

Movement of Papaya Fruit *Carica papaya* from Hawaii into other regions of the United States

Qualitative, Pathway-Initiated Pest Risk Assessment

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A. Introduction

This pest risk assessment was prepared by the Animal and Plant Health Inspection Service (APHIS) of

the U.S. Department of Agriculture (USDA) to examine plant pest risks associated with the movement into the United States of **fresh papaya fruits (*Carica papaya*) grown in Hawaii**. This is a qualitative pest risk assessment, that is, estimates of risk are expressed in qualitative terms such as high or low as opposed to numerical terms such as probabilities or frequencies.

International plant protection organizations (e.g., North American Plant Protection Organization (NAPPO), International Plant Protection Convention (IPPC) of the United Nations Food and Agriculture Organization (FAO)) provide guidance for conducting pest risk analyses. The methods used to initiate, conduct, and report this plant pest risk assessment are consistent with guidelines provided by NAPPO, IPPC and FAO. The biological and phytosanitary terms (e.g., introduction, quarantine pest) used in this document conforms with the *NAPPO Compendium of Phytosanitary Terms* (NAPPO 1995) and the *Definitions and Abbreviations* (Introduction Section) in *International Standards for Phytosanitary Measures, Section 1—Import Regulations: Guidelines for Pest Risk Analysis* (FAO 1995).

Pest risk assessment is one component of an overall pest risk analysis. The *Guidelines for Pest Risk Analysis* provided by FAO (1995) describe three stages in pest risk analysis. This document satisfies the requirements of FAO Stages 1 (initiation) and 2 (risk assessment).

The Food and Agriculture Organization (FAO, 1995) defines "pest risk assessment" as "Determination of whether a pest is a quarantine pest and evaluation of its introduction potential". "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, 1995; NAPPO, 1995). Thus, pest risk assessments should consider both the likelihood and consequences of introduction of quarantine pests. Both issues are addressed in this qualitative pest risk assessment.

This document presents the findings of the qualitative plant pest risk assessment. The assessment methods or the criteria used to rate the various risk elements are not described in detail. The details of methodology and rating criteria can be found in the "template" document: *Pathway-Initiated Pest Risk Assessment: Guidelines for Qualitative Assessments, version 4.0* (USDA, 1995); to obtain a copy of the template, contact the individual named in the proposed regulations.

B. Risk Assessment

1. Initiating Event: Proposed Action

This pest risk assessment is commodity-based, and therefore "pathway-initiated"; the assessment is in response to the request for USDA authorization to allow movement of a particular commodity presenting a potential plant pest risk. In this case, the movement of **fresh papaya fruits (*Carica papaya*) grown in Hawaii** into the U.S. is a potential pathway for introduction of plant pests. Regulatory authority for the movement of fruits and vegetables from Hawaii into other regions of the U.S. is found in 7 CFR §318.13 .

Carica papaya (L.) is a member of the plant family Caricaceae. The family consists of four genera with *Carica* being the most important. The genus *Carica* includes 21 species native in tropical and subtropical America (Ploetz, 1994). Papaya is grown commercially throughout the world in the tropics and subtropics. Commercial production in the United States is limited to Florida, Hawaii, and

Puerto Rico.

2. Assessment of Weediness Potential of papaya, *Carica papaya*

Table 1 shows how the results of the weediness screening for *Carica papaya*. These findings did not require a pest-initiated risk assessment.

Table 1: Process for Determining Weediness Potential of Commodity	
Commodity: <i>Carica papaya</i> L. (papaya) (Caricaceae)	
Phase 1: <i>Carica papaya</i> is grown commercially in Florida and Hawaii. Papaya is also grown in greenhouses throughout the United States, primarily as a curiosity.	
Phase 2: Is the species listed in:	
<u>NO</u>	<i>Geographical Atlas of World Weeds</i> (Holm, 1979)
<u>NO</u>	<i>World's Worst Weeds</i> (Holm, 1977)
<u>NO</u>	<i>Report of the Technical Committee to Evaluate Noxious Weeds; Exotic Weeds for Federal Noxious Weed Act</i> (Gunn & Ritchie, 1982)
<u>NO</u>	<i>Economically Important Foreign Weeds</i> (Reed, 1977)
<u>NO</u>	Weed Science Society of America list (WSSA, 1989)
<u>NO</u>	Is there any literature reference indicating weediness (e.g., <i>AGRICOLA</i> , <i>CAB</i> , <i>Biological Abstracts</i> , <i>AGRIS</i> ; search on "species name" combined with "weed").
Phase 3: Conclusion:	
<i>Carica papaya</i> is grown for commercial and other purposes throughout the United States and the scientific literature provided no indication of weediness potential.	

3. Previous Risk Assessments, Current Status and Pest Interceptions

3a. Decision history for *Carica papaya*.

There were no previous risk assessment (decision sheets) on papaya from Hawaii.

3b. Interceptions from Hawaii FY 1985-95.

PEST	HOST	TOTAL
.....		
<i>Aleurodicus dispersus</i>	<i>Carica papaya</i>	3
<i>Bactrocera cucurbitae</i>	<i>Carica papaya</i>	2
<i>Bactrocera dorsalis</i>	<i>Carica papaya</i>	366
<i>Bactrocera dorsalis</i>	<i>Carica papaya</i>	1
<i>Bactrocera dorsalis</i>	<i>Carica papaya</i>	1
<i>Bactrocera</i> sp.	<i>Carica papaya</i>	5
Tephritidae, species of.	<i>Carica papaya</i>	29
Tephritidae, species of.	<i>Carica</i> sp.	1
<i>Ceratitidis capitata</i>	<i>Carica papaya</i>	1
Cicadellidae, species of.	<i>Carica</i> sp.	1

4. Pest List: Pests Associated with papaya in Hawaii

Table 2 shows the pest list for *Carica* spp. which was developed after a review of the information sources listed in USDA (1995). The pest list summarizes information on the distribution of each pest, pest-commodity association, and regulatory history.

Table 2: Pest List - <i>Carica</i> spp.			
Scientific Name, Classification	Distribution¹	Comments²	References
Pathogens			
<i>Alternaria alternata</i> (Fr.:Fr.) Keissl. (Fungi Imperfecti: Hyphomycetes)	HI,US	c,o, z _e	Farr <i>et. al.</i> , 1989; Raabe <i>et. al.</i> , 1981
<i>Botrytis cinerea</i> Pers.:Fr. (Fungi Imperfecti: Hyphomycetes)	HI,US	o,z _e	Farr <i>et. al.</i> , 1989; Nakahara, 1995
<i>Calonectria crotalariae</i> (Loos) Bell Sobers (Pyrenomycetes: Hypocreales)	HI,US	a,c,o	Farr <i>et. al.</i> , 1989; Raabe <i>et. al.</i> , 1981
<i>Cercospora mamaonis</i> Viegas & Chupp (Fungi Imperfecti: Hyphomycetes)	HI	z _e	Farr <i>et. al.</i> , 1989; Raabe <i>et. al.</i> , 1981; Watson, 1971
<i>Cercospora papayae</i> Hansford (Fungi Imperfecti: Hyphomycetes)	HI,US	c,f,o	Farr <i>et. al.</i> , 1989; Raabe <i>et. al.</i> , 1981
<i>Colletotrichum gloeosporioides</i> (Penz.) Pens. & Sacc. in Penz. (Fungi Imperfecti: Coelomycetes)	HI,US	c,o,z _e	Farr <i>et. al.</i> , 1989; Raabe <i>et. al.</i> , 1981

<i>Fusarium solani</i> (Mart.) Sacc. (Fungi Imperfecti: Hyphomycetes)	HI,US	c,o,z ₁	Farr <i>et. al.</i> , 1989; Raabe <i>et. al.</i> , 1981; Ploetz <i>et. al.</i> , 1994
<i>Glomerella tucumanensis</i> (Speg.) Arx & E. Muller (Pyrenomycetes: Phyllachorales)	HI,US	f,o	Farr <i>et. al.</i> 1989;
<i>Lasiodiplodia theobromae</i> (Pat.) Griffon & Maubl. (Fungi Imperfecti: Coelomycetes)	HI,US	c,z _e	Farr <i>et. al.</i> , 1989; Raabe <i>et. al.</i> , 1981
<i>Mycosphaerella caricae</i> Syd. & P. Syd. (Loculoascomycetes: Dothideales) Anamorph: <i>Phoma caricae-papayae</i> (Tarr) Punithalingham (Syn.: <i>Ascochyta caricae</i> Pat. <i>A. caricae-papayae</i> Tarr)	HI,US	f,o	Farr <i>et. al.</i> , 1989; Raabe <i>et. al.</i> , 1981; Alvarez & Nishijima, 1987; CMI, 1993
<i>Oidium caricae</i> F. Noack (Fungi Imperfecti: Hyphomycetes)	HI,US	a,f,o	Farr <i>et. al.</i> , 1989; Raabe <i>et. al.</i> , 1981; Ploetz <i>et. al.</i> , 1994
<i>Phomopsis caricae-papayae</i> Pet. & Cif. (Fungi Imperfecti: Coelomycetes)	HI	z _e	Farr <i>et. al.</i> , 1989; CMI, 1985
<i>Phytophthora capsici</i> Leonian (Oomycetes: Peronosporales)	HI,US	c,f,o,z _e	Farr <i>et. al.</i> , 1989; CMI, 1985b
<i>Phytophthora nicotianae</i> Breda de Haan var. <i>parasitica</i> (Dastur) G. M. Waterhouse (Oomycetes: Coelomycetes)	HI,US	f,o	Farr <i>et. al.</i> , 1989; CMI, 1964
<i>Phytophthora palmivora</i> (E. J. Butler) E. J. Butler (Oomycetes: Coelomycetes)	HI,CA,FL	c,f,o	Farr <i>et. al.</i> , 1989; CMI, 1985c; Ploetz <i>et. al.</i> , 1994
<i>Pythium aphanidermatum</i> (Edson) Fitzp. (Oomycetes: Peronosporales)	HI,US	a,c,f,o	Farr <i>et. al.</i> , 1989; CMI, 1964a
<i>Pythium ultimum</i> Trow (Oomycetes: Coelomycetes)	HI,US	a,c,f,o	Farr <i>et. al.</i> , 1989; Raabe <i>et. al.</i> , 1981
<i>Pythium vexans</i> de Bary (Oomycetes: Coelomycetes)	HI,US	a,f,o	Farr <i>et. al.</i> , 1989; Raabe <i>et. al.</i> , 1981
<i>Rhizoctonia solani</i> Kuhn (Fungi Imperfecti: Agonomycetes)	HI,US	c,f,o	Yamamoto, 1982; Farr <i>et. al.</i> , 1989
<i>Rhizopus stolonifer</i> (Ehrenb.:Fr.) Vuill. (Zygomycetes: Mucorales)	HI,US	c,f,o,z _e	Farr <i>et. al.</i> , 1989; Raabe <i>et. al.</i> , 1981
<i>Stemphyllium lycopersici</i> (Enjoji) W. Yamamoto (Fungi Imperfecti: Hyphomycetes)	HI,US	c,f,o,z _e	Snowdon, 1990

Bacteria

<i>Enterobacter cloacae</i> (Jordan) Honmaeche & Edwards	HI,US	z ₁	Ploetz <i>et. al.</i> , 1994; Nelson & Craft, 1991
<i>Erwinia herbicola</i> (Loehnis) Dye	HI,US	c,o,z ₁	Raabe <i>et. al.</i> , 1981
<i>Pseudomonas caricapapayae</i> Robbs	HI	a	Nakahara, 1995; Bradbury, 1986

Virus and viruslike agents

Papaya mosaic virus	HI,US	d,f,o	Ploetz <i>et. al.</i> , 1994; Namba & Higa, 1978; Raabe <i>et. al.</i> , 1981
Papaya ringspot virus	HI,US	d,f,o	Raabe <i>et. al.</i> , 1981; Ploetz <i>et. al.</i> , 1994
Tomato spotted wilt virus	HI,US	d,f,o	Brunt <i>et. al.</i> , 1996; Gonsalves & Trujillo, 1986

Diseases of unknown etiology

Freckles	HI	d	Ploetz, <i>et. al.</i> , 1994
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Arthropods

<i>Agrotis ipsilon</i> (Hufnagel) (Lepidoptera: Noctuidae)	HI,US	c,f,o	Yee <i>et. al.</i> , 1970
<i>Aleurodiscus dispersus</i> Russell (Homoptera: Aleyrodidae)	HI,FL	a,g	USDA, 1996; Nakahara, 1996
<i>Amarygmus morio</i> (Fabricius) (Coleoptera: Tenebrionidae)	HI	a	HES, 1974
<i>Amorbia emigratella</i> Busch (Lepidoptera: Tortricidae)	HI,US	c,f,o	Anon., 1994
<i>Amphorophora sonchi</i> (Oestlund) (Homoptera: Aphididae)	HI,US	a,c	Zimmerman, 1948
<i>Aonidiella inornata</i> McKenzie (Homoptera: Diaspididae)	HI,PR	j,z _e	Anon., 1994; Nakahara, 1982
<i>Aphis craccivora</i> Koch (Homoptera: Aphididae)	HI,US	c,f,o,y	Higa & Namba, 1970
<i>Aphis gossypii</i> Glover (Homoptera: Aphididae)	HI,US	c,f,o,y	Higa & Namba, 1970
<i>Aphis middeltonii</i> Thomas (Homoptera: Aphididae)	HI,US	c,f,o	Yee <i>et. al.</i> , 1970
<i>Aspidiotus destructor</i> Signoret (Homoptera: Diaspididae)	HI,US	c,f,o	Nakahara, 1982
<i>Bactrocera cucurbitae</i> (Coquillett) (Diptera: Tephritidae)	HI,US ₃	h,z ₁	Anon., 1994
<i>Bactrocera dorsalis</i> (Hendel) (Diptera: Tephritidae)	HI,US ₃	h,x,z ₁	Anon., 1994
<i>Brevipalpus obovatus</i> Donnadieu (Acari: Tenuipalpidae)	HI,US	c,f,o	Anon., 1994; Jeppson <i>et. al.</i> , 1975
<i>Brevipalpus phoenicis</i> (Geijskes) (Acari: Tenuipalpidae)	HI,US	c,f,o,z _e	Haramoto, 1969; Nakahara, 1978; Jeppson <i>et. al.</i> , 1975
<i>Calacarus brionesae</i> Keifer (Acari: Eriophyidae)	HI	a,z _e	Anon., 1994; Jeppson <i>et. al.</i> , 1975; HES, 1992
<i>Ceratitis capitata</i> (Wiedemann) (Diptera: Tephritidae)	HI,US ₃	h,n,z ₁	Liquido <i>et. al.</i> 1995; EPPO, 1994
<i>Coccus elongatus</i> (Signoret) (Homoptera: Coccidae)	HI,US	c,f,o	Yee <i>et. al.</i> , 1970

<i>Coccus hesperidum</i> L. (Homoptera: Coccidae)	HI,US	c,f,o	Hamon & Williams 1984
<i>Coccus longulus</i> (Douglas) (Homoptera: Coccidae)	HI,US	c,f,o	Hamon & Williams, 1984
<i>Conchaspis angraeci</i> Cockerell (Homoptera: Conchaspidae)	HI,US	c,f,o	Anon., 1994; Pena & Bennett, 1995
<i>Empoasca solana</i> DeLong (Homoptera: Cicadellidae)	HI,US	c,f,o	Anon., 1994; Zimmerman, 1948
<i>Empoasca stevensi</i> Young (Homoptera: Cicadellidae)	HI	a	Anon., 1994
<i>Erimyia ello</i> L. (Lepidoptera: Sphingidae)	HI,US	c	FAO, 1993
<i>Ethiorthrips brevis</i> (Bagnall) (Thysanoptera: Phlaeothripidae)	HI	b	Zimmerman, 1948; Nakahara, 1996
<i>Eutetranychus banksi</i> McGregor (Acari: Tetranychidae)	HI,US	c,f,o	Anon., 1994; Jeppson <i>et al.</i> , 1975
<i>Frankliniella occidentalis</i> Pergande (Thysanoptera: Thripidae)	HI,US	a,e,y	Cook, 1975
<i>Frankliniella schultzei</i> Trybom (Thysanoptera: Thripidae)	HI,FL	a,n,y	Cook, 1975; USDA, 1974
<i>Helicoverpa hawaiiensis</i> (Quaintance and Brues) (Lepidoptera: Noctuidae)	HI	a	Yee <i>et al.</i> , 1970
<i>Howardia biclavis</i> Comstock (Homoptera: Diaspididae)	HI,US	c,f,o	Anon., 1994; Nakahara, 1982
<i>Hyperomyzus lactucae</i> (L.) (Homoptera: Aphididae)	HI,US	c,f,o,y	Higa & Namba, 1970; Blackman & Eastop, 1984
<i>Lepidobregma minuscula</i> (Wassingham) (Lepidoptera: Tineidae)	HI,US	a,c	Zimmerman, 1948
<i>Macrosiphum euphorbiae</i> (Thos.) (Homoptera: Aphididae)	HI,US	c,f,o,y	Higa & Namba, 1970; Blackman & Eastop, 1994
<i>Macrosiphoniella sanborni</i> (Gillette) (Homoptera: Aphididae)	HI,US	a,c	Zimmerman, 1948
<i>Myzus persicae</i> (Sulzer) (Homoptera: Aphididae)	HI,US	c,f,o,y	Namba & Higa, 1978; Blackman & Eastop, 1994
<i>Neomyzus circumflexus</i> (Buckton) (Homoptera: Aphididae)	HI,US	c	Yee <i>et al.</i> , 1970
<i>Nesothrips major</i> (Bagnall) (Thysanoptera: Phlaeothripidae)	HI	b	Zimmerman, 1948; Nakahara, 1996
<i>Nezara viridula</i> (L.) (Heteroptera: Pentatomidae)	HI,US	c,f,o	Yee <i>et al.</i> , 1970
<i>Opogona sacchari</i> (Bojer) (Lepidoptera: Tineidae)	HI,FL	a,g	Anon., 1994; Davis & Pena, 1990
<i>Panonychus citri</i> (McGregor) (Acari: Tetranychidae)	HI,US	c,f,o	Anon., 1994; Jeppson, 1975
<i>Polyphagotarsonemus latus</i> (Banks) (Acari: Tarsonemidae)	HI,US	c,f,o	Higa & Namba, 1970; Jeppson <i>et al.</i> , 1975

<i>Pseudococcus viburni</i> (Signoret) (Homoptera: Pseucoccidae) [Syn: <i>P. affinis</i> (Maskell), <i>P. obscurus</i> (Maskell)]	HI,US	c,f,o	Anon., 1994; McKenzie, 1967
<i>Rhabdoscelus obscurus</i> (Boisduval) (Coleoptera: Curculionidae)	HI	a	Yee <i>et. al.</i> , 1970
<i>Rhopalosiphum maidis</i> (Fitch) (Homoptera: Aphididae)	HI,US	c,f,o,y	Higa & Namba, 1970; Blackman & Eastop, 1984
<i>Tetranychus cinnabarinus</i> (Boisd.) (Acari: Tetranychidae)	HI,US	c,f,o	Higa & Namba, 1970; Anon., 1994; Jeppson <i>et. al.</i> , 1975
<i>Thrips tabaci</i> Linderman (Thysanoptera: Thripidae)	HI,US	c,f,o	Yee <i>et. al.</i> , 1970; Cook, 1975
<i>Trialeurodes vaporariorum</i> (Westwood) (Homoptera: Aleyrodidae)	HI,US	c,f,o	Yee <i>et. al.</i> , 1970
<i>Tuckerella ornata</i> (Tucker) (Acari: Tuckerellidae)	HI,US	c,f,o	Yee <i>et. al.</i> , 1970
<i>Tuckerella pavoniformis</i> (McGregor) (Acari: Tuckerellidae)	HI,US	c,f,o	Yee <i>et. al.</i> , 1970; Jeppson <i>et. al.</i> , 1975

¹ Distribution legend: HI = Hawaii; US = Continental United States; PR = Puerto Rico; FL = Florida; CA = California

- ² Comments:
- a = Pest mainly associated with a plant part other than the commodity.
 - b = Not likely to be a primary plant pest.
 - c = Listed in non-reportable dictionary as non-actionable.
 - d = Commodity is unlikely to serve as inoculum source because vector is unknown or does not feed on commodity and/or seed transmission has not been reported in *Carica* spp.
 - f = Pest occurs in the U.S. and is not subject of official restrictions and regulations.
 - g = Quarantine pest: pest has limited distribution in the U.S. and is under official control as follows: pest listed by name in USDA's pest dictionary, official quarantine action may be taken on this pest when intercepted on this commodity.
 - h = Quarantine pest: pest has limited distribution in the United States and is under official control as follows: (1) pest listed by name in USDA's pest dictionary, official quarantine action taken on this pest when intercepted on this commodity and (2) pest is a "program pest" (there is an official Federal or State program for control of this pest beyond its being listed in the pest dictionary as actionable).
 - j = Armored scale insect: no quarantine action on fruit for consumption because "armored scales in general have a low probability of establishment from infested shipments of commercial fruit: (ARS, 1985).
 - n = Listed in the USDA catalogue of intercepted pests as actionable.
 - o = Pest does not meet the geographic or regulatory definition of a quarantine pest
 - x = Multiple interception records exist.
 - y = Pest is a vector of plant pathogens.
 - z_e = External pest: is known to attack or infest fruits of *Carica* spp. and it would be reasonable to expect the pest may remain with the commodity during processing and shipping.
 - z_i = Internal pest: is known to attack or infest fruits of *Carica* spp. and it would be reasonable to expect the pest may remain with the commodity during processing and shipping.

3. *Bactrocera cucurbitae*, *B. dorsalis* and *Ceratitis capitata* have been detected on occasion in the United States. Whenever they are detected, a quarantine is established and an eradication program implemented. They are considered to be quarantine pests in the United States.

5. List of Quarantine Pests

The list of quarantine pests for commercial shipments of papaya from Hawaii is provided in Table 3. Should any of these pest be intercepted on commercial (or any other) shipments of *Carica papaya*, quarantine action may be taken.

Table 3: Quarantine Pests: Papaya fruits consumption

Fungi	<i>Cercospora mamaonis</i> <i>Phomopsis caricae-papayae</i>
Bacteria	<i>Pseudomonas caricapapayae</i>
Unknown etiology	Freckles
Arthropods	<i>Aleurodiscus dispersus</i> <i>Amarygmus morio</i> <i>Bactrocera cucurbitae</i> <i>Bactrocera dorsalis</i> <i>Calacarus brionesae</i> <i>Ceratitidis capitata</i> <i>Empoasca stevensi</i> <i>Frankliniella schultzei</i> <i>Helicoverpa hawaiiensis</i> <i>Opogona sacchari</i> <i>Rhabdoscelus obscurus</i>

6. Quarantine Pests Likely to Follow Pathway (i.e., Quarantine Pests Selected for Further Analysis)

Only those quarantine pests that can reasonably be expected to follow the pathway, *i. e.*, be included in commercial shipments of *Carica papaya* were analyzed in detail (see USDA, 1995 for selection criteria). Only quarantine pests listed in Table 4 were selected for further analysis and subjected to steps 7-9 below.

Table 4: Quarantine Pest Selected for Further Analysis: Hawaiian Papaya Fruits for consumption	
Pathogens	<i>Cercospora mamaonis</i> <i>Phomopsis caricae-papayae</i>
Unknown etiology	Freckles
Arthropods	<i>Bactrocera cucurbitae</i> <i>Bactrocera dorsalis</i> <i>Calacarus brionesae</i> <i>Ceratitidis capitata</i>

7. Economic Importance: Consequences of Introduction

The consequences of introduction was considered for each quarantine pest selected for further analysis. For qualitative, pathway-initiated pest risk assessments, these risks are estimated by rating each pest with respect to five risk elements. A full description of these elements and rating criteria can be found in USDA (1995). Table 5 shows the risk ratings for these risk elements.

Table 5: Risk Rating: Consequences of Introduction						
Pest	Climate/ Host	Host Range	Dispersal	Economic	Environ- mental	Risk Rating
<i>Cercospora mamaonis</i>	medium	low	medium	low	medium	medium
Freckles	medium	low	low	low	low	low
<i>Phomopsis caricae-papayae</i>	medium	low	medium	medium	medium	medium
<i>Bactrocera cucurbitae</i>	high	high	high	high	high	high
<i>Bactrocera dorsalis</i>	high	high	high	high	high	high
<i>Calacarus brionesae</i>	medium	low	low	medium	medium	medium
<i>Ceratitidis capitata</i>	high	high	high	high	high	high

8. Likelihood of Introduction

Each pest is rated with respect to introduction potential (*i.e.*, entry and establishment). Two separate components were considered. First, the amount of commodity likely to be moved is estimated. More movement leads to greater risk; the result is a risk rating that applies to the commodity and country in question and is the same for all quarantine pest considered. Second, five biological features *i.e.*, risk elements, concerning the pest and its interactions with the commodity are considered. The resulting risk ratings were specific to each pest. The cumulative risk rating for introduction was considered to be an indicator of the likelihood that a particular pest would be introduced. A full description of these elements and rating criteria can be found in USDA (1995). Table 6 shows the ratings for these risk elements.

Pest	Quantity of commodity imported annually	Likelihood survive postharvest treatment	Likelihood survive shipment	Likelihood not detected at port of entry	Likelihood moved to suitable habitat	Likelihood find suitable host	Risk rating
<i>Cercospora mamaonis</i>	low	medium	high	low	low	low	medium
Freckles	low	medium	high	low	low	low	medium
<i>Phomopsis caricae-papayae</i>	low	medium	high	low	low	low	medium
<i>Bactrocera cucurbitae</i>	low	high	high	high	high	high	high
<i>Bactrocera dorsalis</i>	low	high	high	high	high	high	high
<i>Calacarus brioneseae</i>	low	medium	medium	high	low	low	medium
<i>Ceratitis capitata</i>	low	high	high	high	high	high	high

9. Conclusion: Pest Risk Potential and Phytosanitary Measures

The measure of pest risk potential combines the risk ratings for consequences and likelihood of introduction as described in USDA (1995). Table 7 shows the estimated pest risk potential for the quarantine pests selected for further analysis for the movement of *Carica papaya*.

Pest	Pest risk potential
<i>Cercospora mamaonis</i>	medium
Freckles	medium
<i>Phomopsis caricae-papayae</i>	medium
<i>Bactrocera cucurbitae</i>	high
<i>Bactrocera dorsalis</i>	high
<i>Calacarus brionesae</i>	medium
<i>Ceratitis capitata</i>	high

For pests receiving a high PRP risk rating, we recommend specific phytosanitary measures be implemented. For pest receiving a medium PRP risk rating, APHIS risk assessors may, in some cases, recommend specific mitigation measures. Current port of entry inspection procedures should provide sufficient mitigation. However, if these pests are intercepted on Hawaiian papaya fruits, Program Support staff may implement appropriate sanitary and phytosanitary measures they believe necessary to mitigate pest risk. Detailed examination and choice of appropriate sanitary and phytosanitary measures to mitigate pest risk is undertaken as part of the pest risk management phase and is not discussed in this document.

PPQ has intercepted over 450 pests with papaya fruits from Hawaii and other areas; however, virtually all external pests listed could be detected by inspection. Some of these same pests occur in Hawaii in addition to other quarantine pests and have been intercepted as hitchhikers with other commodities. Should any of these pests be intercepted on commercial (or any other) shipments of Hawaiian papaya, quarantine action may be taken.

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