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

New Pest Response Guidelines

Oxycarenus hyalinipennis

Cotton Seed Bug

Adult cotton seed bug (image courtesy of Julieta Brambila, USDA–APHIS–PPQ)

The information contained in a NPRG can aid decision-makers in prioritizing agency resources and response in the event of a new pest outbreak, but an NPRG is not an emergency response plan. PPQ must tailor their response to the specific circumstances of each pest introduction event, which we cannot predict.
These guidelines are based on the best information available at the time of development.
Email PPQ.NPRG@usda.gov if you need updated information or have questions about the information contained in this document.
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Table of Contents and Key Information for *Oxycarenus hyalinipennis* (cotton seed bug)

Biology and Hosts

Scientific Name

Oxycarenus hyalinipennis (Costa, 1847)

Taxonomic Position

Animalia : Arthropoda : Insecta : Hemiptera : Lygaeoidea : Oxycarenidae

Synonyms

Cymus cincticornis Walker, 1870
Aphanus tardus hyalinipennis Costa, 1874
Oxycarenus castaneus (Bergevin, 1932)
Oxycarenus cruralis Stål, 1856
Oxycarenus leucopterus (Fieber, 1852)
Oxycarenus nigricornis Samy, 1969

Common names

Cotton seed bug (CSB)
Cotton stainer
Dusky cotton bug
Egyptian cottonseed bug

Type of Pest

True bug

Biology and Ecology

Cotton seed bug must feed on the oils inside Malvales (the order of flowering plants that includes cotton, hibiscus, and mallows) seeds to complete nymphal development, but the species may feed on numerous other plants and plant parts, usually to acquire moisture (Halbert and Dobbs, 2010). Cotton seed bug will move to additional Malvales hosts as seeds become available, extending the breeding season. Optimum temperatures for CSB reproduction and development are between 71 °F (22 °C) and 95 °F (35 °C) (Khan and Naveed, 2017). A complete generation occurs in about a month. Depending on host availability and temperature, four to seven generations can occur per year (Adu-Mensah and Kumar, 1977; Halbert and Dobbs, 2010).

Eggs are laid in cotton boll lint close to the seed, or in seed pods of other hosts (Bolu et al., 2020). Each female lays up to 110 eggs, either singly or in groups. The incubation period generally lasts from 4 to 8 days (Kirkpatrick, 1923; Sweet, 2000). There are five nymphal stages that last 14 to 22 days, depending on temperature (Kirkpatrick, 1923). To complete their development, the insects must pierce ripe or almost ripe seeds with their stylets (needle-like mouthparts), inject saliva to liquify the contents, and suck the juices out. When dew is present on the host plant, nymphs can be found drinking it from nearby bolls or leaves. When dew is unavailable, they may seek moisture by piercing leaves (Kirkpatrick, 1923) (Fig. 2). Nymphs aggregate on hosts in a feeding swarm, during which they emit a foul odor and are very conspicuous (Fig. 4).

Adults congregate on host plants and begin feeding on seeds as soon as the bolls open.

Mating occurs soon afterwards. At the end of the breeding season, adults enter diapause, leave the cotton fields, and walk or take short flights to various shelter locations for overwintering. During this period, CSB generally prefers cryptic locations such as tree trunks, the undersides of living or dead leaves, pods of leguminous plants, or human-made structures (Adu-Mensah and Kumar, 1977; Kirkpatrick, 1923; Smith and Brambila, 2008). In nursery production, CSB can hide in cryptic locations such as plant debris and nooks and crannies under and around the rims of pots (see Appendix A for discussion regarding nursery environment).

Pest Importance

Cotton seed bug is an economically important pest of cotton and other malvaceous crops. Both nymphs and adults pierce seeds with their stylets (needle-like mouthparts) to extract nutrients that lead to shriveling and reduced germination of seeds. Heavy infestations can cause significant yield losses, particularly in seed cotton intended for planting or oil extraction, as the feeding damage lowers seed viability and oil quality. In addition to direct injuries, the presence of large aggregations of these bugs contaminates harvested cotton lint (Fig. 1), reducing its market value (Annecke and Moran, 1982; Kirkpatrick, 1923; Schaefer and Panizzi, 2000). When present in bolls during the ginning process CSB stains the lint (Halbert and Dobbs, 2010; Sweet, 2000). Other impacts occurring when CBS feeds on cotton or other host fruits include greasy spots and disfigurement of fruits and bolls caused by their saliva liquefying plant tissues (Abbas et al., 2015), a pungent odor on the affected plants, and unsightly black stains caused by CSB feces (Nakache and Klein, 1992; Schaefer and Panizzi, 2000). The pests' wide host range enables populations to persist between cotton growing seasons, making it a persistent management challenge in many cotton-producing regions.

Figure 1. *Oxycarenus hyalinipennis* aggregation inside a cotton boll (Picture courtesy of Julieta Brambila USDA-APHIS-PPQ)

Known Hosts

Cotton seed bugs must feed on seeds from plants in the order Malvales to breed and for the nymphs to mature; the domestic distribution and uses of these natural hosts are listed in Appendix A: Table 1. The primary economic host plants of concern in the United States include cotton (*Gossypium* spp.), hibiscus (*Hibiscus* spp.), and okra (*Abelmoschus* spp.) (Kirkpatrick, 1923; Sweet, 2000). The preferred reproductive host is cotton. Some researchers have noted that CSB may adapt and feed on other plants when Malvales are unavailable; one report includes pearl millet (*Cenchrus americanus* (=*Pennisetum typhoides*) (Poaceae) and pigeon pea (*Cajanus cajan*) (Fabaceae) as non-Malvaceous reproductive hosts (Ram and Chopra, 1984).

In addition, CSB causes damage to but does not reproduce on economically valuable fruits such as apple, apricot, avocados, dates, figs, grapes, peach, pear, persimmon, and quince. Cotton seed bugs affect the quality of fruits with their feces, pungent odors, and toxic saliva (Avidov and Harpaz, 1969; Nakache and Klein, 1992; Sweet, 2000). The species may feed on numerous other plants and plant parts to acquire moisture or shelter, but these are not known to be reproductive hosts. For example, in California, hundreds of CSB have been observed on *Leonotis leonurus* (Hepler, 2025).

Distribution & Spread

Known Distribution

Cotton seed bug is native and widespread in Africa (Abdel-Aziz, 1968; Samy, 1969); however, it has spread and established in parts of Asia, the Middle East, the Mediterranean, and some of Europe (EPPO, 2025). As early as 1917, CSB was detected in parts of South America and in more recent years, researchers have observed this species steadily extending its distribution northward through many Caribbean islands, including Puerto Rico and the U.S. Virgin Islands (Smith and Brambila, 2008), and southern California (CABI, 2025; EPPO, 2025; Slater and Baranowski, 1994).

Oxycarenus hyalinipennis is present in **Africa:** Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, the Democratic Republic of the Congo, Republic of the Congo, Côte d'Ivoire, Egypt, Eritrea, Eswatini, Ethiopia, Ghana, Guinea, Kenya, Libya, Madagascar, Malawi, Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, São Tomé and Príncipe, Senegal, Somalia, South Africa, South Sudan, Sudan, Tanzania, Togo, Tunisia, Uganda, Zimbabwe; **Asia:** Bangladesh, Cambodia, China, India, Iran, Iraq, Israel, Laos, Myanmar, Pakistan, Philippines, Saudi Arabia, Sri Lanka, Syria, Thailand, Turkey, Vietnam, Yemen; **Europe:** Austria, Cyprus, France, Germany, Greece, Hungary, Italy, Kosovo, Malta, Montenegro, Portugal, Russia, Republic of Serbia, Spain; **North America:** United States (southern California, eradicated in Florida); **Central America and the Caribbean:** Bahamas, Cayman Islands, Hispaniola (Dominican Republic and Haiti), Puerto Rico, Turks and Caicos Islands, Virgin Islands; **South America:** Argentina, Bolivia, Brazil, Paraguay (CABI, 2025; EPPO, 2025; Segarra-Carmona et al., 2020; Slater and Baranowski, 1994).

Status of Infestation in North America (September 2025)

In 2010, CSB was detected in Puerto Rico, the US Virgin Islands, and extreme southern Florida (Segarra-Carmona et al., 2020). On Stock Island, FL, the infestation was limited to one *Gossypium* spp. (wild cotton) plant with roughly 100 adults and 100 nymphs, which were immediately destroyed (NAPPO, 2010; Vitanza, 2010). After three years of regulatory and control activities and extensive surveys with no positive detections, Florida Department of Agriculture and Consumer Services and the USDA declared that CSB was eradicated in Florida (APHIS, 2014; UF/IFAS, 2014). This eradication effort occurred under exceptionally advantageous conditions where the CSB population occurred on a single plant on a small island and was detected before it was able to spread (UF/IFAS, 2014). In 2019, CSB was identified from a residential property in Los Angeles County on *Abutilon palmeri* (Palmer mallow) (Beucke, 2019). Subsequent surveys conducted by the California Department of Food and Agriculture confirmed CSB is present in six counties (Los Angeles, Orange, Riverside, Santa Barbara, San Diego, and Ventura) (CDFA, 2021;CDFA, 2025). Additionally, users have posted around **150 observations** of CSB on the community scientist website iNaturalist (iNaturalist, 2025), within five of six counties listed above. A USDA entomology identifier reviewed photographs of these observations and confirmed them to most likely be CSB (Mikulas, 2022). The observations on iNaturalist and BugGuide indicate CSB may have been present in California as early as 2017 (BugGuide, 2025; iNaturalist, 2025).

Potential Distribution within the United States

As of 2019, CSB is likely established in southern California (Beucke, 2019). Based on where CSB is known to occur in the world and comparing those climates with Global Plant Hardiness Zones, it is likely that CSB could survive in Plant Hardiness Zones 8 through 11 (Takeuchi et al., 2018). Moreover, hosts are available throughout these regions of the United States and include field crops (e.g., cotton and okra), horticultural crops (e.g., Hibiscus), and wild plants (native and weeds). Areas of concern are southeastern United States, all of California, much of the western, south central, and eastern United States, and Hawaii. There is a likelihood of establishment map for this species showing regions of the United States with suitable environmental conditions and average generations per year.

Pathways of Spread

Human-Assisted Spread

Cotton seed bug moves easily in trade, even with commodities that are not known hosts (Henry, 1983). The movement and establishment of CSB are primarily associated with hitchhiking behavior on plant materials including nursery stock and cargo (cotton bolls, cut flowers, fruit, sacks, vehicles). Since 2017, agricultural port inspectors have intercepted over 200 *Oxycarenus hyalinipennis* specimens at U.S. ports-of-entry. The majority of the interceptions were on cut flowers or fruit for consumption (USDA, 2025). Nursery production systems can inadvertently provide refuge sites that may act as a pathway for CSB. See Appendix A and Appendix B for additional information.

Natural Dispersal

We found no direct evidence measuring the natural dispersal capabilities of CSB. Adults are not strong fliers and are unlikely to disperse long distances naturally. Flight durations of five seconds were observed in dispersal experiments and adults could not sustain flight (Adu-Mensah and Kumar, 1977). The typical flight behavior of CSB is for an individual insect to climb to the highest point on a leaf, branch, or terminal bud and make a quick take-off in the direction that the wind is blowing. Cotton seed bugs are then able to control flight towards an object in the downwind direction (Adu-Mensah and Kumar, 1977). Cotton seed bug dispersal may also be wind-assisted, and hurricanes or tropical storms may help spread CSB from the Caribbean islands or southern California to the rest of the continental United States (Hepler, 2025).

Identification

Signs and Symptoms

A few visual cues can help surveyors detect the presence and infestation level of CSB in an area. Cotton seed bug populations are more easily detected when fruits, seeds, and seed pods from Malvales plants are available, or after a recent rain (Ismail, 2018; Adu-Mensah and Kumar, 1977). Symptoms to look for include the following:

- Feeding damage is not a reliable indicator of CSB presence, but it can help narrow down an area to begin a survey. Look for brown leaves and stipple marks from feeding (Fig. 2) (Bolu et al., 2020; Kirkpatrick, 1923).
- Host plants show little external signs of damage from CSB (Kirkpatrick, 1923; Sweet, 2000). Inside cotton bolls and flowers, seeds are shriveled and discolored.
- Adults and nymphs commonly congregate together in tight clusters, especially in seed pods, bolls (Fig. 3), or under leaves (Fig. 4) (Adu-Mensah and Kumar, 1977; Chin et al., 2009; Smith and Brambila, 2008).
- Populations of CSB do not damage seeds until the bolls open, but if another pest damages the boll, CSB will enter and feed on the internal seeds (Ismail, 2018; Adu-Mensah and Kumar, 1977; Sharma et al., 2010).
- Symptoms in cotton are most apparent between July and September, when the bolls are open (Ritchie et al., 2004).
- Cotton seed bugs in infested bolls resemble fleas in their appearance and movement through the fibers; look for small black or brown bugs moving quickly through the cotton (Fig. 5) (S&T, 2016).
- Aggregated groups produce a pungent odor (Adu-Mensah and Kumar, 1977; Sharma et al., 2010; Smith and Brambila, 2008).

Figure 2. *Oxycarenus hyalinipennis* will suck fluids from leaves, stems, and flowers for moisture, but it feeds on seeds (image courtesy of Dr. Halil Bolu, Dicle University, Faculty of Agriculture, Diyarbakir, Turkey)

Figure 3. Aggregates of adult and nymph *O. hyalinipennis*. They will cluster inside of dried seed pods. Surveyors should open seed pods if they suspect infestation (image courtesy of Dr. Halil Bolu, Dicle University, Faculty of Agriculture, Diyarbakir, Turkey)

Figure 4. *Oxycarenus hyalinipennis* observed congregating under a leaf (iNaturalist user kjohnson012 (licensed under **CC BY-NC 4.0**))

Figure 5. Infested cotton bolls on Stock Island, FL prior to eradication (image courtesy of Julieta Brambila, USDA-APHIS-PPQ)

Morphological Identification

Definitive species identification is based on morphology of the adult male internal genitalia structures (Brambila, 2020). A field screening aid is available to assist selection of samples for submission (Appendix C).

Adults

Immediately after molting, individuals are pale pink but rapidly turn brown, dark brown, or black (Figs. 6 and 7). Males are typically 3.82 mm long and females are 4.41 mm (Samy, 1969). Male abdomens terminate in a round lobe, while female abdomens are truncated. Other distinguishing characteristics include: three tarsal joints, a pair of red simple eyes situated above and behind the compound eyes, and the second antennal segment is usually partially yellow or pale yellow. The forewings are glassy/translucent and usually whitish. The clavus, base of corium, and costal vein are opaque (Henry, 1983; Kirkpatrick, 1923; Smith and Brambila, 2008).

Figure 6. Dorsal, ventral, and lateral views of an adult male *O. hyalinipennis* (image courtesy of Dr. Halil Bolu, Dicle University, Faculty of Agriculture, Diyarbakir, Turkey)

Figure 7. Lateral and ventral views of an adult female *O. hyalinipennis*. The female has a curved ovipositor, which may not always be visible (image courtesy of Dr. Halil Bolu, Dicle University, Faculty of Agriculture, Diyarbakir, Turkey)

Eggs

Surveyors should not expect to identify CSB eggs in the field. The cylindrical eggs are tiny at 0.29 mm wide by 0.97 mm long. During development, the eggs change from straw yellow to orange or pink (Fig. 8) (Henry, 1983; Sweet, 2000).

Figure 8. *Oxycarenus hyalinipennis* eggs (image courtesy of Dr. Halil Bolu, Dicle University, Faculty of Agriculture, Diyarbakir, Turkey)

Nymphs

Immature CSBs are red-orange on hatching and later develop a dark red abdomen that has a greenish tint (Fig. 9). There are two abdominal scent glands located dorsally between terga 4 to 5 and 5 to 6. The orifices are close together. Kirkpatrick (1923) measured the average instar lengths as first, 1.20 mm; second, 1.58 mm; third, 2.25 mm; fourth, 2.86 mm; and fifth, 3.7 mm (Fig. 10).

Figure 9. Dorsal, ventral, and lateral views of nymph-stage *O. hyalinipennis* (image courtesy of Dr. Halil Bolu, Dicle University, Faculty of Agriculture, Diyarbakir, Turkey)

Figure 10. From left to right, dorsal images of an adult and descending sizes of nymph stage CSB. Adults have fully developed wings, far left. Wingpads are visible on the older instars, indicating the difference between adults and nymphs (image courtesy of Natasha Wright, Division of Plant Industry, Florida Department of Agriculture and Consumer Services)

Molecular Identification

DNA barcoding using the COI region can generally distinguish cotton seed bug from many other taxa, though there is overlap/ambiguity with the congener *Oxycarenus laetus*, which is not present in the United States (Nagoshi et al., 2012).

Similar Species

Numerous species of small seed-feeding bugs in the family Lygaeidae, Rhyparochromidae, and Oxycarenidae are present throughout the United States; some superficially resemble CSB. A few of these include:

- *Nysius* spp. (false chinch bugs) these gray-brown, 3 to 4 mm insects swarm on weedy mustards and disturbed sites. Nymphs have reddish abdomens and adults have glassy corium, like CSB (Fig. 11).
- *Pseudopachybrachius vinctus* (dirt-colored seed bug) a small bug, widespread throughout the eastern United States. Patterning on the wings and red legs set this species apart from CSB (Fig. 12).
- *Scolopostethus thomsoni* another small seed bug which is widespread across much of the northern United States (Fig. 13). Patterned wings and a double row of spines under the fore femora separate this from CSB.

Figure 11. *Nysius raphanus* (iNaturalist user Joshua Ebright (licensed under [CC BY-NC 4.0]))

Figure 12. *Pseudopachybrachius vinctus* (iNaturalist user Jim Walker (licensed under [CC BY-NC 4.0]))

Figure 13. *Scolopostethus thomsoni* (iNaturalist user Hari S. Parker (licensed under [CC BY-NC 4.0]))

There are two similar looking invasive oxycarenids that were introduced into the United States and still present; they are:

- *Metopoplax ditomoides* (Fig. 14) is present in California, Oregon, and Washington (Lattin and Wetherill, 2002; Wheeler and Henry, 2015). Primarily a pest of Asteraceae plants, *M. ditomoides* is distinguishable from CSB because the anterior end of the head is rounded rather than acute.
- *Microplax albofasciata* (Fig. 15) was introduced into California from the Mediterranean area (Wheeler and Henry, 2015). Although the host plants are unknown, researchers suspect an association with plants in the Asteraceae family (Wheeler and Henry, 2015). Identification will require a dissecting microscope. *Microplax albofasciata* has a rectangular patch of fine white hairs above the third segment of the thorax, which CSB lacks (Wheeler and Henry, 2015).

Figure 14. Adult *Metopoplax ditomoides* (image courtesy of Jeffrey W. Lotz, Florida Department of Agriculture and Consumer Services, Bugwood.org)

Figure 15. Adult *Microplax albofasciata* (image courtesy of Thomas J. Henry Systematic Entomology Laboratory, ARS-USDA)

Survey

Laboratory Identification

Prior to beginning any survey, surveyors should determine the appropriate screening and diagnostic resources available. To find an identification laboratory, contact the PPQ National Policy Manager (NPM) or National Operations Manager (NOM) for preliminary identification. Preliminary sample capacity may limit the scope of survey activity so please confirm availability when planning a response. If a suspected positive pest is identified, contact your State Plant Health Director (SPHD)/State Plant Regulatory Official (SPRO) and follow PPQ submission guidelines.

Survey Methods

Since site characteristics and agency resources are unknown prior to a response, PPQ develops situation-specific survey guidance after a pest is detected. Cotton seed bug is a target for early detection surveys through the Cooperative Agricultural Pest Survey (CAPS) program with approved methods for pest surveillance that provide survey method guidance and best practices. Surveyors can use the same methods (visual survey, sweep netting, or beat sampling) for delimitation surveys to determine the extent of an infestation after the confirmation of a detection.

Note: There are no specific traps or lures for surveying cotton seed bug

Timing of Surveys

Conduct delimitation surveys as soon as possible after official confirmation of detection. The breeding period for CSB occurs between late spring and early fall (Kirkpatrick, 1923). During the breeding period, most bugs will be found within bolls and other reproductive structures of the host, and occasionally in leaf litter or under the leaves of plants (Smith and Brambila, 2008). Surveyors can detect CSB on open cotton bolls (Derksen et al., 2010) as early as July, and CSB will remain on host plants until harvest in the fall (Collins, 2020) or until cooler temperatures trigger overwintering behavior. Typically, after harvest, cotton fields are cut, shredded, and tilled to reduce pest pressure (Edmisten et al., 2025), which decreases the likelihood of CSB remaining in fields. Surveying during the overwintering period (fall to early spring) is not recommended, due to the cryptic nature of CSB and low likelihood of detection. If no additional CSB are detected during delimitation, detection surveys should continue in the area for at least three years before confirming eradication. With the potential for four to seven generations per year (Adu-Mensah and Kumar, 1977; Halbert and Dobbs, 2010), surveys can be performed continuously, year-round if CSB is detected in a greenhouse, indoor nursery, or in warmer parts of the US.

Delimitation Survey Design

Delimitation surveys determine the extent of the infested area after a CSB detection. This survey protocol describes how to survey areas located near confirmed CSB detections. For this survey, we are assuming that CSB infestations are dense enough for detection by visual survey, sweep netting, or beat sampling. Because CSB can hide inside seed pods or be difficult to see, beat sampling may be preferred in areas with low CSB pressure or early in the survey season.

We found little evidence of CSB, or closely related species flight capabilities in the literature (see Natural Dispersal). The observed flight duration of CSB under laboratory conditions is reported to be about five seconds, which implies adults primarily move short distances. We consider this pest a weak flier, but we found no observations of individual dispersal distances or spread over time for this species. We cannot delineate the size of a core area based on the pest's biology, so we recommend a core survey area with a radius of 0.5 mi and a buffer area with a radius of 3 mi to ensure full delimitation of a novel CSB infestation. Surveyors should survey the entire core area and certain high-risk areas in the buffer to delimit the pest.

To delimit CSB:

1. Identify and survey the core infested area by drawing a circle that extends 0.5 mi (0.8 km) out from the initial detection (Fig. 16). Thoroughly survey this core infested area because it likely contains dispersing CSB.
    a. If the core infested area is primarily within a cultivated field or fields, proceed to the Surveying in Fields Section.
    b. If the core infested area is primarily within residential or non-cultivated areas, proceed to the Surveying in Residential Areas Section.
    c. If the core infested area is primarily within a nursery, proceed to the Surveying in Nurseries Section.
    d. Core infested areas with roughly equivalent portions of field, residential, and/or nursery areas may require a hybrid survey.

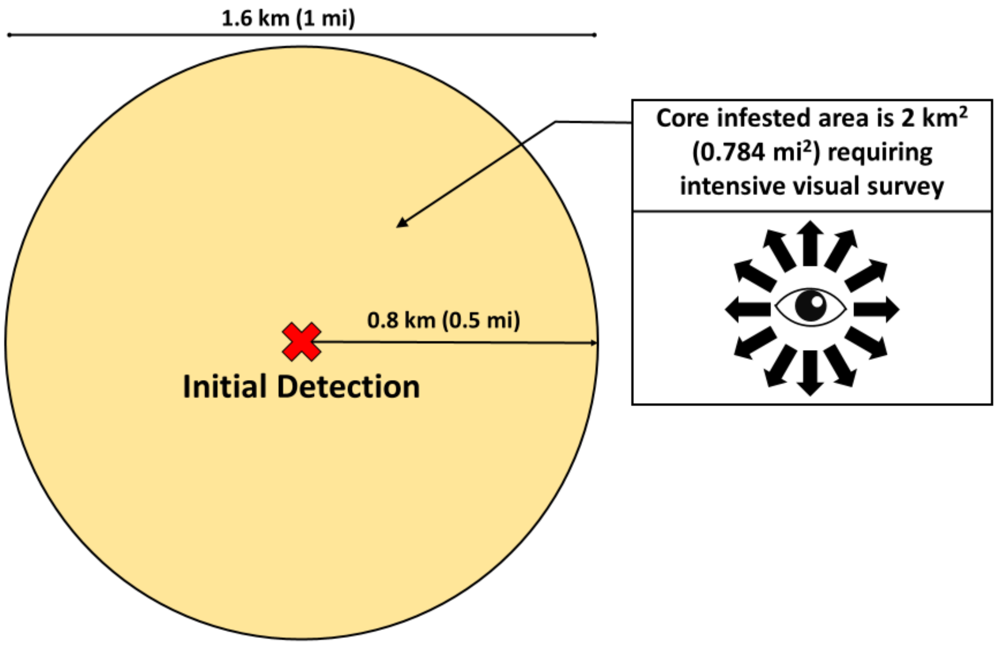

Figure 16. Surveying the core infested area

2. Identify and survey the buffer area by drawing a circle around all points within 3 miles (4.8 km) of the initial detection(s) or 2.5 miles beyond the core area (Fig. 17).
    a. We recommend surveying only in high-risk areas. Designation of high-risk areas will depend on knowledge of cultivated, wild cotton, and other malvaceous hosts available in the area (See Surveying in the Buffer Area Section).
    b. In addition to surveys, we recommend developing a public engagement campaign for potentially affected growers and local residents in the buffer area and vicinity to spread awareness of CSB

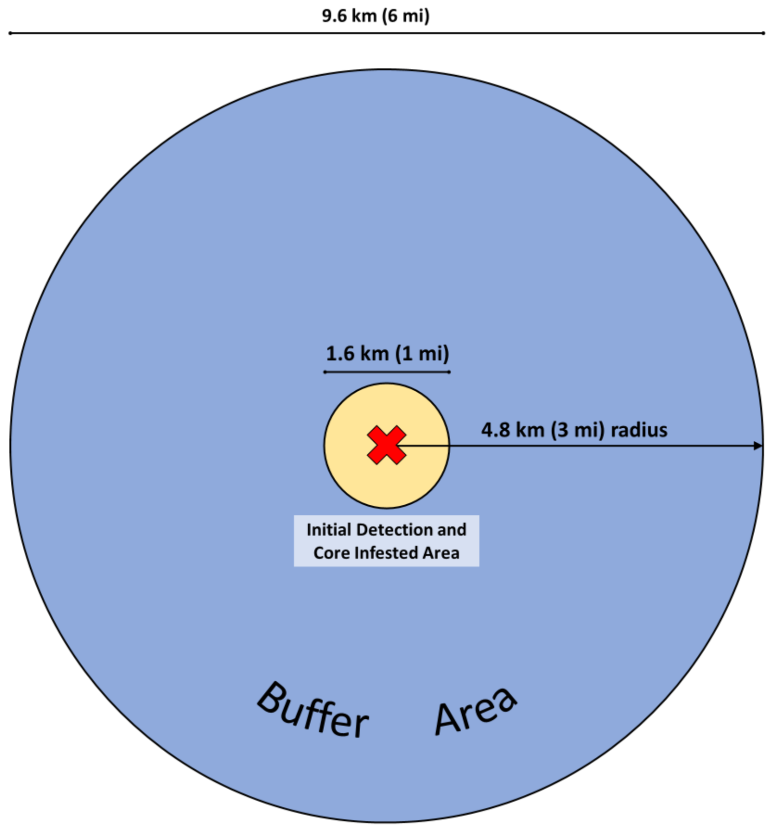

Figure 17. Surveying the buffer area

3. If resources are limited, consider developing smaller sentinel sites in the buffer area for surveys.
    a. A sentinel site, in this case, is a small portion of a cotton field that is easy to reach and regularly inspected along a surveyor's normal route.
    b. We recommend mapping the sentinel site locations to promote even coverage, focusing on high-risk areas near field edges.
    c. If sentinel sites are established for CSB, use GPS to record the perimeter of each sentinel site and draw a map of the immediate area that includes reference points to aid others in finding the areas if necessary.
    d. Once a sentinel site is established, the surveyor should re-inspect it (refer to Timing of Surveys) as frequently as resources permit.

Consider how to expand survey efforts upon additional detections. Instructions are included for each surveying section below.

Surveying in the Core Area

Additional detections of CSB from within the core infested area require no expansions to the delimitation survey. Surveyors can expect to find CSB in the core infested area because of proximity to the initial detection, likelihood of multiple introduced bugs, or the potential for a nearby established population. Record the location of collected individuals to map the distribution of CSB in the core area for control and monitoring efforts.

After detections are made in the core area, completing the remainder of the survey will help accurately delimit the pest population for control or eradication; however, surveyors can choose to stop the survey if the core area is heavily infested. This will allow resource re-allocation to other parts of the survey. After surveys are stopped, surveyors may want to pursue control options within the core area to prevent further spread of the pest (See Eradication and Control).

Surveying in Fields

This section describes how to survey cotton fields within the core infested area, which includes a close examination of plants within 328 ft (100 m) of the initial detection and a walking survey along transects throughout the remainder of the core area. Surveyors should adapt these instructions to survey for CSB in other hosts.

Within the core area, survey plants within 328 ft (100 m) of the initial detection (Fig. 18). Surveying plants for insects may require opening bolls with the fingers or shaking or tapping bolls, other reproductive structures, or other plant parts to reveal CSB.

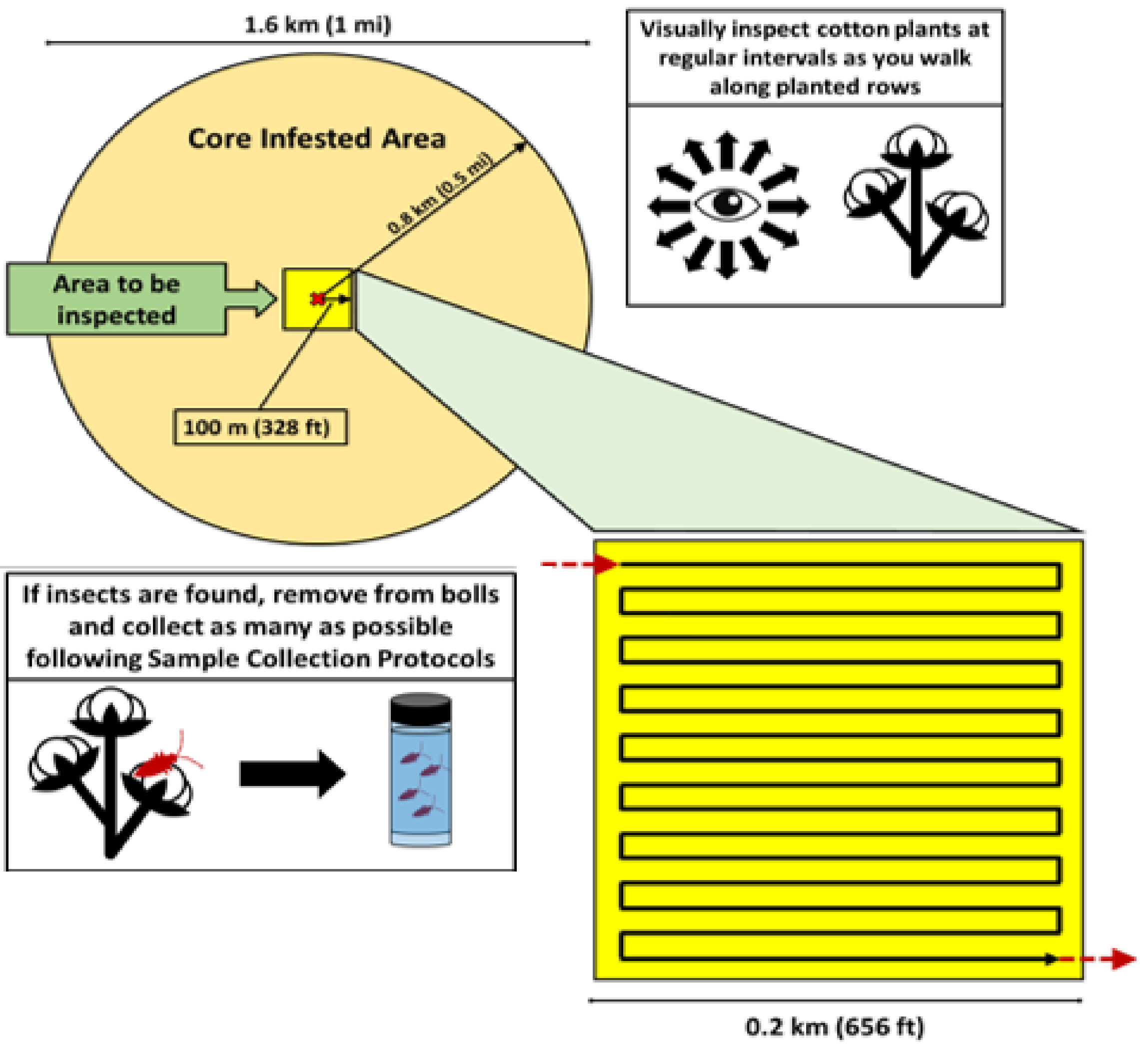

Figure 18. Surveying all plants within 100 m of a detection

Use Table 2 to determine the number of transects to survey in the remainder of the core based on the number of acres in the core area. Visually survey plants along each transect for presence of insects by looking for insects, beat sampling, or sweep netting. If insects resembling CSB are observed, record the location and collect them (See Sample Collection). Opening, shaking, or tapping bolls or other reproductive structures over a tray or white sheet may be necessary to locate and catch insects during surveys. If the core infested area covers multiple fields, surveyors should place transects evenly throughout both fields to ensure accurate delimitation.

Table 2 Minimum number of transects surveyors should walk in cotton fields to effectively inspect plants for CSB based on NSHS Phytosanitary Field Inspection Procedures for non-cereal crops (NSHS, 2019)

Field Size (Acres)	Minimum # transects
0-1	6
1-5	9
5-10	11
10-20	13
20-50	17
50-100	20
100-200	24
200-500	30
500-1000	36

Surveying in Residential Areas

Infestations of CSB in residential areas are likely more difficult to survey because of property lines, fences, and other potential barriers. Additionally, the distribution of host plants in these areas is not predictable; therefore, we generalized the instructions for a residential survey. Surveyors are responsible for modifying the survey to fit their situation.

- Walking linear transects may be difficult on varied terrain but following roads and other natural barriers could facilitate this process.
- Obtaining permission to inspect or walk across private property may be necessary to fully delimit the infestation.
- Unlike in cultivated hosts (e.g. cotton, okra), a wide diversity of host plants may be present in residential areas, including weedy hosts, requiring surveyors to identify potential hosts.

Perform a survey to locate all host plants within the core area. Always ask property owners for permission to access the plants. Walking through public areas or driving through the core and buffer areas is suggested (Fig. 19). It is likely that core infested areas with low host plant density will require sampling every individual.

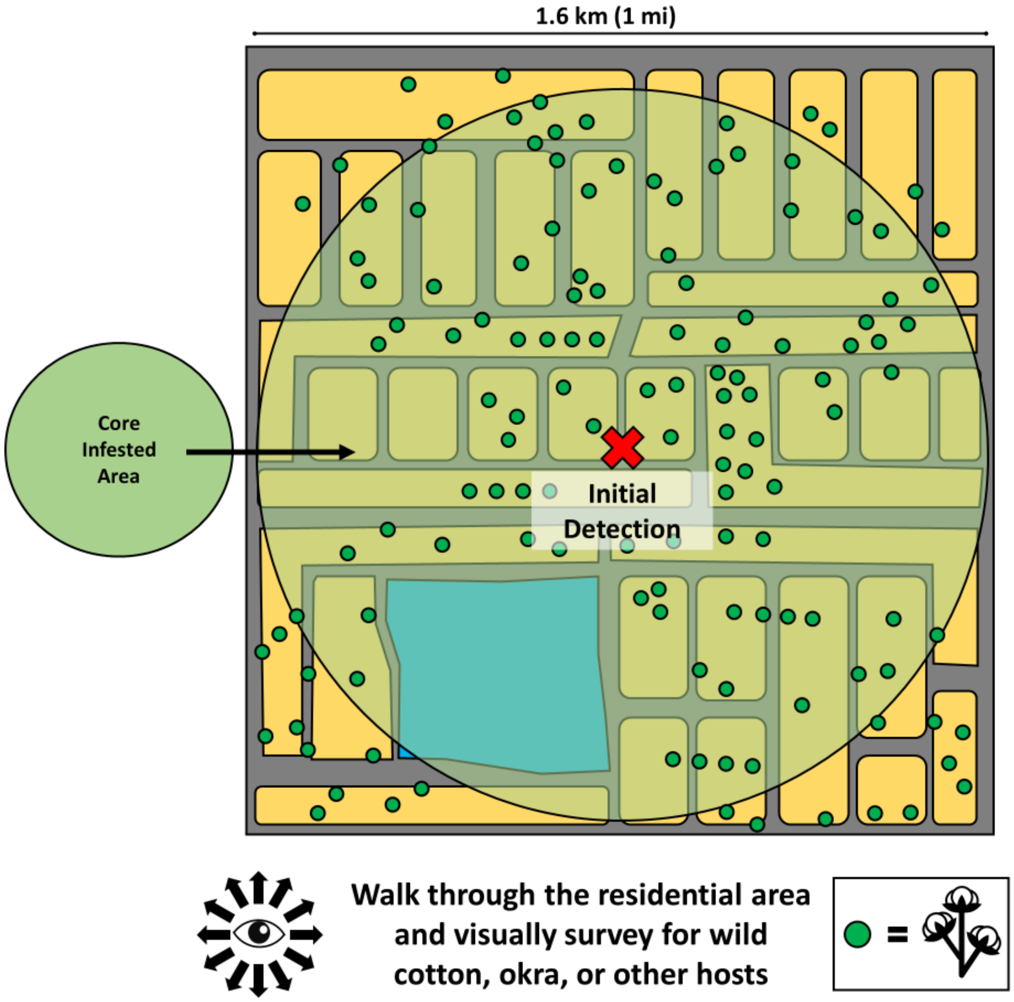

Figure 19. Survey for CSB host plants in a residential survey area

<u>Surveying in Nurseries</u>
Cotton seed bug infestations in nurseries present unique challenges because of the diversity of host plants grown or displayed, high plant density, and frequent movement of plant material (see Human-Assisted Spread). Unlike cotton fields or residential areas, nurseries often include numerous potential malvaceous hosts as well as non-host plants offering more hiding areas for CSB, which may obscure visual survey. In addition, plants in nurseries may be more mobile (sold or shipped quickly), which increases the risk of pest dissemination. For information regarding inspection of nursery stock prior to shipment, see Inspection of Nursery Stock Shipments.

Surveyors should adapt the following instructions to match the layout and practices of the specific nursery or retail establishment:

- Nurseries may have plants arranged in rows, blocks, or benches. Surveyors should adjust their strategy to account for this and ensure representative coverage across the facility. Permission from nursery managers is required to access all areas, including greenhouses, shade houses, and retail display sections.

- Identify and prioritize survey of malvaceous hosts (e.g., okra seedlings, hibiscus, ornamental mallows), while also surveying nearby non-host plants that may serve as resting sites for adult CSB. Because nurseries often intermingle plant species, careful host recognition is critical.
- Conduct a systematic walkthrough of each section, surveying for all life stages of CSB and damage symptoms. Examine beneath and around the rims of containerized plants, check the ground for dried leaves, pods, and debris that CSB may hide in, and look around the base of the plant at the potting medium surface for aggregations of bugs. Examine flower buds and fruiting structures of susceptible host closely, as CSB adults and nymphs often congregate there. When practical, gently shake or tap plants over a white sheet or tray to dislodge concealed insects.
- Scale the number of transects a surveyor should walk according to the size of the facility and the total linear feet of host plant rows. In smaller nurseries with limited host plants, this will often require examining every malvaceous host present. In larger production nurseries, surveys should ensure representative coverage by walking transects evenly throughout propagation blocks, shipping/receiving areas, and retail display sections. As a general guideline, surveyors should complete at least one survey transect for every 30 to 65 ft (10 to 20 linear meters) of host plant rows.
- Record the location (greenhouse number, bench ID, or block designation) of all surveyed plants and any CSB detections. Mapping detections within the facility is recommended to delineate infested areas for control or regulatory actions.
- Because nursery plants are moved rapidly through trade, encourage staff to report any suspected CSB detections immediately. Surveyors should follow strict sanitation procedures to prevent accidental movement of the pest on clothing, equipment, or vehicles.

Surveying in the Buffer Area

Within the buffer area, survey efforts should focus on high-risk areas for CSB infestation and will vary according to available resources. High-risk areas include cotton fields, okra fields, and commercial nurseries with large numbers of known hosts. For fields, consider transect (Table 2) or perimeter surveys. In nurseries, survey within the facility, but consider reducing the number of transects to fit available resources. Patches of wild cotton or other wild malvaceous hosts that are known to be present in the area can also be surveyed, if resources are available. We do not recommend surveying residential areas in the buffer unless they contain large numbers of host plants and resources are available.

Expanding the Delimitation Survey After New Detections in the Buffer

If CSB is detected at any time during the buffer survey, create a new 0.5 mile (0.8 km) core infested area as well as an expanded buffer area (Fig. 20). Buffer areas overlapping with the original survey should be excluded from any expansion.

After detections are made in high-risk areas, completing the remainder of the survey will help accurately delimit the pest population for control or eradication. However, surveyors can choose to stop surveys in or around high-risk areas if a heavy infestation is detected. This will allow resources to be re-allocated to other parts of the original or newly expanded survey. If surveys are stopped, surveyors may want to pursue control options where heavy infestations were found to prevent further spread of the pest (See Eradication and Control).

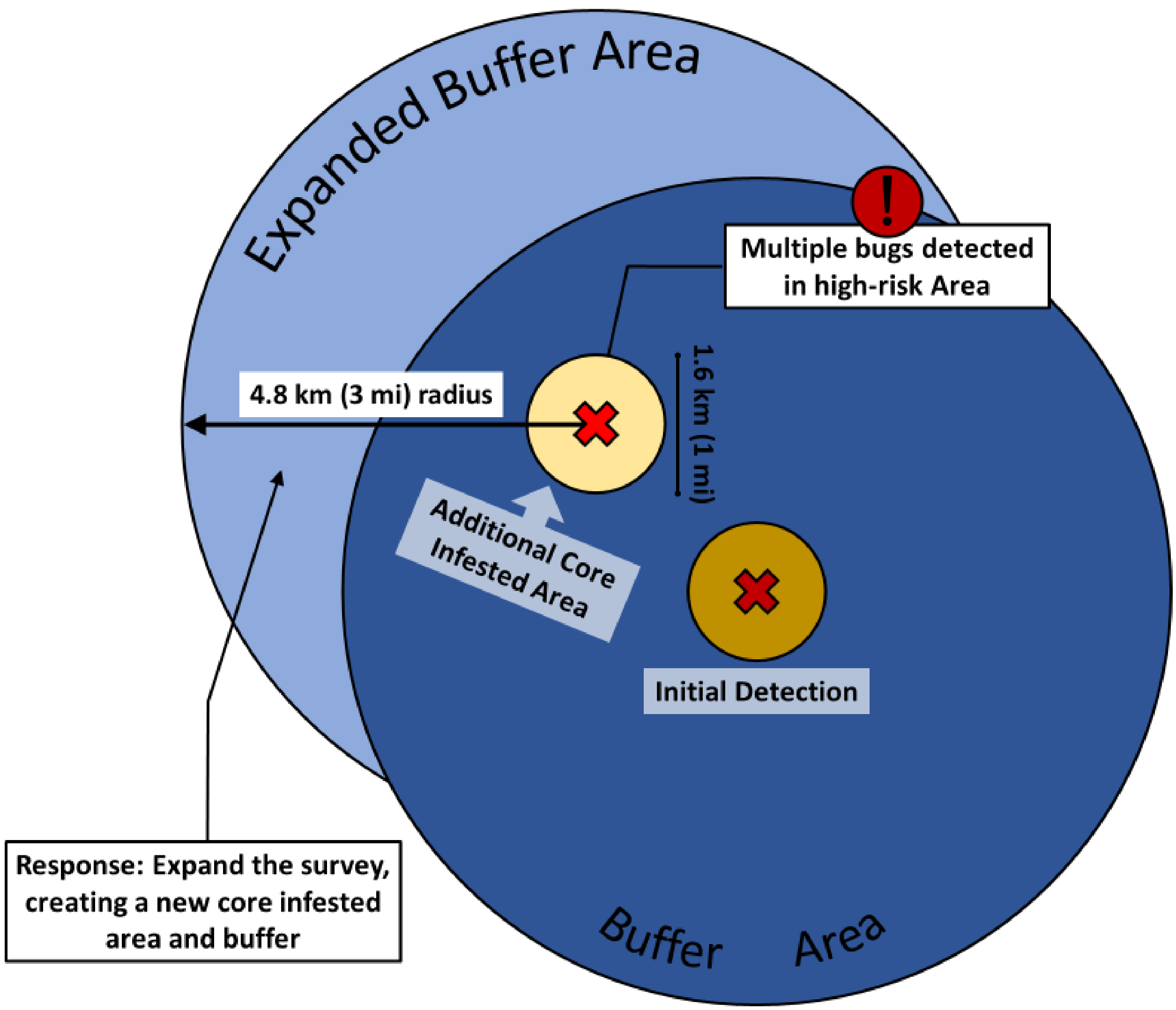

Figure 20. Planned survey expansion after detecting multiple *O. hyalinipennis* near a high-risk area

Public Engagement for CSB in the Buffer Area

If resources are not available to effectively survey the entire delimitation area, consider developing public engagement campaigns to supplement survey efforts. The public engagement campaign may be organized and carried out by state extension services and should operate side-by-side with detection surveys by PPQ staff. This campaign should target surveyed and at-risk areas in the vicinity. It should encourage growers, consumers, and the public in the region to proactively inspect their crops and report infestations (see

Signs and Symptoms) to the proper authorities. Photographs of CSB submitted to local extension agents, state inspectors, CAPS coordinators, and/or PPQ staff will help surveyors map new detections and areas for further investigation. Monitoring community science websites (e.g., iNaturalist.org) or local gardening or farming websites for photographs or descriptions of CSB may also result in additional detections.

Inspection of Nursery Stock Shipments

Plants should undergo a thorough inspection to confirm the absence of CSB. Using a hypergeometric sampling table, inspectors will randomly select a minimum number of plants for detailed inspection to reach a 95 percent confidence that shipped plants have a 1 percent or less infestation rate (see Appendix B for more details). Focus inspections on malvaceous hosts but also check nearby non-host plants that may act as resting sites. Use a bright flashlight, hand lens, and a white beating sheet or tray for dislodging insects (see Sample Collection). Inspect plants in good lighting, look along the midribs and undersides of leaves for small aggregations of nymphs and adults. Open buds or examine developing seed pods where CSB often feed. Check around potting medium, saucers, or under pots where CSB could hide. Seed and fruit discoloration, small feeding punctures, or sooty staining from aggregations are possible indications that CSB is present.

High-risk nurseries, such as those with high pest prevalence, may require increased inspection rates or multiple inspections to ensure confidence in the pest-free status of shipments. If no insects are found after thorough inspection, consider the plants free from CSB for movement. If suspect insects are detected, collect specimens in ethanol for ID confirmation and isolate the affected plants away from the rest of the stock. If CSB is confirmed, remove and destroy heavily infested plant material. Treat remaining plants with an appropriate systemic insecticide and plan to reinspect after treatment but before clearing plants for movement.

Sample Collection

During visual surveys a few techniques to detect cryptic CSB include:

- **Inverted bag and alcohol:** Open bolls, flowers, or reproductive plant parts inside a plastic zipper storage bag and spray gently with a small amount of alcohol (isopropyl works, but ethanol is recommended) from a spray bottle or a perfume atomizer. Close the bag quickly. The alcohol will irritate CSBs, which will quickly become very active. This technique promptly indicates an infested boll. Freeze the sample and then pick out the bugs (Sharma et al., 2010). If an aggregation is observed (Fig. 21, try to capture the whole group.
- **Beat Sampling:** Hold a tray or tub under host branches while tapping the foliage with a stick to dislodge insects. Manually agitate or mash up any flowers or dried plant parts in the tray to flush the insects out of the plant material and use a mouth aspirator to collect any suspect specimens. Once the insects are contained in the aspirator's collection vial, kill them with alcohol or by freezing, move any specimens

into a new vial with alcohol to preserve them, and label.

- **Shaking Containerized Plants:** If CSB is detected in a nursery, laying a white sheet on the ground and quickly shaking containerized plants above the sheet may dislodge any hiding CSB. To collect the suspect specimens, surveyors can use tweezers, an aspirator, or manually place them in an empty vial.

Figure 21. *Oxycarenus hyalinipennis* aggregating under a leaf (iNaturalist user mar_an23 (licensed under CC BY-NC 4.0))

Sample Screening

A Field Screening Aid for the Cotton Seed Bug is available to assist in field identification (Brambila, 2020) and can be found in Appendix C.

Eradication and Control

PPQ decision-makers can use this information after a detection to assess the suitability of potential actions to eradicate, contain, or suppress CSB. The efficacy and feasibility of each control option will depend on the pest situation at the time of detection. Factors including detection location (e.g., natural or urban environment, agricultural crops, greenhouses, nurseries), area of spread, the climatic region, the time of year, the phenology of the host, and current practices already in place contribute to determining whether a particular control option is appropriate.

Eradication Options

Host Removal

Typically, after harvest, cotton fields are cut, shredded, and tilled to reduce pest pressure (Edmisten et al., 2025). Destruction or removal of hosts and crop residues can reduce CSB population size (Atwal, 1976) but is unlikely to eliminate the pest due to its polyphagous nature. There are several methods available to destroy hosts and crop residue including burning, composting, mulching, deep tillage, solarization, steam treatment, and double bagging plant material followed by deep burial. Burning may be restricted by local laws and requires host material to be dry and combustible; check the local ordinance for guidelines and required documentation. Removal of all nearby weeds or alternative Malvales host plants is recommended (Adu-Mensah and Kumar, 1977; Kirkpatrick, 1923). Contact your local extension expert to determine the best way to remove/destroy hosts in your area.

Chemical Control

Various chemical control measures are available for use against CSB (Table 3). However, researchers have found that some populations developed resistance to insecticides (chlorfenapyr, fipronil, neonicotinoids, organophosphates, pyrethroids, spirotetramat, etc.) in lab based studies when exposed to the chemistries repeatedly (Ijaz and Shad, 2018; Ijaz and Shad, 2020; Malik et al., 2019; Ullah and Shad, 2017; Ullah et al., 2016a; Ullah et al., 2016b; Wazir and Shad, 2020). Field evolved resistance to neonicotinoids and flonicamid from CSB collected from fields with treatment records for various insecticides (e.g., pyrethroids, organophosphates, etc.) (Ullah et al., 2021) have been noted. These show that CSB has the potential to develop resistance to various chemicals if continuously exposed to the same chemistries. To avoid inherited resistance, combine or rotate insecticides with differing modes of action (Insecticide Resistance Action Committee, 2020).

Effective application of insecticides for control of CSB may be difficult due to the tendency of this insect to aggregate in many different areas on or near host plants, and to hide within cotton bolls (Atta et al., 2015b). However, experts in other countries have achieved effective control of CSB by combining contact and systemic chemical insecticides (Smith and Brambila, 2008). Some chemical controls should be applied aerially as ultra-low volume sprays in early morning while the insects are less active (Smith and Brambila, 2008). Sprays or dusts may be applied when the insects are seen on newly opened bolls (Hill, 1983).

In Australia, control of the similar species *Oxycarenus luctuosus* (Montrouzier) is difficult because while application of pesticides may kill the pest, it does not restrict reinfestation from the movement of additional *O. luctuosus* bugs from nearby alternative host plants (Chin et al., 2009).

Many chemicals used against CSB are registered in the United States for use on cotton (Table 3) but have not been tested on this pest and host combination in the United States. Also, efficacies in other countries may not be the same in the United States.

Table 3. Insecticides that are registered for use in the United States[1] and have some reported efficacy against CSB. Confirm state registration, use rates, and site restrictions prior to setting up any management program[2]

Active Ingredient[1]	Labeled for use in an Indoor Nursery/ Greenhouse?	Labeled for use in an Outdoor Nursery?	Efficacy[3]	References
Acephate	Yes	Yes	100% mortality	(Zilnik et al., 2025)
Acetamiprid	Yes	Yes	> 75% mortality	(Zilnik et al., 2025)
Avermectin/ Abamectin[4]	Yes	Yes	N/A[5]	(Greene, 2019)
Bifenthrin	Yes	Yes	95% population reduction	(Ibrahim et al., 1993; Ullah and Shad, 2017)
Chlorfenapyr	N/A	Yes	N/A[5]	(Ullah and Shad, 2017)
Chlorpyrifos	Yes	Yes	97% population reduction	(Irshad et al., 2019; Ullah et al., 2021)
Clothianidin	N/A	N/A	88% population reduction	(Irshad et al., 2019; Ullah et al., 2021; Zilnik et al., 2025)
Deltamethrin	N/A	N/A	N/A[5]	(Ijaz et al., 2023)
Dimethoate	N/A	N/A	N/A[5]	(Banazeer et al., 2020)
Dinotefuran	Yes	Yes	> 75% mortality	(Ullah et al., 2021; Zilnik et al., 2025)
Emamectin	N/A	N/A	N/A[5]	(Ullah and Shad, 2017)
Fipronil	N/A	N/A	64% population reduction	(Irshad et al., 2019; Ullah and Shad, 2017)
Flonicamid	Yes	Yes	N/A[5]	(Ullah et al., 2021)

Active Ingredient[1]	Labeled for use in an Indoor Nursery/ Greenhouse?	Labeled for use in an Outdoor Nursery?	Efficacy[3]	References
Flupyradifurone	Yes	Yes	> 75% mortality	(Zilnik et al., 2025)
Imidacloprid	N/A	N/A	> 75% mortality	(Zilnik et al., 2025)
Lambda cyhalothrin[6]	Yes	Yes	89% population reduction	(Abbas et al., 2014; Irshad et al., 2019)
Malathion	N/A	Yes	N/A[5]	(Sweet, 2000)
Methomyl/ diflubenzuron	N/A	N/A	94% population reduction	(Ibrahim et al., 1993)
Spinosad[5]	Yes	Yes	N/A[5]	(Cleveland et al., 2002)
Spirotetramat	Yes	Yes	80% population reduction	(El-Rahim et al., 2015; Ijaz and Shad, 2020)
Sulfoxaflor[5]	Yes	Yes	> 75% mortality	(Wazir and Shad, 2022; Zilnik et al., 2025)
Tau-Fluvalinate	Yes	Yes	97% population reduction	(Ibrahim et al., 1993)
Thiamethoxam	N/A	N/A	> 70% mortality	(Zilnik et al., 2025)
Zeta-cypermethrin	N/A	N/A	N/A[5]	(Ullah et al., 2021)

[1] Mention of compounds does not imply recommendation or endorsement by the USDA over others not mentioned. USDA neither guarantees nor warrants the standard of any product mentioned. Compound names are mentioned solely to report factually on available data and to provide specific information. **Proper rotation of chemistries is essential to prevent the development of resistance.**

[2] Registration status and pest labeling confirmed by Crop Data Management Systems (CDMS (2025) and/or Environmental Protection Agency (EPA (2025). Chemistries are listed by active ingredients only; check labels to determine approved usage, dosage, and availability for your state.

[3] Efficacy reported from multiple trials which may vary in use rate, application details, and pest pressure. Efficacy values should be used as general indications of activity, not directly compared. See references for details.

[4] Some products are not for use with leafy vegetables and/or fruiting vegetables for transplant (Check product labels)

[5] Evidence of use for CSB, but efficacy data not found

[6] Conflicting results in Zilnik et al., (2025), showed similar mortality to water treatment

Biological Control

Biological control using parasites or predators for CSB is generally not a practical control tactic (Sweet, 2000). Although several laboratory studies have shown bioinsecticides such as *Metarhizium anisopliae* (Metschn.) Sorokīn (Sahayaraj and Borgio, 2010) and *Beauveria bassiana* (Bals.-Criv.) Vuill. have some efficacy to manage CSB alone and in combination with conventional insecticides (Ahmed et al., 2020), field studies are absent.

Cultural Control

Reducing the exposure time of seeds to CSB attack by harvesting cotton earlier in the season and at shorter intervals will limit damage to the crop, but will not eliminate the pest (Kirkpatrick, 1923; Odhiambo, 1957). Removal of all infested plants, hibernation sites, and alternative hosts, preservation of natural enemies, and subsequent elimination of residual populations are effective cultural control tactic to suppress CSB populations (Adu-Mensah and Kumar, 1977; Kirkpatrick, 1923; Ullah et al., 2016a). Removing flowers, buds, seed pods, or other structures with crevices or hiding spots on the host plants themselves will also eliminate attractive CSB habitats.

Seed cotton is stored in large, compacted modules after harvest before being sent for ginning (Cotton Counts, 2010). These modules should be covered to prevent further infestation (Pearson, 1958).

For greenhouse or nursery settings, putting uninfested, susceptible plants in a screenhouse or using individual plant covers (screen size 0.3 mm^2 or less) can prevent CSB infestation. Locating nursery stock away from nearby wild or cultivated hosts can reduce migration of CSB into nursery stock.

Sanitary Measures

Removal of all weeds or alternative Malvales host plants near cotton fields is recommended (Adu-Mensah and Kumar, 1977; Kirkpatrick, 1923). Destruction or removal of crop residues after harvest reduces CSB population size (Atwal, 1976).

For greenhouse or nursery settings, sanitation along with habitat reduction is key. Regularly removing leaf litter, plant debris, or other sheltering locations such as burlap sacks, pallets, or unused pots will eliminate locations in which CSB can hide.

Behavioral Control

We found conflicting evidence for the efficacy of mass trapping as a control measure for CSB. Currently, there are no pheromone lures or CSB specific traps (El-Sayed, 2020). Nakache and Klein (1992) noted that CSB was strongly attracted to light at night in Israel. However, Kirkpatrick (1923), was unable to capture any CSB using this method. Additional research regarding the efficacy of UV-light traps is needed. UV-light traps are not pest specific, so they are time-consuming for sorting and identification purposes. In addition, it is unclear whether UV-light traps would be an effective monitoring tool for CSB.

Based on the available information, mass trapping is not a recommended tactic for eradicating or mitigating CSB at this time.

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Appendix A: Nursery and Ornamental Plant Concerns for *Oxycarenus hyalinipennis* (cotton seed bug) (Hemiptera: Oxycarenidae)

Background

Cotton seed bug (CSB; *Oxycarenus hyalinipennis*) is a pest of plants in the order Malvales, including many species of economic importance. The insect is typically considered a field pest that is damaging to cotton because it feeds on seeds and lives within the boll. CSB bodies contaminate and stain the cotton fiber when it is processed (Smith and Brambila, 2008), resulting in substantial cotton fiber yield losses. Recently, detections of CSB on hibiscus, a relative of cotton, in California nurseries, has caused concern of the potential movement of CSB with nursery material. The purpose of this appendix is to provide additional guidance for potential CSB management in a nursery setting, focusing on three topics:

1. An updated host list
2. Updated management options, with information on insecticides registered for indoor or outdoor use on nursery crops in the United States.
3. A discussion of CSB's use of nursery environments, including pots and plant debris, but not soil, as overwintering sites

Cotton Seed Bug Host List

Feeding on seeds within the order Malvales is required for CSB to breed and nymphs to mature. The primary economic host plants of concern in the United States include cotton (*Gossypium* spp.), hibiscus (*Hibiscus* spp.), and okra (*Abelmoschus esculentus* (L.) Moench) (Kirkpatrick, 1923; Sweet, 2000). The preferred reproductive host is cotton.

In addition, CSB damages but does not reproduce on economically valuable fruits such as apple, apricot, avocados, dates, figs, grapes, peach, pear, persimmon, and quince. The cotton seed bug affects the quality of fruits with its feces, pungent odors, and toxic saliva (Avidov and Harpaz, 1969; Nakache and Klein, 1992; Sweet, 2000). In California, hundreds of CSB have been observed on *Leonotis leonurus* (Hepler, 2025), but its status as a host is unknown.

The host list below (Table 1) includes plant species CSB is documented to infest under natural (not experimental) conditions. Please refer to the Ornamental/ Nursery Status column for additional information regarding the hosts listed.

Table 1. Natural hosts of CSB with available nursery information.

Scientific name	Common name	References	Ornamental / Nursery Status	Notes
Abelmoschus esculentus	okra	(Shah et al., 2016)	Crop	**Uncommon in nurseries**
Abelmoschus moschatus subsp. *moschatus*	musk okra	(Rajashekhargouda et al., 1983)	Crop	**Uncommon in nurseries**
Abelmoschus spp.	okra	(El-Rahim et al., 2015)	Crop	**Uncommon in nurseries**, but present in CA trace-forward
Abutilon fruticosum	Texas Indian mallow	(Kirkpatrick, 1923)	Ornamental	Genus level extension literature available, likely to be in some garden nurseries
Abutilon grandifolium (=*Sida mollis*)	hairy Indian mallow	(Kirkpatrick, 1923)	Weed	Native to South America, naturalized widely in the tropics, present in CA (Fryxell et al., 2024) and FL (Wunderlin et al., 2025). Considered a widespread tropical weed (Invasive.org, 2018). **Uncommon in nurseries**
Abutilon incanum	pelotazo	(Shah et al., 2016)	Ornamental	Genus level extension literature available, likely to be in some garden nurseries
Abutilon indicum	monkeybush	(Ananthakrishan et al., 1982)	Weed	Common weed in Asia and Oceania (CABI, 2025). Present in FL (Wunderlin et al., 2025) and HI (USDA NRCS, 2025). **Uncommon in nurseries**

Scientific name	Common name	References	Ornamental / Nursery Status	Notes
Abutilon pictum	Flowering maple, Chinese-lantern	NA	Ornamental	See *Callianthe picta* below
Alcea spp.	hollyhock	(Bolu, 2020)	Ornamental	Common in home gardens, likely to be present in garden nurseries
Alcea rosea (=*Althaea rosea*)	common hollyhock	(Dimetry, 1971; Kirkpatrick, 1923)	Ornamental	Common in home gardens, likely to be present in garden nurseries
Brachychiton populneus (=*Sterculia diversifolia*)	bottletree	(Kirkpatrick, 1923)	Ornamental/ Landscape Tree	This tree appears to be present in at least two arboreta in AZ and CA (The Ruth Bancroft Garden, 2025; University of Arizona Cooperative Extension, 2025).
Cajanus cajan	pigeon pea	(Ram and Chopra, 1984)	Crop	Unlikely to be present in nurseries. Present in FL (GBIF.org, 2025; USDA NRCS, 2025)
Callianthe picta (=*Abutilon pictum*; *Abutilon thompsonii*; *Abutilon venosum*)	Flowering maple, Chinese-lantern	(Ananthakrishan et al., 1982; Kirkpatrick, 1923)	Ornamental	Common in home gardens. Genus level extension literature available, likely to be present in garden nurseries
Cenchrus americanus	pearl millet	(Ram and Chopra, 1984)	Crop	Field crop present across the country (GBIF.org, 2025; USDA NRCS, 2025). **Uncommon in nurseries**
Dombeya spp.	pink ball tree	(Ram and Chopra, 1984)	Ornamental	CSB has been found on *Dombeya cayeuxii* in CA (Zilnik et al., 2025) and plants are available from nurseries online. No home garden/extension information was found.
Gossypium arboreum	tree cotton	(Ram and Chopra, 1984)	Crop	**Uncommon in nurseries**
Gossypium hirsutum	upland cotton	(Ananthakrishan et al., 1982)	Crop	**Uncommon in nurseries**
Gossypium spp.	cotton	(Atta et al., 2015a)	Crop	**Uncommon in nurseries**

Scientific name	Common name	References	Ornamental / Nursery Status	Notes
Grewia asiatica	phalsa	(Shah et al., 2016)	Ornamental	Present in FL (GBIF.org, 2025; USDA NRCS, 2025). Available online from nurseries, mostly tropical.
Grewia tiliifolia (=*Grewia subinaequalis*)	raisin bush	(Ram and Chopra, 1984)	Ornamental	Absent or rare in United States (GBIF.org, 2025; USDA NRCS, 2025). Available online from nurseries, mostly tropical
Herissantia crispa (=*Abutilon crispum*)	bladdermallow	(Ananthakrishan et al., 1982)	Weed	Native in warmer areas of the country; it can be a weed. **Uncommon in nurseries**
Hibiscus cannabinus	Indian hemp/ kenaf	(Kirkpatrick, 1923)	Ornamental/ Fiber crop	Present in FL (Wunderlin et al., 2025), considered a low risk weed in HI; occasional fiber crop and ornamental (CABI, 2025). **Uncommon in nurseries.**
Hibiscus mutabilis	Dixie rosemallow	(Kirkpatrick, 1923)	Ornamental	Common nursery plant, CSB has been found on this plant in CA (Zilnik et al., 2025)
Hibiscus rosa-sinensis	China-rose	(Ram and Chopra, 1984)	Ornamental	Common nursery plant
Hibiscus schizopetalus	coral hibiscus	(Ram and Chopra, 1984)	Ornamental	Common nursery plant
Hibiscus spp.	rosemallow	(Shah et al., 2016)	Ornamental	Common across the US, native and exotic species; common nursery plant
Hibiscus syriacus	rose-of-Sharon	(Ram and Chopra, 1984)	Ornamental	Common nursery plant
Hibiscus trionum	flower of an hour	(Kirkpatrick, 1923)	Ornamental/ Weed	Common across the US (GBIF.org, 2025; USDA NRCS, 2025), tropical weedy species that can also be ornamental/ in nurseries (CABI, 2025).
Lagunaria patersonia	cow-itch-tree	(Beucke, 2021)	Ornamental/ Landscape Tree	Present in CA (GBIF.org, 2025; USDA NRCS, 2025). CSB has been found on this plant in CA (Saveer et al., 2024; Zilnik et al., 2025). Little to no nursery/extension information available.

Scientific name	Common name	References	Ornamental / Nursery Status	Notes
Lavatera spp.	mallow	NA	Ornamental/ Weed	The genera *Lavatera* and *Malva* are very closely related and may be synonymous (Ray, 1995). See *Malva* spp. below for guidance.
Malva spp.	mallow	(Porcelli and Palmieri, 2016)	Ornamental/ Weed	Introduced species from the genus are widely distributed in the United States (GBIF.org, 2025; USDA NRCS, 2025). Multiple ornamental species are available, though many in the genus are not common garden nursery plants.
Malvaviscus spp.	wax mallow	(Ram and Chopra, 1984)	Ornamental	Multiple ornamental species in the United States (N.C. State Extension, 2025).
Pavonia spinifex	gingerbush	(Kirkpatrick, 1923)	Native	Present in FL (GBIF.org, 2025; USDA NRCS, 2025), and SC (USDA NRCS, 2025). No nursery/extension information available. **Uncommon in nurseries**
Phymosia umbellata (=*Sphaeralcea umbellata*)	Mexican bush mallow	(Kirkpatrick, 1923)	Ornamental	Not well recorded in the USA (GBIF.org, 2025) with only herbarium specimens, and no presence data in the PLANTS database (USDA NRCS, 2025). It has been found on garden nursery websites for sale and CSB has been found on it in CA (Zilnik et al., 2025).
Pterospermum acerifolium	bayur tree	(Ram and Chopra, 1984)	Landscape Tree	Tropical. One non-herbarium observation in FL in USA (GBIF.org, 2025), noted as 'blooming in April' by FL Extension (Brown, 2018), no presence data in the PLANTS database USDA NRCS (2025); few live plants found in online nurseries.

Scientific name	Common name	References	Ornamental / Nursery Status	Notes
Sida rhombifolia	Cuban jute	(Ananthakrishan et al., 1982)	Weed	Multiple iNaturalist observations from SE USA (GBIF.org, 2025). Present in the SE USA, CA, and AZ according to the PLANTS database (USDA NRCS, 2025); considered a weed (Cant, 2018). **Uncommon in nurseries**
Sida spp.	fanpetals	(Ram and Chopra, 1984)	Weed	Multiple species spread across eastern and southern US, reaching CA (USDA NRCS, 2025). Considered a rangeland weed. **Uncommon in nurseries**
Sphaeralcea miniata	Latin globemallow	(Kirkpatrick, 1923)	Wild	Absent or rare in the United States (GBIF.org, 2025; USDA NRCS, 2025), native to Argentina with little evidence of spread. **Uncommon in nurseries**
Sphaeralcea spp.	globemallow	(Ram and Chopra, 1984)	Wild/ Ornamental	Multiple species present in western U.S. including native species. Some species are considered xeriscape perennial accents (CSU Extension, 2025; USU Extension, 2025).
Thespesia populnea	portia tree	(Ram and Chopra, 1984)	Ornamental/ Landscape Tree	Present in FL and HI (GBIF.org, 2025; USDA NRCS, 2025). Species not mentioned in garden extension literature, but seeds are available online.
Urena lobata	caesarweed	(Adu-Mensah and Kumar, 1977)	Weed	Present in FL, HI, and LA (GBIF.org, 2025; USDA NRCS, 2025). Considered a weed in multiple habitats (CABI, 2025). **Uncommon in nurseries**
Wissadula amplissima	big yellow velvetleaf	(Adu-Mensah and Kumar, 1977)	Wild	Present in FL, LA, and TX (GBIF.org, 2025; USDA NRCS, 2025). Little available information for nursery status.

The California Department of Food and Agriculture (CDFA) and (Zilnik et al., 2025) have confirmed CSB detections on the following plants not currently in the host table: blue hibiscus (*Alyogyne huegelii* [=*Hibiscus huegelii*]), blue mahoe (*Hibiscus elatus* [=*Talipariti elatum*]), Chinese lantern (*Callianthe tridens* [=*Abutilon tridens*]), flannel bush (*Fremontodendron californicum*), island mallow (*Lavatera assurgentiflora* [=*Malva assurgentiflora*]), Palmer mallow (*Abutilon palmeri*), pima cotton (*Gossypium barbadense*), pink ball tree (*Dombeya cayeuxii*), undetermined abutilon (*Abutilon* sp.), and undetermined 'Malvaceae' - no scientific name (CDFA, 2021). These plant species are most likely hosts, but have no specific evidence of supporting CSB reproduction in the literature. Additionally, we found the following genera of Malvaceae that are present in California: *Anisodontea*, *Anoda*, *Ayenia*, *Eremalche*, *Fremontodendron*, *Hoheria*, *Horsfordia*, *Iliamna*, *Malacothamnus*, *Malvella*, *Modiola*, and *Sidalcea* (Kartesz, 2015). Although we found no specific evidence of these genera being hosts, they can likely support CSB development.

Management of Cotton Seed Bug in Nurseries

Various management practices are available for this species (Table 4) to mitigate entry, establishment, spread, or impacts. Beat sampling, sweep netting, or visual examination of plant material can aid early detection of CSB or determine CSB population levels, which can assist creation of an appropriate CSB management plan using options from Table 4. Visual scouting should consider nymph and adult hiding behavior; thorough examination of small and hidden spaces such as flowers, seed pods, under branches, and in debris is necessary to detect CSB.

Table 4. Summary of management options for CSB. These can be used alone or in combination to mitigate entry, establishment, spread, and/or impacts[1].

Option	Summary
Insecticides	Insecticides with reported efficacy against CSB that are registered in the U.S. are included in Table 5. Insecticides are the primary method for mitigation of CSB in cotton, but very little information is available on managing the insect in nurseries. Cotton seed bug nymphs and adults tend to hide among flowers, under branches, in foliage crevices, and among debris on the ground, giving contact-dependent insecticides little effect within these protected environments (Smith and Brambila, 2008). Foliar contact sprays can knock down exposed individuals but may miss cryptic ones. Systemic or translaminar pesticides are preferable in nursery settings because they reach insects in cryptic locations, have longer residual protection, and are compatible with shipping. During CSB outbreaks, effective control is achieved in other countries with a combination of chemicals that have both contact and systemic properties. These are usually recommended as ultra-low volume sprays applied aerially early in the morning while the insects are less active (Smith and Brambila, 2008). For nursery plants that may harbor CSB, a preferred strategy is a systemic drench combined with a foliar knockdown spray. This dual approach targets both hidden and exposed bugs, with rotation across Insecticide Resistance Action Committee (IRAC) mode-of-action groups for resistance management. In regions where CSB is a major pest, heavy insecticide usage has led to development of resistance to various chemistries (Banazeer et al., 2020; Ijaz and Shad, 2018; Ijaz and Shad, 2020; Ijaz et al., 2023; Ullah et al., 2021; Ullah and Shad, 2017; Ullah et al., 2016a). Rotation of different chemistries for this pest is necessary to prevent or slow resistance development in the United States.

Option	Summary
Cultural Control	**Sanitation/Habitat Reduction:** Regularly removing leaf litter, plant debris, or other sheltering locations such as burlap sacks, pallets, or unused pots will eliminate locations in which CSB can hide. Removing flowers, buds, seed pods, or other structures with crevices or hiding spots on the host plants themselves will also eliminate attractive CSB habitats. Locating nursery stock away from nearby wild or cultivated hosts can reduce migration of CSB into nursery stock. **Exclusion:** Putting uninfested, susceptible plants in a screenhouse or using individual plant covers can prevent CSB from infesting plants when used prior to infestation. **Host Destruction:** Destruction or removal of hosts and crop residues can reduce CSB population size (Atwal, 1976) but is unlikely to eliminate the pest due to its polyphagous nature. There are several methods available to destroy hosts and crop residue including burning, composting, mulching, deep tillage, solarization, steam treatment, and double bagging plant material followed by deep burial. Burning may be restricted by local laws and requires host material to be dry and combustible. Removal of all nearby weeds or alternative Malvales host plants is recommended (Adu-Mensah and Kumar, 1977; Kirkpatrick, 1923).
Biological Control	Biological control using parasites or predators for CSB is generally not a practical control tactic (Sweet, 2000). Although several laboratory studies have shown bioinsecticides such as *Metarhizium anisopliae* (Metschn.) Sorokīn (Sahayaraj and Borgio, 2010) and *Beauveria bassiana* (Bals.-Criv.) Vuill. have some efficacy to manage CSB alone and in combination with conventional insecticides (Ahmed et al., 2020), field studies are absent.
Behavioral Controls	We found conflicting evidence for the efficacy of mass trapping as a control measure for CSB. Currently, we found no pheromone lures or CSB specific traps (El-Sayed, 2020). Nakache and Klein (1992) noted that CSB was strongly attracted to light at night in Israel. However, Kirkpatrick (1923), was unable to capture any CSB. Additional research regarding the efficacy of UV-light traps is needed. UV-light traps are not pest specific, so they are time-consuming for sorting and identification purposes. In addition, it is unclear whether UV-light traps would be an effective monitoring tool for CSB. Based on the available information, mass trapping is not a recommended tactic for eradicating or mitigating CSB at this time.

[1] For definitions of these terms see IPPC (2024).

Table 5. Insecticides that are registered for use in the United States[2] and have some reported efficacy against CSB. Confirm state registration, use rates, and site restrictions prior to setting up any management program.

Active Ingredient[1]	Labeled for use in an Indoor Nursery/ Greenhouse?[3]	Labeled for use in an Outdoor Nursery?[3]	Use in crop Reference	Efficacy
Acephate	Yes – Hibiscus not listed	Yes – Hibiscus not listed	Lab assay (Zilnik et al., 2025)	100% mortality (Zilnik et al., 2025)
Acetamiprid	Yes – Hibiscus not listed	Yes – Hibiscus not listed	Lab assay (Zilnik et al., 2025)	> 75% mortality (Zilnik et al., 2025)
Avermectin/ Abamectin[4]	Yes – Hibiscus not listed	Yes – Hibiscus not listed	Cotton (Greene, 2019)	N/A[5]
Bifenthrin	Yes – Hibiscus not listed	Yes – Hibiscus not listed	Cotton (Ullah and Shad, 2017)	95% population reduction (Ibrahim et al., 1993)
Chlorfenapyr	N/A	Yes – Hibiscus not listed	Cotton (Ullah and Shad, 2017)	N/A[5]
Chlorpyrifos	Yes – Hibiscus listed	Yes – Hibiscus listed	Cotton (Ullah et al., 2021)	97% population reduction (Irshad et al., 2019)
Clothianidin	N/A	N/A	Cotton (Ullah et al., 2021; Zilnik et al., 2025)	88% population reduction (Irshad et al., 2019)
Deltamethrin	N/A	N/A	Cotton (Ijaz et al., 2023)	N/A[5]
Dimethoate	N/A	N/A	Cotton (Banazeer et al., 2020)	N/A[5]
Dinotefuran	Yes – Hibiscus not listed	Yes – Hibiscus not listed	Cotton (Ullah et al., 2021; Zilnik et al., 2025)	> 75% mortality (Zilnik et al., 2025)
Emamectin	N/A	N/A	Cotton/Hibiscus (Ullah and Shad, 2017)	N/A[5]
Fipronil	N/A	N/A	Cotton (Ullah and Shad, 2017)	64% population reduction (Irshad et al., 2019)
Flonicamid	Yes – Hibiscus not listed	Yes – Hibiscus not listed	Cotton (Ullah et al., 2021)	N/A[5]
Flupyradifurone	Yes – Hibiscus not listed	Yes – Hibiscus not listed	Lab assay (Zilnik et al., 2025)	> 75% mortality (Zilnik et al., 2025)
Imidacloprid	N/A	N/A	Lab assay (Zilnik et al., 2025)	> 75% mortality (Zilnik et al., 2025)

Active Ingredient[1]	Labeled for use in an Indoor Nursery/ Greenhouse?[3]	Labeled for use in an Outdoor Nursery?[3]	Use in crop Reference	Efficacy
Lambda cyhalothrin	Yes – Hibiscus not listed	Yes – Hibiscus not listed	Cotton (Abbas et al., 2014)	89% population reduction (Irshad et al., 2019)[6]
Malathion	N/A	Yes – Hibiscus not listed	Cotton (Sweet, 2000)	N/A[5]
Methomyl/ diflubenzuron	N/A	N/A	Cotton (Ibrahim et al., 1993)	94% population reduction (Ibrahim et al., 1993)
Spinosad[4]	Yes – Hibiscus not listed	Yes – Hibiscus not listed	Cotton (Cleveland et al., 2002)	N/A[5]
Spirotetramat	Yes – Hibiscus not listed	Yes – Hibiscus not listed	Cotton (Ijaz and Shad, 2020)	80% population reduction (El-Rahim et al., 2015)
Sulfoxaflor[4]	Yes – Hibiscus not listed	Yes – Hibiscus not listed	Lab assay (Zilnik et al., 2025)	58% mortality (Wazir and Shad, 2022)
Tau-Fluvalinate	Yes – Hibiscus not listed	Yes – Hibiscus not listed	Cotton (Ibrahim et al., 1993)	97% population reduction (Ibrahim et al., 1993)
Thiamethoxam	N/A	N/A	Lab assay (Zilnik et al., 2025)	N/A[5]
Zeta-cypermethrin	N/A	N/A	Cotton (Ullah et al., 2021)	N/A[5]

[1] Mention of compounds does not imply recommendation or endorsement by the USDA over others not mentioned. USDA neither guarantees nor warrants the standard of any product mentioned. Compound names are mentioned solely to report factually on available data and to provide specific information. **Proper rotation of chemistries is essential to prevent the development of resistance.**

[2] Registration status and pest labeling confirmed by Crop Data Management Systems (CDMS (2025) and/or Environmental Protection Agency (EPA (2025)**.** Chemistries are listed by active ingredients only; check labels to determine approved usage, dosage, and availability for your state.

[3] Hibiscus not listed = Hibiscus is not specifically listed on the label; ornamental plants may be more generally listed for some products

[4] Some products are not for use with leafy vegetables and/or fruiting vegetables for transplant (Check product labels)

[5] Evidence of use for CSB, but efficacy data not found

[6] Conflicting results in Zilnik, (Zilnik et al.), similar mortality to water treatment

Cotton Seed Bug overwinters in cryptic locations, not soil; nurseries offer new opportunities

We found no evidence that CSB burrows into or lays its eggs in soil or overwinters underground. When CSB populations are active (i.e., spring and summer in temperate areas or year-round in warmer areas), they spend much of their time hidden on the host plant in bolls, leaves, and flowers, where they lay eggs on the host. In cooler areas, at the end of the breeding season, adults enter a facultative diapause, leave fields, and walk or take short flights to various shelter locations for overwintering. During this period of inactivity, CSB prefers cryptic locations that are often away from host plants, such as tree trunks, the undersides of living or dead leaves, pods of leguminous plants, or human-made structures (Adu-Mensah and Kumar, 1977; Kirkpatrick, 1923; Smith and Brambila, 2008). For both active and overwintering populations of CSB, movement and establishment are primarily associated with hitchhiking behavior on host material and cargo (cotton bolls, cut flowers, fruit, sacks, vehicles) rather than soil.

Relevance to Nursery Stock Pathways

While CSB does not actively use soil as a habitat, it is well adapted to hide in plant debris, refuse, and surface litter. In nursery production, this behavior could bring the insect into close contact with potting soil through associations with fallen leaves or infested plant material that have accumulated *around* containerized plants. While cotton seed bugs do not burrow, soil and potting media can indirectly become points of contact through surface litter.

Risk in Containerized Plants

Containerized plants and nursery stock are likely to provide additional microhabitats for cotton seed bugs:

- Drainage holes, nooks and crannies under and around the rims of pots may provide crevices and protected entryways that mimic the bug’s natural hiding places in bark cracks or leaf litter.
- Because black plastic pots absorb sunlight, they can heat up during cool days, making them potentially attractive shelters for insects seeking warmth. They also retain moisture that is attractive to insects.
- Dead leaves or seed pods on the ground, piled up around pots, or at the crown or soil surface in pots can harbor bugs even if the soil itself is not the primary medium.

These factors indicate nursery stock is a potential pathway, not because the insect uses soil, but because the production environment inadvertently provides suitable hiding places inside nooks and crannies in and around pots. Therefore, soil in containers is not a true pathway itself but the nursery production system can inadvertently provide refuge sites that we should consider in pathway risk assessments.

Appendix B: Inspection of Host Plants Using a Hypergeometric Table

Hypergeometric tables can be used as part of a sampling protocol to achieve a desired confidence level at a predicted infestation rate for a given inspection. For best results with hypergeometric sampling, **it is important that the samples obtained with this method are truly random.** The following are the steps for this sampling protocol:

1. ***Determine the number of plants to inspect within a shipment*** using the table below. For example, to ensure that inspections achieve 95 percent confidence of detecting at a 1 percent infestation rate for a shipment of 1000 plants, you will inspect 258 plants at random.
2. ***Organize and number the plants in the shipment.*** Using the example from Step 1, label the plants in the shipment from 1 to 1000.
3. ***Using the sample size from the hypergeometric table, generate that many random numbers.*** Use a random number generator online. Using the example from step 1, in a shipment with 1000 plants, you will generate 258 random numbers between 1 and 1000.
4. ***Using the plant numbering system, use the randomly generated numbers to identify which plants should be inspected.***

Number of plants in a shipment	Number of plants to be inspected in a shipment (sample size)
100	95
200	155
300	189
400	211
500	225
600	235
700	243
800	249
900	254
1000	258
1500	271
2000	277
4000	288
8000	293
16000	296
30000	297
100000	298

[1] Sample size calculator: https://www.nappo.org/english/learning-tools/Resources-and-Learning-Tools-for-Risk-Based-Sampling/Sample-Size-Calculator

Appendix C: Screening Aid

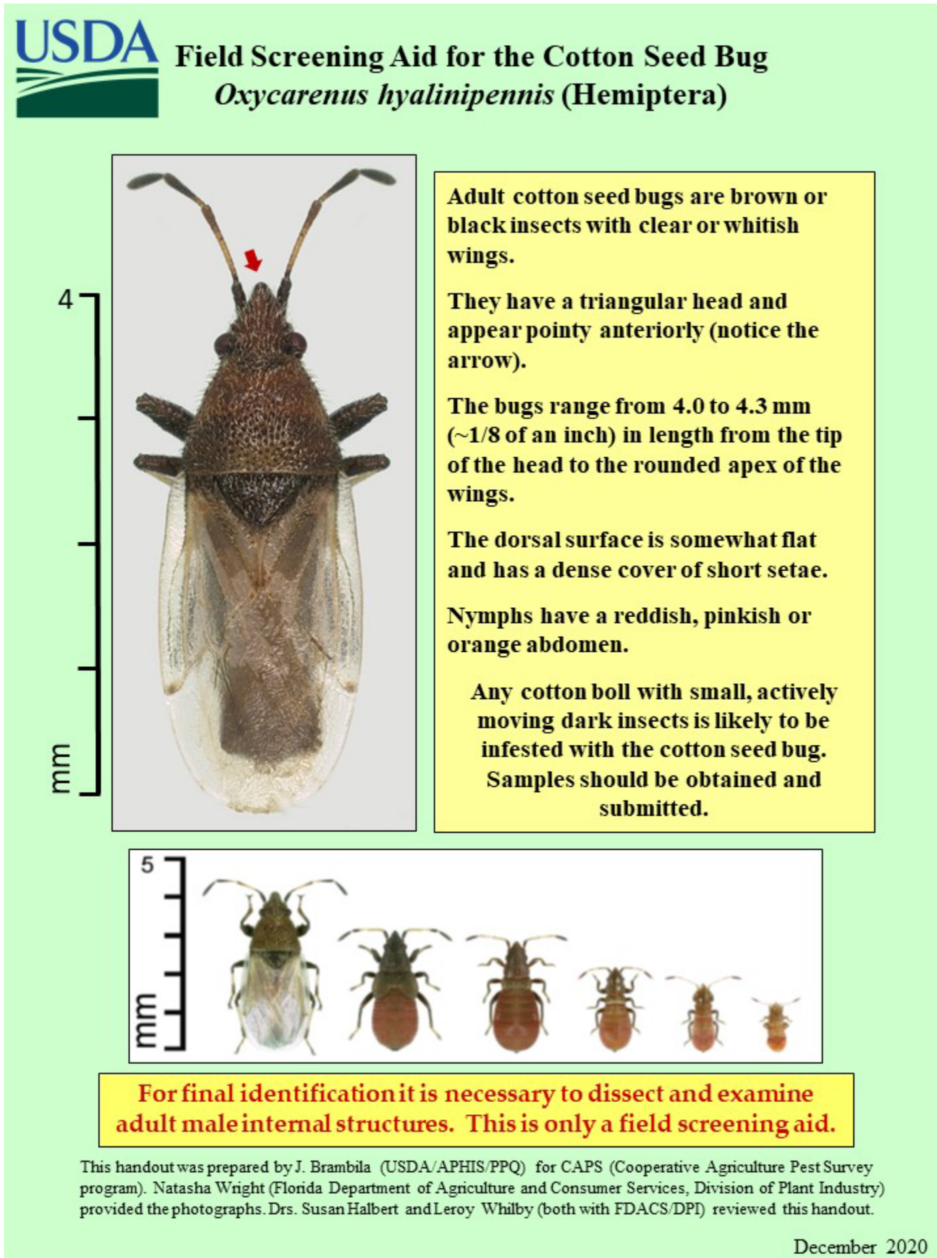

Figure C-1 Field screening aid for *Oxycarenus hyalinipennis* (Brambila, 2020)

Appendix D: Environmental Compliance

Introduction

Use Appendix D as a guide to environmental regulations pertinent to cotton seed bug.

Overview

Program managers of Federal emergency response or domestic pest control programs must ensure that their programs comply with all Federal Acts and Executive Orders pertaining to the environment, as applicable. Two primary Federal Acts, the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA), often require the development of significant documentation before program actions may commence. APHIS, Policy and Program Development, Environmental and Risk Analysis Services (ERAS) is available to provide guidance to program managers and prepare drafts of applicable environmental documentation. PPQ's Compliance and Environmental Coordination program assists ERAS in development of documents and implements environmental monitoring. Program leadership is strongly advised to consult with ERAS and/or the Compliance and Environmental Coordination program early in the development of a program to conduct a preliminary review of applicable environmental statutes and ensure timely compliance.

Environmental monitoring of APHIS pest control activities may be required as part of compliance with environmental statutes, as requested by program managers, or as suggested to address concerns with controversial activities. Monitoring may be conducted with regards to worker exposure, pesticide quality assurance and control, off-site chemical deposition, or program efficacy. Different tools and techniques are used depending on the monitoring goals and control techniques used in the program. Staff from the environmental compliance team (ECT) will work with the program manager to develop an environmental monitoring plan, conduct training to implement the plan, provide day-to-day guidance on monitoring, and provide an interpretive report of monitoring activities.

The following is a list of pertinent laws and Executive Orders:

National Environmental Policy Act (NEPA) – NEPA requires all Federal agencies to examine whether their actions may significantly affect the quality of the human environment. The purpose of NEPA is to inform the decision-maker prior to taking action and to inform the public of the decision. Actions that are excluded from this examination, actions that normally require an Environmental Assessment, and actions that normally require Environmental Impact Statements are codified in APHIS' NEPA Implementing Procedures located in 7 CFR 372.5.

The three types of NEPA documentation are:

1. **Categorical Exclusion**
   Categorical exclusions are classes of actions that do not have a significant effect on the quality of the human environment and for which neither an environmental assessment (EA) nor an environmental impact statement (EIS) is required. Generally, the means through which adverse environmental impacts may be avoided or minimized have actually been built into the actions themselves (see 7 CFR 372.5(c)).
2. **Environmental Assessment (EA)**
   An EA is a public document that succinctly presents information and analysis for the decision-maker of the proposed action. An EA can lead to the preparation of an environmental impact statement (EIS), a finding of no significant impact (FONSI), or the abandonment of a proposed action.
3. **Environmental Impact Statement (EIS)**
   In the event that a major Federal action may significantly affect the quality of the human environment (adverse or beneficial), or the proposed action may result in public controversy, an EIS is prepared.

Endangered Species Act (ESA) – This statute requires that programs consider their potential effects on federally protected species. The ESA requires programs to identify protected species and their habitat in or near program areas and documentation of how adverse effects to these species will be avoided. The documentation may require review and approval by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service before program activities can begin. Knowingly violating this law can lead to criminal charges against individual staff members and program managers.

Migratory Bird Treaty Act – This statute requires that programs avoid harm to over 800 endemic bird species, eggs, and their nests. In some cases, permits may be available to capture birds, which require coordination with the U.S. Fish and Wildlife Service.

Clean Water Act – This statute requires various permits for work in wetlands and for potential discharges of program chemicals into water. This may require coordination with the Environmental Protection Agency, individual states, and the U.S. Army Corps of Engineers. Such permits would be required even if the pesticide label allows for direct application to water.

Tribal Consultation – This Executive Order requires formal government to government communication if a program might have substantial direct effects on any federally-recognized Indian Nation. This process is often incorrectly included as part of the NEPA process, but it must be completed prior to general public involvement under NEPA. Staff should be cognizant of the conflict that could arise when proposed Federal actions intersect with tribal sovereignty. Tribal consultation is designed to identify and avoid such potential conflict.

National Historic Preservation Act – This statute requires programs to consider potential impacts on historic properties (such as buildings and archaeological sites) and requires coordination with local State Historic Preservation Offices. Documentation under this Act involves inventorying the project area for historic properties and determining what effects, if any, the project may have on them. This process may require public involvement and comment prior to the start of program activities.

Coastal Zone Management Act – This statute requires coordination with states where programs may impact Coastal Zone Management Plans. Federal activities that may affect coastal resources are evaluated through a process called “Federal consistency.” This process allows the public, local governments, Tribes, and state agencies an opportunity to review the Federal action. The Federal consistency process is administered individually by states with Coastal Zone Management Plans.

Protection of Children –This Executive Order requires Federal agencies to identify, assess, and address environmental health risks and safety risks that may disproportionately affect children. If such a risk is identified, then measures must be described and implemented to minimize such risks.

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