CAPS Datasheets provide pest-specific information to support planning and completing early detection surveys.

Phthorimaea absoluta

Scientific Name
Phthorimaea absoluta

Synonym:
Tuta absoluta

Common Name
Tomato leafminer, tomato borer, tomato leafminer moth, tomato leaf worm, South American tomato moth

Type of Pest
Moth, borer
Moth, defoliator
Moth, foliage feeder

Taxonomic Position
Class: Insecta, **Order:** Lepidoptera, **Family:** Gelechiidae

Notes on taxonomy and nomenclature: In 2021, this moth was re-classified from *Tuta absoluta* back to its original genus, as *Phthorimaea absoluta* (Chang and Metz, 2021). It is commonly referred to as *Tuta absoluta* in literature. The mitochondrial genome was described and can be used for identification in addition to morphology, which supports its position in the Gelechiidae family of Lepidoptera (Zhang et al., 2019). *Phthorimaea absoluta* has been placed in the genera *Gnorimoschema* (by Meyrick 1925), *Scrobipalpula* (by Povolný in 1967) and *Scrobipalpuloides* (by Povolný in 1993) (Chang and Metz, 2021).

Pest Recognition
This section describes characteristics of the organism and symptoms that will help surveyors recognize possible infestations/infections in the field, select survey sites, and collect symptomatic material. For morphological descriptions, see the Identification/Diagnostic resources on the AMPS pest page on the CAPS Resource and Collaboration website.

Larvae (Fig. 1, 2) start out small ($^{1}/_{28}$ inch) and transparent or white and change to green as they grow larger (to about $^{1}/_{3}$ inch) with a dark head (Garcia and Espul, 1982). Fully developed larvae often have a dark line across the thorax (Fig. 1 C). Larvae

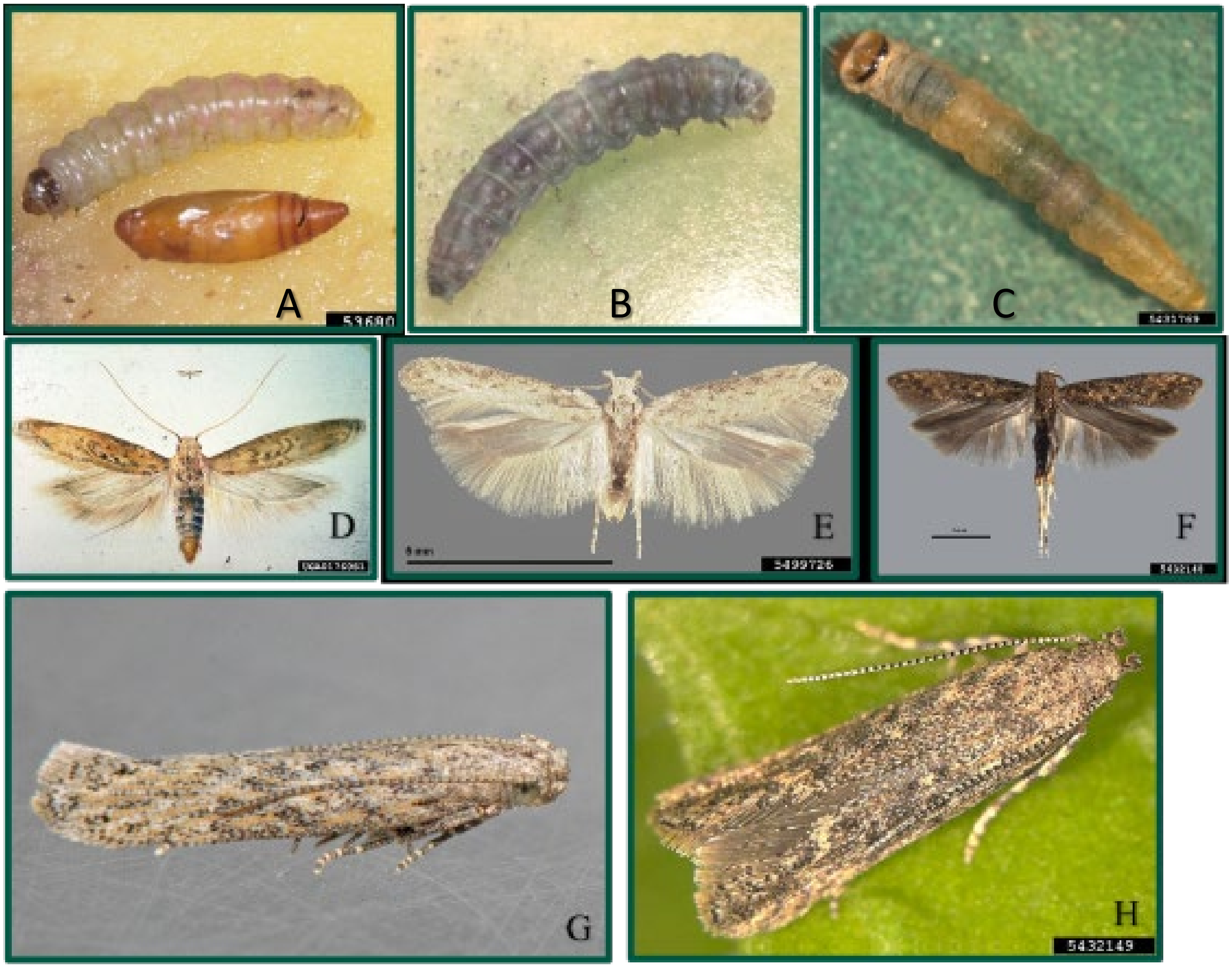

Figure 1. *Phthorimea absoluta* and similar species: larvae of A) potato tuber moth (*Phthorimaea operculella*), B) tomato pinworm (*Keiferia lycopersicella*), and C) tomato leafminer (*P. absoluta*); mounted adults of D) potato tuber moth, E) tomato pinworm, and F) tomato leafminer; resting adults of G) tomato pinworm and H) tomato leafminer. Photos courtesy of Bugwood.org: Central Science Laboratory, Harpenden, British Crown; Alton N. Sparks, Jr., University of Georgia; Merle Shepard, Gerald R.Carner, and P.A.C Ooi, Insects and their Natural Enemies Associated with Vegetables and Soybean in Southeast Asia; Marja van der Straten, NVWA Plant Protection Service; Sangmi Lee, Hasbrouck Insect Collection, Arizona State University; Mark Dreiling; James Hayden, FDACS Division of Plant Industry.

mine all parts of the plants as they get larger, but typically start in the young leaves before moving to other parts of the plant (Tropea Garzia et al., 2012).

Adult (Fig. 1, 2) moths are small ($^{1}/_{4}$ inch long) and gray or cream-colored. Adult wings are narrow and fold over the body at rest, and the antennae are thin and ringed with alternating light and dark bands (Defra-Fera. Korycinska and Moran, 2009; Vargas, 1970). Adults are crepuscular to nocturnal in habit and are unlikely to be seen during the day when resting on leaves (Defra-Fera. Korycinska and Moran, 2009).

Figure 2. *Phthorimaea absoluta* larvae (left) and adult (right) on tomato leaves (left). Notice the damage caused by the larva . Photos courtesy of Metin Gülesci, Bugwood.org

Damage

Phthorimaea absoluta larvae mine the leaves (Fig. 2), shoots, apical buds, flowers, and fruit (Fig. 3) of tomato as well as the leaves and tubers of potato (Pastrana, 2004). As the larvae develop and feed, the leaf mines increase in width. In severe infestations (Fig. 4), the larvae consume all the leaf tissue and leave behind a skeletonized leaf and copious amounts of frass. It is common for larvae of the second to fourth instars to spin silken shelters on leaves or tie leaves together. Larvae can also mine tender shoots and fruits. Infested fruit usually falls to the ground (Vargas, 1970).

Easily Mistaken Species

Phthorimaea absoluta adults look like two other gelechiid species that may be found as pests in tomato fields in the United States: *P. operculella* (potato tuber moth) and *Keiferia lycopersicella* (tomato pinworm) (Fig. 1). *Phthorimaea absoluta* and *K. lycopersicella* adults both have light and dark-banded antennae, labial palps, and similar coloration on the forewings. *Phthorimaea absoluta* has more defined dark patches on the forewings than *K. lycopersicella*, which is light brown to gray with brownish streaks. In addition, the hindwings of *K. lycopersicella* have hair pencils on the anterior margin (Brambila et al., 2010a, 2010b). A genital dissection should be used to confirm all tentative identifications. In some cases, especially at the beginning of the infestation, the mines from larvae feeding can be mistaken for those caused by leafminer flies in the family Agromyzidae (Vargas, 1970).

Commonly Encountered Non-targets

Sinoe capsana is a newly described gelechiid species that has been frequently captured in tomato leafminer detection traps in Florida (Lee and Brambila, 2012); this

Figure 3. Tomato leaflet with mines caused by *Phthorimaea absoluta* larvae (left), tomato fruit infested by *P. absoluta* larvae (center), and *P. absoluta* adult on a tomato leaf (right). Photos are courtesy of Antonio Biondi.

moth is paler than *P. absoluta* and can be easily distinguished on sticky traps (Roda et al., 2015).

Biology and Ecology

Phthorimaea absoluta has a high reproductive potential. Females can lay up to 260 eggs (Biondi et al., 2018) and produce 5 to 13 generations per year, depending on the climate (Tropea Garzia et al., 2012). Generations are overlapping and all life stages can occur during any time of the year (Cocco et al., 2015). The entire lifecycle is 23–76 days depending on temperature (Tropea Garzia et al., 2012). During the day, female adults usually rest on leaves in the upper portion of the plants and emit pheromones to attract males, which fly towards them in groups (Uchoa-Fernandes et al., 1995). Eggs are usually laid singly or in small groups on the underside of new leaves near the top of the plant; however, eggs can be laid anywhere on the plant (Tropea Garzia et al., 2012). Newly hatched larvae feed internally on leaves and move to other parts of the plant as they grow larger, infesting stems, and fruits. Pupation takes usually place on leaves but can also occur in other sheltered places on the plant or in soil. Pupation usually lasts about 5 days before adults emerge (Tropea Garzia et al., 2012).

Degree day models for *P. absoluta* estimate a lower temperature threshold of 44.4 °F for development from egg to adult. The calculated degree days for development from egg to adult emergence is 453.6 degree days (Barrientos et al., 1998). The use of hosts other than tomato allows *P. absoluta* to be present throughout the year as it moves between planted and naturally occurring (weedy) hosts (Mohamed et al., 2015).

Known Hosts

Phthorimaea absoluta is mainly a pest of solanaceous plants (Abbes et al., 2016; Sylla et al., 2019) in both fields and greenhouse environments (Desneux et al., 2010).

Tomato (*Solanum lycopersicum*) is the preferred host, but damage is also observed in eggplant (*S. melongena*), potato (*S. tuberosum*), and pepper (*Capsicum* spp.) (Sylla et al., 2019). Additional plant associations are listed in Table 1.

The host list, below, includes cultivated and wild plants that 1) are infected or infested by the pest under natural conditions, 2) are frequently described as major, primary, or preferred hosts, and 3) have primary evidence for feeding and damage documented in the literature. Plants are highlighted in bold if they are commercially produced and the pest causes economically significant damage.

Major hosts
***Solanum lycopersicum* (tomato)** (Sylla et al., 2019)

Other hosts
See table 1

Table 1. Reported host plants of *P. absoluta* and their presence in the United States

Scientific name	Common name	U.S. Presence	Report Type	Plant Part(s) Attacked	Reference
Amaranthus spinosus L.	spiny amaranth	Present	Field report	not reported	Mohamed et al., 2015
Amaranthus viridis L.	slender amaranth	Present	Field report	not reported	Bayram et al., 2015
Beta vulgaris L.	beet	Present	Field report	not reported	Drouai et al., 2016
Chenopodium album L.	lambsquarters	Present	Field report	not reported	Portakaldali et al., 2013
Chenopodium bonus-henricus L.	good King Henry	Present	Field report	not reported	Drouai et al., 2016
Chenopodium rubrum L.	red goosefoot	Present	Field report	not reported	Drouai et al., 2016
Spinacia oleracea L.	Spinach	Present	Field report	not reported	Drouai et al., 2016
Sonchus oleraceus L.	common sowthistle	Present	Field report	not reported	Polat et al., 2015
Xanthium strumarium L.	rough cocklebur	Present	Field report	not reported	Bayram et al., 2015
Xanthium strumarium subsp. *brasilicum* (Vell.) O. Bolòs & Vigo syn.: *X. brasilicum* Velloso	ramtouk	not present	Field report	not reported	Mohamed et al., 2015; Bayram et al., 2015
Raphanus raphanistrum L.	wild radish	Present	Field report	Leaf	Abdul-Ridha et al., 2012
Sinapis arvensis L.	charlock mustard	Present	Field report	not reported	Polat et al., 2015
Convolvulus arvensis L.	field bindweed	Present	Field report	Leaf	Sabry and Ragaei, 2015
Citrullus lanatus (Thunb.) Matsum. & Nakai	watermelon	Present	Field report	not reported	Mohamed et al., 2015
Jatropha curcas L.	Barbados nut	Present	Field report	not reported	Mohamed et al., 2015
Medicago sativa L.	Alfalfa	Present	Field report	Leaf	Abdul-Rassoul, 2014
Phaseolus vulgaris L.	kidney bean	Present	May not complete development on this host, but reported feeding in field and greenhouse	Leaf	Incomplete development: Đurić et al., 2017; Field: Nitin et al., 2017

Scientific name	Common name	U.S. Presence	Report Type	Plant Part(s) Attacked	Reference
					Field and greenhouse: Drouai et al., 2016
Vicia faba L.	fava bean	Present	May not complete development on this host, but reported feeding in field and greenhouse	Leaf	Oviposition, but not able to develop in lab: Bawin et al., 2016 Feeding in field and greenhouse: Abdul-Ridha et al., 2012
Vigna unguiculata (L.) Walp.	Cowpea	Present	Field report	Leaf	Abdul-Ridha et al., 2012
Malva sylvestris L.	high mallow	Present	Oviposition only in lab	Leaf	Bawin et al., 2016
Sorghum halepense (L.) Pers.	johnsongrass	Present	Field report	not reported	Bayram et al., 2015
Atropa belladonna L.	belladonna	Present	Oviposition, feeding, and development in lab	Leaf	Bawin et al., 2015
Capsicum annuum L.	Pepper	Present	Field report of feeding, but low survival in lab	Leaf	Field: Portakaldali et al., 2013 Bayram et al., 2015 Polat et al., 2015); Lab: Sylla et al., 2019
Datura ferox L.	fireweed	Present	Field reports of larval feeding but no oviposition in lab	not reported	Larval feeding: Garcia and Espul, 1982; No oviposition: Galarza, 1984
Datura stramonium L.	jimsonweed	Present	Field report	not reported	Drouai et al., 2016; Mohamed et al., 2015; Vargas, 1970
Lycium barbarum L. syn.: *L. halimifolium* Mill.	matrimony vine	Present	Oviposition, feeding, and development in lab	Leaf	Bawin et al., 2016
Lycium chilense Bertero	Chilean wolfberry	not present	Unverified listing as host	not reported	Urbaneja et al., 2007
Nicotiana glauca Graham	tree tobacco	Present	Field report	not reported	Garcia and Espul, 1982
Nicotiana rustica L.	Aztec tobacco	Present	Oviposition, feeding, and development in lab	Leaf	Bawin et al., 2016
Nicotiana tabacum L.	tobacco	Present	Oviposition in laboratory	not reported	Galarza, 1984
Physalis angulata L.	cutleaf groundcherry	Present	Field report	not reported	Bayram et al., 2015
Physalis peruviana L.	Cape-gooseberry	Present	Greenhouse report	not reported	Tropea Garzia, 2009
Solanum aethiopicum L.	Ethiopian eggplant, Ethiopian nightshade	not present	Field report	Leaf	Sylla et al., 2019
Solanum americanum Mill.	American black nightshade	Present	Field report	Leaf	Smith et al., 2018
Solanum bonariense L.	none	not present	Oviposition, feeding, and development in lab	not reported	Galarza, 1984
Solanum chilense (Dunal) Reiche, syn.: *Lycopersicum puberulum* Ph.	none	not present	Field report	Leaf	Vargas, 1970
Solanum coagulans Forssk. syn.: *S. dubium* Fresen.	Gubbain	not present	Field report	Leaf, Fruit	Mohamed et al., 2015

Scientific name	Common name	U.S. Presence	Report Type	Plant Part(s) Attacked	Reference
Solanum dulcamara L.	climbing nightshade	Present	Oviposition, feeding, and development in lab	Leaf	Bawin et al., 2016
Solanum elaeagnifolium Cav.	silverleaf nightshade	Present	Field report	not reported	Drouai et al., 2016
Solanum habrochaites S. Knapp & D. M. Spooner, syn.: *Lycopersicon hirsutum* Dunal f. *glabratum* C.H. Müll.	none	not present	Minimal feeding in laboratory or greenhouse; Identified as resistant host	Leaf	Bottega et al., 2015
Solanum melongena L.	eggplant	Present	Field report	Leaf, Fruit, Shoot	Mohamed et al., 2015; Portakaldali et al., 2013
Solanum muricatum L.	pepino	Present	Field report	not reported	Portakaldali et al., 2013
Solanum nigrescens M. Martens & Galeotti (syn. *Solanum gracilius* Herter.)	divine nightshade	Present	Feeding, development, and oviposition in laboratory	not reported	Galarza, 1984
Solanum nigrum L.	black nightshade	Present	Field report	Leaf	Smith et al., 2018
Solanum pimpinellifolium Jusl.	currant tomato	Present	Experimental	Leaf	Bottega et al., 2015
Solanum pseudocapsicum L.	Jerusalem cherry	Present	Oviposition in laboratory, but no development to adults	not reported	Galarza, 1984
Solanum quitoense Lam.	naranjilla	Present	Field report	not reported	Povolny, 1975
Solanum saponaceum Dunal			Field report	not reported	Povolny, 1975
Solanum sisymbriifolium Lam.	sticky nightshade	Present	Feeding, development, and oviposition in laboratory	not reported	Galarza, 1984
***Solanum tuberosum* L.**	**potato**	Present	Field report	Leaf, Tuber	Mohamed et al., 2015; Portakaldali et al., 2013; Povolny, 1975

Pest Importance

Tomato is one of the most important crops in the United States. In 2020, over 36 million tons of tomatoes were cultivated at a market value of $3.3 billion (NASS, 2021b). Potato is another important crop, planted on over 2.7 million acres in the United States in 2020. In 2019, potato sales were over $3.9 billion (NASS, 2021a).

Yield losses from *P. absoluta* in tomatoes were about 80 percent in unmitigated field and greenhouse experiments in 2015–2017 (Shiberu and Getu, 2018a; Shiberu and Getu, 2018b); losses of 50–100 percent have been reported in areas where it is invasive (Han et al., 2019). In Sudan, *P. absoluta* was recorded to be feeding on the tubers and leaves of potato plants, causing direct yield losses of 5 percent and indirect yield losses of up to 50 percent (Mohamed et al., 2012). *Phthorimaea absoluta* also caused severe damage to eggplant that was intercropped with tomato (Mohamed et al., 2012); however, damage was considered minor in monocropping eggplant fields (Mohamed et al., 2015).

In addition to direct economic damage, there are considerable economic costs to controlling *P. absoluta*. For instance, chemical control significantly increases costs where *P. absoluta* has been introduced (Campos et al., 2017). Larvae are difficult to control because they develop within the plant, making the use of contact pesticides less effective (Biondi et al., 2018). Intensive use of pesticides to control *P. absoluta* has led to pesticide resistance in some areas where this moth is prevalent (Guedes et al., 2019; Roditakis et al., 2018). Monitoring activities and the use of pheromone traps also incur a high cost in areas where *P. absoluta* has been detected (Campos et al., 2017).

Figure 4. *Phthorimea absoluta* damage to greenhouse tomato plants. Photo is courtesy of Metin Gülesci, Bugwood.org

Phthorimaea abosoluta has spread rapidly throughout Europe, Africa, and Eurasia (Campos et al., 2017) and is on the European and Mediterranean Plant Protection Organization (EPPO) A2 pest list, which contains damaging pests that are not widely distributed in the EPPO region (EPPO, 2020). The United States and Canada have imposed strict import conditions for tomatoes where *P. absoluta* is present in Europe (Campos et al., 2017).

Phthorimaea absoluta is listed as a harmful organism under the synonym *Tuta absoluta* for eight countries as well as the Eurasian Customs Union: Canada, Egypt, Eurasian Customs Union, Georgia, Guatemala, Honduras, Japan, Mexico, and Nicaragua

(USDA-APHIS-PPQ-PCIT, 2021). There may be trade implications if this moth becomes established in the United States.

Pathogens or Associated Organisms Vectored

Phthorimaea absoluta is not known to be associated with pathogens or other organisms; however, mining by this species can predispose the leaves and fruits to secondary pathogens (Mouttet et al., 2013).

Known Distribution

Phthorimea absoluta is native to the highlands of Peru and has spread from there (Biondi et al., 2018). Sources for distributions below are from Santana et al., 2019 unless otherwise noted.

Americas: Argentina, Bolivia, Brazil, Cayman Island, Chile, Colombia, Costa Rica, Ecuador, Haiti (Verheggen and Fontus, 2019), Panama, Paraguay, Peru, Uruguay, and Venezuela.

Phthorimaea absoluta has been introduced and likely established in the following countries:

Africa: Algeria, Botswana, Burkina Faso, Burundi (Ndayizeye et al., 2019), Cape Verde, Eritrea, Egypt, Ethiopia, Ghana (Mansour et al., 2018), Kenya, Mayotte Island, Mozambique, Namibia, Rwanda, Senegal, South Africa, Sudan, Tanzania, Togo (Fiaboe et al., 2020), Tunisia, Uganda, and Zambia. **Asia:** Afghanistan, Bangladesh, China (Zhang et al., 2020), India, Iran, Iraq, Israel, Jordan, Kuwait, Kyrgyzstan, Lebanon, Nepal, Pakistan (Ishtiaq et al., 2020), Saudi Arabia, Tajikistan (Saidov et al., 2018), and Yemen. **Europe:** Austria, Belgium, Bulgaria, Croatia, Cyprus, France, Georgia, Greece, Hungary, Italy, Kosovo, Malta, Montenegro, Portugal, Romania, Russia, Serbia, Slovenia, Spain, and Turkey.

Phthorimaea absoluta has been either reported from, detected and is transient, eradicated, or of restricted distribution in the following countries:

Africa: Libya, Morocco, Niger, Nigeria, Tanzania, and The Democratic Republic of Congo (Mukwa et al., 2021). **Asia:** Qatar, Syria, and United Arab Emirates. **Europe:** Albania, Bosnia-Herzegovina, Czech Republic, Germany, Guernsey, Lithuania, The Netherlands, Norway (EPPO, 2017), Switzerland, Ukraine, and United Kingdom.

An online information network was created by Russell IPM to monitor new detections of *P. absoluta* across the globe. Records are confirmed through the information network (AGRIPEST, 2021).

Pathway

Since *P. absoluta* larvae feed internally on fruit (Vargas, 1970), they are difficult to detect in fresh tomato products (Han et al., 2019). *Phthorimaea absoluta* has spread from South America to Europe through transportation of infested tomatoes (Campos et al., 2017). They continue to spread in Europe and across the Asian continent through the import of tomatoes and other goods, and possibly with workers commuting between Europe and the Middle East (Campos et al., 2017). Tomato crates and packing boxes are also important pathways through which *P. absoluta* could be introduced into the United States (Karadjova et al., 2013).

This moth has been intercepted four times at U.S. ports of entry since 2013 (ARM, 2021). The interceptions from Lebanon (2013) and India (2017) both occurred on tomato fruit that was found in passenger baggage. The interception from Italy (2016) was found on imported tile and the Colombia interception (2019) was found on imported cut flowers (hydrangea) (ARM, 2021).

Phthorimaea absoluta appears to spread at a rate of around 800 km per year in areas where it has been introduced (Biondi et al., 2018). Adults can fly, have high reproductive potential and a wide range of hosts, and can survive in a variety of environmental conditions (Guimapi et al., 2020). *Phthorimaea absoluta* has spread more quickly than expected; it reached Southeast Asia from Turkey in half the time predicted (Guimapi et al., 2020). It has also spread throughout Europe and Africa from Spain in less than 10 years (Campos et al., 2017).

Use the PPQ Commodity Import and Export manuals listed below to determine 1) if host plants or material are allowed to enter the United States from countries where the organism is present and 2) what phytosanitary measures (e.g., inspections, phytosanitary certificates, post entry quarantines, mandatory treatments) are in use. These manuals are updated regularly.

Agricultural Commodity Import Requirements(ACIR) manual: ACIR provides a single source to search for and retrieve entry requirements for imported commodities. https://acir.aphis.usda.gov/s/

Plants for Planting Manual: This manual is a resource for regulating imported plants or plant parts for propagation, including buds, bulbs, corms, cuttings, layers, pollen, scions, seeds, tissue, tubers, and like structures.
https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/plants_for_planting.pdf

Treatment Manual: This manual provides information about treatments applied to imported and domestic commodities to limit the movement of agricultural pests into or within the United States.
https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/treatment.pdf

Potential Distribution within the United States

California and Florida are the main tomato-producing states in the country (Biondi et al., 2018), but other solanaceous crops, such as potato, are grown commercially across the United States (NASS, 2021a, 2021b). Solanaceous hosts are also popular plants in home gardens. As a result, *P. absoluta* is unlikely to be limited by a lack of available hosts in the United States.

A climate suitability map, produced by the SAFARIS Team (Takeuchi et al., 2018), identifies Global Plant Hardiness Zones 9 to 13 as suitable for *P. absoluta*. In the United States, these zones encompass the southern portion of the continental United States and run northward along the coasts into the northwestern and northeastern United States. Hawaii, Puerto Rico, and other territories are also included in these zones. *Phthorimaea absoluta* could potentially establish in these areas where host plants are present.

Survey and Key Diagnostics

Approved Methods for Pest Surveillance:

For currently approved methods and guidance for survey and identification, see Approved Methods for Pest Surveillance (AMPS) pest page on the CAPS Resource and Collaboration website, at https://caps.ceris.purdue.edu/approved-methods.

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Versions

- **March 2014:** Complete revision of the datasheet
- **August 2014:** Updated distribution and pathways sections; included information on Federal Order DA2014-33
- **December 2022:** Complete revision of the datasheet, new template

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