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

Neoleucinodes elegantalis

Figure 1. Adult *N. elegantalis* (Photo courtesy of Kurt Ahlmark, Microlepidoptera on Solanaceae, USDA APHIS PPQ, Bugwood.org)

Scientific Name
Neoleucinodes elegantalis (Guenée, 1854)

Synonym(s):
Leucinodes elegantalis Guenée

Common Name
Tomato fruit borer, eggplant moth,
cocona fruit borer

Type of Pest
Moth, borer

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

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.

Pest Description
Descriptions and illustrations of all stages can be found in Capps (1948).

Adults: Adult moths are small, with a wingspan of 1/2 -1 1/4 inches, and translucent white, with irregular black and brown spots and fringed wing edges (Fig. 1) (Caceres, 2020; Capps, 1948; Serrano et al., 1992). Adults hide among vegetation during the day and fly at night (Jaffe et al., 2007; Obando Melo, 2011).

Eggs: Eggs are elliptical and slightly sculptured, with an average diameter of 0.27-0.54 mm (Díaz Montilla et al., 2013; Serrano et al., 1992). Eggs are initially white to pale yellow and turn brown before hatching (Serrano et al., 1992). They are laid individually or in groups, typically on the fruit calyx, on small unripe fruits (diameter less than 1 1/4 inches), or on flowers and fruit stems (Fig. 2) (Blackmer et al., 2001; Salas et al., 1991).

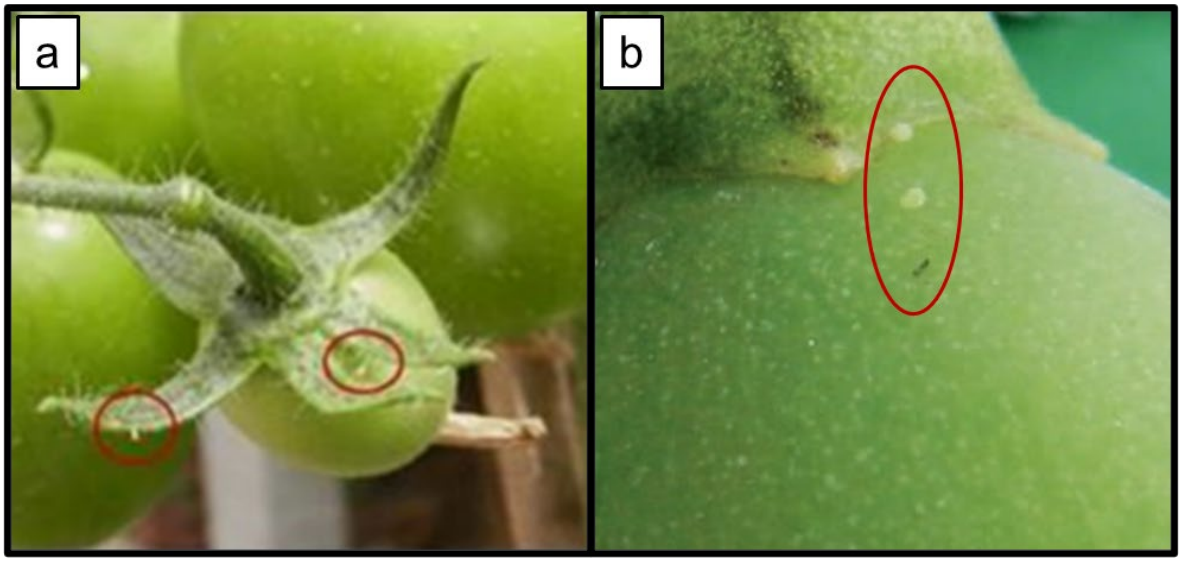

Figure 2. *N. elegantalis* eggs. (a): Eggs on upper side of fruit calyx; (b): on fruit. (Photos courtesy of Diaz, 2013; A. E. Diaz, Corpoica La Selva (Colombia)).

Larvae: Newly hatched larvae are small (1/32 of an inch long) and can grow to approximately 3/4 inch (Capps, 1948; Noboa and Viera, 2020). Last-instar larvae have tapered abdomens with a pale yellow to light brown head. The larvae change from a white/light pink to a dark pink hue as they mature (Fig. 3). All larval stages occur inside the fruit (Capps, 1948; Serrano et al., 1992).

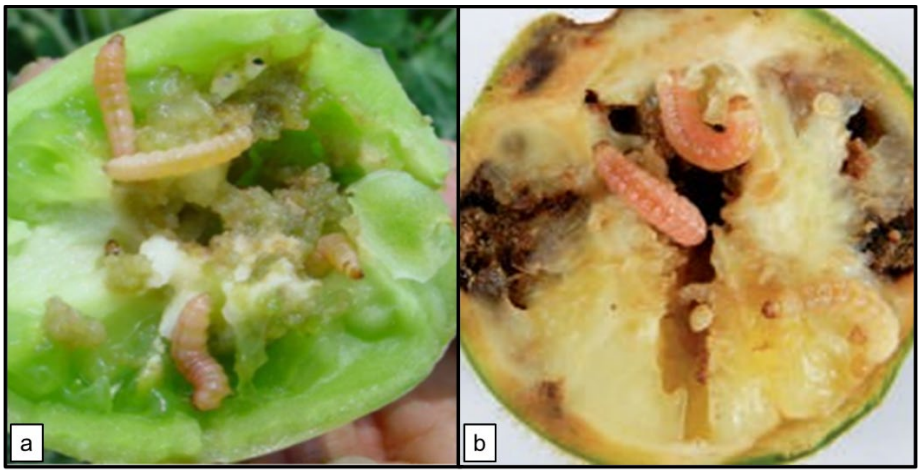

Figure 3. *Neoleucinodes elegantalis* mature larvae. (a) in tomato; (b) in *S. quitoense* (Photos courtesy of Diaz, 2013; A. E. Diaz, Corpoica La Selva - Colombia).

Pupae: Pupae are approximately 1/4 to 1/2 inch long and light to dark brown (Caceres, 2020; Serrano et al., 1992). They can be found in the soil, rolled up in green or dry leaves, or in between fruits (Fig. 4) (Díaz Montilla, 2013; Salas et al., 1991; Viáfara Millán et al., 1999).

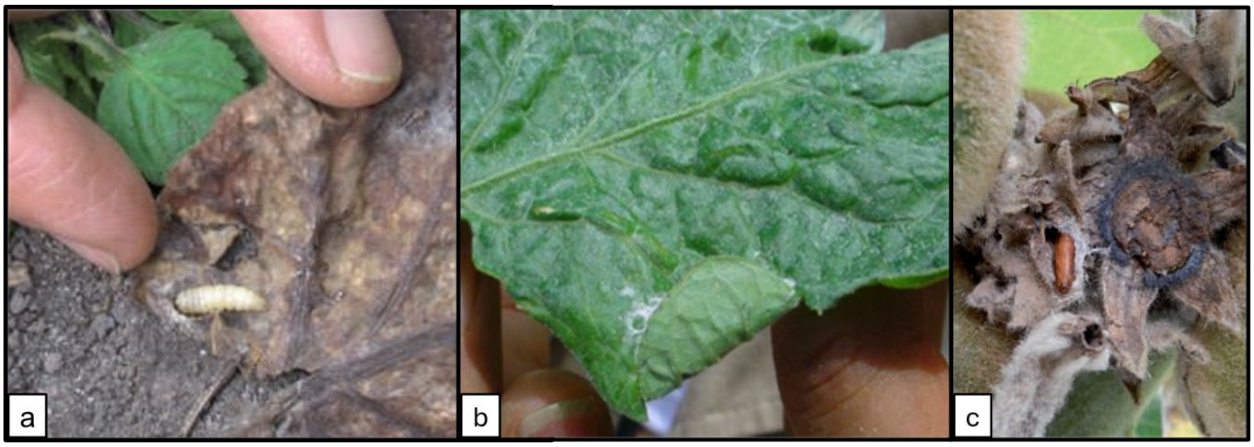

Figure 4. *N. elegantalis* prepupa & pupa: (a): in dry leaves. (b): in folded leaves (c): in *S. quitoense* fruit cluster. (Photos courtesy of Diaz, 2013, A. E. Diaz, Corpoica La Selva (Colombia)).

Signs

The larva enters the fruit, leaving an entry point on the surface that is submerged and surrounded by a chlorotic, yellow halo that can be easily distinguished with the naked eye (Fig. 5 a & b) (Díaz Montilla, 2013).

Signs of the larva feeding on the pulp and seeds become more noticeable as the larva grows (Fig. 3), and it leaves a conspicuous hole when it exits the fruit to pupate (Fig. 5 c & d) (Serrano et al., 1992). Droppings can be observed outside of the fruit in *Solanum quitoense* and *S. betaceum* (Díaz Montilla, 2013).

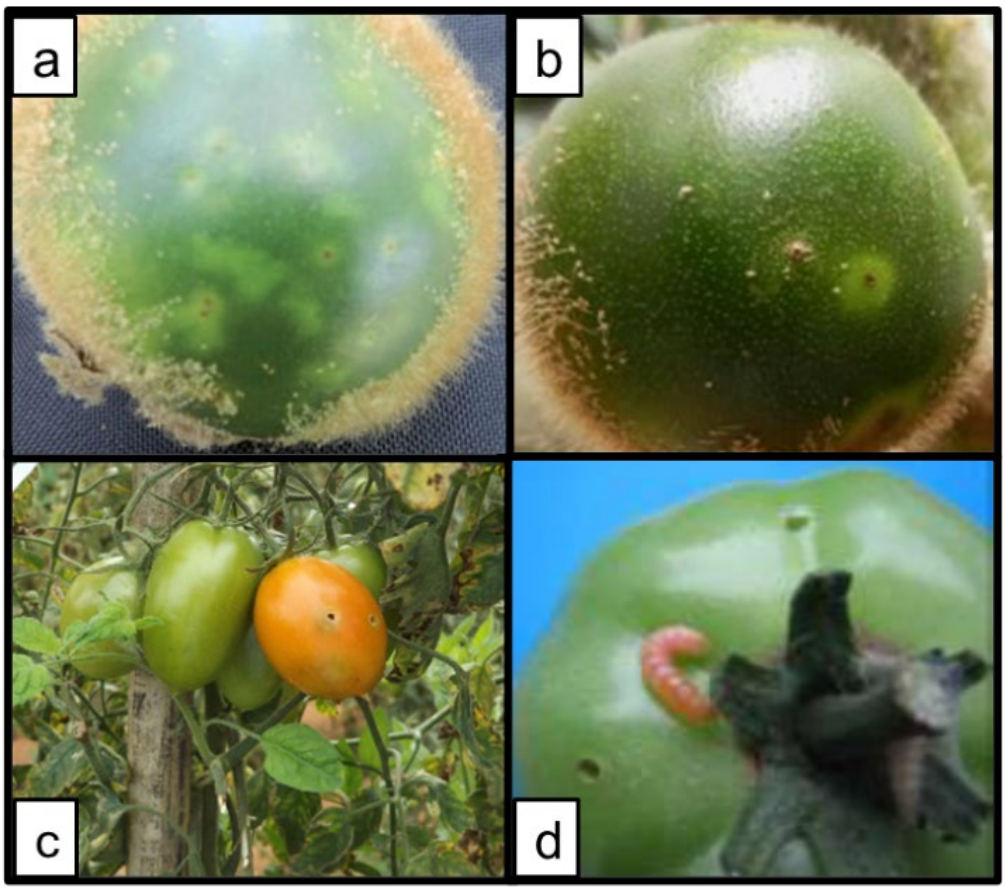

Figure 5. *Neoleucinodes elegantalis* infestation signs (a & b): *N. elegantalis* larva entry hole (Photos courtesy of A. E. Diaz, Corpoica La Selva - Colombia). (c & d): Exit holes in tomato (Photos courtesy of R. da Silva, Universidad Federal de Viçosa and S. Caceres, Instituto Nacional de Tecnología Agropecuaria, Argentina).

Easily Mistaken Species

Neoleucinodes elegantalis is similar to three species of *Neoleucinodes*: *N. prophetica, N. torvis,* and *N. silvaniae* (Díaz Montilla, 2013; Hayden et al., 2013). *Leucinodes orbonalis* and larvae of *Phthorimaea absoluta* are also easily mistaken for *N. elegantalis*.

Neoleucinodes prophetica (potato tree borer) and *N. torvis* (turkeyberry borer) are present in the United States and have been reported from southern Florida in wild solanaceous hosts (Hayden and Dickel, 2014). *Neoleucinodes prophetica* is similar *to N. elegantalis* in size and wing patterns whereas *N. torvis* is much smaller, has less black scaling on the wings and the orange spot in the front wing is oblique rather than triangular shaped as in the other species (Fig. 6) (Hayden and Dickel, 2014). They can be differentiated from *N. elegantalis* based on the genitalia; a key is available in Capps (1948).

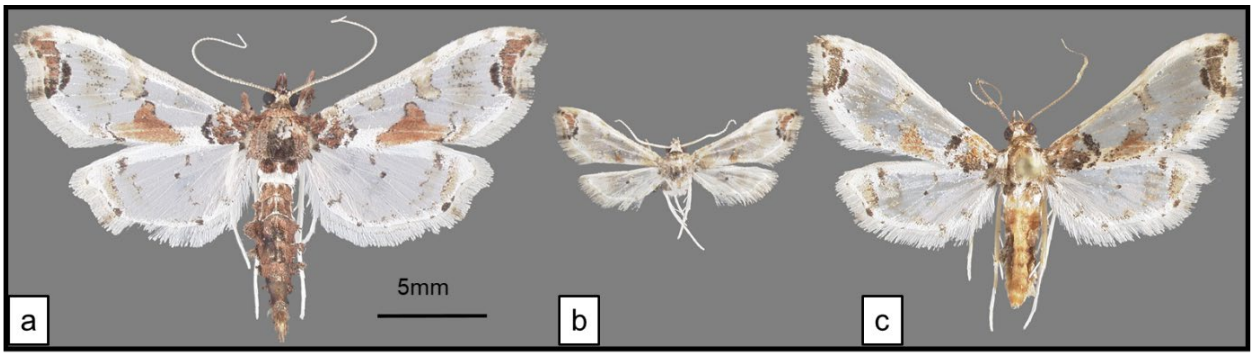

Figure 6. (a) *Neoleucinodes elegantalis,* (b) *N. torvis*, and (c) *N. prophetica* (Source: Hayden et al. 2013, IDtools.org).

Neoleucinodes silvaniae is not known to occur in the United States. It has only been reported from Colombia, infesting *Solanum lanceifolium* (Diaz and Solis, 2007). It looks almost identical to *N. elegantalis,* having very similar wing patterns and size, with *N. elegantalis* being slightly larger (Diaz and Solis, 2007; Royals et al., 2019). Diaz and Solis (2007) present some external characters and descriptions of genitalia to differentiate them.

Leucinodes orbonalis (eggplant fruit borer) has been reported from Africa and Asia and is not known to occur in the United States. It prefers eggplant as the main host whereas *N. elegantalis* prefers tomato. They can be distinguished by their genitalia, wing venation, and other characteristics (Capps, 1948).

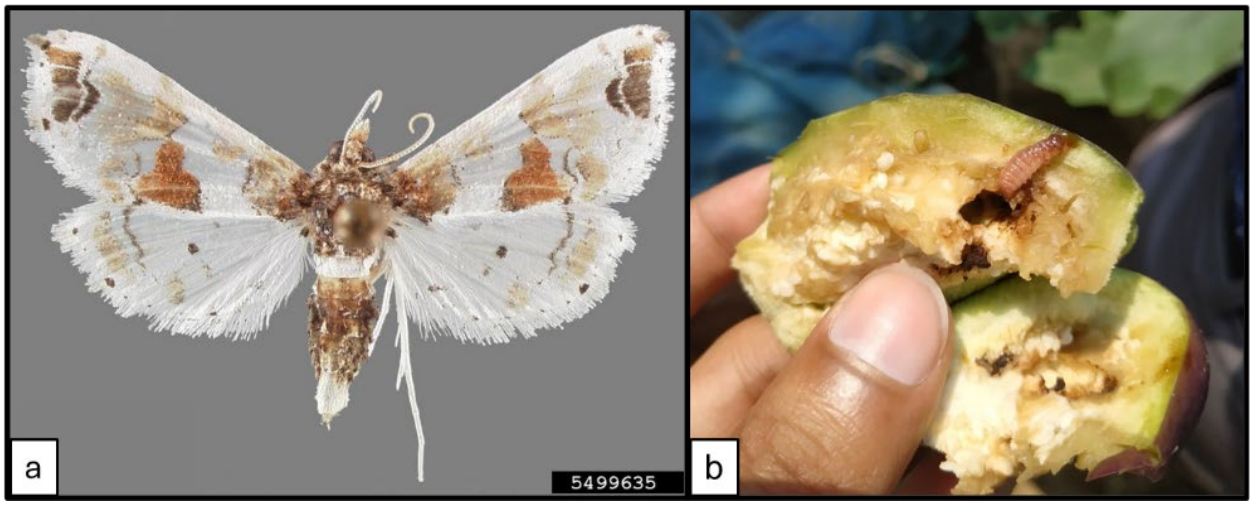

Figure 7. *Leucinodes orbonalis*: (a) adult female (Photo by Kurt Ahlmark, Microlepidoptera on Solanaceae, USDA APHIS PPQ, Bugwood.org) and (b) larva and fruit damage on eggplant (Photo by Syed Zahid Hasan, Sylhet Agricultural University, Bugwood.org)

The larvae of *Phthorimaea absoluta* (tomato leafminer) also feed inside tomato fruit and can be pink in color, similar to that of *N. elegantalis* larvae (Fig. 8). *Phthorimaea absoluta* is not known to occur in the United States (Simmons et al., 2018).

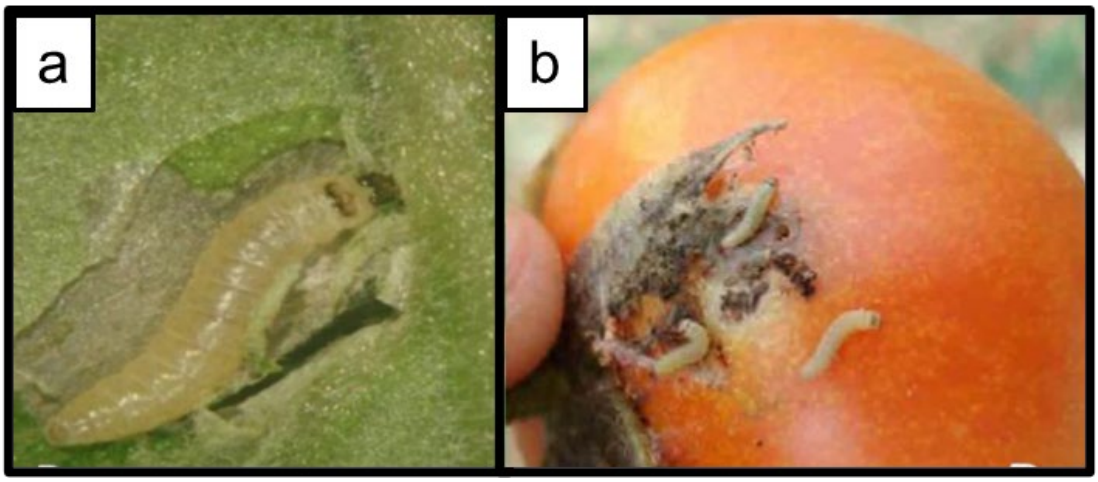

Figure 8 *Phthorimaea absoluta* (a) larva and (b) larvae and damage in fruits of tomato (Photos courtesy of N. Mujica, International Potato Center)

Commonly Encountered Non-targets

The approved survey method for *N. elegantalis* is pheromone trapping using the *Neoleucinodes elegantalis* (E11-16OH) lure. Commonly encountered non-targets include the following moths, which are also attracted to the lure: *Diaphania hyalinata, D. nitidalis, Lonomia obliqua, Neoleucinodes prophetica, N. torvis* and *Tyta luctuosa* (Badji et al., 2003; El-Sayed, 2024).

Biology and Ecology

Neoleucinodes elegantalis infests only fruits of solanaceous plants (Díaz Montilla et al., 2013).

In tomatoes, eggs are laid preferentially on the calyx and skin of fruits that are small ($^{3}/_{16}$ -$1^{3}/_{16}$ inches in diameter) (Blackmer et al., 2001). They are laid individually or in groups of up to 23 eggs (Díaz Montilla et al., 2013; Serrano et al., 1992). The eggs typically hatch in about a week, after which the larvae bore into the fruit within two hours (Díaz Montilla, 2013; Eiras and Blackmer, 2003). The larvae feed inside the fruit, eating the seeds and flesh (Fig. 3) (Medal et al., 1996; Serrano et al., 1992; Toledo, 1948). There are usually 1 to 3 larvae per fruit, but there can be more (Capps, 1948).

The larvae progress through four or five larval instars, depending on temperature and host (Marcano, 1991a; Noboa and Viera, 2020). The larval stage lasts 14 to 19 days (Díaz Montilla et al., 2013; EDA, 2007). Once larvae are mature, they exit the damaged fruit to pupate (Díaz Montilla et al., 2013). In tomato, pupation occurs in green or dry leaves near the damaged fruits (Caceres, 2020; Viáfara Millán et al., 1999) or in the soil (Salas et al., 1991).

Pupae develop for 7-12 days before adults emerge (Fernández and Salas, 1985; Muñoz et al., 1991). During the day, adults hide in shaded areas, such as within crops or in surrounding vegetation (Carneiro et al., 1998; Eiras, 2000). They can be seen on the foliage in a resting position with spread wings (Obando Melo, 2011). Moths are active for a few hours at sunset and night, either walking or taking short flights (Jaffe et al., 2007; Marcano, 1991b; Salas et al., 1991). Mating begins when moths are 2-3 days old and females release sex pheromones to attract mates (Eiras, 2000; Jaffe et al., 2007). Females have been recorded laying up to 196 eggs, with an average of 30-34 (Fernández and Salas, 1985; Toledo, 1948). Adults live for 1-8 days (Fernández and Salas, 1985; Jaffe et al., 2007; Serrano et al., 1992).

Neoleucinodes elegantalis completes its cycle in 34 days, on average, at 82°F and 67% relative humidity in tomato (Fernández and Salas, 1985). Moraes and Foerster (2015) determined the minimum temperature threshold is 48°F for egg development and 46°F for larval and pupal development. Based on developmental models, *Neoleucinodes elegantalis* is estimated to require between 588 and 673 degree-days for its full development (Barker and Coop, 2020; Moraes and Foerster, 2015). Humidity seems to be an important factor in the development of *N. elegantalis*, which thrives in humid regions in Colombia and Brazil during the rainy season (Díaz-Montilla et al., 2011; Silva et al., 2020). Dry stress is predicted to impact the survival of the moth, with the prepupal stage likely the most affected (da Silva et al., 2018).

Neoleucinodes elegantalis has no apparent photoperiodic response, diapause, or specific overwintering stage (Barker et al., 2020). Barker et al. (2020) predicted that *N. elegantalis* could have 2-9 generations per year in the United States.

Known Hosts

Neoleucinodes elegantalis is known to infest only solanaceous fruits (da Silva et al., 2017a). Major hosts include tomato, pepper, and eggplant (Díaz Montilla et al., 2013), which are cultivated in open fields, greenhouses, gardens, and backyards. The borer can potentially develop, survive, and find refuge in wild solanaceous plants (Moraes and Foerster, 2015).

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.

Table 1. Preferred hosts of *N. elegantalis*.

Scientific Name	Common Name	Presence in the US	Type/Use	Reference
Capsicum annuum	green pepper	Present	Cultivated	Diaz-Montilla, 2010
Solanum betaceum (=Cyphomandra betacea)	tree tomato	Absent	Cultivated	Díaz Montilla, 2013
Solanum lycopersicum	tomato	Present	Cultivated	Blackmer et al., 2001

Solanum melongena	eggplant	Present	Cultivated	Espinoza, 2008
Solanum quitoense	Quito-orange	Absent	Cultivated	Díaz Montilla, 2013
Solanum sessiliflorum	cocona	Absent	Cultivated	Anteparra et al., 2010
Solanum torvum	turkey berry	Present	Wild	Diaz Montilla, 2009
Solanum viarum	tropical soda apple	Present	Wild	Medal et al., 1996

Pest Importance

Neoleucinodes elegantalis causes economic losses throughout South America in many solanaceous crops, including *Solanum lycopersicum* (tomato), *S. melongena* (eggplant), *Capsicum annuum* (pepper), *S. betaceum* (tomato tree), and *S. quitoense* (Quito-orange or lulo) (Diaz and Solis, 2007).

In Brazil, *N. elegantalis* is one of the most important pests in tomato, causing yield losses of up to 90% (de Paulo Arcanjo et al., 2021). In Colombia, yield losses can be up to 60% in tomato and *S. quitoense* (lulo), and up to 21% in *S. betaceum* (tree tomato) (Díaz Montilla, 2016). In Ecuador, yield losses of up to 70% have been reported in *S. quitoense* (Noboa and Viera, 2020). Yield losses of 1% have been reported for eggplant in Honduras, and the pest presence compromises exportation of this vegetable to the United States (EDA, 2007; Espinoza, 2008).

Neoleucinodes elegantalis is on the European and Mediterranean Plant Protection Organization (EPPO) A1 pest list, which includes pests that are absent in the EPPO region (EPPO, 2023). Additionally, Argentina, Chile, Honduras, Jordan, Morocco, Republic of North Macedonia, and United Kingdom have *N. elegantalis* listed as a harmful organism (USDA-PCIT, 2024). There may be trade implications if this pest becomes established in the United States.

Pathogens or Associated Organisms Vectored

Neoleucinodes elegantalis is not known to be associated with pathogens or other organisms, although the tunnels made by larval feeding might facilitate the entry of pathogens (Paredes et al., 2010).

Known Distribution

Neoleucinodes elegantalis occurs in the Neotropical region (da Silva et al., 2017b; de Paulo Arcanjo et al., 2021).

Table 2. Countries where *N. elegantalis* is known to occur.

Region/Continent	Country	Reference
Caribbean	Cuba	Águila, 2004
Central America	Costa Rica	Hayden and Dickel, 2014
Central America	Guatemala	Hayden and Dickel, 2014
Central America	Honduras	Miller et al., 2012
North America	Mexico	Hayden and Dickel, 2014
South America	Argentina	Olckers et al., 2002

South America	Bolivia	Hayden and Dickel, 2014
South America	Brazil	Benvenga et al., 2010
South America	Colombia	Díaz Montilla, 2016
South America	Ecuador	Noboa and Viera, 2020
South America	Paraguay	Olckers et al., 2002
South America	Peru	Anteparra et al., 2010
South America	Suriname	A. A. A. G., 2008
South America	Uruguay	Biezanko et al., 1974
South America	Venezuela	Marcano, 1991a

Although this species has been reported to occur in Puerto Rico (Capps, 1948), M.A. Solis, a pyraloid moth expert at the Systematic Entomology Laboratory (SEL), Agricultural Research Service (ARS), concluded that it is likely a misidentification that has been perpetuated in later literature. They also found that there are no *N. elegantalis* larval and adult specimens from Puerto Rico in the U.S. National Collection located at the National Museum of Natural History, Washington, DC (Solis, 2013).

The records from Hayden and Dickel (2014) for Bolivia, Costa Rica, Guatemala and Mexico consist of single specimens collected from each country and kept in the National Museum of Natural History. No other direct evidence was found. French Guiana, Grenada, Jamaica, Panama, and Trinidad and Tobago were not included in this list because no recent evidence of this moth was found other than Dyer (1914) and Capps (1948).

Pathway

Movement of *N. elegantalis* is associated with international trade and smuggling of infested fruits. There are numerous reports of interceptions at international airports (AQAS, 2012). In Brazil, the distribution of *N. elegantalis* throughout the country is associated with human migration from tomato-producing regions (Maia et al., 2016). Although *N. elegantalis* is an internal feeder that can fully complete all larval stages inside one fruit, it is unclear whether this pest can successfully develop under storage conditions (Maia et al., 2016).

Flying adults may naturally spread infestations among fields (Eiras, 2000), but we found no observations or measures of the dispersal capability of this moth in the literature.

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

Based on the known distribution of this pest and comparing those climates to global Plant Hardiness Zones, we expect that *N. elegantalis* could establish in plant hardiness zones 9-13 (de Paulo Arcanjo et al., 2021; Díaz Montilla et al., 2013; Noboa and Viera, 2020; Takeuchi et al., 2018). The Southeast region, coastal portions of the West Coast, and coastal portions of some Mid-Atlantic states are at risk for establishment due to suitable climate (Barker and Coop, 2020). Dry stress, or prolonged periods of low humidity, is predicted to impact the survival of *N. elegantalis* (da Silva et al., 2018), which could alter its potential distribution.

Tomatoes are grown throughout the continental United States and Puerto Rico, but California, Florida, Tennessee, New Jersey, South Carolina, North Carolina, Georgia, Virginia, and Alabama are major producers that also have suitable climate (USDA NASS, 2024). Major pepper-producing states with suitable climate include Florida, California, Georgia, New Jersey, and North Carolina (USDA NASS, 2024). Major eggplant-producing states with suitable climate include California, Georgia, Florida, and New Jersey (USDA NASS, 2024).

Of these states, Florida, California, and Georgia are at highest risk because they are major producers of tomato, pepper, and eggplant and have suitable climate (USDA NASS, 2024).

Survey and Key Diagnostics

Approved Methods for Pest Surveillance*:

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

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Versions

March 2014: Datasheet completed (Version 1)

October 2024 (Version 2)

- Created new **Pest Recognition** section by combining Pest Description and Damage/Signs and Symptoms
- Added **Easily Mistaken Species** section, adding *Neoleucinodes prophetica* and *N. torvis*.

- Added **Commonly Encountered Non-targets** section
- Updated **Biology & Ecology** section
- Updated **Pest importance** with more recent economic losses.
- Updated **Known hosts** section, wild hosts have been updated.
- Updated **Known Distribution** section
- Updated **Pathway** section
- Updated **Potential Distribution within United States**

Reviewers

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