.) 1977. Diseases, Pests and Weeds in Tropical Crops. John Wiley and Sons, New York, New York.

KSPP (Korean Society of Plant Protection). 1972. A list of plant diseases, insect pests, and weeds in Korea. Korean Society of Plant Protection. 424 pp.

Kwon, J.H., Kang, S.W., Kim, J.S., and Park, C.S. 2001. First report of Corynespora leaf spot in pepper caused by *Corynespora cassicola* in Korea. Plant Pathology Journal, Vol. 17, No.3, pp. 180-183.

Lewis, T. 1997. Thrips as crop pests. CABI, Wallingford. 740 pp.

Martin, J.L. and Mau, R.F.L. 1992. *Thrips palmi* (Karny). <http://www.extento.hawaii.edu/kbase/crop/Type/t_palmi.htm> *Last accessed*, 8 July 2003.

Matthews, C., Cockrell, P. and Aerts, M. 1999. USDA Crop Profile Florida Peppers. <http://pestdata.ncsu.edu/cropprofiles/docs/FLpeppers-bell.html> *Last accessed*, 1 December 2003.

Mau, R.F.L. and Messing, J.L.M. 1991. *Chrysodeixis eriosoma* <www.extento.hawaii.edu> *Last accessed*, 17 July 2003.

Metcalf, C.L. , Flint, W.P., and Metcalf, R.L. 1962. Destructive and useful insects. McGraw-Hill Book Co., New York, New York. 1087 pp.

Mound, L.A. and Halsey, S.H. 1978. Whitefly of the world. John Wiley and Sons, Chichester, United Kingdom. 340 pp.

Nakahara, S. 1982. Checklist of the armored scales (Homoptera: Diaspididae) of the conterminous United States. USDA-APHIS-PPQ, government Printing Office, Washington. 110 pp.

Nakahara, S. 1994. The genus *Thrips* Linnaeus (Thysanoptera: Thripidae) of the New World. USDA-ARS Technical Bulletin 1822. 183 pp.

NAPPO 2001. *Ralstonia* (*Pseudomonas*) *solanacearum* (E.F. Smith, 1896) Yabuuchi et al., 1995 race 3, biovar 2. Phytosanitary Alert System. <http: www. Pestalert.org> *Last accessed,* 15 March 2003.

NASS (National Agricultural Statistics Service). 2002. Agricultural statistics. USDA, Washington.

NASS. 2003. Agricultural statistics. USDA, Washington. <http://www.usda.gov/nass/> *Last accessed,* 28 November 2003.

Navajas, M.; Gutierrez, J.; Lagnel, J. and T. Gotoh. 1999. DNA sequences and cross-breeding experiments in the hawthorn spidermite *Amphitetranychus viennensis* reveal high genetic differentiation between Japanese and French populations. Entomol. Exp. Appl., 90: 113-122.

NIAST. 2002. National Institute of Agricultural Science and Technology. Research Highlights. <http://www.niast.go.kr/english/sub/highlights.htm> *Last accessed,* 15 May 2002.

NPQS (National Plant Quarantine Service). 2000. Data sheet: Insect pests associated with hot-pepper, dropwort, and tomato in Korea. Republic of Korea. Unpublished data sheet. 164 pp. (On file with USDA-APHIS-PPQ-CPHST).

NRCS. 2002. The PLANTS Database, Version 3.5. USDA, Natural Resources Conservation Service, National Plant Data Center, Baton Rouge, LA. <http://plants.usda.gov/plants/plantmenu.html> *Last accessed,* 28 November 2003.

NZNPPO. 2002. Import Health Standard, Commodity Sub-class: Fresh Fruit/Vegetables Capsicum, *Capsicum annuum* from Australia. New Zealand National Plant Protection Organization. Issued 9 June 2000.

Olsson, K. 1976. Overwintering of *Pseudomonas solanacearum* in Sweden. In: International Planning Conference and workshop on the Ecology and Control of Bacterial Wilt Caused by *Pseudomonas solanacearum*. (Ed. By Sequeira, L. and Kelman, A.) pp. 105-109. North Carolina State University, Raleigh, North Carolina.

Ong, C.A., Varghese, G. and, Ting, W.P. 1979. Aetiological investigations on a veinal mottle virus of chilli (*Capsicum annuum* L.) newly recorded from Peninsular Malaysia. MARDI Research Bulletin, 7:78-88.

Ong, C.A., Varghese, G. and, Ting, W.P. 1980. The effect of chilli veinal mottle virus on yield of chilli (*Capsicum annuum* L.). MARDI Research Bulletin, 8:74-78.

Park, C.-Y. 2002. Paprika information and pest list. National Plant Quarantine Service, Republic of Korea. Unpublished memo to PPQ. 5 pp. (On file with USDA-APHIS-PPQ-CPHST).

Park, C.-Y. 2003. Personal communication from Chong-Seo Park, Director, International Quarantine Cooperation Division, National Plant Quarantine Service/MAF Republic of Korea to Ray I. Miyamoto, Acting Area Director, USDA/APHIS US Embassy, Seoul, South Korea. Unpublished memo to PPQ. 1pp. (Subject: Reprint of Pepper vein chlorosis virus article and discussion of status in Korea. On file with USDA-APHIS-PPQ-CPHST).

Park, J.S. 1958. Fungous Diseases of Plants in Korea (1). Bulletin No. 1. College of Agriculture, Chungnam University, Taejon, Taiwan.

Parsons W. and Cuthbertson, E. 2001. Noxious weeds of Australia. CSIRO Publishing, Collingwood. 698 pp.

Pernezny, K., Roberts, P.D., Murphy, J.F., and Goldberg, N.P. (Eds.). 2003. Compendium of Pepper Diseases. The American Phytopathological Society, APS Press, St. Paul, Minnesota. 63 pp.

PIN 309. 2003; 2005. USDA-APHIS Port Information Network. Computer port interception database.

PPQ. 2002. Treatment manual. www.aphis.usda.gov/ppq/manuals. Accessed 19 July 2003.

Randall, R.P. 2002. A global compendium of weeds. R. G. and F. J. Richardson, Melbourne. 905 pp.

Reed, C.F. 1977. Economically Important Foreign Weeds, Potential problems in the United States. US Government Printing Office. Agriculture Handbook No. 498. 746 pp.

Rhoades, R.E., Hijmans, R.J., and Huaccho, L. 2002. World potato atlas—Malawi. <www.cipotato.org/wpa/africa/malawi> *Last accessed*, 16 July 2003.

Roosjen, M.G. , Stigter, M. and Oomen, P.A. 1999. Greenhouse pest exclusion and eradication safeguards and principles : 182-185. *In* Kahn, R.P. and Mathur, S.B. (eds.). Containment facilities and safeguards for exotic plant pathogens and pests. APS Press, St. Paul, Minnesota. 213 pp.

Selina, P. S. and Bledsoe, M. E. 2002. U. S. greenhouse/hothouse hydroponic tomato timeline. http://pestdata.ncsu.edu/cropTimelines/ pdf/USgreenhousetomato.PDF *Last accessed*, 7 July 2005.

Sequeira, L. 1994. Epilogue: Life with a "Mutable and Trecherous Tribe". In Hayward, A.C. and Hartman, G.L. (eds.) Bacterial Wilt, The Disease and its Causative Agent, *Pseudomonas solanacearum*, pp. 235-247.

Sherf, A.F. and MacNab, A.A. 1986. Vegetable diseases and their control, 2nd Edition. John Wiley and Sons, New York, New York. 728 pp.

Shin, H.D. 1988. Erysiphaceae of Korea. PhD. Thesis. Plant Pathology Lab., Dept. of Agric. Biology, College of Agriculture, Seoul National University, Suwon, Korea. 305 pp.

Shin, H.D. and Braun, U. 1993. Notes on Korean Cercosporae and Allied Genera (1). Mycotaxon 49: 351-362.

Shin, H.D. and Lee, H.T. 1999. Notes on powdery mildew of *Dahlia* in Korea. Korean J. Pl. Pathol. 27: 234-236.

Shin, H.D., Sameva, E.F. and Kim, J.D. 2001. Morphometric studies on the genus *Septoria* in Korea (I). Mycobiology 29: 145-153.

Shipp, J.L. 1995. Monitoring of western flower thrips on glasshouse and vegetable crops : 547-555. In Parker, B.L., Skinner, M. and Lewis, T. (eds.). Thrips biology and management. Plenum, New York, New York. 636 pp.

Small, J.K. 1913. Flora of the southeastern United States. John Kunkel Small, NY. 1394 pp.

Spizes. 2002. Global Commercial Services for the Spice Industry. <http://www.spizes.com> *Last accessed,* 12 December 2002.

Sutherst, R.W., Maywald, G.F., Yonow, T. and Stevens, P.M. 1999. Climex-predicting the effects of climate on plants and animals, Ver. 1.1. CSIRO Pub., Australia, 88 pp.

Thomas, M.C. 2000. The exotic invasion of Florida. <http://doacs.state.fl.us/~pi/enpp/ento/exoticsinflorida.htm> *Last accessed*, 18 July 2003.

Tiryaki, O., Aydin, G. and Gurer, M. 1994. Post-harvest disease control of apple, quince, onion, and peach with radiation treatment. J. Turkish Phytopathol. 23: 143-152.

Ullman, D.E., German, T.L., Sherwood, J.L., and Westcot, D.M. 1995. Thrips transmission of Tospoviruses: future possibilities for management : 135-151. *In* Parker, B. L., Skinner, M. and Lewis, T. (eds.). Thrips biology and management. Plenum, New York, New York. 636 pp.

USDA 1959. Pepper Production, Disease and Insect Control. Farmers' Bulletin No. 2051. Washington, DC. 33 pp.

USDA. 1964-1991. List of Intercepted Plant Pests. USDA-APHIS-PPQ, Riverdale, MD.

USDA. 1988. Decision Sheet: Determination of Entry Status Under Fruit and Vegetable Quarantine No. 56. Pepper (*Capsicum* spp.) leaves from Korea to Guam. (On file in USDA *Capsicum* Decision Sheet File).

USDA. 1992. Memo from John Lightfield, Agriculturalist, BATS, PPQ, USDA to Frank Cooper, Senior Staff Officer, Port Operations, USDA. [Subject: Decision on bell pepper (*Capsicum* sp.) fruit from Korea to Guam. On file in USDA *Capsicum* Decision Sheet File)].

USDA. 2000. Guidelines for pathway-initiated pest risk assessments (version 5.02), USDA-APHIS-PPQ, MD. <http://www.aphis.usda.gov/ppq/pra/active> *Last accessed*, 11 January 2002.

USDA. 2003a. *Ralstonia solanacearum* race 3, biovar 2 Action Plan. USDA-APHIS-PPQ.http://www.aphis.usda.gov> *Last accessed*, 15 December 2003.

USDA. 2003b. Regulating the Importation of Fresh Fruits and Vegetables. Nonpropagative Manual. USDA, MRP, APHIS, PPQ. <http://www.aphis.usda.gov/ppq/manuals/pdf_files/FV%20Chapters.htm> *Last accessed*, 15 July 2003.

Van Elsas, J.D., Kastelein, P., Van Bekkum, P., Van der Wolf, J.M., De Vries, P.M., and Van Overbeck, L.S. 2000. Survival of *Ralstonia solanacearum* Biovar 2, The Causative Agent of Potato Brown Rot, in Field and Microcosm Soils in Temperate Climates. Phytopathology 90: 1358-1366.

van Regenmortal, M.H.V., Fauquet, C.M., Bishop, D.H.L, Carstens, E.B., Estes, M.K., Lemon, S.M., Maniloff, J., Mayo, M.A., McGeoch, D.J., Pringle, C.R., and Wickner, R.B. (eds.) 2000. Virus

Taxonomy. Seventh Report of the International Committee on Taxonomy of Viruses. Academic Press, San Diego, CA. 1162 pp.

Vierbergen, G. 1995. International movement, detection, and quarantine of Thysanoptera pests: 119-132. In Parker, B. L., Skinner, M. and Lewis, T. (eds.). Thrips biology and management. Plenum, New York, New York. 636 pp.

Weber, G.F. 1973. Bacterial and fungal diseases of plants in the tropics. Univ. Florida Press, Gainesville. 673 pp.

Wiersema, J. and León, B. 1999. World economic plants. CRC Press, Washington, D.C. 749 pp.

WSSA. 1989. Composite list of weeds. Weed Science Society of America, Champaign, Illinois. 112 pp.

Yi, Y.K. and Seo, H.S. 2000. Soft rot of red-pepper fruit caused by *Pseudomonas fluorescens* biovar II. Research in Plant Disease, Vol. 6, No. 1, pp. 1-5.

Zhang, B.-C. 1994. Index of economically important Lepidoptera. CABI, Wallingford, United Kingdom. 599 pp.

IV. Analysts and Reviewers

Authors:

Lynn Evans-Goldner, Plant Pathologist
USDA-APHIS-PPQ
Pest Detection and Management Programs
4700 River Road
Riverdale, MD 20737
lynn.e.goldner@aphis.usda.gov
301-734-7228

Michael K. Hennessey, Entomologist
USDA-APHIS-PPQ
Center for Plant Health Science and Technology
Plant Epidemiology and Risk Analysis Laboratory
Raleigh, NC
mike.k.hennessey@aphis.usda.gov
919-855-7514

Stacy Scott, Botanist
USDA-APHIS-PPQ
4700 River Road
Riverdale, MD 20737
stacy.e.scott@aphis.usda.gov
301-734-5303

Reviewers:

Thomas Culliney, Entomologist
Melissa Dirani, Editor
Eileen Sutker, Plant Pathologist
Marina Zlotina, Entomologist
USDA-APHIS-PPQ
Center for Plant Health Science and Technology
Plant Epidemiology and Risk Analysis Laboratory
Raleigh, NC

Edward Podleckis, Plant Pathologist
USDA-APHIS-PPD
Riverdale, MD

Ralstonia solanacearum Race 3 Biovar 2 Likelihood of Entry, Introduction, and Establishment, and Mitigation Recommendations: Supplement to the USDA-APHIS Pest Risk Assessment Importation of fresh paprika pepper fruit (*Capsicum annuum* L. var. *annuum*) from the Republic of South Korea into the continental United States.

Contacts:

Michael K. Hennessey, Entomologist, USDA-APHIS-PPQ-CPHST-PERAL, Raleigh, North Carolina (michael.k.hennessey@aphis.usda.gov)

Scott C. Redlin, Plant Pathologist, USDA-APHIS-PPQ-CPHST-PERAL, Raleigh, North Carolina (scott.c.redlin@aphis.usda.gov)

Executive Summary

This report is an addendum to the USDA-APHIS Pest Risk Assessment (PRA) Importation of Fresh Paprika Pepper Fruit (*Capsicum annuum* L. var. *annuum*) from the Republic of Korea into the Continental United States (PERAL, 2005). The likelihood of entry, introduction, and establishment of *Ralstonia solanacearum* Race 3 Biovar 2 (R3B2) via the importation of fresh Korean paprika pepper fruit for consumption grown hydroponically in greenhouses are analyzed. The magnitude of the consequences of introduction is high. The prevalence of R3B2 in Korean paprika peppers is low, but if infection were to occur, it would most likely be the stem of the harvested fruit that would be infected. Because peppers are harvested and marketed with attached fruit stems, R3B2 could enter with the fruit under those circumstances. The likelihood of introduction, entry, and establishment are low but there is some uncertainty about the likelihood of entry because it is uncertain as to whether or not the bacterium can be present in the pepper fruit. It is recommended that APHIS accept the voluntary mitigations proposed by the Korean National Plant Protection Organization (NPPO).

Request: Evaluate the likelihood of *R. solanacearum* Race 3 Biovar 2 being in the commodity pathway [likelihood of entry, introduction, and establishment, where introduction is entry resulting in establishment (IPPC, 2002)] and need for mitigation. *Ad hoc* request from Jeanne Van Dersal, Korea Trade Director, PIM, through Ron Sequeira, NSPL, CPHST

A. Likelihood of Entry

The PRA for this commodity (PERAL, 2005) submitted to the PPQ Phytosanitary Issues Management (PIM) staff analyzed "*Ralstonia solanacearum* Race 3", which is considered synonymous with "*Ralstonia solanacearum* Race 3 Biovar 2" (R3B2) (French, 1995). That PRA concluded that R3B2 is in the pathway with potentially high magnitude consequences if introduced. The following is evidence on host status, infectivity, and likelihood of entry:

1. Absence in Korean paprika peppers: Evidence that peppers (*Capsicum* spp.) are or can be a host comes from APHIS (2004), Janse *et al.* (2005), Martin and French (1995) and Elphinstone (2005a). Two reports (NIAST, 2002; Park, 2002) submitted to APHIS by the Korean NPPO indicated that the pathogen was present in Korea in the commodity. In their official evaluation of the PRA sent to APHIS (Korea, 2004), the government of Korea acknowledged having "*Ralstonia solanacearum* Race 3" in the commodity and offered mitigation measures. Korea did not explain their evidence for that determination. In response to a recent inquiry concerning this analysis, the Korean NPPO indicated that R3B2 was not commonly found in Korea although no survey evidence was provided in support of the statement (Ball, 2005). In the most recent response concerning this analysis, the Korean NPPO clarified, based on further investigations, that R3B2 has not been recorded in paprika, but recorded in potato and only in the limited potato growing areas of Korea (NPPO, 2005).

2. Fruit as a host: There is evidence that R3B2 does not infect tomato fruit or seed (Allen, 2005; Elphinstone, 2005a; Martins *et al.,* 2005). Data and research are lacking for pepper fruit (and seeds), so they are not ruled out as hosts (Elphinstone, 2005a).

3. Attached fruit stems as a host: The fruit will be hand-harvested by cutting but a portion of the fruit stem will necessarily remain attached to the fruit (Park, 2002). If the pepper plants are infected, there could be a reasonably high likelihood that at least the fruit stems attached to the fruits could be infected (Elphinstone, 2005a). Additionally, knives contaminated with bacterial cells are an effective means of spreading the pathogen from plant to plant during harvest of geraniums (APHIS, 2004) and that is also a way the pathogen could be spread among pepper plants in Korea.

4. Host fruit being exported: There is probably low likelihood that many marketable tomato fruit would be produced on infected plants expressing wilt symptoms because yield would be reduced (Elphinstone, 2005a; USDA, 2005). In the case of peppers, infected plants may not die or even show symptoms before producing fruit (Allen, 2005). Under typical conditions, symptomatic plants would be rogued prior to harvesting fruit. Under typical market conditions, most infected harvested fruit showing symptoms would be of noticeably lower quality with a high likelihood of being culled at the packinghouse.

6. Likelihood of Entry: Despite a lack of published evidence, *Ralstonia* experts (Allen, 2005; Priou, 2005) have expressed the opinion that there is a low likelihood that the R3B2 could enter with the commodity.

Conclusion: There is evidence as well as expert judgement to support the low likelihood of R3B2 entering the United States via the importation of fresh pepper fruit for consumption. However, uncertainty as to whether or not pepper fruit tissue can be infected and the inclusion of possibly infected fruit stems on the commodity could increase that likelihood. The above is based on limited experimentation with peppers. The NPPO claims that the pathogen has been recorded for potatoes, but not for paprika peppers in Korea. This statement is given weight because it comes from an official document of the exporting NPPO. The NPPO of Korea also stated that R3B2 "is not found very often in Korea." Conclusions on entry based on peppers may not be wholly applicable to tomatoes, eggplants, and other solanaceous fruits because of differences in susceptibility and the lack of available data.

B. Likelihood of Establishment

There are more R3B2 infectivity studies on tomatoes than for peppers. There are no studies directly addressing the risk to U. S. agriculture of importing pepper fruit, or any other fruit, for consumption from an infected source. The following factors address the likelihood of establishment in agricultural situations resulting from entry of R3B2 in paprika pepper fruit:

1. Possible pathways: Eight pathways were investigated by Gould *et al.* (2004) in a risk analysis that looked at fresh asparagus infested with lepidopteran eggs. This study is relevant to this analysis because it may be used to illustrate the fate of fresh produce. The study examined disposal methods at 14 commercial import warehouses in the U.S. that represented 85% of the asparagus imports from Peru. That report concluded: 76.0 % went unbagged into dumpsters; 4.5% went bagged into dumpsters; 11.2% was compacted (landfilled); 7.3% went to soup kitchens (consumed); 0.5% was put in the garbage disposal (municipal sewage); 0% went as discounted produce (consumed); 0% was composted; 0% went for animal feed. Dumpsters are a dead-end pathway because they lead to landfills which are also dead-end pathways (Auclair *et al.,* 2005).

2. Consumer pathways: Fruit is taken home from supermarkets by consumers. A first discard scenario can be where most of the fruit is consumed, but stems and seeds are discarded into a garbage disposal where they end up in sewage. A second discard scenario can be where stems and seeds are bagged and put into the trash where they end up in a landfill. Sewage is a dead-end pathway (Zipper *et al.,* 2003). There are no studies on the proportion of fruits and vegetables that consumers discard as backyard compost in the U. S. One foreign study estimated that up to 0.5% of U. S. apples purchased in Japan ended up as compost (Roberts *et al*., 1998). Another study estimated that 5% of U. S. cherries purchased in New Zealand ended up as compost (Wearing *et al*., 2001). If it is assumed that 5% composting mirrors U. S. practices, then there is low likelihood that the commodity would be discarded on compost piles. Although no studies have been done, it is assumed that all compost produced by consumers is used on home gardens or yards and not spread directly onto agricultural fields.

3. Irrigation water pathway: A main method of spread of the pathogen in crop systems is by contaminated irrigation water (Pernezny *et al*., 2003). Symptoms of bacterial wilt have been observed in susceptible solanaceous crops after irrigation with water from contaminated rivers. Outbreaks in Scotland and Spain have been traced to contaminated rivers along which infected solanaceous weeds, serving as reservoirs for the pathogen, were present. Once introduced into river water, the pathogen may remain viable and continue to be infective for two months at 25°C (Caruso *et al*., 2005). It is not known how much runoff from backyard compost piles contributes to irrigation water in the U. S., but the following is assumed:

a./ There is probably low likelihood that most U. S. homeowner compost piles are near streams that are used for irrigation of agricultural crops.

b./ There is low likelihood that the pathogen would survive in compost for more than a few days (Elphinstone, 2005b) or weeks, depending on the quality of the compost. In a study of compost at 52°C, *R. solanacearum* was destroyed within one day (Ryckeboer *et al.*, 2002). In a study of compost at <40°C, *R. solanacearum* was inactivated within six weeks (Termershuizen *et al*., 2003). In a study of 35°C compost piles, the related bacterium *Pseudomonas phaseolicola* was inactivated after four days (Lopez-Real and Foster, 1985). Burial of infected geraniums under compost is one of the mitigations suggested for controlling the pathogen, according to APHIS (2004).

c./ The scenario that would allow pathogens from infected peppers to enter irrigation water would involve several intermediate steps including rain to runoff occurring within the limited amount of time before inactivation, runoff going into a stream, uptake into an irrigation system, and contact with a host. Therefore, there is probably low likelihood that infected peppers would contaminate irrigation water and come into contact with crops.

4. APHIS has long permitted the entry of tomato and pepper fruit for consumption from countries where R3B2 is known to occur. These commodities have been permitted entry with only a port of entry inspection for R3B2. Inspections target symptomatic fruit. Asymptomatic but infected fruits would probably not be detected during inspection (PERAL, 2005). According to the PPQ 280 database, in FY 2003 alone, 458, 367,147 kg of pepper fruit were imported from countries reporting the presence of R3B2. To date, no known introductions of R3B2 have occurred as a result of these importations. This supports the assumption that even if R3B2 entered with fruit, there is a low likelihood of establishment.

Conclusions: In the PRA (PERAL, 2005) it was determined that there would be high risk consequences of introduction into temperate areas of the U. S., especially those near commercial potato and tomato production areas. In the PRA (PERAL, 2005), it was also determined that the likelihood of introduction and the overall risk potential would be high. This analysis concludes that the likelihood of introduction is reduced when the low likelihood of establishment is considered. The likelihood that the pathogen could infect susceptible backyard garden plants or weeds and become established as a result of use of infected homeowner compost is probably higher than the likelihood that the pathogen could infect agricultural crops as a result of homeowner use of compost. Even when infected geraniums entered the U. S. in large quantities in 2003, and then came into contact with susceptible crops, there was no evidence that R3B2 was established as a consequence (APHIS, 2004). Furthermore, given the large volumes of peppers already imported into the United States from R3B2 countries without establishment of this pathogen, it seems unlikely that pepper fruit for consumption is an effective pathway for introduction of R3B2.

Because other types of susceptible fruits for consumption (including tomatoes, eggplants, bitter gourd, string bean [Janse *et al.,* 2005]) imported from countries reporting R3B2 would be likely to follow consumer pathways similar to those described for paprika peppers, the above conclusions about establishment would be applicable to them.

Table 1 summarizes the conclusions of this analysis.

Table 1. *Ralstonia solanacearum* R3B2: Unmitigated entry, establishment, and introduction---summary of likelihood estimates for paprika peppers grown hydroponically in greenhouses for consumption from Korea

Event	**Likelihood**
Pathogen is present in Korea	High (PERAL, 2005; NPPO, 2005)
Pathogen is prevalent in paprika peppers in Korea	Low (Ball, 2005; NPPO, 2005)
Magnitude of consequences of introduction	High (PERAL, 2005)
Asymptomatic but infected fruits would not be detected at port of entry	High (PERAL, 2005)
Pathogen enters in asymptomatic but infected commodity	Low (Allen, 2005; Priou, 2005)
Under typical conditions, lower quality, symptomatic fruit would not be culled	Low
Commercial culls go to commercial compost, compactor, animal feed, garbage disposal, soup kitchen, or discounted produce	Low
Commercial culls go to dumpster	High
Infected culls in a dumpster would contaminate irrigation water	Low
Establishment from fruits, stems, and seeds that are discarded into the garbage disposal where they end up in sewage or bagged and put in the trash where they end up in a municipal landfill	Low
High proportion of commodity discarded on compost piles	Low
U. S. homeowner compost piles are near streams that are used for irrigation	Low
The pathogen would survive in compost for more than a few days or weeks	Low
Infected peppers in compost would contaminate irrigation water	Low
Establishment	Low
Introduction	Low

C. Mitigation Recommendations

Mitigation of the R3B2 in peppers (*Capsicum* spp.) or tomatoes for consumption from countries where R3B2 occurs is not currently required by APHIS.

The government of Korea has proposed the following mitigations:

a.) Grow in water and treated "soil" (or approved media) in greenhouses approved by National Plant Quarantine Service;
b.) Inspections at flowering and before harvest;
c.) Culling of infected fruits prior to shipment;
d.) Export inspection;
e.) Phytosanitary Certificate declaration "As a result of the inspection, the fruits are found to be free of *Ralstonia solanacearum* Race 3" (Korea, 2004).

In order to reduce the likelihood of the pathogen being in the pathway, it is recommended that APHIS accept Korea's offer to conduct the additional phytosanitary measures beyond port of entry inspection. Korea might also consider additional good management practices including:

a. Certification of the production sites.
b. Weed host control around the sites.
c. General sanitation (e.g., harvesting knives, water, media).

References

Allen, C. 2005. Email from C. Allen, Dept. Plant Pathology and Women's Studies Program, Univ. Wisconsin-Madison to S. Redlin, 3/31/05.

APHIS. 2004. New pest response guidelines: *Ralstonia solanacearum* race 3 biovar 2-southern wilt of geranium. 74 pp.

Auclair, A. N. D., G. Fowler, G., M. K. Hennessey, A. T. Hogue, M. Keena, D. R. Lance, R. M. McDowell, D. O. Oryang, A. J. Sawyer. 2005. Assessment of the risk of introduction of *Anplophora glabripennis* (Coleoptera: Cerambycidae) in municipal solid waste from the quarantine area of New York City to landfills outside of the quarantine area: a pathway analysis of the risk of spread and establishment. J. Econ. Entomol.. 98:47-60.

Ball, G. A. 2005. Personal communication. E-mail from G. Ball, Acting Area Director, USDA, APHIS, IS, Seoul, Korea to A. Belano, Import Specialist, USDA, APHIS, PPQ. 13 June 2005.

Caruso, P., J. L. Palomo, E. Bertolini, B. Alvarez, M. M. Lopez, and E. G. Biosca. 2005. Seasonal variation of *Ralstonia solanacearum* Biovar 2 populations in a Spanish river: recovery of stressed cells at low temperatures. Applied and Environmental Microbiology 71: 140-148.

Elphinstone, J. 2005a. Email from J. Elphinstone, CSL, United Kingdom to S. Redlin, 4/6/05.

Elphinstone, J. 2005b. Email from J. Elphinstone, CSL, United Kingdom to S. Redlin, 4/8/05, (reference to his unpublished studies of infected tomato plants placed in compost in Egypt).

French, E. R. 1995. Interaction between strains of *Ralstonia solanacearum*, its hosts and the environment :94-104. In: Pentley, G. J., (ed.), Bacterial wilt disease in Asia and the South Pacific. ACYAR Proc., Canberra.

Gould, J., R. Venette, and J. Seltzer. 2004. The pathways followed by fresh produce in the United States and how they impact the risk of establishment for exotic pests. Unpublished APHIS poster.

IPPC. 2002. Glossary of phytosanitary terms. FAO, Rome.

Janse, J. D., H. E. van den Beld, J. Elphinstone, S. Simpkins, L. N. A. Tjou-Tam-Sin, and J. van Vaerenbergh. 2005. Introduction into Europe of *Ralstonia solanacearum* Biovar 2, Race 3 in *Pelargonium zonale* cuttings from Kenya :81-91. In: Allen, C., P. Prior, and A. C. Hayward (eds.). Bacterial wilt disease and the *Ralstonia solanacearum* complex. American Phytopathological Soc. Press, St. Paul. 510 pp.

Korea. 2004. Opinion of the Government of Korea on APHIS draft PRAs on Korean paprika and sweet potato. 2 pp.

Lopez-Real, J. and M. Foster. 1985. Plant pathogen survival during the composting of agricultural organic wastes, pp. 291-300. In: Gasser, J. K. R., (ed.), Composting of agricultural and other wastes. Elsevier, London. 320 pp.

Martin, C. and E. French. 1995. Covered field host range for *Pseudomonas solanacearum* race 3/biovar 2. Bacterial Wilt Newsletter 12. (abstract)

Martins, O. M., F. Nabizadeh, and K. Rudilph. 2005. Seeds from infected tomato plants appear to be free from contamination by Ralstonia solanacearum when tested by PCR or microbiological assays: 95-100. In: Allen, C., P. Prior, and A. C. Hayward (eds.). Bacterial wilt disease and the Ralstonia solanacearum complex. American Phytopathological Soc. Press, St. Paul. 510 pp.

Mexico Avocado PRA. 2004. USDA-APHIS-CPHST-PERAL. 141 pp.

NIAST. 2002. National Inst. Agric. Science and Technol. Research highlights [Korea]. http://www.niast.go.kr/english/sub/highlights.htm> *Last accessed,* 15 May 2002.

NPPO. 2005. Letter from J. Baek, Korean NPPO Director to G. Ball, Acting APHIS Area Director, Seoul, June 21, 2005. Response to APHIS official request to clarify status of R3B2 in paprika in Korea for purposes of this analysis.

Park, C.-Y. 2002. Paprika information and pest list. National Plant Quarantine Service, Republic of Korea. Unpublished memo to PPQ. 5 pp. (On file with USDA-APHIS-PPQ-CPHST).

PERAL. 2005. PRA: Importation of fresh paprika pepper fruit (*Capsicum annuum* L. var. *annuum*) from the Republic of South Korea into the continental United States. 75 pp.

Pernezny, K., Roberts, P.D., Murphy, J.F., and Goldberg, N.P. (Eds.). 2003. Compendium of Pepper Diseases. American Phytopathological Society, St. Paul, Minnesota. 63 pp.

Priou, S. 2005. Email from S. Priou, Head Bacteriology Unit, International Potato Center, Lima, Peru, to S. Redlin, 4/1/05.

Roberts, R. C., T. van der Zwet, C. E. Miller, and S. C. Redlin. 1998. The potential for spread of *Erwinia amylovora* and fire blight via commercial apple fruit: A critical review and risk assessment. Crop Prot. 17: 19-28.

Ryckeboer, J., S. Cops, and J. Coosemans. 2002. The fate of plant pathogens and seeds during anaerobic digestion and aerobic composting of source separated household wastes. Compost Science & Utilization 10: 204-216. (abstract)

Termorshuizen, A. J., D. Volker, W. J. Blok, E. Brummler, B. J. Hartog, J. D. Janse, W. Knol, and M. Wenneker. 2003. Survival of human and plant pathogens during anaerobic mesophilic digestion of vegetable, fruit, and garden waste. European Journal Soil Biology 39: 165-171. (abstract)

USDA. 2005. Importation of Fresh Tomato Fruit (*Lycopersicon esculentum* Mill.) from Chile into the United States : A Pathway-Initiated Plant Pest Risk Analysis. USDA, APHIS, PPQ, Riverdale, MD.

Wearing, C. H., J. Hansen, C. Whyte, C. E. Miller, and J. Brown. 2001. The potential for spread of codling moth (Lepidoptera: Torticidae) via commercial sweet cherry fruit: a critical review and risk assessment. Crop Prot. 20: 465-488.

Zipper, C. R. B. Renaue, Jr., and A. Jantrania. 2003. On-site sewage treatment alternatives. Virginia Coop. Extension Pub. 448-407. http://www.ext.vt.edu/pubs/waterquality/448-407/448-407.pdf. *Last accessed* 13 July 2005.

Reviewers

R. Bulluck, Plant Pathologist, USDA-APHIS-PPQ-CPHST, Raleigh, North Carolina
B. Caton, Ecologist, USDA-APHIS-PPQ-CPHST, Raleigh, North Carolina
R. Griffin, USDA-APHIS-PPQ-CPHST-PERAL Laboratory Director, Raleigh, North Carolina
E. Podleckis, Plant Pathologist, USDA-APHIS-PPD, Riverdale, MD
B. Spears, Entomologist, USDA-APHIS-PPQ-CPHST-PERAL , Raleigh, North Carolina