USDA Animal and Plant Health Inspection Service
U.S. DEPARTMENT OF AGRICULTURE

Importation of dragon fruit (*Selenicereus undatus* (Haworth) Hunt) for consumption from Dominican Republic into the United States and territories

A Qualitative, Pathway Initiated Pest Risk Assessment

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Executive Summary

The purpose of this report is to assess the pest risks associated with importing commercially produced fresh fruit of dragon fruit, *Selenicereus undatus* (Haworth) Hunt (Cactaceae), from the Dominican Republic into the United States and territories for consumption.

Based on the new market access submitted by the Dominican Republic, we considered the pathway to include fresh dragon fruit. No pest exclusion or mitigation measures were considered.

We used scientific literature, port-of-entry pest interception data, and information from the government of the Dominican Republic to develop a list of pests with quarantine significance for the United States. These are pests that occur in the Dominican Republic on any host and are associated with the commodity plant species, anywhere in the world.

The following organisms are candidates for pest risk management because they have met the threshold for unacceptable consequences of introduction.

Pest type	Taxonomy	Scientific name	Likelihood of Introduction
Arthropod	Hemiptera: Coreidae	*Leptoglossus concolor* (Walker)	Low*

*This risk rating applies only to Hawaii and the territories.

A detailed examination and choice of appropriate phytosanitary measures to mitigate pest risk are addressed separately from this document.

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1. Introduction

1.1. Background

The purpose of this report is to assess the pest risk associated with the importation of commercially produced fresh fruit of dragon fruit (*Selenicereus undatus* (Haworth)) for consumption from the Dominican Republic (referred to as the export area) into the United States and territories[a] (referred to as the pest risk analysis or PRA area).

The USDA recognizes the current binomial name for these species to be *Selenicereus undatus* (Haworth) D.R. Hunt, with *Hylocereus undatus* (Haworth) Britton & Rose reduced to synonymy. This is consistent with the current taxonomic revisions (Hunt, 2017; Jacono, 2021; Korotkova et al. 2017).

This is a qualitative risk assessment. The likelihood of pest introduction is expressed as a qualitative rating rather than on numerical terms. This methodology is consistent with guidelines provided by the International Plant Protection Convention (IPPC) in the International Standard for Phytosanitary Measures (ISPM) No. 11, "Pest Risk Analysis for Quarantine Pests" (IPPC, 2017). The use of biological and phytosanitary terms is consistent with ISPM No. 5, "Glossary of Phytosanitary Terms" (IPPC, 2019).

As defined in ISPM No. 11, this document comprises Stage 1 (Initiation) and Stage 2 (Risk Assessment) of risk analysis. Stage 3 (Risk Management) will be covered in a separate document.

1.2. Initiating event

The importation of fruits and vegetables for consumption into the United States is regulated under Title 7 of the Code of Federal Regulations, Part 319.56-3 (7 CFR §319.56-3, 2019). Under this regulation, the entry of dragon fruit from the Dominican Republic into the PRA area is not authorized. This commodity risk assessment was initiated in response to a request by the Ministry of Agriculture of the Dominican Republic to change the Federal Regulation to allow entry (Lazala, 2021).

1.3. Potential weediness of the commodity

In some cases, an imported commodity could become invasive in the PRA area. If warranted, we analyze the commodity for weed risk. A weed risk analysis is not required when (a) the commodity is already enterable into the PRA area from other countries, (b) the commodity plant species is widely established (naturalized) or cultivated in the PRA area, or (c) the imported plant part(s) cannot easily propagate on its own or be propagated. We determined that the weed risk of dragon fruit does not need to be analyzed because this commodity is already enterable from other countries (USDA APHIS, 2021).

1.4. Description of the pathway

A pathway is "any means that allows the entry or spread of a pest" (IPPC, 2019). In the context of this document, the pathway is the commodity to be imported, together with all the processes

[a]The PRA area includes all 50 states, Guam, the Commonwealth of the Northern Mariana Islands, Puerto Rico, and the U.S. Virgin Islands.

the commodity undergoes from production through importation and distribution. The following description of this pathway focuses on the conditions and processes that may have an impact on pest risk. Our assessment is, therefore, contingent on the application of all components of the pathway as described in this section.

1.4.1. Description of the commodity
The specific pathway of concern is the importation of fresh dragon fruit for consumption.

1.4.2. Summary of the production, harvest, post-harvest, shipping, and storage conditions considered
Production, harvesting, and post-harvesting procedures in the Dominican Republic were not considered as part of the assessment. Likewise, shipping and storage conditions were not considered as part of the assessment.

2. Pest List and Pest Categorization

The pest list is a compilation of plant pests of quarantine significance to the United States and territories. This list includes pests that are present in the Dominican Republic on any host and known to be associated with *Selenicereus undatus* anywhere in the world. Pests are considered to be of quarantine significance if they (a) are not present in the PRA area, (b) are actionable at U.S. ports of entry, (c) are regulated non-quarantine pests, (d) are under Federal official control, or (e) require evaluation for regulatory action. Consistent with ISPM No. 5, pests that meet any of these definitions are considered "quarantine pests" and are candidates for analysis. Species with a reasonable likelihood of following the pathway into the PRA area are analyzed to determine their pest risk potential.

2.1. Pest list

We developed the pest list based on the scientific literature, port-of-entry pest interception data, and information provided by the government of the Dominican Republic. We listed the pests that are of quarantine significance to the PRA area under Table 1. For each pest, we provided evidence of the pest's presence in the Dominican Republic and its association with *Selenicereus undatus*. We also indicated the plant parts with which the pest is generally associated and provided information about the pest's distribution in the United States, if any. Pests that are likely to remain associated with the harvested commodity in a viable form are indicated by shaded rows and are listed separately under Table 2.

Table 1. List of quarantine pests associated with *Selenicereus undatus* (in any country) and present in the Dominican Republic (on any host).

Pest name	Presence in the Dominican Republic	Host association	Plant part(s) [b]	Considered further? [c]
INSECT: Coleoptera: Cerambycidae *Trachyderes succinctus* (Linnaeus)	Ueda, 2021; Peck, 2011 (listed in Hispaniola)	Romero, 1994	Stems (Romero, 1994)	No
INSECT: Hemiptera: Coreidae *Leptoglossus concolor* (Walker)	**Texas A&M University Insect Collection, 2021**	**Carrillo et al., 2021**	**Fruit, stems Eggs may be laid on stems, or fruit (Carrillo et al., 2021)**	**Yes. Adults are large, mobile, and conspicuous; they would escape fruit if disturbed; however, eggs may be laid on fruit. Present in the continental United States (Florida; Carrillo et al., 2021) and U.S. Virgin Islands (Brailovsky, 2019)**
INSECT: Thysanoptera: Thripidae *Thrips palmi* Karny	**EPPO, 2021; Serra, 2003**	**Carrillo et al., 2021**	**Flowers, fruit (Carrillo et al., 2021)**	**Yes. Present in the continental United States, Hawaii, and Puerto Rico (EPPO, 2021)**

2.3. Pests considered but not included on the pest list

2.3.1. Organisms with non-quarantine status

We found evidence of organisms that are associated with dragon fruit, and are present in the export area, but are not of quarantine significance for the PRA area. These organisms are listed in the Appendix.

2.3.2. Organisms identified only to the genus level

In commodity risk assessments, the taxonomic unit for pests selected for evaluation beyond the pest categorization stage is usually the species (IPPC, 2017). Generally, we do not assess risk for organisms identified only to the genus level, especially if the genus is reported in the PRA area. Many genera contain multiple species, and we cannot know if the unidentified species occurs or is regulated in the PRA area. Since the organism has not been fully identified, we cannot properly assess the likelihood and consequences of its introduction. However, if the genus is

[b] The plant part(s) listed are those for the plant species under analysis. If the information has been extrapolated, such as from plant part association on other plant species, we note that.

[c] "Yes" indicates simply that the pest has a reasonable likelihood of being associated with the harvested commodity; the level of pest prevalence on the harvested commodity (low, medium, or high) is qualitatively assessed as part of the Likelihood of Introduction assessment (section 3).

absent from the PRA area or is actionable at U.S. ports of entry, the genus can be regulated as a quarantine pest.

We found evidence that the following organisms identified only to the genus level are reported on *Selenicereus undatus* (*H. undatus*) in Dominican Republic: Arthropods- *Spissistilus* sp. (Hemiptera: Membracidae). This insect was reported on the flowers and stems of dragon fruit and is located in the Dominican Republic (Romero, 1994; Ueda, 2021). While we were unable to determine what species the authors were referring to, *Spissistilus festinus* (Say) (synonym *Spissistilus festina* (Say)) is the only species of *Spissistilus* that we could locate in the Dominican Republic (Perez-Gelabert, 2015; Ueda, 2021). This species is present in the continental United States (Deitz and Wallace, 2012), Hawaii (Heu, 2007), and Puerto Rico (Cabrera Asencio et al., 2007). The genus *Spissistilus* is quarantine, but the species *Spissistilus festinus* is non-quarantine (ARM, 2021). We provided this basic information about this organism to help risk managers determine if measures beyond those intended to mitigate fully identified pests are warranted.

2.4. Pests selected for further analysis or already regulated

We identified two quarantine pests for further analysis (Table 2).

Table 2. Pests selected for further analysis.

Pest type	Taxonomy	Scientific name
Arthropod	Hemiptera: Coreidae	*Leptoglossus concolor* (Walker)
Arthropod	Thysanoptera: Thripidae	*Thrips palmi* Karny

3. Assessing Pest Risk Potential

3.1. Introduction

We estimated the risk potential for each pest selected for further analysis. Risk is described by the likelihood of an adverse event, the potential consequences, and the uncertainty associated with these parameters. For each pest, we determined if an endangered area exists within the United States and territories. The endangered area is defined as the portion of the PRA area where ecological factors favor the pest's establishment and where the pest's presence will likely result in economically important impacts. If a pest causes an unacceptable impact (i.e., it is a threshold pest), that means it could adversely affect agricultural production by causing a yield loss of 10 percent or greater, by increasing U.S. production costs, or by impacting an environmentally important host or international trade. After the endangered area is defined, we assessed the pest's likelihood of introduction into that area on the imported commodity.

The likelihood of introduction is based on the potential entry and establishment of a pest. We qualitatively assess this risk using the ratings: Low, Medium, and High. The risk elements comprising the likelihood of introduction are interdependent; therefore, the model is multiplicative rather than additive. We defined the risk ratings as follows:

> **High**: This outcome is highly likely to occur.
> **Medium**: This outcome is possible; but for that to happen, the exact combination of required events needs to occur.

Low: This outcome is unlikely to occur because one or more of the required events are unlikely to happen, or because the full combination of required events is unlikely to align properly in time and space.

We addressed uncertainty associated with each risk element as follows:

Negligible: Additional or more reliable evidence is very unlikely to change the rating.
Low: Additional or more reliable evidence probably will not change rating.
Moderate: Additional or more reliable evidence may or may not change rating.
High: Reliable evidence is not available.

3.2. Assessment

3.2.1. *Leptoglossus concolor* (Hemiptera: Coreidae)

Leptoglossus concolor is a leaf-footed bug that is large, conspicuous, and flies with a buzzing sound (Carrillo et al., 2021). Minimal information is available on this leaf-footed bug. It is not considered to be a major pest; rather, it is considered to be an occasional pest (Carrillo et al., 2021). *Leptoglossus concolor* is native to much of North America (see Climactic suitability); therefore, this assessment is for Hawaii which is the only area that is potentially endangered.

The endangered area for *Leptoglossus concolor* within Hawaii	
Climatic suitability	*Leptoglossus concolor* is present in **North America:** Belize, Costa Rica, Cuba, Dominican Republic, Haiti, Guatemala, Honduras, Mexico, Nicaragua, Panama, Puerto Rico, United States (Florida), and the Virgin Islands, and **South America:** Argentina, Colombia (Brailovsky and van der Heyden, 2019; Carrillo et al., 2021; Coscaron and Pall, 2015; Eger Jr et al., 2015; Linares, 2016; Linares and Orozco, 2017; Maes, 2013; Texas A&M University Insect Collection, 2021). These areas encompass Plant Hardiness Zones 10-13 (Takeuchi et al., 2018). The insect is present in the continental United States (Florida) (Carrillo et al., 2021), Puerto Rico, and the Virgin Islands (Brailovsky, 2019), but Hawaii remains endangered.
Hosts in PRA area	Hosts in the PRA area include **Bixaceae:** *Bixa orellana* (lipsticktree) (Linares and Orozco, 2017); **Cactaceae:** *Selenicereus undatus* (dragon fruit) (Carrillo et al., 2021); **Euphorbiaceae:** *Jatropha curcas* (Barbados nut) (Guillén et al., 2013); and **Myrtaceae:** *Psidium guajava* (guava) (CABI, 2021; Linares and Orozco, 2017) (NRCS, 2021).
Economically important hosts at risk[d]	Dragon fruit, guava

[d] As defined by ISPM No. 11, supplement 2, "economically" important hosts refers to both commercial and non-market (environmental) plants (IPPC, 2017).

Potential consequences on economically important hosts at risk	This pest is likely to cause unacceptable consequences because on dragon fruit, the insect punctures fruit, leaving behind puncture marks which are vulnerable to invasion by bacteria or fungi (Carrillo et al., 2021). Dragon fruit stems and arms are also punctured and damaged. If insect numbers are high, economic damage may occur. The insect also lays eggs on the fruit or stems (Carrillo et al., 2021). Eggs on the fruit could serve as a pathway of introduction.
Endangered Area	The endangered area includes areas in Plant Hardiness Zones 10 through 13 where host plants are present. The insect is present in the continental United States (Florida) (Carrillo et al., 2021), Puerto Rico, and the Virgin Islands (Brailovsky, 2019), but Hawaii may be endangered.

The likelihood of entry of *Leptoglossus concolor* into the endangered area via dragon fruit imported from the Dominican Republic

Risk Element	Risk Rating	Uncertainty Rating	Evidence for rating (and other notes as necessary)
Pest prevalence on the harvested commodity	Medium	Low	The nymph and adult leaf-footed bugs are conspicuous (Carrillo et al., 2021) and will likely be noticed at harvest and/or move when disturbed. Feeding by the nymphs and adults leaves behind punctures, resulting in poor fruit quality (Carrillo et al., 2021). The punctures also allow for the entry of bacteria and fungi into the fruit (Carrillo et al., 2021). However, this leaf-footed bug lays eggs on the fruit of dragon fruit (Carrillo et al., 2021) which may go unnoticed. Therefore, we chose a rating of Medium.
Likelihood of surviving post-harvest processing before shipment	Medium	n/a	Post-harvest processes were not considered as part of this assessment; therefore, the risk rating remains unchanged.
Likelihood of surviving transport and storage conditions of the consignment	Medium	n/a	Transport and storage conditions were not considered as part of this assessment; therefore, the risk rating remains unchanged.
Overall Likelihood of Entry	Medium	n/a	n/a

The likelihood of establishment of *Leptoglossus concolor* into the endangered area via dragon fruit imported from the Dominican Republic

Risk Element	Risk Rating	Uncertainty Rating	Evidence for rating (and other notes as necessary)
Likelihood of Establishment	Low	Low	The life stage likely to be present with the fruit is the egg. From the egg stage, an insect must go through all nymphal instars before reaching the adult stage. Nymphs can proficiently walk, but the insect must reach the adult stage before it can fly. There is minimal information available about this insect, but the known host range of this insect is limited which would make establishment in a new area less likely. Because numerous developmental milestones must be met before its full dispersal abilities are realized and the known host range is limited, we determined the likelihood of establishment to be Low.
Likelihood of Introduction (combined likelihoods of entry and establishment)	Low	n/a	n/a

The likelihood of introduction (combined likelihoods of entry and establishment) of *Leptoglossus concolor* into the endangered area via dragon fruit imported from the Dominican Republic is Low.

3.2.2. *Thrips palmi* (Thysanoptera: Thripidae)

A full pest analysis is not needed for *Thrips palmi* (melon thrips) because we determined that no endangered area exists in the United States.

The endangered area for *Thrips palmi* within the United States and territories

Climatic suitability	*Thrips palmi* is distributed throughout tropical regions in Asia, Africa, South America, Oceania, and the Caribbean (CABI, 2021), as well as Hawaii, Puerto Rico, and southern Florida (Capinera, 2015; Seal, 2001). While melon thrips is an important greenhouse pest and it may infest protected environments anywhere, researchers estimate that the outdoor establishment of permanent populations would be restricted to tropical regions (Capinera, 2015). Permanent populations have only been documented in Florida, south of Orlando (Capinera, 2015). Initially detected in 1990 (Capinera, 2015), melon thrips is not under official control. Surveys conducted over the last thirty years indicate that melon thrips is likely established throughout the climate zones suitable for population development. The possibility of melon thrips populations overwintering in greenhouse and then moving outdoors in the summer (Kawai, 1990; McDonald et al., 1999) has not been realized.
Endangered Area	*Thrips palmi* appears to be established throughout its potential range in the United States; therefore, no endangered area exists.

4. Summary

Of the organisms associated with dragon fruit worldwide and present in the export area, we identified one organism that is a quarantine pest for the United States and territories. This pest is likely to meet the threshold for unacceptable consequences in the PRA area, and have a reasonable likelihood of following the commodity pathway (Table 3). Thus, this pest is a candidate for risk management. This result represents a baseline estimate of the risks associated with the import commodity pathway as described in section 1.4.

Table 3. Summary of pests that met the threshold for unacceptable consequences of introduction, have a reasonable likelihood of following the commodity pathway, and thus are candidates for risk management.

Pest type	Scientific name	Likelihood of Introduction	Uncertainty statement (optional)[a]
Arthropod	*Leptoglossus concolor* (Walker)	Low	n/a

[a]The uncertainty statement, if included, identifies the most important source(s) of uncertainty.

Our assessment of risk is contingent on the application of all components of the pathway as described in section 1.4. Appropriate phytosanitary measures to mitigate pest risk are addressed separately from this document.

5. Literature Cited

7 CFR § 319.56-3. 2019. U.S. Code of Federal Regulations, Title 7, Part 319.56-3 (7 CFR § 319.56-3 – General requirements for all imported fruits and vegetables). https://www.govinfo.gov/app/details/CFR-2019-title7-vol5/CFR-2019-title7-vol5-sec319-56-3.

AntWeb. 2021. AntWeb. Version 8.56.1. California Academy of Sciences. https://www.antweb.org.

ARM. 2021. Agricultural Risk Management System. United States Department of Agriculture, Animal and Plant Health Inspection Service. https://arm.aphis.edc.usda.gov/.

Brailovsky, H., and T. van der Heyden. 2019. New distributional notes and key to the known species of *Leptoglossus* Guérin-Méneville from Guatemala (Heteroptera: Coreidae: Coreinae: Anisoscelini). Revista Chilena de Entomología 45(1).

Brailovsky, H. a. v. d. H., T. 2019. New distributional notes and key to the known species of *Leptoglossus* Guérin-Méneville from Guatemala (Heteroptera: Coreidae: Coreinae: Anisoscelini). Revista Chilena de Entomología 45(1).

CABI. 2021. Crop Protection Compendium. CAB International. https://www.cabi.org/cpc/.

Cabrera Asencio, I., A. Segarra, and E. C. Estévez. 2007. Reporte de nuevos hospederos de *Spissistilus festinus* Say (Homoptera: Membracidae) para Puerto Rico. Journal of Agriculture of the University of Puerto Rico 91(1/2):53-55.

Capinera, J. 2015. *Thrips palmi* - melon thrips (EENY-135). https://www.entnemdept.ufl.edu/creatures/veg/melon_thrips.htm

Carrillo, D., R. Duncan, and J. E. Peña. 2021. Pitaya (Dragon Fruit) (*Hylocereus undatus*) Pests and Beneficial Insects. University of Florida, IFAS Extension, Entomology and Nematology, Tropical REC in Homestead (TREC), Homestead, Florida. 13 pp.

Castro, J. C., E. H. Endo, M. R. de Souza, E. B. Zanqueta, J. C. Polonio, J. A. Pamphile, T. Ueda-Nakamura, C. V. Nakamura, B. P. Dias Filho, and B. A. de Abreu Filho. 2017. Bioactivity of essential oils in the control of *Alternaria alternata* in dragon fruit (*Hylocereus undatus* Haw.). Industrial Crops and Products 97:101-109.

Choi, K. S., J. Y. Yang, Y. M. Park, S. Kim, H. Choi, D. Lyu, and D.-S. Kim. 2013. Pest lists and their damages on mango, dragon fruit and atemoya in Jeju, Korea. Korean Journal of Applied Entomology 52(1):45-51.

Coscaron, M. d. C., and J. Pall. 2015. The Tribe Anisoscelini (Hemiptera: Heteroptera, Coreidae) in Argentina. Zootaxa 4033(3):411-426.

Deitz, L. L., and M. S. Wallace. 2012. Richness of the Nearctic treehopper fauna (Hemiptera: Aetalionidae and Membracidae). Zootaxa 3423(1):1-26.

Eger Jr, J., H. Brailovsky, and T. J. Henry. 2015. Heteroptera attracted to butterfly traps baited with fish or shrimp carrion. Florida Entomologist 98(4):1030-1035.

EPPO. 2021. EPPO Global Database. European and Mediterranean Plant Protection Organization. https://gd.eppo.int/.

FAO RAP. 2004. Fruits of Vietnam: 4. Other Fruits. Food and Agriculture Organization of the United Nations, Regional office for Asia and the Pacific, Bangkok, Thailand. 1-13 pp.

Farr, D. F., and A. Y. Rossman. 2021. U.S. National Fungus Collections Database, ARS, USDA. United States Department of Agriculture, Agricultural Research Service. https://nt.ars-grin.gov/fungaldatabases/.

Galvao Pierangeli, E. C. 2019. Espécies de fungos e bactérias associados á cultura da pitaia e avaliacao de estádios dematuracao na qualidade do fruto [Thesis]. Universidade Federal de Lavras. 107 p.

García-Morales, M., B. D. Denno, D. R. Miller, G. L. Miller, Y. Ben-Dov, and N. B. Hardy. 2016. ScaleNet: A literature-based model of scale insect biology and systematics. http://scalenet.info.

Gotzek, D., and S. Martinez. 2021. First record of the red imported fire ant, *Solenopsis invicta* Buren, from Hispaniola. BioInvasions Records 10.

Guillén, G. L., J. F. B. Gaytán, J. L. Gómez, and A. Z. Colmenero. 2013. *Jatropha curcas* L. Pages 69-81 *in* A. Z. Colmenero and J. L. S. Bonilla, (eds.). *Jatropha curcas* L. - Alternativa bioenergética en México (1). AveDos Taller Creativo.

Guo, L. W., Y. X. Wu, H. H. Ho, Y. Y. Su, Z. C. Mao, P. F. He, and Y. Q. He. 2014. First report of dragon fruit (*Hylocereus undatus*) anthracnose caused by *Colletotrichum truncatum* in China. Journal of Phytopathology 162(4):272-275.

Heu, R. 2007. Distribution and host records of agricultural pests and other organisms in Hawaii. Hawaii Department of Agriculture, Plant Industry Division, Plant Pest Control Branch, Survey Program, Honolulu, HI. 71 pp.

IPPC. 2017. International Standards For Phytosanitary Measures, Publication No. 11: Pest Risk Analysis for Quarantine Pests. Food and Agriculture Organization of the United Nations, Secretariat of the International Plant Protection Convention (IPPC), Rome, Italy. 40 pp.

IPPC. 2019. International Standards for Phytosanitary Measures, Publication No. 5: Glossary of Phytosanitary Terms. Food and Agriculture Organization of the United Nations, Secretariat of the International Plant Protection Convention (IPPC), Rome, Italy. 35 pp.

Jacono, C. 2021. Subject: Report to IRM (Imports, Regulations and Manuals) in response to 3 questions regarding taxonomy and nomenclature of dragon fruit. United States Department of Agriculture, Animal and Plant Health Inspection Services, Plant

Protection Quarantine, Plant Health Programs, National Identification Services - USDA-APHIS-PPQ-NIS. 10 pp.
Kawai, A. 1990. Life cycle and population dynamics of *Thrips palmi* Karny. Japan Agricultural Research Quarterly 23(4):282-288.
Lazala, R. 2021. Request for Risk Analysis / Questionnaires for Zapote, Pitahaya, Soursop and Sweet potato. *in*, Santo Domingo, República Dominicana.
Le, V. T., N. Nguyen, D. D. Nguyen, T. K. T. Dang, C. T. Nguyen, V. H. M. Dang, N. H. Chau, and N. L. Trinh. 2000. Quality assurance system for dragon fruit. ACIAR Proceedings 100:101-114.
Linares, C. A. 2016. Familia Coreidae en Honduras: diversidad, distribución y hospederos [Thesis]. Escuela Agrícola Panamericana, Zamorano Honduras. 52 p.
Linares, C. A., and J. Orozco. 2017. The Coreidae of Honduras (Hemiptera: Coreidae). Biodiversity Data Journal (5):1-24.
Maes, J.-M. 2004. Catálogo de Insectos y Artrópodos Terrestres de Nicaragua. Last accessed September 10, 2004, http://www.insectariumvirtual.com/termitero/nicaragua.htm.
Maes, J. 2013. Museo Entomológico de León – MEL. Museo Entomológico de León – MEL. https://www.gbif.org/occurrence/768627076.
MAG-FOR. 2004. Lista oficial de plagas reportadas en Nicaragua Ministerio de Agricultura, Ganadería y Forestal, Managua (Nicaragua). 1-65 pp.
MAG. 1994. Catálogo de plagas (bacterias, hongos, nematodes e insectos) de la pitahaya (*Hylocereus undatus* Briton & Rose) en Nicaragua 1993-1994. [Catalog of pests (bacteria, fungi, nematodes and insects) of pitahaya (*Hylocereus undatus* Briton & Rose) in Nicaragua from 1993 to 1994]. Ministerio de Agricultura y Ganaderia (MAG), Managua, Nicaragua. 5 pp.
McDonald, J. R., J. S. Bale, and K. F. A. Walters. 1999. Temperature, development and establishment potential of *Thrips palmi* (Thysanoptera: Thripidae) in the United Kingdom. European Journal of Entomology 96:169-173.
Meza, K., M. Cusme, J. Velasquez, and D. Chirinos. 2020. Thrips (Thysanoptera) associated with pitahaya *Selenicereus undatus* (Haw.) DR Hunt. Species, population levels and some natural enemies. La Granja 32(2):93-105.
Mound, L., S. Nakahara, and D. M. Tsuda. 2016. Thysanoptera-Terebrantia of the Hawaiian Islands: an identification manual. ZooKeys (549):71.
Ngoc, N. K., N. V. Phong Nguyen, P. T. M. An, A. B. Woolf, and R. A. Fullerton. 2018. Effect of storage temperatures on postharvest diseases of dragon fruit (*Hylocereus undatus* Haw.) in the Mekong Delta Region, Vietnam. Acta Horticulturae 1213:453-460.
NIS. 2008. Change in action status for armored scales (Hemiptera: Diaspididae) on material for consumption (NIS action policy, March 25, 2008). United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, National Identification Services (NIS). 2 pp.
NRCS. 2021. PLANTS Database. United States Department of Agriculture, Natural Resources Conservation Service. https://plants.sc.egov.usda.gov/home.
Palmateer, A. J., R. C. Ploetz, E. Van Santen, and J. C. Correll. 2007. First occurrence of anthracnose caused by *Colletotrichum gloeosporioides* on pitahaya. Plant Disease 91(5):631.
Paull, R. E., and O. Duarte. 2012. Tropical Fruits, 2nd edition, volume II. CAB International. 371 pp.

Peck, S. B. 2011. The diversity and distributions of the beetles (Insecta: Coleoptera) of the northern Leeward Islands, Lesser Antilles (Anguilla, Antigua, Barbuda, Nevis, Saba, St. Barthélemy, St. Eustatius, St. Kitts, and St. Martin-St. Maarten. Insecta Mundi 0159: 1-54.

Perez-Gelabert, D. E. 2008. Lampyridae de Hispaniola (República Dominicana Y Haití). JEBC Collection (Los Niches-Curicó-Chile). http://coleoptera-neotropical.org/paginaprincipalhome.html.

Perez-Gelabert, D. E. 2015. Entomofauna de la Reserva Científica Ébano Verde, Cordillera Central, República Dominicana. Novitates Caribaea (8):61-81.

Perez-Gelabert, D. E., and G. González-F. 2009. Coccinellidae de Hispaniola (República Dominicana Y Haití). JEBC Collection (Los Niches-Curicó-Chile). http://coleoptera-neotropical.org/paginaprincipalhome.html.

Perez, Q. 2014. Consultoría para el levantamiento de información sobre plagas y enfermedades que afectan las plantaciones de aguacate y plan para su manejo integrado, República Dominicana. 35 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/.

Ríos Fornos, G. F., and A. F. Villavicencio Castillo. 1997. Estudio epidemiológico y etiológico de la bacteriosis de la pitahaya (*Hylocereus undatus*, Britt y Rose), Smith, y su efecto sobre cinco variedades del cultivo [Thesis]. Universidad Nacional Agraria, Managua, Nicaragua. 25 pp.

Rita, W. S., D. N. Suprapta, I. M. Sudana, and I. M. D. Swantara. 2013. First report on *Fusarium solani*, a pathogenic fungus causing stem rot disease on dragon fruits (*Hylocereus* sp.) in Bali. Journal of Biology Agriculture and Healthcare 3(17):93-99.

Romero, A. 1994. Manejo fitosanitario de la pitahaya en Nicaragua. Insectos. Comunidad Económica Europea, Managua (Nicaragua); Asociación Nicaraguense de Productores y Exportadores de Productos No tradicionales, Managua, Nicaragua. 86-98 pp.

Santiago-Blay, J., and S. Medina-Gaud. 1986. Notes on the biology of *Aspisoma ignitum* (L.) (Coleoptera: Lampyridae): a new firefly record for Puerto Rico. The Florida Entomologist 69(2):440-444.

Seal, D. R. 2001. Seasonal abundance and distribution of *Thrips palmi* Karny (Thysanoptera: Thripidae) in southern Florida. Proceedings of the Floria State Horticultural Society 114:337-342.

Senckenberg. n.d. Collection Thysanoptera SMF. GBIF.org. https://www.gbif.org/occurrence/207834865.

Serra, C. A., Jorge, P.E., Abud-Antún, A.J., Alvarez, P. and Perguero, B. 2003. Invasive alien species in the Dominican Republic: their impact and strategies to manage introduced pests. Caribbean Food Crops Society. Thirty Ninth annual meeting, Grenada. Proceedings of the Caribbean Food Crops Society 39(1):109-118.

Slots, J., T. E. Rams, D. Feik, H. D. Taveras, and G. M. Gillespies. 1991. Subgingival microflora of advanced periodontitis in the Dominican Republic Journal of Periodontology 62(9):543-547.

Soto, J., C. Cadenas, L. Mattos, and C. Trigoso. 2019. First report of *Enterobacter cloacae* as a causative agent of soft rot disease in dragon fruit (*Hylocereus undatus*) stems in Peru. Peruvian Journal of Agronomy 3(3):144-152.

Takeuchi, Y., G. Fowler, and A. S. Joseph. 2018. SAFARIS: Global Plant Hardiness Zone Development. North Carolina State University, Center for Integrated Pest Management; United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Science and Technology, Plant Epidemiology and Risk Analysis Laboratory, Raleigh, NC. Last accessed 4/27/2021, https://safaris.cipm.info/safarispestmodel/StartupServlet?phz.

Texas A&M University Insect Collection. 2021. Texas A&M University Insect Collection. https://www.gbif.org/occurrence/3049132467; https://www.gbif.org/occurrence/3048786956; https://www.gbif.org/occurrence/3048649144.

Ueda, K. 2021. iNaturalist Research-grade Observations. iNaturalist.org. Occurrence dataset https://doi.org/10.15468/ab3s5x accessed via GBIF.org on 2021-06-09. https://www.gbif.org/occurrence/3005190519; https://www.gbif.org/occurrence/3090615621; https://www.gbif.org/occurrence/2294566342; https://www.gbif.org/occurrence/3090738650.

USDA APHIS. 2021. Commodity Summary: Approved Countries. United States Department of Agriculture, Animal and Plant Health Inspection Service (USDA-APHIS). Last accessed 8/13/2021,

Valdez, F. J., L. A. Matos, and P. A. Álvarez. 2016. Índice de Plagas y Enfermedades de Importancia Económica en la República Dominicana. *in* D. d. S. Vegetal, ed. Ministerio de Agricultura, Oficina de Ejecución de Proyectos Viceministerio de Extensión y Capacitación Agropecuarias, Santo Domingo, República Dominicana. 244 p.

Valencia Botín, A. J., P. Cruz Hernández, and A. Rodríguez Canto. 2003. Avances en la etiología y manejo de la pudrición blanda de tallos en pitahaya, *Hylocereus undatus* H. (Cactaceae). Fitosanidad 7(1):11-17.

Viteri, D., I. Cabrera, and C. E. de Jensen. 2010. Identification and abundance of thrips species on soybean in Puerto Rico. International Journal of Tropical Insect Science 30(1):57-60.

Wetterer, J. K. 2011. Worldwide spread of the tropical fire ant, *Solenopsis geminata* (Hymenoptera: Formicidae). Myrmecological News 14(1):21-35.

6. Appendix: Pests with non-quarantine status

We found evidence that the organisms, listed below, are associated with fresh dragon fruit and present in the Dominican Republic. Because these organisms are not of quarantine significance for the United States and territories (PestID, 2019; or as defined by ISPM 5, IPPC, 2019), we did not list them under Table 1 nor did we intensively evaluate their association with dragon fruit and their presence in the Dominican Republic. Therefore, the organisms are considered to have only "potential" association with the commodity and presence in the Dominican Republic.

We listed these organisms along with the references supporting their potential presence in the Dominican Republic, their presence in the United States and territories (if applicable), and their potential association with the dragon fruit. If any of the organisms are **not** present in the United States and territories, we also provided justification for their non-quarantine status. Unless otherwise noted, these organisms are non-actionable at U.S. ports of entry (PestID, 2019).

Organism	**In Dominican Republic**	**In U.S.**	**Host Association**	**Notes**
INSECT: Coleoptera: Coccinellidae *Cycloneda sanguinea* (Linnaeus)	Ueda, 2021 (listed in Hispaniola) Perez-Gelabert and González-F., 2009	CABI, 2021; Ueda, 2021	MAG, 1994	
INSECT: Coleoptera: Lampyridae *Aspisoma* sp.	Ueda, 2021 (*Aspisoma ignitum* is listed in Hispaniola) Perez-Gelabert, 2008	N/A	Romero, 1994	*Aspisoma ignitum* is present in Puerto Rico (Santiago-Blay and Medina-Gaud, 1986). Genus is non-quarantine (ARM, 2021).
INSECT: Hemiptera: Aphididae *Aphis gossypii* Glover	CABI, 2021	CABI, 2021; Carrillo et al., 2021	Carrillo et al., 2021; Choi et al., 2013	
INSECT: Hemiptera: Diaspididae[e] *Lopholeucaspis cockerelli* (Grandpre & Charmoy)	García-Morales et al., 2016	García-Morales et al., 2016	García-Morales et al., 2016	
INSECT: Hemiptera: Diaspididae *Pseudischnaspis bowreyi* Cockerell	García-Morales et al., 2016	García-Morales et al., 2016	Maes, 2004	

[e]

INSECT: Hemiptera: Pseudococcidae *Dysmicoccus brevipes* (Cockerell)	García-Morales et al., 2016	García-Morales et al., 2016	FAO RAP, 2004	
INSECT: Hemiptera: Pseudococcidae *Phenacoccus madeirensis* Green	García-Morales et al., 2016	García-Morales et al., 2016	García-Morales et al., 2016	
INSECT: Hemiptera: Pseudococcidae *Pseudococcus jackbeardsleyi* Gimpel & Miller	García-Morales et al., 2016	García-Morales et al., 2016	García-Morales et al., 2016	
INSECT: Hymenoptera: Formicidae *Odontomachus* sp.	AntWeb, 2021	N/A	Romero, 1994	*Odontomachus bauri* and *Odontomachus ruginodis* are the only *Odontomachus* species listed for the ant taxa of the Dominican Republic (AntWeb, 2021). *Odontomachus ruginodis* is present only in CONUS (AntWeb, 2021). Genus is non-quarantine (ARM, 2021).
INSECT: Hymenoptera: Formicidae *Pheidole megacephala* (Fabricius)	AntWeb, 2021	AntWeb, 2021	FAO RAP, 2004	
INSECT: Hymenoptera: Formicidae *Solenopsis geminata* (Fabricius)	Gotzek and Martinez, 2021	CABI, 2021; Wetterer, 2011	FAO RAP, 2004; MAG-FOR, 2004	
INSECT: Hymenoptera: Formicidae *Solenopsis* sp.	AntWeb, 2021	N/A	MAG, 1994	*Solenopsis geminata* is the only *Solenopsis* species listed for the ant taxa of the Dominican Republic (Ant Web 2021). *Solenopsis geminata* is present in CONUS (AntWeb 2021), and Hawaii (Heu, 2007). Genus is non-quarantine (ARM, 2021).

INSECT: Hymenoptera: Vespidae *Polistes instabilis* de Saussure	Texas A&M University Insect Collection, 2021	Texas A&M University Insect Collection, 2021	Romero, 1994	Genus is non-quarantine (ARM, 2021).
INSECT: Thysanoptera: Thripidae *Frankliniella insularis* (Franklin)	Senckenberg, n.d.	Carrillo et al., 2021; Mound et al., 2016; Viteri et al., 2010	Carrillo et al., 2021	
INSECT: Thysanoptera: Thripidae *Frankliniella occidentalis* (Pergande)	EPPO, 2021	Carrillo et al., 2021; EPPO, 2021	Carrillo et al., 2021; Meza et al., 2020	
BACTERIUM *Enterobacter cloacae* (Jordan) Hormaeche & Edwards	Slots et al., 1991	CABI, 2021	Stem (Soto et al., 2019)	
BACTERIUM *Pectobacterium carotovorum* (Jones) Waldee, syn.: *Erwinia carotovora* (L. R. Jones) Holland	Valdez et al., 2016	CABI, 2021	Ríos Fornos and Villavicencio Castillo, 1997; Valencia Botín et al., 2003	
FUNGUS *Alternaria alternata* (Fr.: Fr.) Keissl.	Farr and Rossman, 2021	Farr and Rossman, 2021	Castro et al., 2017; Farr and Rossman, 2021	
FUNGUS *Aspergillus niger* Tiegh.	Farr and Rossman, 2021	Farr and Rossman, 2021	Le et al., 2000	
FUNGUS *Aspergillus flavus* Link: Fr.	Farr and Rossman, 2021	Farr and Rossman, 2021	Le et al., 2000	
FUNGUS *Athelia rolfsii* (Curzi) C.C. Tu & Kimbr.	Farr and Rossman, 2021	Farr and Rossman, 2021	Farr and Rossman, 2021	
FUNGUS *Botryosphaeria dothidea* (Moug.: Fr.) Ces. & De Not.	Farr and Rossman, 2021	Farr and Rossman, 2021	Farr and Rossman, 2021	
FUNGUS *Cladosporium herbarum* (Pers.: Fr.) Link	Farr and Rossman, 2021	Farr and Rossman, 2021	Ngoc et al., 2018	

FUNGUS *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc., syn.: *Glomerella cingulata* (Stoneman) Spauld. & H. Schrenk	Farr and Rossman, 2021; Perez, 2014	Farr and Rossman, 2021	Farr and Rossman, 2021; Palmateer et al., 2007
FUNGUS *Colletotrichum truncatum* (Schwein.) Andrus & W.D. Moore	Farr and Rossman, 2021	Farr and Rossman, 2021	Farr and Rossman, 2021; Guo et al., 2014
FUNGUS *Curvularia lunata* (Wakker) Boedijn	Farr and Rossman, 2021	Farr and Rossman, 2021	Paull and Duarte, 2012
FUNGUS *Diaporthe phaseolorum* (Cooke & Ellis) Sacc.	Farr and Rossman, 2021	Farr and Rossman, 2021	Farr and Rossman, 2021
FUNGUS *Fusarium oxysporum* Schltdl.: Fr.	Farr and Rossman, 2021	Farr and Rossman, 2021	Farr and Rossman, 2021; MAG, 1994
FUNGUS *Fusarium proliferatum* (Matsush.) Nirenberg ex Gerlach & Nirenberg	Farr and Rossman, 2021	Farr and Rossman, 2021	Galvao Pierangeli, 2019
FUNGUS *Neocosmospora solani* (Mart.) L. Lombard & Crous, syn.: *Fusarium solani* (Mart.) Sacc.	Farr and Rossman, 2021	Farr and Rossman, 2021	Rita et al., 2013
FUNGUS *Rhizopus stolonifer* (Ehrenb.: Fr.) Vuill.	Farr and Rossman, 2021	Farr and Rossman, 2021	Ngoc et al., 2018