Review of the PERAL 2009 Greater Caribbean Region (GCR) Pathway Analysis
June 21, 2019

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1. Introduction

This review answers the following questions: Are the prioritized pathways as identified in the 2009 analysis, "Evaluation of Pathways for Exotic Plant Pest Movement into and within the Greater Caribbean Region" (PERAL, 2009), still relevant and correct? If yes, how do these prioritized pathways relate to the five pests that are common between the 2015 APHIS Prioritized Offshore Pest List and the Caribbean Plant Health Directors Forum (CPHD) Regional Priority Pest List?

The pests in common between the 2015 APHIS Prioritized Offshore Pest List and the CPHD Regional Priority Pest List are the following:

- *Ceratitis capitata* (Diptera: Tephritidae)
- Citrus leprosis virus
- Ralstonia solanacearum race 3 biovar 2
- *Tuta absoluta* (Lepidoptera: Gelechiidae)
- *Xanthomonas* (citrus canker)

The objective of the 2009 pathway analysis was to contribute to an improved understanding of pathways for plant pest movement into and within the entire Greater Caribbean Region (GCR). For the purposes of the 2009 report, the GCR was defined as all countries bordering the Caribbean Sea, plus the Bahamas, Turks and Caicos, El Salvador, Suriname, Guyana, and the U.S. Gulf States (Florida, Alabama, Mississippi, Louisiana, and Texas). The pest risk to Mexico, Venezuela, and Colombia was not addressed in the report, though these countries were considered as sources of pest risk. The pathways discussed and their estimated pest risk ratings are listed as follows. The relative importance of each pathway was rated based on the available data. Although the pathways are discussed separately, they have considerable overlap. Not every potential pathway of pest movement was analyzed; the report focused on those that seemed most significant.

Pest risk rating was rated **very high** for:

- human movement[1]
- hitchhikers[2]
- wood packaging materials
- forestry-related pathways[3]
- propagative materials

[1] People moving between areas may contribute to the spread of plant pests in several different ways: carrying the pest on themselves, their clothing, or their shoes; transporting the pest on objects brought to an area (e.g., handicrafts made from plant parts), or by intentionally collecting the pest to take it to a different location (PERAL, 2009).

[2] "A hitchhiker pest is a plant pest that is moved, not on a host commodity, but either with a non-host commodity directly or on/in the conveyance (airplane, maritime vessel, etc.) or shipping container used for transport" (PERAL, 2009).

[3] "include wood products, non-wood forest products, Christmas trees, and trees for planting; non-wood forest products include food products (e.g., nuts, berries, leaves, and edible fungi), medicinals, bamboo, and craft products" (PERAL, 2009).

Pest risk rating was rated medium for:

- airline passenger baggage
- international mail
- natural pest spread

None of the pathways assessed were rated as high, low, or negligible risk. The following pathways were not addressed in the 2009 report:

- cut flowers entering Miami from the Caribbean
- air cargo
- garbage
- live animals as a pathway for weed seeds
- military
- medicinal plants harvested from forests
- bonsai trees from Asia
- commodities*

*The following justification was given for not analyzing the commodities pathway: "The pest risk associated with commodities, while very possibly the most important threat, is difficult to characterize due to the immense number of different commodities arriving from all over the world, each having a different level of pest risk associated with it. Given that legally traded commodities already receive attention from importing countries, and given that a general process for commodity pest risk assessment is in place (IPPC, 2007) and must be commodity- and origin-specific to be meaningful, this chapter [on maritime traffic] does not focus on commodities." (PERAL, 2009).

2. Review results

2.1 Are the prioritized pathways as identified in the 2009 analysis (PERAL, 2009) still relevant and correct?

We determined that the prioritized pathways as identified in the 2009 analysis are still relevant and correct. Much of the data used for the analysis was based on 2009 or earlier port data (e.g., pest interceptions, quarantine material approach rates, container volumes, number of maritime vessels and aircraft arrivals, number of travelers). While the numbers for this port data could be updated, we found no evidence to indicate that updating these numbers would change the overall or relative pest risks of the different pathways. For example, we reviewed data for the number of tourists in the Caribbean by country and region of origin from 2008 through 2019 (CTO, 2019). While the total number of tourists fluctuated (but mainly increased) to some extent over this time frame, the relative numbers by country and region of origin did not change much at all. Other types of data were also used in the 2009 analysis, such as scientific literature on pest spread and country import regulations. An update of these types of data to include information since 2009 would be unlikely to change the overall or relative pest risks of the different pathways. For instance, pest biology and human behavior that contributes to pest movement would not have changed since 2009. Also, country import regulations may have changed some but likely not significantly. For example, in the 2009 analysis, the following countries in the GCR required treatment of wood packaging material in accordance with ISPM #15: Costa Rica, Cuba, Dominican Republic, Guyana, Guatemala, Honduras, Nicaragua, and the United States. Since 2009,

Jamaica and Trinidad and Tobago are the only additional countries that require ISPM #15 treatment (APHIS, 2017). Therefore, the majority of GCR countries still do not require ISPM #15 treatment. In summary, based on our review of the 2009 analysis, we conclude that the pest risk ratings for the pathways analyzed likely would not change if the analysis were updated with more recent data.

2.2 How do these prioritized pathways relate to the five pests that are common between the 2015 APHIS Prioritized Offshore Pest List and the Caribbean Plant Health Directors Forum (CPHD) Regional Priority Pest List?

The 2009 pathway analysis characterized the relative risks of the different pathways in terms of plant pests in general (i.e., the whole universe of potential plant pests). While the risk ratings for the different pathways are still relevant for the overall pest universe, each of these risk ratings do not necessarily apply to individual pests. Therefore, for each of the five pests in common between the APHIS and CPHD pest lists, we give a very rough preliminary estimate as to whether each risk rating in the 2009 analysis likely applies to the pest, and we give a very rough preliminary risk rating for each pest and pathway combination. The preliminary risk ratings are based on: 1) information and conclusions from the 2009 analysis about the pathways in general, 2) evidence from the literature and U.S. interception data on means of spread for each pest, 3) evidence of presence of each pest in the GCR (as this can impact the likelihood of natural spread).

We give the detailed results for each pest in Tables 1 through 5; the pathways with preliminary ratings of medium or higher are highlighted in gray. We rate some pathways as "unknown" because we do not have enough information on the particular pathway to make a preliminary determination.

Ceratitis capitata

Notes on *Ceratitis capitata* that are relevant to the preliminary estimate of the pathway risk ratings:

- Distribution includes countries in the GCR (Colombia, Venezuela, Costa Rica, Nicaragua, and Panama) (CABI, 2019).
- Means of spread include:
    - human movement across land borders (PERAL, 2009: "[T]here is speculation that [temporary] workers enter Belize with infested fruit fly host material, thus introducing the unwanted Medfly, *Ceratitis capitata.*")
    - fruit containing larvae in cargo (CABI, 2019)
    - infested smuggled fruit in airline passenger baggage (CABI, 2019) (PestID, 2019: The pest has been intercepted in passenger baggage at U.S. ports of entry 3,301 times since 1985.)
    - infested fruit in mail (CABI, 2019) (PestID, 2019: The pest has been intercepted 31 times in mail, mostly as larvae and pupae with fruit.)
    - propagative material (CABI, 2019: *C. capitata* pupae can occur in growing medium accompanying plants) (PestID, 2019: The pest has been intercepted 16 times with propagative material, mostly as larvae with fruit in passenger baggage.)
    - pupae in soil (CABI, 2019)
    - adult flight (CABI, 2019)
    - hitchhiker (PestID, 2019: Since 1985, adults "at large" were intercepted with aircraft and maritime vessels at U.S. ports of entry 14 times.)

Table 1. ***Ceratitis capitata***: Comparison of risk ratings in 2009 Pathway Analysis with preliminary risk ratings for this specific pest. Pathways with preliminary rating of medium or higher are highlighted gray.

Pathway	Risk rating for the pathway in the 2009 Pathway Analysis	Preliminary risk rating for the pest
human movement	very high	very high
hitchhikers	very high	very high
wood packaging materials	very high	negligible[4]
forestry-related pathways	very high	negligible or low[5]
propagative materials	very high	very high
airline passenger baggage	medium	high or very high[6]
international mail	medium	high[7]
natural pest spread	medium	medium[8]
cut flowers entering Miami from the Caribbean	not addressed	negligible or low[9]
air cargo	not addressed	addressed by other pathways
garbage	not addressed	unknown
live animals as a pathway for weed seeds	not addressed	N/A[10]
military	not addressed	addressed by other pathways
medicinal plants harvested from forests	not addressed	unknown
bonsai trees from Asia	not addressed	addressed by propagative materials pathway
commodities	not addressed	not addressed[11]

[4] Based on biology (i.e., fruit feeder) and lack of evidence of this being a pathway.
[5] Based on biology (i.e., fruit feeder) and lack of evidence of this being a pathway.
[6] Based on interception data (PestID, 2019), that fruit are among the most intercepted quarantine materials in airline passenger baggage (PERAL, 2009), and that adults can fly from fruit to find new host material.
[7] Based on interception data and that adults can fly from fruit to find new host material.
[8] Based on adult flight and that this species occurs in the GCR.
[9] Since 1985, live *C. capitata* have only been intercepted seven times with cut flowers (PestID, 2019); therefore, this appears to be an unlikely pathway compared to the others.
[10] Not a weed seed.
[11] Probably does not need to be addressed further for the same reasons as presented in the 2019 pathway analysis.

Citrus leprosis virus

Notes on *Citrus leprosis virus* that are relevant to the preliminary estimate of the pathway risk ratings:

Distribution of the virus includes countries in the GCR (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama) (CABI, 2019).

Means of spread include:

- *Brevipalpus* mites (CABI, 2019: "The main means of movement and dispersal of the virus is via the vector mites of the genus *Brevipalpus,* which colonize most species of *Citrus* and many other plant species.")
- infected *Brevipalpus* mites on propagative material (Childers and Rodrigues, 2005) (PestID, 2019: *Brevipalpus* mites have been intercepted with commercial propagative material 80 times.)
- wind dispersal of infected *Brevipalpus* mites (Childers and Rodrigues, 2005)
- passenger baggage (PestID, 2019: *Brevipalpus* mites have been intercepted in passenger baggage 396 times.)
- mail (PestID, 2019: *Brevipalpus* mites have been intercepted in mail 17 times.)
- human movement across land borders (Castillo et al., 2011: The virus "may have been brought accidentally into Southern Mexico by the flux of immigrants from Guatemala bringing in contaminated orange fruits, discarded during the journey.")

Table 2. ***Citrus leprosis virus*-infected *Brevipalpus* mites**: Comparison of risk ratings in 2009 Pathway Analysis with preliminary risk ratings for this specific pest. Pathways with preliminary rating of medium or higher are highlighted gray.

Pathway	Risk rating for the pathway in the 2009 Pathway Analysis	Preliminary risk rating for the pest
human movement	very high	very high
hitchhikers	very high	negligible[12]
wood packaging materials	very high	negligible[13]
forestry-related pathways	very high	negligible or low[14]
propagative materials	very high	very high
airline passenger baggage	medium	medium
international mail	medium	medium
natural pest spread	medium	medium[15]
cut flowers entering Miami from the Caribbean	not addressed	low or negligible[16]
air cargo	not addressed	addressed by other pathways
garbage	not addressed	negligible
live animals as a pathway for weed seeds	not addressed	N/A[17]
military	not addressed	addressed by other pathways
medicinal plants harvested from forests	not addressed	unknown

Pathway	Risk rating for the pathway in the 2009 Pathway Analysis	Preliminary risk rating for the pest
bonsai trees from Asia	not addressed	negligible[18]
commodities	not addressed	not addressed[19]

[12] Based on mite vectors not having ability to fly onto ships or into cargo holds, and lack of evidence of this being a pathway.
[13] Based on mite vectors being non-wood feeders (Hill, 1983; Johnson and Lyon, 1991) and lack of evidence of this being a pathway.
[14] Based on mite vectors being non-wood feeders (Hill, 1983; Johnson and Lyon, 1991) and lack of evidence of this being a pathway.
[15] Mite vectors might be able to spread by wind or on animals (Alves and Omoto, 2005; Peña et al., n.d.), and the virus occurs in the GCR.
[16] *Brevipalpus* mites have only been intercepted twice with cut flowers at the Miami airport (PestID, 2019). These mites are probably not likely to spread from cut flowers to hosts for reproduction.
[17] Not a weed seed.
[18] *Citrus leprosis virus* does not occur in Asia.
[19] Probably does not need to be addressed further for the same reasons as presented in the 2019 pathway

Ralstonia solanacearum race 3 biovar 2

Notes on *Ralstonia solanacearum* race 3 biovar 2 that are relevant to the preliminary estimate of the pathway risk ratings:

- Distribution of the pathogen includes countries in the GCR (Colombia, Costa Rica, Guadeloupe, Guatemala, and Venezuela) (APHIS, 2019).
- Hosts: The major hosts are potato (*Solanum tuberosum*), tomato (*Solanum lycopersicum*), and geranium (*Pelargonium* spp.) (APHIS, 2019).
- Means of spread include:
    - propagative material (APHIS, 2019; CABI, 2019) (PERAL, 2009: "On several occasions, *Ralstonia solanacearum* race 3 biovar 2 (Burkholderiales), a bacterial pathogen, was found in geranium cuttings shipped from commercial greenhouses in Guatemala and Kenya to the United States for rooting and sale")
    - water [The bacterium can spread through contaminated irrigation and surface runoff water (APHIS, 2019). It can also spread when infected riparian weeds grow in or near water and the contaminated water is used for irrigation (CABI, 2019).]
    - soil (APHIS, 2019; CABI, 2019)
    - cut flowers (CABI, 2019)
    - human movement (e.g., footwear, clothing) (CABI, 2019)
    - vehicles, machinery, tools, and equipment (APHIS, 2019; CABI, 2019)
    - mail (CABI, 2019)

Table 3. ***Ralstonia solanacearum* race 3 biovar 2**: Comparison of risk ratings in 2009 Pathway Analysis with preliminary risk ratings for this specific pest. Pathways with preliminary rating of medium or higher are highlighted gray.

Pathway	Risk rating for the pathway in the 2009 Pathway Analysis	Preliminary risk rating for the pest
human movement	very high	very high
hitchhikers	very high	very high[20]
wood packaging materials	very high	negligible[21]
forestry-related pathways	very high	negligible[22]
propagative materials	very high	very high
airline passenger baggage	medium	medium
international mail	medium	medium
natural pest spread	medium	medium[23]
cut flowers entering Miami from the Carribbean	not addressed	unknown[24]
air cargo	not addressed	addressed by other pathways
garbage	not addressed	unknown
live animals as a pathway for weed seeds	not addressed	N/A[25]
military	not addressed	addressed by other pathways
medicinal plants harvested from forests	not addressed	unknown
bonsai trees from Asia	not addressed	negligible[26]
commodities	not addressed	not addressed[27]

[20] Based on soil.
[21] Based on host range.
[22] Based on host range.
[23] Based on fact that it has wild hosts, can spread by water, and occurs in the GCR.
[24] Cut flowers reported as a potential pathway (CABI, 2019), and host range includes geraniums, which can be in cut flower pathway (PestID, 2019). We rated this pathway as "unknown" because more information is needed.
[25] Not a weed seed.
[26] Based on host range.
[27] Probably does not need to be addressed further for the same reasons as presented in the 2019 pathway analysis.

Tuta absoluta

- Notes on Tuta absoluta that are relevant to the preliminary estimate of the pathway risk ratings:
- Distribution includes countries in the GCR (Costa Rica, Haiti, Panama, Colombia, and Venezuela) (CABI, 2019).
- Hosts: Tomato and potato. There are references to other hosts in the family Solanaceae (mainly wild hosts) (CABI, 2019).
- Means of spread include:
    - natural spread through adult flight (Baniameri and Cheraghian, 2012; Garzia et al., 2012; Muruvanda et al., 2013)
    - plants for planting (Muruvanda et al., 2013; NAPPO, 2008)

- tomato fruit (Garzia et al., 2012; Muruvanda et al., 2013; NAPPO, 2008) (PestID, 2019: *T. absoluta* has been intercepted twice at U.S. ports of entry, both times larvae in fruit in passenger baggage.)

Table 4. ***Tuta absoluta***: Comparison of risk ratings in 2009 Pathway Analysis with preliminary risk ratings for this specific pest. Pathways with preliminary rating of medium or higher are highlighted gray.

Pathway	Risk rating for the pathway in the 2009 Pathway Analysis	Preliminary risk rating for the pest
human movement	very high	very high
hitchhikers	very high	very high[28]
wood packaging materials	very high	negligible[29]
forestry-related pathways	very high	negligible[30]
propagative materials	very high	very high
airline passenger baggage	medium	medium
international mail	medium	medium
natural pest spread	medium	medium[31]
cut flowers entering Miami from the Caribbean	not addressed	negligible[32]
air cargo	not addressed	addressed by other pathways
garbage	not addressed	unknown
live animals as a pathway for weed seeds	not addressed	N/A[33]
military	not addressed	addressed by other pathways
medicinal plants harvested from forests	not addressed	unknown
bonsai trees from Asia	not addressed	negligible[34]
commodities	not addressed	not addressed[35]

[28] Although *T. absoluta* has not been intercepted as a hitchhiker, a "very high" rating may apply since adults fly and therefore could fly onto ships or into cargo holds, etc.
[29] Based on host range and being non-wood feeder (CABI, 2019) and lack of evidence of this as a pathway.
[30] Based on host range and being non-wood feeder (CABI, 2019) and lack of evidence of this as a pathway.
[31] Based on adult flight and occurrence in the GCR.
[32] Based on host range.
[33] Not a weed seed.
[34] Based on host range.
[35] Probably does not need to be addressed further for the same reasons as presented in the 2019 pathway

Xanthomonas (citrus canker)

Notes on citrus canker that are relevant to the preliminary estimate of the pathway risk ratings:

- Distribution of the pathogen includes countries in the GCR [United States (Florida) and British Virgin Islands] (CABI, 2019).
- Hosts: *Citrus* species and their hybrids and trifoliate orange (*Poncirus trifoliata*) (CABI, 2019)
- Means of spread include:
    - movement of infected fruit and leaves (CABI, 2019; Chung et al., 2002) (PestID, 2019: This pathogen has been intercepted over 20,000 times with fruit and leaves at U.S. ports of entry since 1985.)
    - passenger baggage (PestID, 2019: This pathogen has been intercepted in passenger baggage at U.S. ports of entry over 17,000 times since 1985.)
    - propagative material (CABI, 2019; Chung et al., 2002; Irey et al., 2006; Telford, 2008)
    - short-distance dispersal in rainwater or rain with wind (CABI, 2019; Gottwald et al., 1997)
    - long-distance dispersal through meteorological events, such as thunderstorms, tornadoes, tropical storms, and hurricanes (Gottwald et al., 1997; Irey et al., 2006)
    - saprophyte on straw mulch (CABI, 2019)
    - soil (CABI, 2019)
    - vehicles, machinery, equipment, and tools (CABI, 2019; Chung et al., 2002; Telford, 2008)
    - human movement (hands, shoes, and clothing) (Chung et al., 2002; Telford, 2008; PERAL, 2009)
    - mail (PERAL, 2009) (PestID, 2019: The pathogen has been intercepted over 1,700 times in mail at U.S. ports of entry since 1985.)

Table 5. **Citrus canker**: Comparison of risk ratings in 2009 Pathway Analysis with preliminary risk ratings for this specific pest. Pathways with preliminary rating of medium or higher are highlighted gray.

Pathway	Risk rating for the pathway in the 2009 Pathway Analysis	Preliminary risk rating for the pest
human movement	Very high	Very high
hitchhikers	very high	very high[36]
wood packaging materials	very high	negligible[37]
forestry-related pathways	very high	negligible[38]
propagative materials	very high	very high
airline passenger baggage	medium	medium or high[39]
international mail	medium	medium
natural pest spread	medium	medium or high[40]
cut flowers entering Miami from the Caribbean	not addressed	negligible[41]
air cargo	not addressed	addressed by other pathways
garbage	not addressed	unknown

Pathway	Risk rating for the pathway in the 2009 Pathway Analysis	Preliminary risk rating for the pest
live animals as a pathway for weed seeds	not addressed	N/A[42]
military	not addressed	addressed by other pathways
medicinal plants harvested from forests	not addressed	unknown
bonsai trees from Asia	not addressed	addressed by propagative materials pathway
commodities	not addressed	not addressed[43]

[36] Based on soil.
[37] Based on host range.
[38] Based on host range.
[39] May be high based on interception data.
[40] May be high based on evidence of its spread with tropical storms and hurricanes and the fact that it occurs in the GCR.
[41] Based on host range and lack of any interceptions with cut flowers (PestID, 2019). Also, this pathogen already occurs in Florida.
[42] Not a weed seed.
[43] Probably does not need to be addressed further for the same reasons as presented in the 2019 pathway

3. Summary

We conclude that the prioritized pathways as identified in the 2009 analysis are still relevant and correct for plant pests in general. The pest risk ratings for the pathways analyzed likely would not change if the analysis was updated with more recent data. However, not all these risk ratings necessarily apply to individual pests. For the five pests in common between the APHIS and CPHD pest lists, we give a very rough preliminary risk rating for each pest/pathway combination. Of the priority pathways in the 2009 analysis (that is, those rated "medium" or "higher"), we estimate that only two are likely not priority pathways for the five pests: wood packaging materials and forestry-related pathways. We estimate that all the other 2009 priority pathways are likely important for one or more of the five pests. We gave a preliminary "very high" rating to those pathways in bold, and the rest received a "medium" or "high" rating:

- *Ceratitis capitata*: human movement, propagative materials, hitchhikers, airline passenger baggage, international mail, and natural pest spread
- *Citrus leprosis virus* (via infected *Brevipalpus* mites): human movement, propagative materials, airline passenger baggage, international mail, and natural pest spread
- *Ralstonia solanacearum* race 3 biovar 2: human movement, hitchhikers, propagative materials, airline passenger baggage, international mail, and natural pest spread
- *Tuta absoluta*: human movement, hitchhikers, propagative materials, airline passenger baggage, international mail, and natural pest spread

- *Xanthomonas* (citrus canker): human movement, hitchhikers, propagative materials, airline passenger baggage, international mail, and natural pest spread

As these are only preliminary risk ratings, we recommend further assessment and peer review to confirm the risk of each pest/pathway combination.

4. References

Alves, E. B., and N. F. B. C. C. Omoto. 2005. Dispersal mechanisms of *Brevipalpus phoenicis* (Geijskes) (Acari: Tenuipalpidae) in citrus groves. Neotropical Entomology 34(1):89-96.

APHIS. 2017. Countries Requiring ISPM 15. United States Department of Agriculture, Animal and Plant Health Inspection Service (APHIS). Last accessed June 13, 2019, https://www.aphis.usda.gov/aphis/ourfocus/planthealth/sa_export/sa_wood_packaging/sa_by_country

APHIS. 2019. New Pest Response Guidelines: *Ralstonia solanacearum* (Smith, 1896) Yabuuchi et al., 1996 "race 3 biovar 2", brown rot of potato. United States Department of Agriculture, Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine. 52 pp.

Baniameri, V., and A. Cheraghian. 2012. The first report and control strategies of *Tuta absoluta* in Iran.

EPPO Bulletin 42(2):322-324.

CABI. 2019. Crop Protection Compendium. Centre for Agriculture and Biosciences (CABI). http://www.cabi.org/cpc/.

Castillo, I. I., L. F. Z. Diaz, W. Mendez, G. Otero-Colina, J. Freitas-Astua, and C. Locali-Fabris. 2011.

Confirmation of the presence of the Citrus leprosis virus C (CiLV-C) in Southern Mexico. Tropical plant pathology 36(5):400-403.

Childers, C., and J. Rodrigues. 2005. Potential mite species collected on ornamental plants from Central America at port of entry to the United States. The Florida Entomologist 88(4):408-414.

Chung, K. R., T. S. Schubert, J. H. Graham, and L. W. Timmer. 2002. 2003 Florida Citrus Pest Management Guide: Citrus Canker (PP-182). University of Florida, Institute of Food and Agricultural Sciences.

CTO. 2019. Annual Reviews & Prospects. Caribbean Tourism Organization (CTO). Last accessed June 7, 2019, https://www.onecaribbean.org/statistics/annual-reviews-prospects/.

Garzia, G. T., G. Siscaro, A. Biondi, and L. Zappalà. 2012. *Tuta absoluta*, a South American pest of tomato now in the EPPO region: biology, distribution and damage. EPPO Bulletin 42(2):205-210.

Gottwald, T. R., J. H. Graham, and T. S. Schubert. 1997. An epidemiological analysis of the spread of citrus canker in urban Miami, Florida, and synergistic interaction with the Asian citrus leafminer [Abstract]. Fruits 52:371-378.

Hill, D. S. 1983. Agricultural Insect Pests of the Tropics and their Control. Cambridge University Press, New York, NY. xii+ 746 pp.

IPPC. 2007. International Standards For Phytosanitary Measures, 1 to 29 (2007 edition). Food and Agriculture Organization of the United Nations, Secretariat of the International Plant Protection Convention (IPPC), Rome, Italy. 376 pp.

Irey, M., T. R. Gottwald, J. H. Graham, T. D. Riley, and G. Carlton. 2006. Post-hurricane analysis of citrus canker spread and progress towards the development of a predictive model to estimate disease spread due to catastrophic weather events. Plant Management Network 7(1):15 pp.

Johnson, W. T., and H. H. Lyon. 1991. Insects that Feed on Trees and Shrubs, Second Edition, Revised.

Comstock Publishing Associates, Cornell University Press, Ithica, NY. 560 pp.

Muruvanda, D. A., D. Holden, M. Juárez, C. Ramos, and R. Lee. 2013. Surveillance Protocol for the Tomato Leaf Miner, *Tuta absoluta*, for NAPPO Member Countries, Ottawa, Ontario, Canada. 17 pp.

NAPPO. 2008. First detection of tomato leafminer (*Tuta absoluta*) in Spain. North American Plant Protection Organization (NAPPO), Phytosanitary Alert System. Last accessed June 18, 2019, http://www.pestalert.org/viewNewsAlert.cfm?naid=57.

Peña, J. E., I. Baez, M. Hennessey, and K. Santos. n.d. Dispersal of *Brevipalpus phoenicis* from ctrus fruits.

University of Florida, Tropical Research and Education Center, Homestead, FL & United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Center for Plant Health Science and Technology, Raleigh, NC. 42 pp.

PERAL. 2009. Evaluation of Pathways for Exotic Plant Pest Movement into and within the Greater Caribbean Region. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Plant Epidemiology and Risk Analysis Laboratory (PERAL), Raleigh, NC. 278 pp.

PestID. 2019. Pest Identification Database (PestID). United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine. https://aqas.aphis.usda.gov/aqas/.

Telford, G. 2008. Exotic plant pests - citrus canker. The State of Queensland, Department of Primary Industries and Fisheries, Australia. 8 pp.