Importation of *Phalaenopsis* spp. Orchid Plants in Approved Growing Media from China into the Continental United States

A Pathway-Initiated Pest Risk Assessment

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Version 4

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Executive Summary

In this pathway-initiated commodity risk assessment, we examined the risks associated with the proposed importation of *Phalaenopsis* spp. plants (at least four months old) established in APHIS-approved growing media from the People's Republic of China into the continental United States. We found three quarantine pests likely to follow the pathway with this commodity: a noctuid moth, *Spodoptera litura*; a fungal pathogen, *Cylindrosporium phalaenopsidis*, and a mollusk, *Lissachatina fulica*. We analyzed these pests using the methodology described in the USDA-APHIS-PPQ Guidelines for Pathway-Initiated Risk Analysis 5.02, which examine pest biology in the context of the Consequences of Introduction and the Likelihood of Introduction and estimate the baseline Pest Risk Potential, which is the risk in the absence of mitigation.

We rated the Pest Risk Potential of all four pests as Medium. All plants in growing media imported into the United States must be approved by APHIS and must comply with the requirements in 7 CFR 319.37-8, but specific additional phytosanitary measures may be necessary for pests with medium risk potentials.

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1. Background

This document was prepared by the Plant Epidemiology and Risk Analysis Laboratory of the Center for Plant Health Science and Technology, USDA Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ), in response to a request to evaluate the risks associated with the importation of commercially produced, at least four month old *Phalaenopsis* spp. plants established in APHIS-approved growing media from China into the continental United States.

The International Plant Protection Convention (IPPC) provides guidance for conducting pest risk analyses. The methods used here are consistent with guidelines provided by the IPPC, specifically the International Standard for Phytosanitary Measures (ISPM) on 'Pest Risk Analysis for Quarantine Pests, Including Analysis of Environmental Risks and Living Modified Organisms' (IPPC, 2009: ISPM #11). The use of biological and phytosanitary terms is consistent with the 'Glossary of Phytosanitary Terms' (IPPC, 2009: ISPM #5).

Three stages of pest risk analysis are described in international standards: Stage 1, Initiation; Stage 2, Risk Assessment; and Stage 3, Risk Management. This document satisfies the requirements of Stages 1 and 2.

This is a qualitative risk analysis; estimates of risk are expressed in terms of High, Medium, and Low pest risk potentials based on the combined ratings for specified risk elements (PPQ, 2000) related to the probability and consequences of importing *Phalaenopsis* spp. plants established in APHIS-approved growing media from China. For the purposes of this assessment High, Medium, and Low probabilities will be defined as:

High: More likely to occur than not to occur
Medium: As likely to occur as not to occur
Low: More likely not to occur than to occur

All plants in growing media imported into the United States must be approved by APHIS and must comply with all requirements in 7 CFR 319.37-8. Identification of additional phytosanitary measures to mitigate the risk, if any, for these pests is undertaken as part of Stage 3 (Risk Management).

2. Risk Assessment

2.1. Initiating Event: Proposed Action

This commodity-based, pathway-initiated pest risk assessment was prepared in response to a request for USDA authorization to allow the importation from China of *Phalaenopsis* spp. orchid plants with roots in approved growing media according to the requirements in 7 CFR 319.37-8. This also includes the written agreement that will be established between APHIS and the national plant protection organization of China.

2.2. Assessment of the Weed Potential of *Phalaenopsis* spp. Orchids

If the species considered for import poses a risk as a weed pest, then a "pest initiated" risk assessment is conducted. The results of the screening for weed potential for *Phalaenopsis* spp. orchids (Table 1) did not prompt a pest initiated risk assessment because *Phalaenopsis* plants are already present in the United States and are not reported as weeds.

Table 1. Process for determining weed potential of *Phalaenopsis* spp. orchids.

The genus *Phalaenopsis* (Orchidaceae) contains more than 70 species of orchids from the subfamily Epidendroideae (NRCS, 2011). Species of *Phalaenopsis* are found throughout tropical Asia and the larger islands of the Pacific Ocean. The western distribution of *Phalaenopsis* is in Sri Lanka and South India. The eastern limit of the range is in Papua New Guinea. To the north, they are distributed in Yunnan Province (China) and Taiwan. The southern limit is in northern Australia (Tsai et al., 2006).

Phase 1. Is the genus is new to or not widely prevalent in the United States? (exclude plants grown under USDA permit in approved containment facilities)

Phalaenopsis spp. orchids are widely cultivated in Florida, California, and other places in the United States, often in greenhouses (Griesbach, 2002).

Phase 2. Answer Yes or No to the following questions:

Is the genus listed in:

- No Geographical Atlas of World Weeds (Holm et al., 1997)
- No World's Worst Weeds (Holm et al., 1977)
- No Report of the Technical Committee to Evaluate Noxious Weeds; Exotic Weeds for Federal Noxious Weed Act (Gunn and Ritchie, 1982)
- No Economically Important Foreign Weeds (Reed, 1977)
- No Weed Science Society of America list (WSSA, 2007)
- No Is there any literature reference indicating weed potential (e.g., AGRICOLA, CAB, Biological Abstracts, AGRIS; search on "Phalaenopsis" combined with "weed")?

Phase 3. Conclusion: Some species of this genus are present in the United States, and the answer to all of the questions is no; therefore, the commodity does not have weed potential.

2.3. Current Status and Pest Interceptions

There are no previous requests from China for *Phalaenopsis* spp. rooted in APHIS-approved growing media.

From 1985 to 2011, U.S. agricultural inspectors listed 193 different pests intercepted on *Phalaenopsis* spp. worldwide. Of those, 98 were listed as non-reportable and 77 were not identified past the family level. Thirteen pests were intercepted at least four times each on *Phalaenopsis* spp. and from China (Table 2).

Inspection station identifiers are limited by current taxonomic specificity and the stage or condition of the submitted specimen. Generally, only the biological hazards of organisms identified to the species level are assessed because most genera contain many species. By necessity, pest risk assessments focus on the organisms for which biological information is available. Development of detailed assessments for known pests that inhabit a variety of ecological niches, such as the surfaces or interiors of fruit, stems, or roots, allow effective mitigation measures to eliminate the known organisms as well as similar but incompletely identified organisms that inhabit the same niche. Quarantine species may be present in those groups identified only to the genus level. Should these incompletely identified species be intercepted by PPQ officers during port of entry inspection, quarantine action will be required.

Table 2. Reportable pests intercepted from China on all hosts and on *Phalaenopsis* spp. orchids worldwide at least five times from 1985 to 2011 by U.S. agricultural inspectors (PestID, 2011).

Pest	**Intercepted**	
	from China (all hosts)	**on Phalaenopsis (worldwide)**
Mites		
Tarsonemus bilobatus Suski (Tarsonemidae)[NR]	6	15
Tarsonemus sp. (Tarsonemidae)	29	13
Insects		
Pseudococcus longispinus (Targioni-Tozzetti) (Pseudococcidae)[NR]	5	4
Pseudococcus sp. (Pseudococcidae)	32	7
Saissetia coffeae (Walker) (Coccidae)[NR]	3	4
Mollusks		
Zonitoides arboreus (Say) (Gastrodontidae)[NR]	12	5
Pathogens		
Colletotrichum crassipes (Speg.) Arx (Coelomycetes)[NR]	6	4
Colletotrichum gloeosporioides (Penz) Penz & Sacc. (Coelomycetes)[NR]	41	4
Glomerella cingulata (Stoneman) Spauld. & H. Schrenk (Glomerellaceae)[NR]	6	5
Microsphaeropsis sp. (Coelomycetes)	30	4
Phoma sp. (Coelomycetes)	65	5
Phomopsis sp. (Coelomycetes)	77	4
Pseudomonas sp. (Pseudomonadaceae)	5	11

[NR] Non-reportable

2.4. Pest Categorization

2.4.1. Methodology

In this process we determine if a pest has the characteristics of a quarantine pest or those of a regulated non-quarantine pest. Our procedures are based on ISPM 11 (IPPC, 2009). First, we develop a comprehensive list of potential quarantine pests known to occur in the country or region from which the commodity is to be exported and which are associated with the commodity. To be a quarantine pest the organism must be "of potential economic importance" and must not yet be present in the area being assessed, or if present, it should be under official control. Because all pests on the list are associated with the plant species, they are considered to be "of potential economic importance" (IPPC, 2009: ISPM #11). The listed pests may or may not also occur in the United States.

Pests associated with *Phalaenopsis* spp. in China are listed below (Table 3). We produced the list based on evidence in the scientific literature, manuals on orchid production, a list provided by the Chinese Ministry of Agriculture, and other sources of general information. This list identifies: (1) the presence or absence of these pests in the United States, (2) the generally affected plant part or parts, (3) the quarantine status of the pest with respect to the United States, (4) potential for commercial *Phalaenopsis* spp. orchids in approved growing media to introduce the pest into the United States and (5) pertinent citations for the distribution or the biology of the pest. Because of specific characteristics of biology and distribution, many organisms are eliminated from further consideration as sources of phytosanitary risk on *Phalaenopsis* spp. orchids because they do not satisfy the IPPC definition of a quarantine pest. We shaded the quarantine pests identified as likely to follow the commodity pathway and selected for further analysis.

Even if non-quarantine pests are able to follow the pathway, phytosanitary measures against these pests would not be justified because the pests already occurs in the United States so information on plant part association and whether the pest is likely to follow the pathway is not needed for non-quarantine pests. Therefore, for the non-quarantine pests in below, we put N/A (= Not Applicable) in the columns for "Plant Part(s) Association" and "Likely to Follow Pathway."

Table 3. Pests of *Phalaenopsis* spp. orchids in China.

Pest and host association	Distribution[1]	Quarantine pest	Plant part association	Follow pathway
ARTHROPODA				
ACARI				
Tarsonemidae				
Tarsonemus sp. (PestID, 2011)	CN (PestID, 2011), US (CABI, 2011)	Yes	Leaf, stem (PestID, 2011)	Yes[2]
Metatarsonemus sp. (PestID, 2011)	CN (PestID, 2011)	Yes	Leaf, stem (Jeppson et al., 1975)	Yes[2]

[1] CN= China, US= United States, CA= California, FL= Florida, HI= Hawaii.

[2] Please see section 2.3 for an explanation of why this pests was not analyzed.

Pest and host association	Distribution[1]	Quarantine pest	Plant part association	Follow pathway
Xenotarsonemus sp. (PestID, 2011)	CN (PestID, 2011)	Yes	Leaf, stem (Jeppson et al., 1975)	Yes[2]
INSECTA				
Hemiptera: Aleyrodidae				
Trialeurodes vaporariorum (Westwood) (AQSIQ, 2009)	CN (AQSIQ, 2009) US (CABI, 2011)	No	N/A	N/A
Hemiptera: Aphididae				
Aphis gossypii (Glover) (CABI, 2011)	CN, US (CABI, 2011)	No	N/A	N/A
Myzus persicae (Sulzer) (CABI, 2011)	CN, US (CABI, 2011)	No	N/A	N/A
Hemiptera: Coccidae				
Coccus hesperidum (L.) (CABI, 2011)	CN, US (CABI, 2011)	No	N/A	N/A
Chrysomphalus aonidum (L.) (AQSIQ, 2009)	CN (AQSIQ, 2009), US (CABI, 2011)	No	N/A	N/A
Diaspis boisduval Signoret (Espinosa et al., 2010)	CN (AQSIQ, 2009),US (Espinosa et al., 2010)	No	N/A	N/A
Parlatoria pretens(AQSIQ, 2009)	CN (AQSIQ, 2009), US (Felt, 1901)	No	N/A	N/A
Saissetia coffeae (Walker) (Signoret) (Hamon and Williams, 1984)	CN, US (CABI, 2011)	No	N/A	N/A
Hemiptera: Diaspididae				
Parlatoria proteus (Curtis) (Yang, 1997)	CN, US (Ben-Dov et al., 2011)	No	N/A	N/A
Pinnaspis strachani (Cooley) (Ben-Dov et al., 2011)	CN, US (Ben-Dov et al., 2011)	No	N/A	N/A
Hemiptera: Pseudococcidae				
Pseudococcus longispinus (Targioni Tozzetti) (Yang, 1997)	CN, US (CABI, 2011)	No	N/A	N/A
Lepidoptera: Noctuidae				
Spodoptera litura Fabricius (AQSIQ, 2009)	CN (AQSIQ, 2009)	Yes	Leaf (CABI, 2011)	Yes
Thysanoptera: Thripidae				
Dichromothrips smithi (Zimmermann) (Lee et al., 2002)	CN (Li-zhong, 2000)	Yes	Flower (Lee et al., 2002)	No[3]
Thysanoptera: Thripidae				
Frankliniella intonsa (Trybom) (AQSIQ, 2009)	CN (AQSIQ, 2009)	No	N/A	N/A
Frankliniella occidentalis (Pergande) (Baker et al., 2007)	CN (Wu et al., 2009), US (CABI, 2011)	No	N/A	N/A

[3] Hosts for this insect are not naturalized in the Continental United States

Pest and host association	**Distribution**[1]	**Quarantine pest**	**Plant part association**	**Follow pathway**
Thrips palmi (Karny) ({Maketon, 2014 #1362})	CN ({He, 2008 #1363}) US (HI) ({Rosenheim, 1990 #1364}) (FL) ({Castineiras, 1997 #1365})	Yes	Flower	Yes
MOLLUSKS				
Achatinidae				
Lissachatina fulica (Bowdich) (Raut and Barker, 2002)	CN (PestID, 2011)	Yes	Leaf, stem (Raut and Barker, 200)	Yes
Gastrondontidae				
Zonitoides arboreus (Say) (PestID, 2011)	CN, US (PestID, 2011)	No	N/A	N/A
FUNGI and CHROMISTAS[4]				
Athelia rolfsii (Curzi) Tu & Kimbr Anamorph: ***Sclerotium rolfsii*** Sacc (AQSIQ, 2009; Farr and Rossman, 2011)	CN (AQSIQ, 2009; CABI, 2011), US (CABI, 2011)	No	N/A	N/A
Botryosphaeria rhodina (Berk. & M.A. Curtis) Arx Anamorph: ***Lasiodiplodia theobromae*** (Pat.) Griffon & Maubl. (Ellis & Pierce) (AQSIQ, 2009)	CN (AQSIQ, 2009; PestID, 2011), US (CABI, 2011)	No	N/A	N/A
Botryotinia fuckeliana (de Bary) Whetzel Anamorph: ***Botrytis cinerea*** (Ellis & Pierce) (AQSIQ, 2009)	CN (AQSIQ, 2009; PestID, 2011), US (CABI, 2011)	No	N/A	N/A
Choanephora cucurbitarum (Berk. & Ravenel) (Farr and Rossman, 2011)	CN (Farr and Rossman, 2011), US (CABI, 2011; Farr and Rossman, 2011)	No	N/A	N/A
Cladosporium cladosporioides (Fresen.) G.A. De Vries (Farr and Rossman, 2011)	CN, US (Farr and Rossman, 2011)	No	N/A	N/A
Cladosporium oxysporum Berk. & M.A. Curtis (Farr and Rossman, 2011)	CN, US (Farr and Rossman, 2011)	No	N/A	N/A
Cochliobolus lunatus Nelson & Haasis (CABI, 2011; Farr and Rossman, 2011)	CN, US (CABI, 2011; Farr and Rossman, 2011)	No	N/A	N/A
Curvularia eragrostidis (Henn.) J.A. Mey (Farr and Rossman, 2011)	CN, US (Farr and Rossman, 2011)	No	N/A	N/A

[4] Taxonomy according to Farr and Rossman (2011). A synonym printed in bold type is not the current name, but is the name reported in China.

Pest and host association	Distribution[1]	Quarantine pest	Plant part association	Follow pathway
Curvularia lunata (Wakker) Boedijn (Farr and Rossman, 2011)	CN, US (Farr and Rossman, 2011)	No	N/A	N/A
Cylindrosporium phalaenopsidis Sawada (Farr and Rossman, 2011)	CN (James, 2011)	Yes	Leaf (James, 2011)	Yes
Fusarium oxysporum Schltdl. : Fr. (Farr and Rossman, 2011)	CN, US (Farr and Rossman, 2011)	No	N/A	N/A
Fusarium proliferatum (Matsush.) Nirenberg ex Gerlach & Nirenberg (Farr and Rossman, 2011)	CN, US (Farr and Rossman, 2011)	No	N/A	N/A
Glomerella cingulata (Stoneman) Spauld & H. Schrenk. Anamorph: ***Colletotrichum gloeosporioides*** (Penz) Penz & Sacc. (AQSIQ, 2009; Redlin, 2002)	CN (AQSIQ, 2009; PestID, 2011), US (CABI, 2011)	No	N/A	N/A
Globisporangium ultimum (Trow) Uzuhashi, Tojo & Kakish. Syn: ***Pythium ultimum*** Trow	CN (Farr and Rossman, 2011), US (Cating et al., 2009; Farr and Rossman, 2011)	No	N/A	N/A
Haematonectria haematococca (Berk. & Broome) Samuels & Rossman Anamorph: ***Fusarium solani*** (Mart.) Sacc (Farr and Rossman, 2011)	CN, US (CABI, 2011; Farr and Rossman, 2011)	No	N/A	N/A
Nigrospora sphaerica (Sacc.) E.W. Mason (Farr and Rossman, 2011)	CN, US (Farr and Rossman, 2011)	No	N/A	N/A
Pestalotiopsis palmarum (Cooke) Steyaert (Farr and Rossman, 2011)	CN, US (Farr and Rossman, 2011)	No	N/A	N/A
Phyllosticta capitalensis Henn. (Farr and Rossman, 2011)	CN, US (Farr and Rossman, 2011)	No	N/A	N/A
Phytophthora nicotianae Breda de Haan Syn: ***P. parasitica*** Dastur (AQSIQ, 2009)	CN (AQSIQ, 2009; PestID, 2011), US (CABI, 2011)	No	N/A	N/A
Phytophthora palmivora var. *palmivora* E.J. Butler Syn: ***P. palmivora*** Bulter (Cating et al., 2009; AQSIQ, 2009)	CN (AQSIQ, 2009; Farr and Rossman, 2011), US (Cating et al., 2009; Erwin and Ribeiro, 1996; Farr and Rossman, 2011)	No	N/A	N/A
Thanatephorus cucumeris (A.B. Frank) Donk Anamorph: ***Rhizoctonia solani*** Kuhn (Farr and Rossman, 2011)	CN, US (Farr and Rossman, 2011)	No	N/A	N/A

Pest and host association	Distribution[1]	Quarantine pest	Plant part association	Follow pathway
BACTERIA [5]				
Acidovorax avenae subsp. *cattleyae* (Pavarino) Willems et al. Syn: ***Pseudomonas avenae*** Manns, ***P. catteyae*** (Pavarino) Savulescu (AQSIQ, 2009; Redlin, 2002)	CN (AQSIQ, 2009, US (CABI, 2011)	No	N/A	N/A
Dickeya chrysanthemi (Burkholder et al.) Samson et al. Syn: ***Erwinia chrysanthemi*** Burkholder Burkholder, McFadden & Dimock. (AQSIQ, 2009; CABI, 2011)	CN (AQSIQ, 2009), US (CABI, 2011)	No	N/A	N/A
Dickeya zeae Samson et al. 2005 Syn: ***Erwinia chrysanthemi pv. zeae*** (Sabet 1954) Victoria, Arboleda & Munoz (Liu et al., 2008; CABI, 2011)	CN (Liu et al., 2008), US (CABI, 2011)	No	N/A	N/A
Pectobacterium cartovorum subsp. carotovorum (Jones) Hauben et al. Syn: ***Erwinia carotovora*** subsp. ***carotovora*** (Jones) Bergey et al. (CABI, 2011)	CN, US (CABI, 2011)	No	N/A	N/A
Pectobacterium cypripedii (Hori) Brenna Syn: ***Erwinia cypripedii*** (Hori) Bergey	CN (Ping et al., 1994), US (CABI, 2011)	No	N/A	N/A
VIRUSES and VIRUS-LIKE AGENTS				
Capsicum chlorosis virus (CaCV) (Zheng et al., 2008)	CN (Chen et al., 2007), US (Kunkalikar et al., 2010)[6]	No	N/A	N/A
Cymbidium mosaic virus (CyMV) (AQSIQ, 2009; CABI, 2011)	CN (AQSIQ, 2009; CABI, 2011), US (CABI, 2011)	No	N/A	N/A
Odontoglossum ringspot virus (ORSV) (AQSIQ, 2009; CABI, 2011)	CN (AQSIQ, 2009; CABI, 2011), US (CABI, 2011)	No	N/A	N/A
Impatiens necrotic spot virus (INSV) (CABI, 2011; Liu et al., 2010; Zhang et al., 2010)	CN (CABI, 2011), US (Baker et al., 2007; CABI, 2011)	No	N/A	N/A

[5] Taxonomy according to Euzéby (2007).
[6] An isolate of *Capsicum chlorosis virus* from the United States (CaCV-Gl-USA; AF059578) was included in this research paper.

Pest and host association	Distribution[1]	Quarantine pest	Plant part association	Follow pathway
Tomato spotted wilt virus (TSWV) (Baker and Baker, 2006; Baker et al., 2007; CABI, 2011)	CN (AQSIQ, 2009;); US (CABI, 2011)	No	N/A	N/A

2.4.2. Pest List Discussion

Non-specific pest identification. The biological hazard of organisms identified only to the genus level is not directly assessed in this document. International Standard for Phytosanitary Measures No. 11 states that "[t]he identity of the pest should be clearly defined to ensure that the assessment is being performed on a distinct organism, and that biological and other information used in the assessment is relevant to the organism in question" (IPPC, 2009). Risk assessments generally consider organisms defined to the species level only, unless a genus containing potential pests is not present in the importing country.

Doubtful host associations or distributions. Pest interceptions may be evidence that a pest is present in a particular country, but a few interceptions over the course of 20 years, especially if only in passenger baggage, are insufficient evidence that a pest is present in a country or attacks a commodity. Passengers may transit several countries before arriving in the United States, and inspectors or identifiers may make errors while processing large volumes of passengers or shipments. Likewise, commodities carried may not be commercial quality produce.

Pseudococcus cryptus Hempell was intercepted on *Phalaenopsis* spp. from the Philippines prior to 1985 (Williams, 2004), but has not been intercepted again. Therefore, we did not include it above. Zhang (1994) listed orchids as a host of the lymantrid moth *Orgyia postica*, an insect which occurs in China. However, this host association was insufficient, given the immense variety of orchid genera and species, for us to conclude that it is a pest of *Phalaenopsis* orchids.

2.4.3. Quarantine pests that are likely to follow the pathway

In this risk assessment we identify and characterize the main sources of uncertainty. These include the use of a developing or evolving process (Orr et al., 1993), the approach used to combine risk elements (Bier, 1999; Morgan and Henrion, 1990), and the evaluation of risk by comparisons to lists of factors within the guidelines (Kaplan, 1991; Orr et al., 1993). Sources of uncertainty in this analysis stem from the quality of the biological information, which includes increased uncertainty whenever biological information is lacking on the regional flora and fauna (Gallegos and Bonano, 1993) and the inherent biological variation within a population of organisms (Morgan and Henrion, 1990). To address this uncertainty, only the quarantine pests that can reasonably be expected to follow the pathway, i.e., be included in commercial shipments of *Phalaenopsis* plants, are further analyzed. We found four quarantine pests that are likely to follow the pathway on *Phalaenopsis* in growing media from China: the insects, *Spodoptera litura* and *Thrips palmi*, the fungus, *Cylindrosporium phalaenopsidis*, and the mollusk, *Lissachatina fulica.*

2.5. Consequences of Introduction

2.5.1. Overview
The undesirable consequences that may occur from the introduction of quarantine pests are assessed in this section. For each quarantine pest, the potential consequences of introduction are rated using five Risk Elements: Climate-Host Interaction, Host Range, Dispersal Potential, Economic Impact, and Environmental Impact. These elements reflect the biology, host range and climatic/geographic distribution of each pest and are supported by published biological information. For each element, pests are assigned a rating of Low (1 point), Medium (2 points) or High (3 points). Cumulative risk values are then calculated by adding the ratings. The following scale is used to interpret this total: Low (5-8 points), Medium (9-12 points), and High (13-15 points) and are summarized below (Table 5). The ratings were determined using the criteria in the Guidelines for Pathway-Initiated Risk Assessments, Version 5.02 (PPQ, 2000).

2.5.2. *Cylindrosporium phalaenopsidis*
Climate-Host Interaction. The orchid black spot caused by *C. phalaenopsidis* was reported from production areas in the provinces of Fujian, Yunnan, Jiangsu, Shanghai, Nanjing and Guangdong in China (James, 2011; Lu et al., 1994) and Taiwan (Farr and Rossman, 2011). Those places, and the subtropical and tropical orchid-growing areas of China and Taiwan (Zheng et al., 2008) correspond to Plant Hardiness Zones 9–11 in the continental United States (Widilech, 2011) (Fig. 1). While orchids may be grown outdoors in the southern tier of the United States, they generally are grown indoors and/or in temperature controlled production facilities (Simone and Burnett, 1995). The risk rating for the Climate-Host Interaction for this pest is **Medium**.

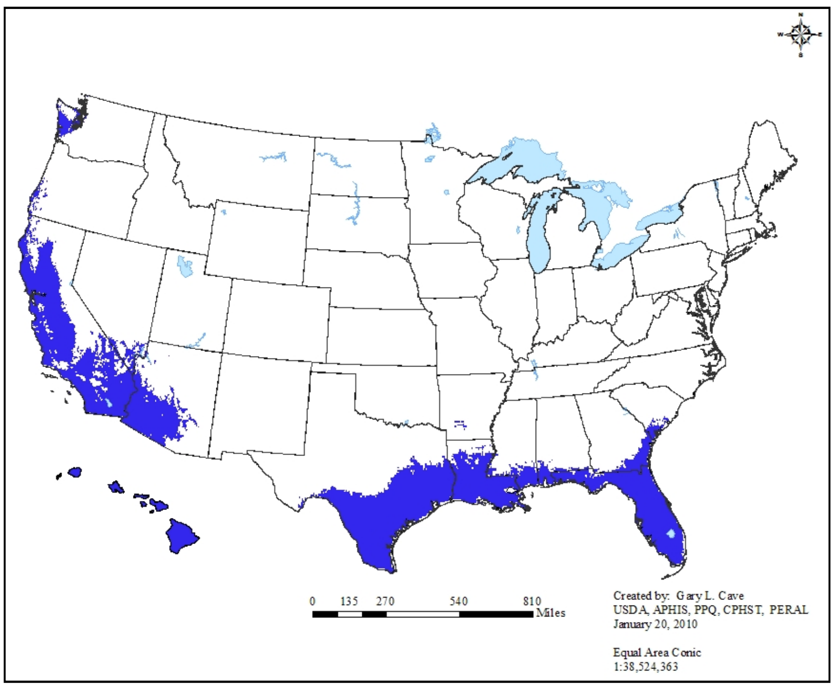

Figure 1. Plant Hardiness Zones potentially suitable for establishment by *Cylindrosporium phalaenopsidis.*

Host Range. The host range for *C. phalaenopsidis* includes *Cymbidium* spp., *Calanthe* spp., and *Phalaenopsis* spp. (James, 2011). All three genera are members of the family Orchidaceae. The risk rating for the host range for this pathogen is **Medium**.
Dispersal Potential. *Cylindrosporium phalaenopsidis* produces spores in acervuli (spore-forming structures) (Agrios, 1997). The spores are splashed by irrigation or rain onto nearby hosts (Agrios, 1997; Pirone, 1978), but are not likely to be widely dispersed over long distances (Agrios, 1997). Spores are produced throughout the growing season, indicating the formation of several asexual reproductive cycles of this pathogen (Agrios, 1997). For these reasons, we rated this element **Medium.**

Economic Impact. *Cylindrosporium phalaenopsidis* infects leaves (PestID, 2011; Lu et al., 1994). Most leaf-spot-causing pathogens reduce quality and decrease the value of ornamental crops in addition to reducing the available photosynthetic area and plant vigor (Agrios, 1997; Pirone, 1978). These losses reduce the market value of the plants (Agrios, 1997). Hence, we rated the Economic Impact as **Medium**.

Environmental Impact. We found no evidence that any Endangered, Threatened species are hosts of this pathogen (50 CFR§17.12, 2005). Chemical control programs [1% Bordeaux Mix and 50% Mancozeb, twice every 10 to 15 days (James, 2011)] would likely be implemented against this pest. Therefore, we rated Environmental Impact as **Medium**.

<u>2.5.3. *Lissachatina fulica*</u>
Climate-Host Interaction. *Lissachatina fulica* has been found in the tropics and sub-tropics throughout sub-Saharan Africa, Asia, the Caribbean, South America, and Oceana (CABI, 2011). In Africa, the range extends into South Africa, even to the southern coast (Raut and Barker, 2002). This distribution corresponds to USDA Plant Hardiness Zones 8-11 in the United States. Because Zone 11 is too small to count toward the total, the risk rating for this pest is **Medium**.

Host Range. The host range for *L fulica* is very large, including many different plant families across a wide genetic range including Aloeaceae, Amaranthaceae, Asteraceae, Cucurbitaceae, Orchidaceae, and Nyctaginaceae to name only a few. (Raut and Baker, 2002). The risk rating for Host Range is **High**.

Dispersal Potential. *Lissachatina fulica* can produce clutches of 100-400 eggs, up to three times a year. The snails are hermaphroditic and do not need to mate to produce eggs. An introduction in Florida involving as few as three individuals led to a large, but localized population in the course of three years (Poucher, 1975). Movement of snails is slow. For this pest we rated Dispersal Potential **Medium**.

Economic Impact. *Lissachatina fulica* has a large host range, and is reported to be a "serious" pest in many crops, although specific crop information was limited to coffee (Raut and Barker, 2002). The nuisance factor is also an issue that may cause control to be needed in non-agricultural settings. When the snail was briefly introduced into Florida in 1969, during the peak of the infestation, it was impossible to walk any distance in an infested area without stepping on a snail (Poucher, 1975). We rated this element **Medium**.

Environmental Impact. None of the recorded hosts of *L. fulica* are listed as threatened or endangered, although the polyphagous nature of the snail does not preclude it from feeding on not yet listed hosts. Eradication efforts would almost certainly be attempted for small infestations. The eradication effort in Florida involved 128 tons of arsenate-metaldehyde bait treatment over the course of 4.5 years (Poucher, 1975). Thus, we rated Environmental Impact **Medium**.

2.5.4. *Spodoptera litura*

Climate-Host Interaction. This noctuid caterpillar is widely distributed throughout tropical and temperate Asia, Australasia and the Pacific Islands (CABI, 2011). This distribution corresponds to USDA plant hardiness zones 7-11 in the United States (Magarey et al., 2008). The risk rating for the Climate-Host Interaction for this pest is **High**.

Host Range. *Spodoptera litura* is polyphagous and feeds on at least 120 species in many plant families (CABI, 2011). The risk rating for the host range for this insect is **High**.

Dispersal Potential. The eggs of *S. litura* are laid in clusters of 200-300 and the life cycle is completed in about 25 days (Schreiner, 2000). Female moths lay an average of 2600 eggs in their lifetime (Etman and Hooper, 1979). In tropical areas the moth can complete up to 12 generations per year (CABI, 2011). The moths have a flight range of 1.5 km during a period of 4 hours overnight, facilitating dispersion and oviposition on different hosts (Salama and Shoukry, 1972). For these reasons, Dispersal Potential was rated **High.**

Economic Impact. Under favorable conditions, i.e. no insecticide, populations of *S. litura* can increase very rapidly and move across fields like an army, hence the name ‘‘armyworm’’ (Ahmad et al., 2007). However, *S. litura* is very similar to moth species already present in the United States like *Spodoptera frugiperda* and *S. exigua*. Thus it is unlikely to add significantly to management costs should it become established. Consequently, we rated the Economic Impact as **Medium**.

Environmental Impact. *Spodoptera litura* is similar in biology and host range to army worms already present in the United States. It is therefore unlikely to increase the risk to threatened or endangered species in the United States. We rated Environmental Impact **Low**.

2.5.5 Thrips palmi

Climate-Host Interaction. *Thrips palmi* has been present in south Florida at least since 1991 and has not moved north of Palm Beach County in the 23 years since that time (Castineiras et al., 1997), despite unrestricted movement of plant material throughout the state. This evidence indicates that *T. palmi* has probably reached the northernmost limit of its potential climatic range. The insect is distributed through the tropics worldwide (CABI, 2011). This risk rating for Climate Host interaction is **Low**.

Host Range. *Thrips palmi* is polyphagous and feeds on a wide range of species in multiple families (CABI, 2011). For this reason the host range for this insect is **High**.

Dispersal Potential. *Thrips palmi* has not dispersed from southern Florida in the 23 years since it was first discovered there, indicating that it has a limited ability to disperse northward due to climatic factors. This element is rated **Low**.

Economic Impact. Since *T. palmi* is already established in southern Florida, the impact of this pest is based soley on its ability to transmit tospoviruses from China into the United States by way of *Phalaenopsis* imports. The viruses listed in this assessment are all present in the United States, although *Capsicum chlorosis virus* (CaCV) may not be widely distributed. *Thrips palmi* has been mentioned as potential vector of CaCV (Persley et al 2006; McMichael et al., 2002; and Goldach and Kuo, 2006), but these references only cite evidence that *T. palmi* transmits some tospoviruses and do not refer to direct evidence. Zheng et al., (2008) found that *T. palmi* was not capable of transmitting the *Phalaenopsis* variety of the virus, CaCV-Ph. This element is rated **Low**.

Environmental Impact. Since *T. palmi* is already established in southern Florida at the extent of its probable northern range, no environmental impact is anticipated. The element is rated **Low**.

Table 5. Summary of the risk ratings and the cumulative Consequences of Introduction rating.

Pest	Climate-Host Interaction	Host Range	Dispersal Potential	Economic Impact	Environment-al impact	Cumulative risk rating (score)
Cylindrosporium phalaenopsidis	Med (2)	Med (2)	Med (2)	Med (2)	Med (2)	Medium (10)
Lissachatina fulica	Med (2)	High (3)	Med (2)	Med (2)	Med (2)	Medium (11)
Spodoptera litura	High (3)	High (3)	High (3)	Med (2)	Low (1)	Medium (12)
Thrips palmi	Low (1)	High (3)	Low (1)	Low (1)	Low (1)	Low (7)

[a] Low = 5-8 points, Medium = 9-12, and High = 13-15.

2.6. Likelihood of Introduction

The likelihood of introduction for a pest is rated relative to six factors, which include the quantity imported annually (PPQ, 2000). As per the Guidelines for Pathway-Initiated Risk Assessments, Version 5.02 (PPQ, 2000), the value for the Likelihood of Introduction is the sum of all the ratings, which we summarized below (Table 6).

2.6.1. Quantity imported annually

We base this rating on the amount proposed by the country for export, converted into standard units of 40-foot-long shipping containers. Permission to import into the United States is likely to be linked with an increase in production in the future and subsequent increases in the volumes of imports. No more than 10 containers per year are expected to be exported from China into the United States; therefore we rated all pests **Low** for this element.

<u>2.6.2. Availability of post-harvest treatments</u>
With the exception of the removal of diseased leaves and application of pesticides from December to March to control diseases during seedling production (Lu et al., 1994), no specific post-harvest treatments have been proposed to control, reduce, or eliminate the pests. Thus, we rated this element **High** for all pests.

<u>2.6.3. Survive shipment</u>
The plants are likely to be shipped at moderate temperatures and humidity, which are unlikely to adversely affect pest populations present on the shipments. Therefore, we rated this element **High** for all pests.

<u>2.6.4. Not detected at the port-of-entry</u>
As defoliators, *Spodoptera litura* larvae produce fairly obvious leaf damage, especially on a smaller, ornamental plant. We rated *S. litura* **Low** for this element.

Thrips palmi are small and difficult to detect. The rating for T. palmi is **High**.

Spores of pathogens like *Cylindrosporium phalaenopsidis* readily produce symptoms after spore germination; the mycelium grow in the mesophyll and in approximately two weeks form the acervuli and conidia in upper surface of affected tissue (Agrios, 1997). *Cylindrosporium phalaenopsidis* cause leaf spots (Agrios, 1997; Pirone, 1978) that are easily detected by trained inspectors. Latent infections, on the other hand, are unlikely to be detected (Agrios, 1997; Pirone, 1978). The risk rating for *C. phalaenopsidis* is **Medium.**

Lissachatina fulica can be easily detected by trained inspectors, especially by checking for damaged leaves. The rating for *L. fulica* is **Low.**

<u>2.6.5. Moved to a suitable habitat</u>
Spodoptera litura could survive in USDA Plant Hardiness Zones 7 respectively (Magarey et al., 2008), covering at least half of the continental United States, so we rated them **High** for this element. The geographic area suitable to *L. fulica* survival is limited to southern states, so we rated this pest **Medium** for this element.

Thrips palmi has demonstrated the ability to live in USDA Plant Hardiness Zone 11 only (Kawai, 1990), and is already present in the area of Florida corresponding to this Zone (Castineiras et al., 1997). This pest is rated **Low** for this element.

The spores of fungal pathogens are readily disseminated by a variety of mechanisms (Agrios, 1997; Pirone, 1978). Spores often require high relative humidity and moderate temperatures for limited periods of time to infect (Agrios, 1997). In China, *C. phalaenopsidis* caused an epidemic in orchids when environmental conditions of "cloudy and drizzly weather" occurred in the otherwise windless, hot, and sunny climate (Lu et al., 1994). Normal orchid culture conditions provide both high relative humidity and moderate temperatures (Hartmann and Kester, 1959), so spores seem very likely find suitable conditions for infection. Thus, we rated the pest **High**.

2.6.6. Contact with Host Material

All five pests are highly likely to come into contact with host material if it enters the United States because infested orchids are likely to be grown near other orchids indoors or in greenhouses. Additionally, close proximity in these indoor environments is likely to facilitate dissemination of fungal spores to other orchid plants (Agrios, 1997; Pirone, 1978). We rated all four pests **High** for this element.

Table 6. Summary of the Risk Ratings for the Likelihood of Introduction.

Pest	Quantity imported annually	Survive post-harvest treatment	Survive shipment	Not detected at port-of-entry	Moved to a suitable habitat	Find suitable hosts	Cumulative risk rating[b]
Cylindrosporium phalaenopsidis	Low (1)	High (3)	High (3)	Med (2)	High (3)	High (3)	High (15)
Lissachatina fulica	Low (1)	High (3)	High (3)	Low (1)	Med (2)	High (3)	Medium (13)
Spodoptera litura	Low (1)	High (3)	High (3)	Low (1)	High (3)	High (3)	Medium (14)
Thrips palmi	Low (1)	High (3)	High (3)	High (1)	Low (1)	High (3)	Medium (12)

[b] Low = 6-9 points, Medium = 10-14 points, and High = 15-18 points.

2.7. Pest Risk Potential and Conclusion

We analyzed four quarantine pests in this risk assessment. The overall pest risk potential for all pests was Medium. Specific phytosanitary measures may be necessary for pests with a Medium rating, and are strongly recommended for pests with High pest risk potentials. Risk management measures are considered elsewhere, as part of the risk management phase.

Table 7. Pest Risk Potentials for quarantine pests of *Phalaenopsis* spp. from China.

Pest	Consequences of Introduction	Likelihood of Introduction	Pest risk potential[a]
Cylindrosporium phalaenopsidis	Medium (11)	High (15)	Medium (26)
Lissachatina fulica	Medium (11)	Medium (13)	Medium (24)
Spodoptera litura	Medium (12)	Medium (14)	Medium (26)
Thrips palmi	Low (7)	Medium (12)	Medium (19)

[a] Low (11-18 points), Medium (19-26 points), and High (27-33 points)

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