Anthonomus grandis

Scientific Name
Anthonomus grandis Boheman

Synonyms:
Anthonomas grandis grandis

Common Name(s)
Boll weevil and southeastern boll weevil

Type of Pest
Weevil

Taxonomic Position
Class: Insecta, **Order**: Coleoptera, **Family**: Curculionidae

Reason for Inclusion In Manual
PPQ Program Pest

Pest Description
There are three forms of *A. grandis* found in the United States, the Mexican boll weevil (intermediate), thurberia weevil (*A. grandis thurberiae*), and the southeastern boll weevil (*A. grandis grandis*) (EPPO, n.d.). This datasheet deals specifically with *A. grandis grandis* unless otherwise stated.

Figure 1. Larva of *Anthonomus grandis grandis* in cotton square. Image courtesy of Alton N. Sparks, Jr., University of Georgia, www.bugwood.org.

Figure 2. Adult boll weevil, *Anthonomus grandis grandis*. Image courtesy of Anyi Mazo-Vargas. University of Puerto Rico, www.bugwood.org.

Eggs: Eggs are slightly elliptical, opaque, and 1 mm (0.04 in.) long (Leigh et al., 1996).

Larvae: Larvae (Fig. 1) have a distinct head, are C-shaped, and cream colored with a tan head (Leigh et al., 1996) and legless (Matthews, 1989). Larvae can grow to 9.5 mm (0.375 in.) (Leigh et al., 1996).

Pupae: Pupae are similar to the adult form as their snout, legs, and wings are visible through the cuticula (Parrott et al., 1970; Roach, 1973; Leigh et al., 1996).

Adults: Adults (Fig. 2) are 3.2 to 8.5 mm (0.125 to 0.33 in.) in length. Colors of adults can range from tan to dark gray and sometimes dark brown (Parencia, 1978). Black colored weevils may occur, but these are not common (Bartlett, 1967; McGovern et al., 1974). The upper side of the elytra is pale with fine parallel lines (EPPO, n.d.). Adults

are covered densely with gray pubescence (Matthews, 1989). Adults have a curved snout and the femur of the front leg has a large double tooth (Leigh et al., 1996).

Biology and Ecology:
Development is completed in 2.5 to 3 weeks when conditions are favorable (Smith and Harris, 1994) with the average development time taking from 20 to 80 days (Loftin, 1946). Higher temperatures and humidity increase the rate of development (Smith and Harris, 1994). Up to seven generations a year may develop in the extreme southern parts of the United States cotton belt (Smith and Harris, 1994).

Adults that have recently emerged prefer feeding on the pollen of open flowers. After a few days, the elongated rostrum allows adults to penetrate the flower bud (also called the square) (Wagner et al., 1996).

Figure 3. Damage caused by *Anthonomus grandis grandis*. An egg-laying puncture may be seen on the upper right edge of the square on the left; a typical feeding puncture appears on the square on the right. Image courtesy of Clemson University - USDA Cooperative Extension Slide Series, www.bugwood.org.

In spring, females usually lay eggs on flower-buds singly unless populations are high and there are few buds (Smith and Harris, 1994) in which case, eggs may then be laid on young bolls (Parencia, 1978). Oviposition occurs during the daytime soon after mating (EPPO, n.d.). Females can lay from 100 to 300 eggs (Matthews, 1989). Eggs hatch in three to five days. Larvae bore into buds or bolls where they feed for seven to twelve days (Smith and Harris, 1994). Weevils take longer to develop in bolls versus squares (Loftin, 1946). Larvae go through three instars (Matthews, 1989). The pupal stage then lasts 3 to 5 days before adults emerge (Smith and Harris, 1994). Females can begin laying eggs three to four days after emergence (Cross, 1983). Adults make deep punctures in which the female lays a single egg (Fig. 3). The wound is then sealed with frass and a mucous secretion (Smith and Harris, 1994).

New generations will continue to occur until the host plant is killed by cold weather (Parencia, 1978). Adults then hibernate, staying in the surface litter and surrounding areas around the crop (Smith and Harris, 1994). Diapausing adults prefer leaf litter over well-drained soil under deciduous trees (Matthews, 1989). A high mortality (95%) of hibernating adults is common (EPPO, n.d.).

Symptoms/Signs

Both feeding and oviposition cause damage to the plant (Smith and Harris, 1994). Both males and females make feeding punctures while feeding (Parencia, 1978). Yellowish frass may be present around the feeding area (Leigh et al., 1996).

When initially attacked, a small puncture (either for oviposition or feeding) can be seen on the side of the flower bud (Fig. 3 & 4).

Figure 4. Adult *Anthonomus grandis grandis* damaging a bud (Image courtesy of Clemson University - USDA Cooperative Extension Slide Series, www.bugwood.org).

With oviposition wounds, the bracts around plant buds will flare and turn yellow. Damaged buds and young bolls will drop to the ground after a few days. Large bolls may not drop but can be invaded by microorganisms. Infested locs, the cotton segments of the boll, produce little if any cotton and the quality is inferior (Smith and Harris, 1994). Bolls are hollowed out as the larvae feed (Leigh et al., 1996).

Several larvae may develop in a single boll when food is scarce; this can lead to the entire boll being ruined (Loftin, 1946).

Larvae can be found in holes in the lint when conducting visual surveys (Leigh et al., 1996).

Pest Importance

This species initially spread from Mexico into the southern tip of Texas around 1892 (Burke et al., 1986). *A. grandis grandis* moved across the cotton production area quickly, reaching the Atlantic seaboard of Georgia in 1916 and close to the northern limits of cotton production by 1922 (Loftin, 1946). During the first few years, losses in newly invaded areas ranged from one-third to one-half of their cotton yields; this threatened to ruin the cotton industry, which at the time made up the majority of southern agriculture and industry (Loftin, 1946).

The quick movement coupled with the South's dependence on cotton led to serious consequences: bankrupted farmers, merchants, and bankers, deserted farms and homes, and demoralized laborers and tenants (Loftin, 1946). Loftin (1946) sums up its impact by stating that *A. grandis grandis* "affected both the economic and social welfare of more Americans than any other insect".

According to Smith and Harris (1994) this is the most costly insect pest of cotton in the United States, with yield losses over 8% annually. Control of this pest adds cost to cotton production and is estimated to average $75 million annually in the United States (Smith and Harris, 1994). *A. grandis grandis* has cost American cotton producers more than $15 billion in yield losses and control since its introduction (National Cotton Council, n.d.).

Since its discovery in the United States, research has been conducted, first to determine how to slow the spread and later to determine how to eradicate and control the pest (Loftin, 1946). The impact of this pest has also led to the development of new varieties of cotton that were more resistant to *A. grandis* attacks (Loftin, 1946).

The serious impacts of this pest led to the National Cotton Council requesting increased research and technology development from the United States to aid in the eradication of *A. grandis* (Smith and Harris, 1994). This eventually led to an eradication trial located in northeast North Carolina and southern Virginia towards the eastern extremity of the cotton belt (Smith and Harris, 1994). This trial was successfully completed in 1980 and included:

- Late season insecticide treatments,
- Pheromone traps to monitor populations,
- Diflubenzuron applications when needed,
- Sterile weevil releases,
- Defoliant applications to destroy food and breeding sites before stalk destruction,
- Stalk destruction soon after harvest, and
- Monitoring for other pests (primarily bollworms) and treatments when needed (Smith and Harris, 1994).

The successfulness of the program led to its spread to other parts of the United States, including North and South Carolina (1983 to 1985); Arizona, southern California, and northwestern Mexico (beginning in 1985); and Georgia, Florida, and portions of Alabama (beginning in 1986) (Smith and Harris, 1994). As of 2009, it has been successfully eradicated from Alabama, parts of Arkansas, Arizona, California, Florida, Georgia, Kansas, Kentucky, parts of Louisiana, Mississippi, Missouri, New Mexico, North Carolina, Oklahoma, South Carolina, parts of Tennessee, parts of Texas, and Virginia (Grefenstette, 2009).

Detailed information on the eradication of *A. grandis grandis* can be found in (King et al., 1996).

Known Hosts

Principle plant hosts for *A. grandis* are found in four closely related genera within the Malvaceae family: *Cienfuegosia*, *Gossypium*, *Hampea*, and *Thespesia* (Cross et al., 1975).

Major Hosts: *Cienfuegosia affinis* (fly mallow), *C. drummondii* (yellow flymallow), *C. rosei* (fly mallow), *Gossypium barbadense* (Creole cotton; wild host), *G. davidsonii* (Davidson's cotton), *G. harknessii* (San Marcos hibiscus), *G. hirsutum* (upland cotton), *G. laxum*, *G. lobatum*, *G. thurberi* (Thurber's Cotton), *Hampea nutricia*, *H. rovirosae*, and *Thespesia populnea* (Portia tree) (Cross et al., 1975).

Minor Hosts: *Cienfuegosia digitata* (fly mallow), *C. heterophylla* (variable leaf flymallow), *C. hildebrandtii* (fly mallow), *C. yucatanensis* (Yucatan flymallow), *Gossypium areysianum*, *G. armourianum*, *G. gossypioides*, *G. klotzschianum*, *G. longicalyx*, *G. raimondii*, *G. robinsonii*, *G. somalenses*, *Hibiscus syriacus* (rose of Sharon; not a good host), *Pseudabutilon lozani* (Lozano's false Indianmallow), *Sphaeralcea angustifolia* (copper globemallow), and *Thespesia lampas* (common mallow) (Cross et al., 1975; Matthews, 1989; Smith and Harris, 1994; EPPO, n.d.).

Marginal hosts: *Cienfuegosia heterophylla*, *Hibiscus syriacus*, *Pseudabutilon lozani*, and *Sphaeralcea angustifolia* (Cross et al., 1975).

Adults may feed on the following: *Abutilon giganteum* (Indian mallow), *A. hirtum* (Florida Keys Indian mallow), *Hibiscus* (*Abelmoschus*) *esculentus* (okra), *H. mutabilis* (Dixie rosemallow), *H. rosa-sinensis* (shoeblackplant), *Malvaviscus drummondii* (wax mallow), *Sphaeralcea ambigua* (desert globemallow), *Sphaeralcea coulteri* (Coulter's globemallow), *Sphaeralcea emoryi* (Emory's globemallow), *Wissadula contracta*, and *Sida* spp. (fanpetals) (Cross et al., 1975).

Both Matthews (1989) and Smith and Harris (1994) state that *C. drummondii* (yellow flymallow), is the most important host of *A. grandis grandis* in the United States as it serves as a reservoir for the species. Other wild hosts may also help maintain populations of *A. grandis grandis* when cotton is unavailable.

Pathogens or Associated Organisms Vectored

This species is not known to vector any pathogens; however, wounds caused by *A. grandis grandis* may be invaded by microorganisms.

Known Distribution

A. grandis grandis is indigenous to Central America (Matthews, 1989).

This species is currently found in: **Caribbean:** Cuba, Dominican Republic, Haiti, Martinique, and St. Kitts-Nevis. **Central America:** Belize, Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua. **North America:** Mexico and United States. **South America:** Argentina, Brazil, Colombia, Ecuador, Paraguay, and Venezuela (EPPO, 2007).

Distribution within the United States

Adults are strong fliers and can migrate large distances. The weevil's initial spread from Texas to other cotton growing states in the United States is believed to have happened almost entirely by natural dispersal (Smith and Harris, 1994). During the spread of this

pest in the United States, the average annual spread was 80 km (49.7 miles). They can also be moved large distances by wind dispersal (Smith and Harris, 1994) or by human-mediated means (Kim and Sappington, 2004).

This species spread from Mexico into the southern tip of Texas around 1892 (Burke et al., 1986).

As of 2009, eradication for this pest is actively occurring in Arkansas, Louisiana, Missouri, Tennessee, Texas, and parts of northern Mexico. Post eradication activities are occurring in states where *A. grandis grandis* was previously eradicated: Alabama, parts of Arkansas, Arizona, California, Florida, Georgia, Kansas, Kentucky, parts of Louisiana, Mississippi, Missouri, New Mexico, North Carolina, Oklahoma, South Carolina, parts of Tennessee, parts of Texas, and Virginia (Grefenstette, 2009).

Detailed descriptions on the history, management and eradication efforts can be found in King et al. (1996). Information on the current status of this pest in the United States can be found on the PPQ Program website found here: http://www.aphis.usda.gov/plant_health/plant_pest_info/cotton_pests/index-bw.shtml.

Pathway

EPPO (2007) states that *A. grandis grandis* may be able to travel through international trade on cotton through both seeds and stored products.

This species initially entered the United States through natural dispersal. Its movement throughout the United States was largely through flight and local movement of cotton products to and from public gins, including un-ginned cotton and cotton seed (Loftin, 1946). This species can disperse long distances (Kim and Sappington, 2004).

This species can also spread through human-mediated assistance through road vehicles, movement of infested machinery and equipment, and movement of infested host or habitat material.

Survey

CAPS-Approved Method*:

Trap and lure. The trap and lure combination is the boll weevil trap, boll weevil lure, and an insecticidal strip. The lure is available in either a two-or four-week duration formulation; however, the four-week lure is the most appropriate for CAPS surveys (Schoenholz, 2011). The lure dispenser type is a plastic square.

The boll weevil trap is a plastic trap made up of three parts: 1) a green plastic body, 2) a molded screen cone that fits on top of the body, and 3) a collection chamber at the top of the trap. Traps must include an insecticidal strip to contain the weevils and prevent predation in traps. The lure and insecticidal strip are placed in the collection chamber.

IPHIS Survey Supply Ordering System Product Names:

1) Boll Weevil Trap
2) Boll Weevil Lure - 4 Week
3) Boll Weevil Insecticide Strip

IMPORTANT
Before planning a boll weevil survey it is IMPERATIVE that you contact your PPQ Regional Cotton Program Manager to determine if your state should survey for this pest. CAPS surveys should NOT be conducted in areas that have PPQ Boll Weevil Program trapping programs.

Time of year to survey:
Weevils begin emerging once average night temperatures reach 20-21°C (68-69.8°F) (Smith and Harris, 1994). Emergence from overwintering sites takes place from April to the end of June/ early July for about 90% of the population (Schoenholz, 2011). Emergence can extend to early August in the most northerly part of the insect's distribution (Matthews, 1989). To survey for migrating populations, surveys may be initiated later in the season (August-October) (Schoenholz, 2011).

More information can be found on the USDA-APHIS-PPQ program pest page for *A. grandis grandis* which can be found here: http://www.aphis.usda.gov/plant_health/plant_pest_info/cotton_pests/index-bw.shtml.

Trap Placement:
Traps should be placed atop a 1.2 to 1.5 meter (4 to 5 feet) reed or stake driven into the ground to a depth where it will stand up straight (Schoenholz, 2011).

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Key Diagnostics/Identification

CAPS-Approved Method*: Morphological.

Samples are screened for the presence of the boll weevil. Level 1 screening for this pest requires experience sorting wood-borers and bark beetles to morpho-species. Initial screening should be performed using the following characters:

1. Face terminates with a long snout (rostrum).

2. Antennae elbowed, originate just over half way down the rostrum.

3. Body 3.2 to 8.4 mm (0.125 to 0.33 inches) long, reddish brown, covered in whitish hair-like scales.

4. Pronotum with a longitudinal white midline.

5. Femur swollen with double-pointed teeth on the inner margin.

Suspect boll weevil samples will then be forwarded to experienced eradication program personnel or entomology taxonomists at the state department of agriculture or a land grant university within the state for Level 2 Examination.

Boll weevil identification requires specialized training and family-level identification expertise. If such expertise is unavailable, samples should be forwarded directly to the designated identifier.

If program personnel believe the specimen is a boll weevil, they will initiate appropriate response activity (intensified trapping, ground and aerial treatments).

Suspect *Anthonomous grandis grandis* specimens will be forwarded via overnight mail, with a telephone alert, to:

Areas EAST of the Mississippi River (AL, FL, GA, KY, MS, NC, SC, TN, and VA)

Dr. Richard L. Brown
Mississippi Entomological Museum
100 Twelve Lane
Mississippi State, MS 39762
Phone: (662) 325-2990
Fax: (662) 325-8837
E-mail: RBrown@entomology.msstate.edu

Designated States WEST of the Mississippi River (AR, CA, KS, LA, MO, NM, OK, and TX)

Kira Metz
USDA APHIS PPQ
412 Minnie Belle Heep Center,
TAMU 2475
College Station, TX 77843-2475
Phone: (979) 862-3052 ; Cell: (979) 450-5492
E-mail: kira.metz@aphis.usda.gov

Please make sure to include form 391 “Specimens for Determination” with each sample.

Arizona
The Arizona Cotton Council screens trap samples and differentiates *Anthonomous grandis grandis* from *Anthonomous grandis thurberiae*, which occurs in Arizona and feeds on wild cotton. Questionable specimens are sent to CPHST Mission lab for molecular analysis.

For instructions on how to submit specimens, refer to the **Guidelines for Submitting Wood Borer and Bark Beetle (WBBB) Specimens for Identification** at http://caps.ceris.purdue.edu/taxonomic_services/wbbb_sample_submission.

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Literature-Based Methods:
Recently, adult weevils collected in Chihuahua, Mexico were successfully identified using a new molecular diagnostic tool. The tool was developed to help distinguish the *Anthonomus grandis* southeastern variant, which attacks commercial cotton, from the thurberia weevil variant, that prefers the use of wild cotton hosts.

A PCR method has been developed to differentiate *A. grandis grandis* from other superficially similar weevils, but it does not distinguish *A. grandis grandis* from the sub-specific weevil *A. grandis thurberiae* (Kim et al., 2009). Characteristics to compare the three forms of *A. grandis* can be found in Clark and Burke (1986).

More information can be found on the USDA-APHIS-PPQ program pest page for *A. grandis grandis* which can be found here: http://www.aphis.usda.gov/plant_health/plant_pest_info/cotton_pests/index-bw.shtml.

Easily Confused Pests

A key to distinguish *A. grandis* from four other species in the "*A. grandis* group" is found in Jones and Burke (1997). It includes *A. townsendi*, *A. hunteri*, *A. mallyi*, and *A. palmeri* (Jones and Burke, 1997). *A. hunteri* is known to only develop on *Hampera trilobata*, an endemic plant to the Yucatan Peninsula, Belize, and northern Guatemala (PaDIL, 2010). None of these species are currently known to be present in the United States.

The similar-looking sub-species, *A. grandis thurberiae,* should only be of concern in surveys conducted in the Southwestern United States.

Commonly Encountered Non-targets

There are some superficially similar weevils that can be attracted to components of the *A. grandis grandis* lure or trap color including *A. eugenii* (pepper weevil), *A. eugenii musculus* (cranberry weevil), and *Curculio caryae* (pecan weevil) (Kim et al., 2009). They may be hard to distinguish from *A. grandis grandis* if the weevil samples are partially destroyed by predatory insects.

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