TEXAS A&M AGRILIFE EXTENSION

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Controlling the Pecan Weevil

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The pecan weevil (*Curculio caryae* [Horn]) is a key pest of pecans in the United States, specifically in portions of Texas. Pecan weevils are obligatory nut feeders and will feed on all species of North American hickory and *Juglans regia* (English walnut). Pecan weevils can be found from New York to Iowa, south to Oklahoma, and across the southeastern states from Florida to West Texas (Fig. 1). More recently, they have been observed in some counties in eastern New Mexico.

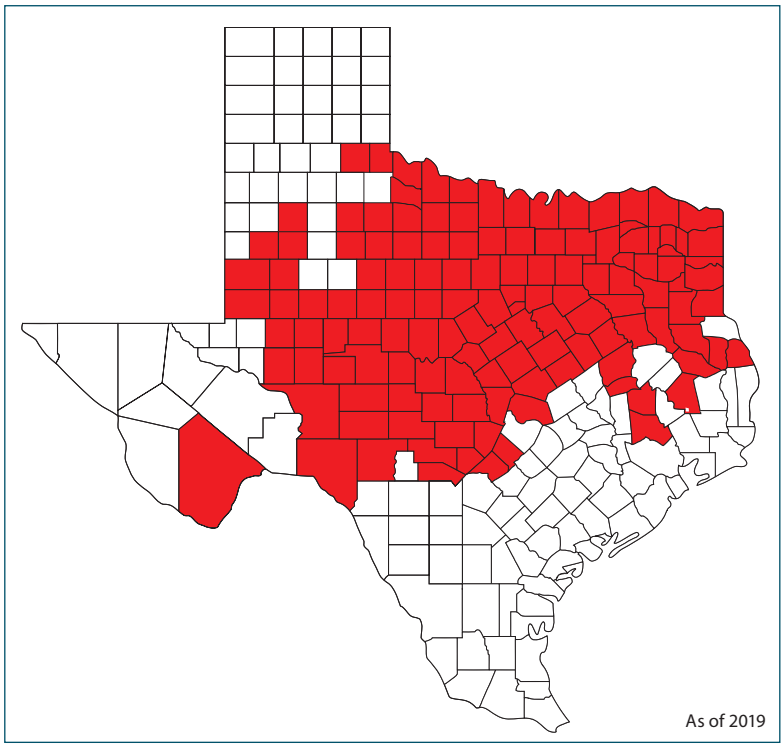

Figure 1. Texas counties with records of pecan weevils found on pecans are shown in red.

Description

The adult pecan weevil is a brownish color and is about ⅜ inch long. The female's snout is as long as its body while the male's snout is somewhat shorter (Fig. 2). The larvae are cream-colored grubs with reddish heads. They reach a length of ⅗ inch before entering the adult stage (Fig. 3).

Biology

Both male and female adult weevils damage pecans by feeding on or laying eggs in nuts. Although damage can occur from the time of adult emergence to shuck split, the key to weevil control is to prevent oviposition (egg lay).

Pecan weevil activity starts in early August. Adults emerge from the soil where they have spent 2 or 3 years in soil cells located 4 to 12 inches beneath the soil surface. The time at

Figure 2. Adult male pecan weevil (left) and adult female pecan weevil (right). *Photo credit: Bill Ree*

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Figure 3. Pecan weevil larvae in a nut. *Photo credit: Bill Ree*

which adult pecan weevils emerge is directly related to the type of soil and soil moisture conditions. Drought conditions and clay soils can delay the emergence of adults by a month or more.

Under normal soil moisture conditions, approximately 80 percent of adult weevils emerge between August 20 and September 10 (Fig. 4). This emergence pattern is typical across the pecan belt. However, soils hardened by drought or the presence of clay soils delay adult emergence. During drought conditions from 1977 to 1978, almost 30 percent of the adult weevils emerged after an October 19 rain (Fig. 5). Drought-delayed emergence can only be avoided

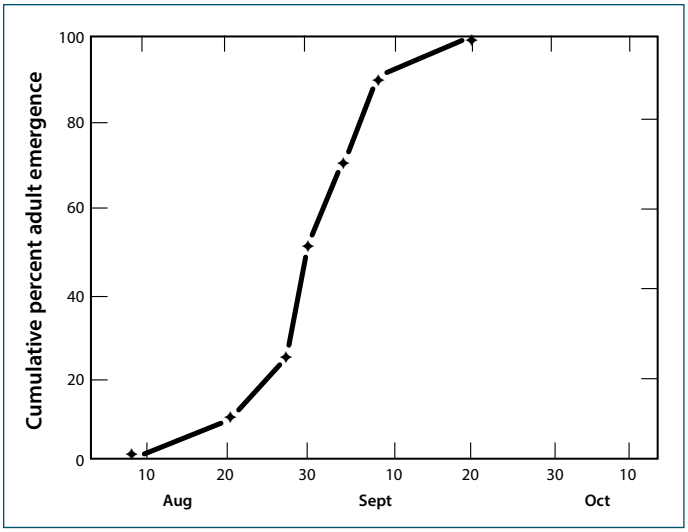

Figure 4. Cumulative percent of adult pecan weevil emergence when soil hardness is not a factor.

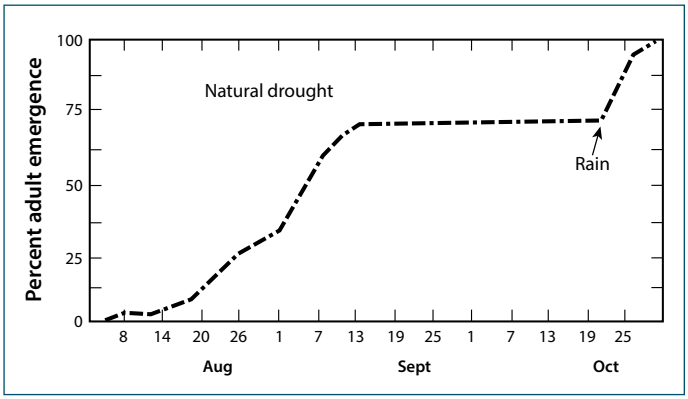

Figure 5. Cumulative percent of adult pecan weevil emergence from drought-hardened soils and subsequent adult emergence after soils are sufficiently softened by rain. *Graph reprinted from The Pecan Quarterly, Vol. 14, No. 2*

when the soil is softened by moisture, either from irrigation or rainfall.

Hard soil acts as a physical barrier to adults moving from their soil cells to the soil surface. Irrigation can be used to ensure adult weevils emerge at the normal time (Fig. 4). An application of 2 to 3 acre-inches of water in mid-August should prevent most soils from being drought-hardened during the critical emergence period (August 20 to September 10). Irrigation can prevent drought delay but will not encourage weevil emergence to begin earlier than normal. Schedule irrigation to ensure weevil emergence at the normal time while allowing time for soils to dry enough to allow pesticide sprayers access before emerging weevils begin to lay eggs. The time from emergence to egg laying is about 5 days. Orchards under drip irrigation will have normal weevil emergence near water emitters but under drought conditions will have delayed emergence from the harder soils away from the emitters.

Testing for Soil Hardness

The degree of soil hardness is based on soil types and can greatly influence adult emergence. Clay-type soils that are hard due to drought conditions prevent weevils from emerging normally while light textured soils will still allow normal emergence under drought conditions. Soil hardness can be measured by applying pressure to a dowel rod inserted into the soil.

To determine if your soil hardness could prevent weevil emergence, take an 8-inch length of ½-inch

dowel rod fitted with a handle (Fig. 6). Press the flat surface of the dowel rod onto the soil surface and apply up to 132 pounds of force to the handle. If the dowel rod penetrates the soil to a depth of 6 inches, weevils should emerge during the normal time (Fig. 2). If the rod does not penetrate the soil, the emergence of some weevils will be delayed until the soil becomes softer. Soil hardness should be tested for all soil types present in the orchard.

Figure 6. Dowel rod and handle used as a tool to test for soil hardness. *Photo credit: Bill Ree*

Upon emergence from the soil, adult pecan weevils move to the nearest tree. Research indicates that 77 percent of adults fly to the tree trunk at heights between 6 and 8 feet, 5 percent walk to the tree trunk, and 15 percent fly directly into the canopy. Once in the canopy, weevils feed and mate.

Feeding activity of male and female adult weevils that takes place before nuts enter the gel stage can cause nut drop. After shell hardening, males only feed on the shuck, which does not cause nut drop. A close inspection of damaged pecans will reveal a puncture the size of a straight pin that can be traced through shuck and shell to the liquid endosperm area of the nut (Fig. 7). This is a feeding puncture or egg-laying site and will be surrounded by a circle of tracks created by the adult (Fig. 8). The presence of punctures and tracking confirms weevil presence.

Feeding rates for males and females before shell hardening are low (around 0.25 nuts/day/adult). Most weevils emerge at or shortly after the pecan's gel stage. Therefore, nut losses caused by adult feeding are few compared to those caused by egg laying. The adult emergence period lasts for several weeks.

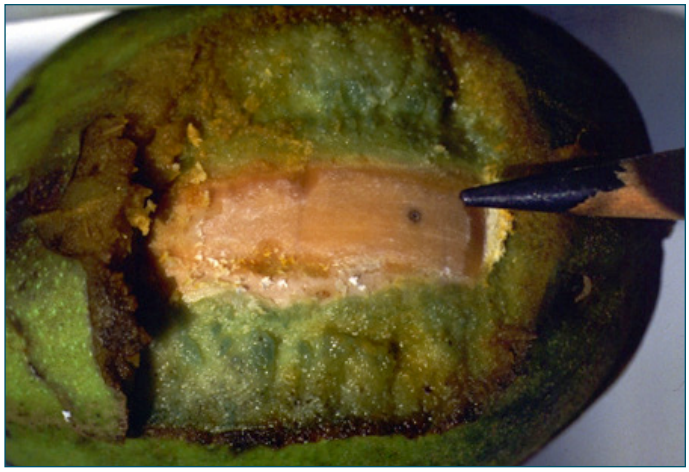

Figure 7. Pecan weevil puncture through pecan shell.
Photo credit: Allen Knutson

Figure 8. Pecan weevil puncture and tracking.
Photo credit: Allen Knutson

Time spray treatments to prevent oviposition rather than to prevent feeding on the few nuts that will be lost during the water stage. The key to managing the pecan weevil population is to prevent egg laying.

Female weevils do not begin laying eggs until 5 days after they emerge from the soil. For egg lay to be successful, nuts must be in or past the gel stage. Nuts are susceptible to oviposition from the gel stage to shuck split.

To deposit eggs in pecans, a female feeds through the shuck and shell to the kernel. She then excavates a small cavity into the developing kernel. She turns around and uses her ovipositor to place three to four eggs (per nut) on the developing kernel.

A female weevil will avoid pecans in which eggs already have been laid by other females. A female will lay approximately 75 eggs in her life at a rate of 2.6 to 3.8 eggs per day. Each female will oviposit in approx-

imately 30 nuts during her 3- to 4-week life. Female weevils cannot lay eggs in nuts after shuck split.

Larvae hatch and feed in the kernel. When fully developed, larvae chew a single hole (occasionally two) through the shuck and shell (Fig. 9), exit the nut, and drop to the ground. The time from egg lay to larval emergence is approximately 42 days.

Figure 9. Exit holes created by grubs. *Photo credit: Pat Porter*

Once larvae have dropped to the ground, they burrow into the soil to a depth of 4 to 12 inches where they create a cell. A year later, about 90 percent of these larvae pupate during a 3-week period. After pupation, the adult pecan weevil remains in the soil for another year. Adults emerge the following year, resulting in a 2-year life cycle. The remaining 10 percent delay pupation and remain in the soil as larvae a second year. At the end of the second year, they pupate and in the soil 3 weeks later as adults. These adults also remain in the soil for another year and begin to emerge the following August, which results in a 3-year life cycle.

Adults do not fly far, causing the natural spread of infestations to occur within a one-mile radius. Movement over longer distances results from the transport of infested nuts by humans.

Integrated Pest Management Practices

The objective in a pecan weevil integrated pest management (IPM) program is to prevent female weevils from laying eggs in nuts. Because the larvae, pupae, and adults are covered with 4 to 12 inches of soil for most of their lives and pesticides cannot reach larvae inside the nuts, management of these life stages is not practical. The only possible time to manage infestations is after adults have emerged from the soil and before egg laying begins. To prevent weevils from laying eggs, pecan producers must:

- Monitor kernel development to determine when the earliest maturing cultivars reach a stage susceptible to oviposition,
- Monitor adult emergence from the soil, and
- Apply an effective insecticide at the proper time to prevent emerging weevils from laying eggs in susceptible nuts.

Monitoring Kernel Development: Pecan kernel development must be in the gel or dough stage for oviposition, larval hatch, and development to occur. It is important to detect this early kernel developmental stage to determine when oviposition will begin. To monitor kernel development, cut the distal or tip end of the nutlets of the earliest maturing varieties to check for the beginning of the gel stage. Pecans mature from the distal end to the stem end, so the distal end will enter the gel stage first.

Monitoring Adult Emergence: There are several monitoring techniques to detect adult pecan weevil activity. They include inspecting dropped nuts for punctures and using knockdown sprays, sticky bands, limb jarring, and assorted traps. Wire cone traps, pyramid or "Tedders" traps, and circle traps are commonly used.

Wire cone traps are placed on the ground beneath pecan trees with a known history of pecan weevil infestations. These traps are durable and can be used for many years with limited maintenance. However, these traps are expensive, labor intensive, and cannot be used around livestock unless the trap area is fenced.

The pyramid or "Tedders" trap is built of two triangular pieces of ½-inch hardboard. Each piece is slotted in the center so that one piece slips over the other at a 90° angle. The result is a 4-foot-high vertical pyramid. The trap is painted a dark color and fitted with a boll weevil trap to collect adults. A single trap is placed beneath a tree canopy 8 to 10 feet from the trunk. One trap per tree is recommended, but no more than 15 traps are needed for 100 acres. Since this trap works as a visual preference for the weevils, the tree trunk next to the trap should be painted white from the base up

to a height of 6 to 8 feet. Trap efficiency is enhanced by keeping grass and weeds mowed around the monitoring trees. These traps require little effort to put up and are relatively inexpensive. Like the wire cone traps, these traps cannot be used in livestock grazing areas unless the trap area is fenced.

The circle trap is a wire cone trap placed on the side of a tree. Trap placement on the tree allows for use with grazing livestock. Trap construction plans or sources for the purchase of traps can be obtained from your local county Extension office.

Regardless of the type of trap used, place traps on or under trees with known weevil infestations. If an orchard has several soil types (sandy, loam, clay), place traps under infested trees growing on each soil type. Place traps in the orchard for 1 to 2 weeks before the earliest maturing varieties reach the gel stage and monitor the traps every 2 to 3 days until the latest maturing variety has reached shuck split. Adult weevils collected in the traps should be counted and removed with each inspection.

Instructions for building these traps are detailed in the Oklahoma State University publication "Monitoring Adult Weevil Populations in Pecan and Fruit Trees in Oklahoma", EPP-7190, and available at http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2367/F%EE%80%807190%EE%80%81web.pdf

There is a commercially available pecan weevil lure, but it is not reliable in monitoring adult pecan weevil activity and is not recommended as a monitoring tool.

Applying Insecticide: If adult pecan weevils are found in an orchard, economic damage will occur if the orchard is not treated. A treatment program for the pecan weevil requires at least two properly timed insecticide applications. In some cases, three or four applications may be needed to prevent economic loss.

The first insecticide treatment should be made in August when the earliest maturing nuts are entering the gel stage, regardless of trap catches.

The initial insecticide application should be effective for 5 days. Adult female pecan weevils do not begin to lay eggs until 5 days after emergence so the earliest time to retreat will be 10 days after the initial application. If emergence traps are collecting adult weevils on or after the sixth day following the initial insecticide application, a second application is needed. The second application should be made no sooner than 10 days after the first treatment. If no adult weevils are trapped 6 days after the initial treatment, then the second application can be delayed until traps detect adult activity again. At least two sprays are needed to control established pecan weevil infestations. If drought has caused the soil to become hard and adults continue to be trapped for more than 5 days after the second application, a third insecticide application will be needed. Any pecan that has not reached shuck split will be susceptible to pecan weevils and should be protected with an insecticide application. Insecticides labeled for control of pecan weevils are shown in Table 1.

Table 1. Suggested insecticides for control of pecan weevil. This information is provided for educational purposes. Read and follow label directions.

		Insecticide		
Active ingredient	**IRAC group**	**Brand name**	**Pre-harvest interval**	**Remarks**
Bifenthrin	3A	Brigade® WSB, Brigade 2 EC, Bifen 2 AG Gold, Bifenture EC Bifenture 10F, Fanfare ES, Fanfare 2EC, Sniper	21 days	Do not graze treated orchards.
Carbaryl	1A	Sevin® 80WSP, Sevin® 80S, Carbaryl® 4L, Prokoz Sevin® SL	14 days	Grazing allowed
Lamda-cyhalothrin	3A	Warrior®, Warrior II®, Grizzly Z® Kaiso 24® WG, Karate® w/ zeon® tech, Lambda-CY® EC, Province®	14 days "	Grazing allowed
Zeta-cypermethrin	3A	Mustang Max® EC, Mustang Max®, Respect® EC	21 days	Grazing allowed
Zeta-cypermethrin and bifenthrin	3A and 3A	Hero®	21 days	Do not graze treated orchards.

*Texas A&M AgriLife Extension does not recommend adding a spreader sticker to insecticide applications for pecan weevils.

Pecan Weevil Eradication

Integrated pest management (IPM) practices in pecans are designed to keep pecan weevil populations below economic loss levels. Alternatively, the goal of eradication is to eliminate a pest species from an area. Occasionally, efforts to eradicate pecan weevils are attempted when isolated populations are detected. An eradication program is typically conducted under the authority and regulation of the Texas Department of Agriculture. Eradication efforts require an intensive insecticide treatment program, destruction of infested nuts and discarded trash, and strict quarantines to prevent the movement of infested nuts into the eradication area.

To eradicate pecan weevils, insecticides are applied just before the gel stage and repeated at 7- to 10-day intervals until shuck split. Several applications that blanket the presumed adult emergence period are made in an effort to kill all emerging weevils. This spray program is repeated for at least 3—preferably 4—consecutive years. Eradication is considered complete when no pecan weevil larvae are found during harvest for four consecutive seasons.

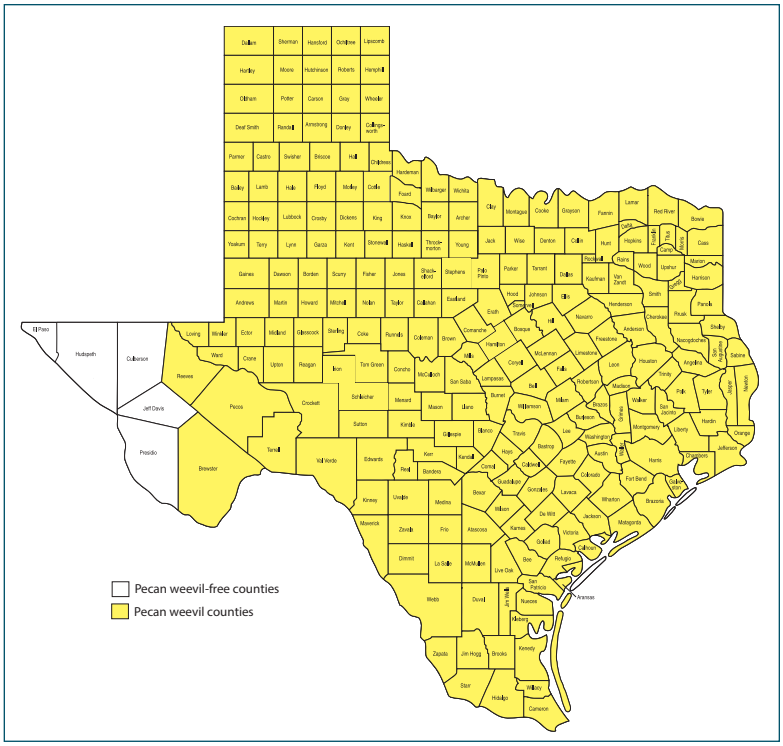

Figure 10: All of TX is under a pecan weevil quarantine (counties in yellow), except for the five most western counties, regardless of the presence of pecan weevils as shown in Figure 1.

Pecan weevil quarantine

In Texas, the pecan weevil is a Texas Department of Agriculture Quarantined Pest and all counties in Texas are quarantined regardless of known infestations—except El Paso, Hudspeth, Culberson, Presidio and Jeff Davis counties. Quarantine restrictions mean that any in-shell pecan or pecans packaged with shell pieces that are being moved to New Mexico, Arizona, and California or internationally need to meet a quarantine treatment of 0°F. for 168 hours. There are no quarantine requirements for movement of in-shell pecans or pecan equipment between counties in the quarantine area regardless of known infestations. Additional information on the pecan weevil code can be found in the Texas Administrative Code (Last Updated: February 25, 2017) TITLE 4. AGRICULTURE; PART 1. TEXAS DEPARTMENT OF AGRICULTURE, CHAPTER 19. QUARANTINES AND NOXIOUS AND INVASIVE PLANTS; SUBCHAPTER L. PECAN WEEVIL QUARANTINE; http://txrules.elaws.us/rule/title4_chapter19_subchapterl.

The pecan weevil is a serious threat for individual producers and for state production and is an international pest. The intentional or unintentional movement of this insect to un-infested areas can have serious consequences. If pecan weevil activity is observed in any county not currently indicated on the infestation map (Fig. 1), the infestation should be reported to the local county Extension agent. If possible, damaged pecans should be collected and submitted with location data.

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