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

# *Helicoverpa armigera* (Hübner, 1809)

Synonyms:
*Chloridea armigera* (Hübner, 1809)
*Heliothis armigera* (Hübner, 1809)
*Heliothis obsoleta* Auctorum
*Heliothis pulverosa* Walker, 1857
*Heliothis uniformis* Wallengren, 1860
*Heliothis rama* Bhattacherjee & Gupta, 1972

## Common Name
**Old World bollworm,** cotton bollworm, scarce bordered straw

## Type of Pest
Moth, borer

## Taxonomic Position
**Class:** Insecta, **Order:** Lepidoptera, **Family:** Noctuidae

**Figure 1.** *Helicoverpa armigera* adult female (top), and adult male (bottom) (Todd Gilligan, USDA-APHIS-PPQ-S&T).

Notes on taxonomy and nomenclature:
Confusion between *Helicoverpa armigera* (Fig. 1) and *H. zea* exists in the older literature. Refer to Hardwick (1965) for a catalog of literature and species names used.

There are three recognized subspecies: *Helicoverpa armigera armigera* (Hübner) from temperate and tropical regions of Asia, Europe, and Africa, *H. a. conferta* (Walker) from Australasia, and *H. a. commoni* (Hardwick) which is confined to Canton Island in the central Pacific (Anderson et al., 2016; Anderson et al., 2018; Hardwick, 1965).

*Helicoverpa armigera* and *H. zea* can interbreed and produce fertile offspring, and more recently, *H. a. armigera* was found to be naturally hybridizing with *H. zea* in Brazil, resulting in individuals with varying degrees of genetic mixture (Anderson et al., 2018; Hardwick, 1965; Laster and Hardee, 1995; Laster and Sheng, 1995).

## 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

**Larvae** are highly variable in color and become darker with each instar. They may be brownish, reddish, or pale green with brown lateral stripes and a distinct dorsal stripe (Fig. 2) (Hardwick, 1965). The final instar ranges from 3.5 to 4.2 cm (approx. 1 3/8 to 1 5/8 in) in length (King, 1994).

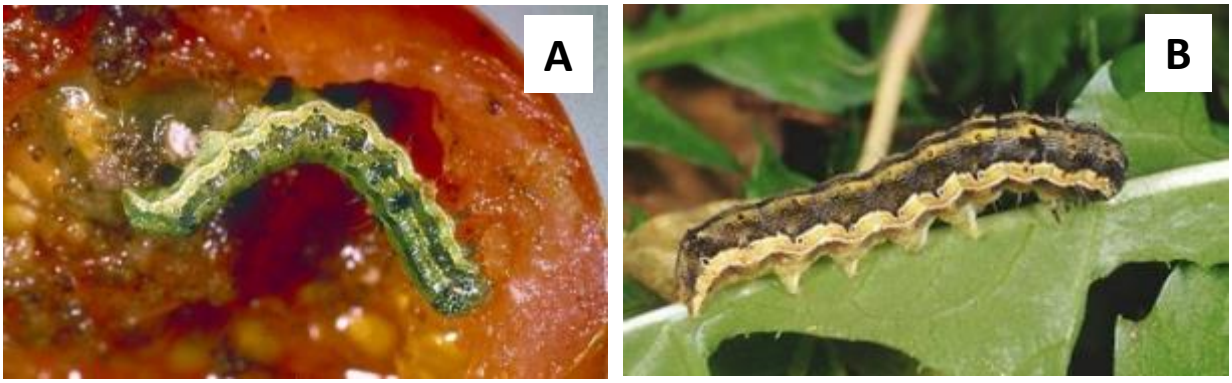


**Figure 2.** *Helicoverpa armigera larvae* (images not to scale). (Source: (A) Central Science Laboratory Harpenden Archive, and (B) Paolo Mazzei, www.bugwood.org).

**Adult** moths are stout-bodied with a wingspan of 30 to 42 mm (approx. 1 1/4 to 1 1/2 in) (Hardwick, 1965). The wing color is variable, ranging from yellowish-brown for males and dull orange-brown, reddish-brown or brick red for females (Figs. 1, 3) (Hardwick, 1965). Forewings have a black or dark brown kidney-shaped marking near the center (Brambila, 2009a). Hind wings are creamy white with a wide dark brown or gray band on the outer margin (Brambila, 2009a). *Helicoverpa armigera* is indistinguishable from *H. zea*. Morphological identification of *H. armigera* requires dissection of genitalia (Brambila, 2009b; Common, 1953; Hardwick, 1965). Adults may be active during the day, but most activity occurs at night starting at dusk (Zalucki et al., 1986).

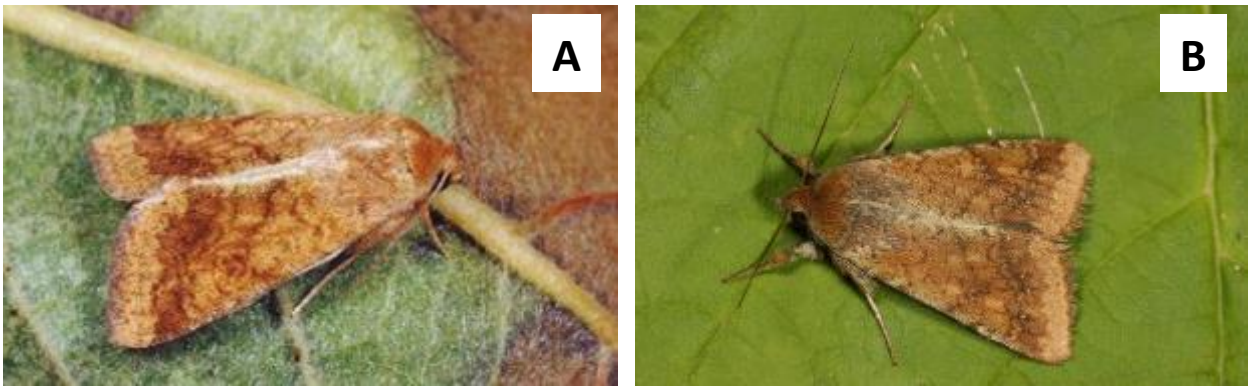


**Figure 3.** *Helicoverpa armigera* adults (images not to scale). (Source: (A) Paolo Mazzei, and (B) Gyorgy Csoka, www.bugwood.org

Signs and Symptoms

*Helicoverpa armigera* larvae primarily feed on reproductive parts of hosts (flowers and fruits) but may also feed on foliage (Bouchard et al., 1992; Saoud et al., 1989). The larvae bore into and feed within the reproductive structures (Fig. 4) (Bouchard et al.,

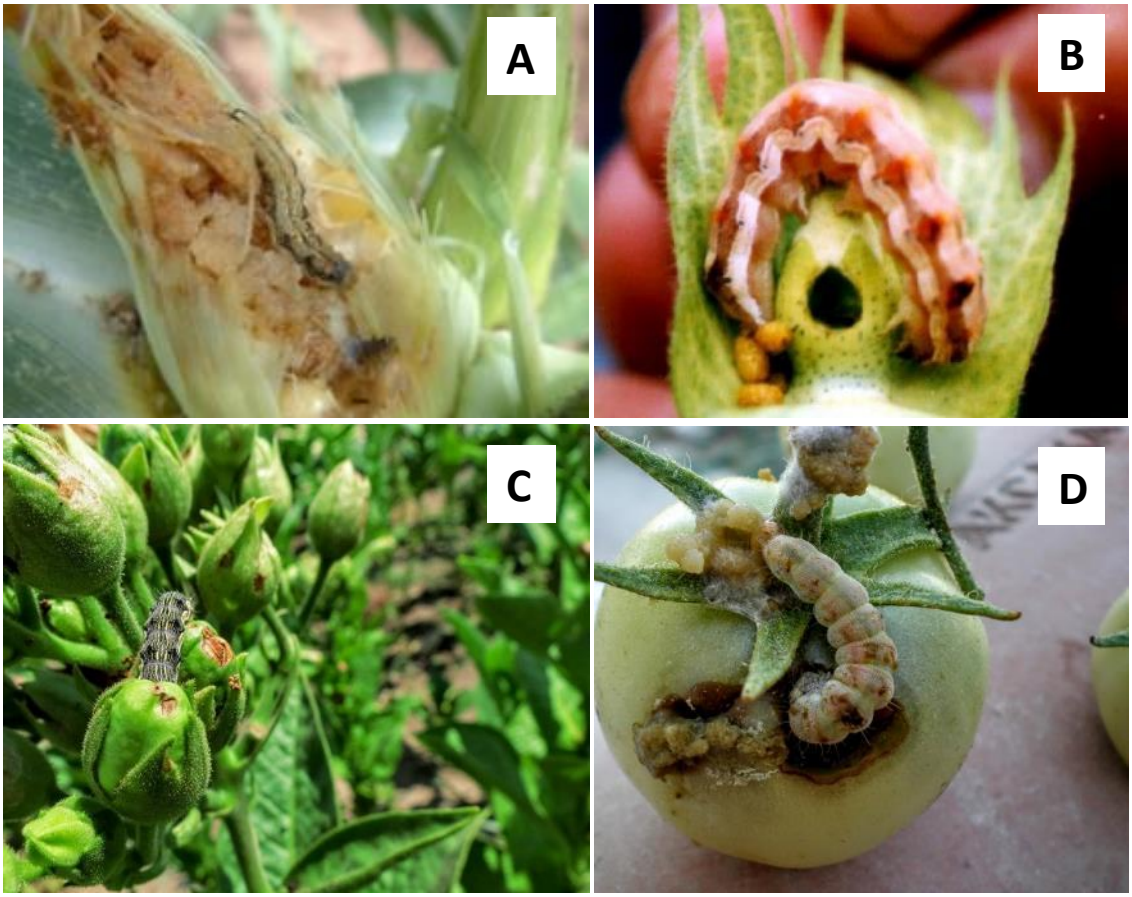


**Figure 4.** *Helicoverpa armigera* larvae feeding on (A) a corn cob, (B) a young cotton flower bud,(C) a tobacco seed cove, and (D) a developing tomato fruit. (Source: (A) Antoine Gyonnet, (B) OP Sharma, and (C, D) Metin Gulesci; www.bugwood.org)

1992). Frass may accumulate at the entrance hole (Bouchard et al., 1992) and secondary pathogen infections may occur (EPPO/CABI, No Date). It may be necessary to cut the structure open to find the pest. Foliage feeding can cause defoliation (War et al., 2012) or may destroy young seedlings (Saoud et al., 1989).

In **corn**, early instar larvae may be seen feeding on silks (Hosseininejad et al., 2015). In the third instar, they bore into the ear to feed and complete larval development (Fig. 4A) (Hosseininejad et al., 2015). Secondary bacterial infections may occur (EPPO/CABI, No Date).

In **cotton**, larvae feed on flower buds and bolls (DAF, 2018). Feeding may cause small bolls to drop, inhibit boll development, or induce rot in maturing bolls (DAF, 2018). Bore holes are visible at the base of flower buds; these buds may be hollowed out from feeding (Fig. 4B) (DAF, 2018).

In **tomato**, larvae bore into developing fruits, creating lesions and rendering the fruit unmarketable (Fig. 4D) (Pratissoli et al., 2015). Lesions vary in size from a small pinhole to a large divot in the fruit (Pratissoli et al., 2015). A single larva can damage several

fruit prior to pupation (Pratissoli et al., 2015). Larvae may also feed on leaves, buds, growing tips, and flowers if fruit is not readily available (Pinto et al., 1997).

## Easily Mistaken Species

There are 148 known heliothine moth species in 14 different genera in North America (Cunningham and Zalucki, 2014). Several of these moths can be confused with *H. armigera*, including *H. zea* and *Chloridea virescens* (formerly *Heliothis virescens*), which are both present in the United States and feed on many of the same hosts (Hardwick, 1965). These species can be difficult to identify based on morphology, but *Helicoverpa armigera* adults can be distinguished from closely related species based on the structure of their genitalia (Hardwick, 1965). Larvae of *H. armigera* and *H. zea* must be distinguished using molecular methods, as morphological methods are inadequate (Gilligan et al., 2015).

## Commonly Encountered Non-targets

The Approved Method for Pest Surveillance for *H. armigera* is a trap and lure. The following species have been regularly found in *H. armigera* traps and may be attracted to the *H. armigera* lure:

*Helicoverpa zea*
*Leucania spp.*
*Spodoptera frugiperda*
*Spodoptera ornithogalli*

## Biology and Ecology

The lifecycle of *H. armigera* varies based on climate and photoperiod (Mironidis, 2014; Mironidis and Savopoulou-Soultani, 2012). The duration of the different life stages shortens as temperature increases from 15°C to 32.5°C (59°F to 91°F). On average, approximately 475 degree-days are needed to complete development from egg to adult (Mironidis, 2014; Mironidis and Savopoulou-Soultani, 2012). In temperate regions, *H. armigera* enters facultative winter diapause when day-length grows shorter (10 to 12 hours) and ambient temperatures drop to 24°C to 15°C (75°F to 59°F). Few individuals enter diapause when ambient temperatures are at 25°C (77°F) or greater, and all individuals enter diapause when ambient temperatures are 15°C (59°F) (Mironidis and Savopoulou-Soultani, 2012). Additionally, larvae enter a summer diapause when exposed to prolonged hot, dry conditions above 37ºC (98.6ºF) (Nibouche et al., 1998). Typically, two to five overlapping generations occur in subtropical and temperate regions and up to 11 generations can occur in optimal conditions, particularly in tropical areas (King, 1994).

Early instar larva enter the reproductive organs of host plants, including flowers, bolls, and fruits (DPI&F, 2005; Hardwick, 1965). Later instar larvae are aggressive, often cannibalizing younger larvae when encountered, resulting in one larva per flower or fruit (Kakimoto et al., 2003; Zalucki et al., 1986). Mature larvae drop off the host plant and pupate 2 to 17.5 cm (approx. ¾ to 7 in) below the soil surface in a silk-lined chamber, though pupation may occur within the host plant (DPI&F, 2005; Hardwick, 1965). During

the growing season, individuals pupate for 10 to 16 days (average is 13.2 days) before emerging as adults to start the next generation (DPI&F, 2005; Hardwick, 1965).

In temperate regions, *H. armigera* overwinters in the soil as pupa. Adult moths emerge from May to June and begin feeding on nectar within hours (DPI&F, 2005; Firempong and Zalucki, 1990). They can mate several times and lay hundreds of single eggs or clusters over several days (DPI&F, 2005; Firempong and Zalucki, 1990; Hardwick, 1965). A single female can lay 3,000 to 4,400 eggs under laboratory conditions, but the average in the field is closer to 500 to 1,000 (Hardwick, 1965; Mironidis and Savopoulou-Soultani, 2012; Shanower et al., 1997). When selecting oviposition sites, female moths consistently prefer plants in flowering stages (Firempong and Zalucki, 1990; Fitt, 1989) and tend to choose hairy over smooth surfaces (King, 1994). Eggs are typically laid on or near floral structures or growth points but also may be found on leaves (Firempong and Zalucki, 1990).

Adult *H. armigera* moths can disperse distances of up to 10 km (6.2 mi.) during non-migratory flights and 600 to 2,000 km (372.8 to 1242.7 mi.) during seasonal migration (Feng et al., 2009; Fitt, 1989). Migration allows *H. armigera* to take advantage of hosts in regions that may be otherwise unsuitable for establishment (Casimero et al., 2001; Nibouche et al., 1998; Saito, 2000; Zhou et al., 2000). In China, *H. armigera* migrate northward, over the Bohai Sea, on southerly winds in the spring and summer, produce one to two generations, and then their offspring return south on northerly winds in the fall (Feng et al., 2009).

## Known Hosts

*Helicoverpa armigera* is polyphagous, feeding on plants in a wide range of families, including Asterceae, Fabaceae, Malvaceae, Poaceae, and Solanaceae (Cunningham and Zalucki, 2014). Its host range includes at least 60 species of economically important plants (Cunningham and Zalucki, 2014; Fitt, 1989). Not all host plants are equally preferred for oviposition but may be used in the absence of a preferred host. For a detailed list of hosts see Cunningham and Zalucki, 2014.

*The host list below includes cultivated and wild plants that 1) are 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 the pest causes economically significant damage*.

**Preferred hosts**

***Abelmoschus esculentus* (okra)**[*], *Aeschynomene indica* (Indian jointvetch)[*], *Allium* spp. (onions, garlic, leek, etc.)[*], *Amaranthus* spp. (pigweed, amaranth)[*], *Antirrhinum majus* (snapdragon)[*], *Arachis hypogaea* (peanut)[*], *Avena sativa* (oats)[*], *Beta vulgaris* (common beet)[*], *Brassica* spp.[*], *Brassica juncea* (mustard)[*], *Brassica oleracea* (kale)[*], *Brassica oleracea botyris* (cauliflower)[*], *Brassica oleracea capitata* (cabbage)[*], ***Cajanus***

[*] Hosts with known U.S. distribution

***cajan* (pigeon pea)***, *Cannabis sativa* (hemp)*, *Capsicum annuum* (bell pepper, chili pepper)*, *Carthamus tinctorius* (safflower)*, ***Cicer arietinum* (chickpea, gram)***, *Citrullus lanatus* (watermelon)*, *Citrus limon* (lemon)*, *Citrus sinensis* (sweet orange)*, *Coffea arabica* (coffee)*, *Cucumis sativus* (cucumber)*, *Cucurbita maxima* (pumpkin or winter squash)*, *Dianthus caryophyllus* (carnation)*, *Fragaria* spp. (strawberry)*, *Gladiolus* spp. (gladiolus)*, ***Glycine max* (soybean)***, ***Gossypium* spp. (cotton)***, *Helianthus annuus* (common sunflower)*, *Hordeum vulgare* (barley)*, *Ipomoea batatas* (sweet potato)*, *Lablab purpureus* (hyacinth bean), *Lathyrus odoratus* (sweet pea), *Malus* spp. (apple)*, *Medicago sativa* (alfalfa)*, *Mentha spicata* (spearmint)*, ***Nicotiana tabacum* (tobacco)***, *Papaver somniferum* (breadseed poppy)*, *Pennisetum glaucum* (pearl millet)*, *Phaseolus vulgaris* (common bean)*, *Pisum sativum* (pea)*, *Ricinus communis* (castor bean)*, *Sesamum indicum* (sesame)*, ***Solanum lycopersicum* (tomato)***, *Solanum melongena* (eggplant)*, *Solanum tuberosum* (potato)*, *Sonchus oleraceus* (annual sowthistle)*, ***Sorghum bicolor* (sorghum)***, *Sphaeranthus indicus* (East Indian globe thistle), *Spinacea oleracea* (spinach)*, *Trifolium alexandrinum* (Egyptian clover, berseem)*, *Trifolium resupinatum* (reversed clover, Persian clover)*, *Triticum aestivum* (wheat),*Vigna radiata* (mung bean, green gram)*, *Vigna unguiculata* (cowpea)*, and ***Zea mays* (corn)***.

(Abhilasha, 2017; Aslam, 1988 Balakrishnan et al., 2004; Bantewad and Sarode, 2000 Bhagat and Bhalani, 1994 Bisane, 2013; Chaudhari et al., 2003; Cunningham and Zalucki, 2014; Dhembare, 1999; Enrique et al., 2016; EPPO, 2020b; Firempong and Zalucki, 1990; Franzmann et al., 2008; Gill et al., 2015; Golparvar and Naseri, 2016 Grande et al., 2016; Gu and Walter, 1999; Hardwick, 1965; Hemati et al., 2012; Iqbal and Mohyuddin, 1990 Jaglan and Saini, 2003; Jallow and Matsumura, 2001; Judal and Upadhyay, 1989; Kakimoto et al., 2003; Keszthelyi et al., 2011Kumar et al., 2004; Leite et al., 2014 Namin et al., 2014; Paiva and Yamamoto, 2014 Parmar et al., 2015 Patil et al., 2017 Reddy and Subbi Reddy, 1999; Shi et al., 1995; Singh and Battu, 2002 Sreenivasa Rao and Koteswara Rao, 1999; Sujalata Devi and Singh, 2001; Sujalata Devi and Singh, 2004; War et al., 2012).

## Pest Importance

*Helicoverpa armigera* is a member of the Heliothis clade, a subgroup of polyphagous heliothine moths, several of which are considered important pests of field and horticultural crops (Cunningham and Zalucki, 2014; Fitt, 1989). *Heliothis virescens* and the closely related *H. zea* also belong to the Heliothis clade and are two key pests that have management programs in the United States (Cunningham and Zalucki, 2014; Kriticos et al., 2015).

*Helicoverpa armigera* is one of the most damaging pests of agriculture in Asia, Europe, Africa, and Australasia, causing crop damage estimated at greater than $2 billion annually (Tay et al., 2013). According to another estimate, the worldwide annual cost of *H. armigera* infestations, including pest control and yield loss, is about $5 billion (Murua et al., 2014).

In countries where it is present, *H. armigera* damages numerous crops that are also

grown throughout the United States (Cunningham and Zalucki, 2014). Corn, cotton, soybean, sorghum, and solanaceous crops are commercially grown on hundreds of millions of acres in the continental United States (NASS, 2019). The value of the 2017 harvest of the following preferred hosts of *H. armigera* in the United States was: corn ($48.5 billion), soybean, ($41 billion), cotton ($7.2 billion), tomato ($1.6 billion), tobacco ($1.5 billion), and sorghum ($1.1 billion) (NASS, 2019).

*Helicoverpa armigera* is listed as a harmful organism in numerous locations, including the European Union and several countries in Central and South America (Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, and Uruguay) (PExD, 2020). *Helicoverpa armigera* is also listed as an A2 quarantine pest in the European Union (EPPO, 2020a). Trade issues may arise with these countries if this moth becomes established in the United States.

## Pathogens or Associated Organisms Vectored

This species is not known to vector any pathogens or associated organisms; however, secondary pathogens (fungi, bacteria) may develop due to wounding from feeding on host plants (EPPO/CABI, No Date).

## Known Distribution

**Africa:** Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Cote d'Ivoire, Democratic Republic of the Congo, Egypt, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Kenya, Lesotho, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Morocco, Mozambique, Namibia, Niger, Nigeria, Republic of the Congo, Réunion, Rwanda, Saint Helena, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, and Zimbabwe; **Asia:** Afghanistan, Armenia, Azerbaijan, Bangladesh, Bhutan, Bismarck Archipelago, Brunei, Cambodia, China, Cocos Islands, Georgia, Hong Kong, India, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Kazakhstan, South Korea, Kuwait, Kyrgyzstan, Laos, Lebanon, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Saudi Arabia, Singapore, Sri Lanka, Syria, Taiwan, Tajikistan, Thailand, Turkey, Turkmenistan, United Arab Emirates, Uzbekistan, Vietnam, and Yemen; **Caribbean:** Dominican Republic and Puerto Rico; **Europe:** Albania, Andorra, Austria, Azores Islands, Balearic Islands, Belgium, Bosnia and Herzegovina, Bulgaria, Canary Islands, Corsica, Cyprus, Dodecanese Islands, Finland, France, Germany, Gibraltar, Greece, Hungary, Italy, Kriti (Crete), Lithuania, Macedonia, Madeira Island, Malta, Moldova, Montenegro, Portugal, Romania, Russia, Sardinia, Selvagens Islands, Serbia, Sicily, Slovenia, Spain, Sweden, Switzerland, the Netherlands, Turkey (European), and Ukraine; **Oceania:** American Samoa, Australia, Belau, Christmas Island, Cook Islands, Federated States of Micronesia, Fiji, Guam, Kiribati, Marshall Islands, New Caledonia, New Zealand, Norfolk Island, Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, and Vanuatu; **South America:** Argentina, Bolivia, Brazil, Colombia, Paraguay, Peru, Suriname, and Uruguay

(Abhilasha, 2017; Castiglioni et al., 2016; Czepak et al., 2013; EPPO, 2020b; Hardwick, 1965; Kazimierczak, 2009; Keszthelyi et al., 2013; Kriticos et al., 2015; Leite et al.,

2014; Murua et al., 2014; NAPPO, 2014; Specht et al., 2013; Tay et al., 2013).

*Helicoverpa armigera* was previously recorded in Croatia, Czech Republic, Estonia, Latvia, Norway, Poland, Slovakia, and the United Kingdom, but it is considered eradicated or otherwise not present in those countries (EPPO, 2020b)

## Pathway

International trade poses a risk for the introduction of *H. armigera* into the United States. *Helicoverpa armigera* is regularly intercepted at U.S. ports of entry and has been intercepted 843 times from over 60 different countries across six continents since 2010 (AQAS, 2020; ARM, 2020). Interceptions have occurred on numerous plant commodities, a wide variety of cut flowers, permit cargo, general cargo, baggage, and mail (AQAS, 2020; ARM, 2020).

*Helicoverpa armigera* can quickly spread across new areas. In 2013, it was officially detected in the Western Hemisphere (Brazil) for the first time, and it has rapidly spread throughout South America and the Caribbean region (Kriticos et al., 2015). With its recent establishment in the New World, natural spread through migration is another possible pathway into North America (Kriticos et al., 2015).

*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.*

**Fruits and Vegetables Import Requirements (FAVIR) Online Database:** The FAVIR database lists all import requirements for fruits and vegetables. To search by commodity, select 'Approved Name' at the top left of the page. Select the commodity from the drop-down menu and then click 'Search'. Click on the 'Commodity Summary' tab for details.
https://epermits.aphis.usda.gov/manual/index.cfm?action=pubHome

**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

**Cut Flowers and Greenery Import Manual:** This manual is a resource for regulating imported fresh, cut plants used for decoration and for protecting plants from extinction due to trade.
https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/cut_flower_imports.pdf

**Miscellaneous and Processed Products Import Manual:** This manual is a resource

for regulating imported processed plant and non-plant that may introduce exotic pests. https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/miscellaneous.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

*Helicoverpa armigera* is established in many countries throughout the world that encompass Plant Hardiness Zones (PHZ) 1-14 (Takeuchi et al., 2018). A risk assessment concluded that *H. armigera* may establish in 49% of the land in the continental United States, in areas ranging from Minnesota (PHZ 3-5) to Florida (PHZ 9-12) (Venette et al., 2003).

## Survey and Key Diagnostics

**Approved Methods for Pest Surveillance*:**

For the current 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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## Revisions

April 2014 (version 2)

1. Revised the **Key Diagnostics/Identification** section
2. Revised the **Easily Confused Species** section
3. Added the **Commonly Encountered Non-targets** section
4. Added Figure 6 and link to Brambila, J. 2010 and images of *Leucania adjuta* genitalia

July 2014 (version 2.1)

1. Revised the **Distribution** section

June 2018 (version 3)

1. Revised all sections to include current information after a comprehensive literature search
2. Updated the Literature-Based Methods in the **Survey** section
3. Updated the Literature-Based Methods in the **Key Diagnostics/Identification** section
4. Added new **References**

June 2021 (version 4)

1. Converted the datasheet to a new template (v2.1)
2. Updated every section to include current information after a comprehensive literature search
3. Revised the **Pest Recognition** section and its figures to focus on information that is most useful in the field
4. Revised the **Biology and Ecology** and **Damage** sections to include more concise and specific information on the most vulnerable hosts

5. Revised the **Known Host** section to include only hosts with direct evidence of pest damage.
6. Revised the **Survey and Key Diagnostics** section to direct readers to the online AMPS page for approved survey and diagnostic methods.
7. Updated figures of adult and larva moths. Removed figures of closely related species and eggs.

## Reviewer(s)

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