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PECAN INSECTS



OF TEXAS

Contents

Key to Pecan Insects	3
Pecan Insects	
Pecan Nut Casebearer	4
Hickory Shuckworm	6
Pecan Weevil	7
Stink and Plant Bugs	9
Aphids	9
Mites	9
Pecan Leaf Casebearer	10
Leafminers	10
Pecan Phylloxera	11
Sawflies	11
May Beetles	11
Pecan Cigar Casebearer	12
Fall Webworm	12
Walnut Caterpillar	12
Pecan Catocala	13
Pecan Spittlebug	13
Pecan Bud Moth	13
Twig Girdler	14
Red-shouldered Shot-Hole Borer	14
Flatheaded Borers	14
Obscure Scale	15
Spray Equipment	15
Pesticide Calibration	16
Seasonal Pecan Pest Profile	17

KEY TO PECAN INSECTS

INSECTS ATTACKING THE NUTS

Olive green caterpillars up to 1/2 inch long feeding in the nuts or, later in the season, in the shucks

White caterpillars up to 3/8 inch long tunneling in the shucks

White legless grubs feeding in the nuts in late summer

Green or brown bugs sucking the sap from the nuts

PECAN NUT CASEBEARER

HICKORY SHUCKWORM

PECAN WEEVIL

STINK BUGS AND
PLANT BUGS

INSECTS ATTACKING THE FOLIAGE

Soft-bodied yellow insects producing honeydew, or small black insects causing yellow blotches on the foliage

Tiny green arthropods in webs near the midrib, leaves appear scorched

Caterpillars feeding in gray cases about 1/2 inch long in the spring; small winding blotches produced in the leaves in summer

Olive green caterpillars tunneling in the shoots in early spring

Tiny caterpillars in light brown cigar-shaped cases about 1/4 inch long

Galls on the leaves, twigs and nuts

Leaves eaten in the early spring by a light green caterpillar which leaves the midribs and veins intact

Beetles feeding on the foliage at night

Caterpillars in large white webs encasing entire branches

Caterpillars with long soft hairs feeding in colonies on the foliage without producing webs

Dark gray, active caterpillars up to 3 inches long feeding on the foliage in early spring

Masses of frothy white foam enclosing tiny, light green insects in the spring

Tiny greenish caterpillars feeding in the terminals and axils of the buds on young pecan trees

Small larvae feeding between the upper and lower leaf surfaces, producing winding tunnels in leaves

APHIDS

MITES

PECAN LEAF CASEBEARER

PECAN NUT CASEBEARER

PECAN CIGAR
CASEBEARER

PECAN PHYLLXERA

SAWFLIES

MAY BEETLES

FALL WEBWORM

WALNUT CATERPILLAR

PECAN CATOCALA

PECAN SPITTLEBUG

PECAN BUD MOTH

LEAFMINERS

INSECTS ATTACKING THE LIMBS, TRUNK AND TWIGS

Beetle girdling twigs and limbs in late summer and fall

Holes about 1/8 inch in diameter in dying limbs

White borers with an enlargement behind the head tunneling underneath the bark of trunk and limbs

Limbs encrusted with scales which closely resemble the color of the bark

PECAN TWIG GIRDLER

RED-SHOULDERED
SHOT-HOLE BORER

FLATHEADED BORERS

OBSCURE SCALE

PECAN INSECTS OF TEXAS

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The pecan is native to Texas, and recent estimates indicate that approximately 22.8 million native and "improved" trees populate about 840,000 acres of the state. To realize the productive potential of the pecan, trees must be protected from destructive insects. More than 20 species of insects cause damage to the leaves, nuts, twigs, buds, branches or bark of the pecan in Texas. These insects may directly affect pecan production by feeding on the nuts or by injuring the tree so severely that developing pecans cannot mature. Indirect damage also may occur as insects deplete the trees' reserve in a given year to such an extent that nut production is reduced the following year.

Pecan insects are not uniformly distributed across Texas. Therefore, potentially damaging insects in one area may be absent from other areas. Commercial orchards provide ideal environments for an increase in the severity of pecan insect pests. Recent survey data on pecan insect damage reveal that statewide production might be increased approximately 50 percent if insect control was maximized. Vital to a successful control program is the producer's ability to correctly identify and understand the biology of various insect pests. With this knowledge, the producer can employ certain management practices which will help minimize damage from insects that threaten his pecan production.

PECAN NUT CASEBEARER

The pecan nut casebearer, *Acrobasis nuxvorella* Neunzig, is the major pest of Texas pecans. In early spring, the larvae of the overwin-

tered generation feed first in buds and then in developing shoots, causing them to wilt and die (Figure 1). Larvae of succeeding generations feed on nuts during late spring and summer. Severe infestations may destroy the entire pecan crop.



Fig. 1. Terminal shoot damage (flagging) by the overwintering pecan nut casebearer larva. (Courtesy Rudy Granado, New Mexico Cooperative Extension Service.)

The adult is a light gray moth about 1/3 inch long. The wings are gray, and the forewings have a ridge of dark scales across them about a third the distance from the base (Figure 2). The moths fly at night and spend the day in concealment.

Young larvae are first white to pink in color, but later become olive gray to green and attain a length of about 1/2 inch.

This insect overwinters as a partially grown larva in a tiny silken cocoon called a hiber-

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naclum, which is usually attached to the base of a bud (Figure 3). In spring, larvae feed for a short time on buds, but soon begin tunneling in developing shoots until reaching maturity (Figure 4). Pupation may occur in these burrows, or larvae may crawl down the limb to pupate in the rough bark of larger limbs. Moths from the overwintering generation emerge in late April and May.

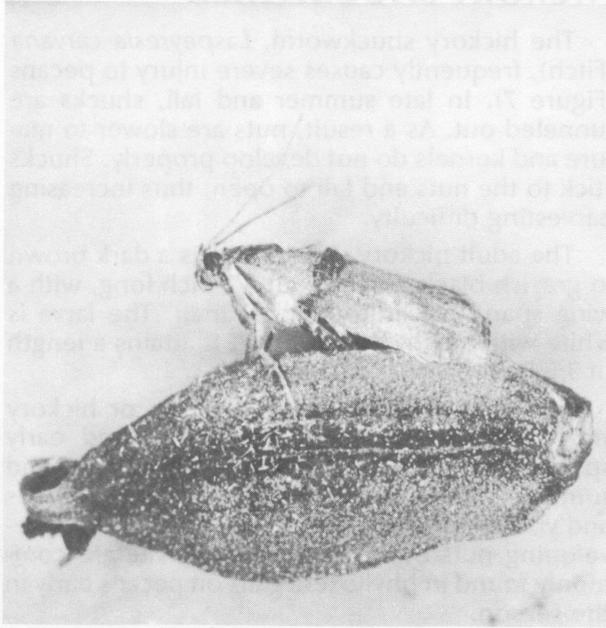


Fig. 2. Pecan nut casebearer moth on pecan nutlet. (Courtesy Rudy Granado, New Mexico Cooperative Extension Service.)



Fig. 3. Location of overwintering cocoons, or hibernacula, of the pecan nut casebearer.

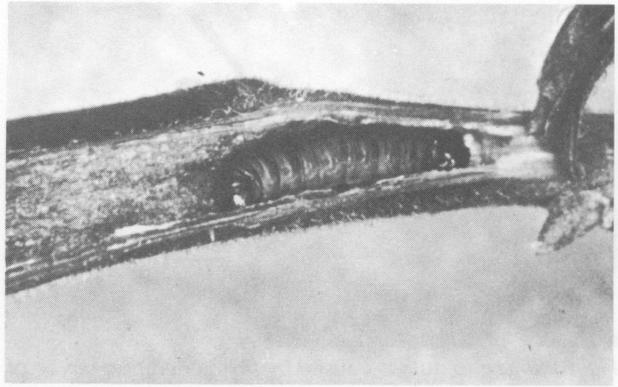


Fig. 4. Overwintered larva of the pecan nut casebearer and characteristic injury to the developing shoots. (Courtesy Rudy Granado, New Mexico Cooperative Extension Service.)

Two or 3 days after adult females emerge, they deposit from 50 to 150 eggs on the tips of nuts (Figure 5). Eggs, just visible to the naked eye, are greenish white when deposited, but later become reddish. After larvae hatch, the egg shell is opaque white and remains in place. First-generation larvae hatch from eggs in 4 or 5 days and migrate to buds below the nuts to feed. After a day or two they enter the nuts, usually at the base. As it feeds, each larva frequently destroys several or all of the small pecans in a cluster. Bits of frass and webbing can be seen projecting from injured nuts (Figure 6). Upon reaching maturity, larvae pupate in nuts and emerge as adults approximately 42 to 45 days later, in June and early July.

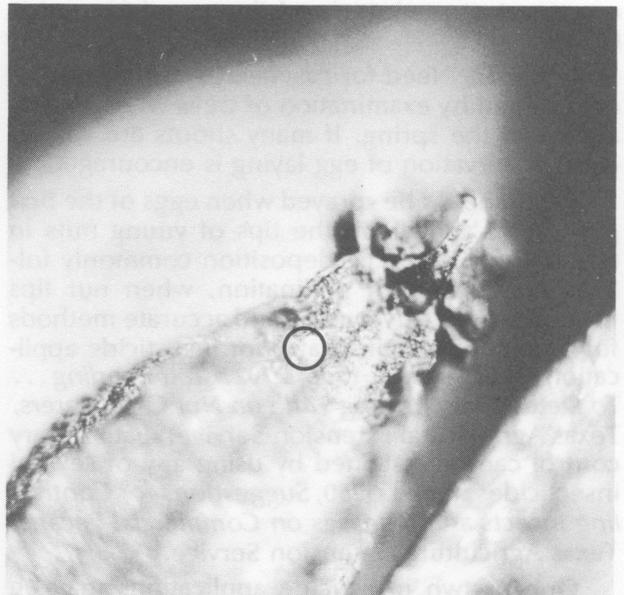


Fig. 5. Egg of the first generation pecan nut casebearer deposited on the tips of young nuts. (Courtesy Rudy Granado, New Mexico Cooperative Extension Service.)

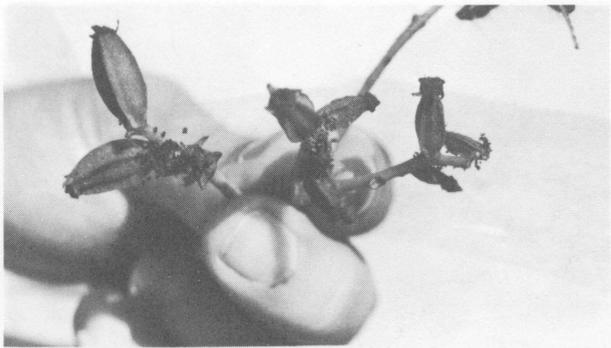


Fig. 6. Injury to nutlets caused by first generation larvae of the pecan nut casebearer.

Adults deposit eggs in grooves on the tips or bases of nuts. Second-generation larvae which hatch from these eggs also feed in the nuts. Less injury usually is produced by this second generation, because the nuts are larger and each larva requires only one or two nuts to complete development. Pupation occurs in hollowed-out nuts and moths emerge from late July to early September.

A third generation usually follows, but as nut shells harden only a few of the nuts are penetrated by larvae. Instead, larvae feed in the shucks. Many third-generation larvae construct hibernacula, while the remainder pupate and appear as adults, emerging from late August to October. Adults deposit eggs which hatch into fourth-generation larvae. If nuts are available, their shucks constitute the principal food for this generation. In the absence of nuts larvae feed on buds and leaf stems. Partially grown larvae construct overwintering hibernacula by mid-November.

Control. Need for casebearer control can be determined by examination of trees when shoots appear in the spring. If many shoots are wilted, close observation of egg laying is encouraged.

Trees should be sprayed when eggs of the first generation appear on the tips of young nuts in late April or May. Egg deposition commonly follows completion of pollination, when nut tips turn brown. Relatively easy and accurate methods for predicting specific dates for insecticide application are available. (See L-702, *Tree Banding... To Determine Spraying Time on Nut Casebearers*, Texas Agricultural Extension Service.) Satisfactory control can be obtained by using any of several insecticides. (See L-1350, *Suggestions for Controlling Insects and Diseases on Commercial Pecans*, Texas Agricultural Extension Service.)

One or two insecticide applications may be required to control first generation nut casebearers. If trees surrounding the treated area are not sprayed, moths may enter the sprayed area and a

serious infestation of second-generation larvae may develop. Under these circumstances, an application may be required in June or early July when second-generation eggs are deposited.

HICKORY SHUCKWORM

The hickory shuckworm, *Laspeyresia caryana* (Fitch), frequently causes severe injury to pecans (Figure 7). In late summer and fall, shucks are tunneled out. As a result, nuts are slower to mature and kernels do not develop properly. Shucks stick to the nuts and fail to open, thus increasing harvesting difficulty.

The adult hickory shuckworm is a dark brown to grayish-black moth about 3/8 inch long, with a wing span of a little over 1/2 inch. The larva is white with a light brown head. It attains a length of 3/8 inch before pupating.

Larvae overwinter in fallen pecan or hickory shucks. They pupate in late winter and early spring, emerging as adults during spring and summer. Adults deposit eggs mainly on leaves and young nuts of hickory, and larvae feed in developing nuts in early summer. Larvae are commonly found in phylloxera galls on pecans early in the season.

Succeeding generations develop in pecan nutlets during June, July and early August, and in shucks during the remainder of the season. Before pupating, larvae cut a hole to the outside and then spin a cocoon. When the moth emerges, the empty pupal skin is left projecting from the hole and can be seen afterward on the shuck. As many

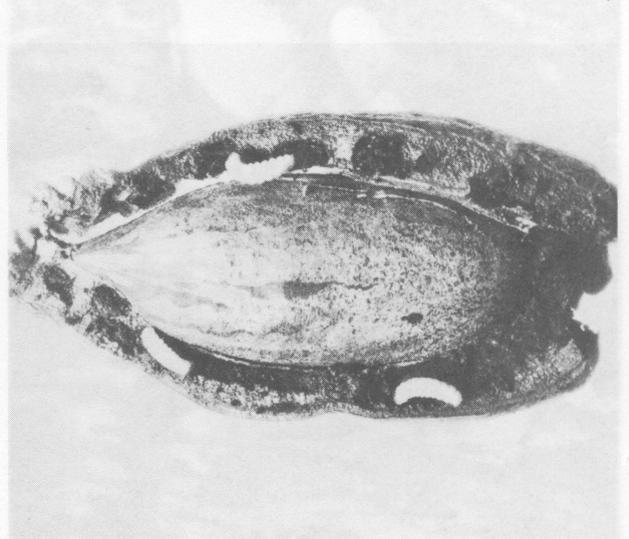


Fig. 7. Hickory shuckworm larvae feeding in pecan shuck. (Courtesy John Durkin, New Mexico Cooperative Extension Service.)

as five generations may be completed each year before last generation larvae go into hibernation.

Control. Chemical controls should begin in mid-August or as shells harden. Cultural measures will aid in reducing populations. During July and August, plow under infested shucks. Larvae are unable to mature in decaying shucks, and adults cannot emerge from the soil. Be sure to completely cover fallen shucks, but regulate plowing depth to prevent root damage. Infested pecans culled at harvest should be composted or destroyed.

PECAN WEEVIL

The pecan weevil, *Curculio caryae* (Horn), is a late-season pest of pecans in several areas of Texas. In years when severe infestations occur, this insect may destroy a large portion of the pecan crop. Feeding of adult weevils causes the nuts in the water stage to drop. After the kernel has hardened the nut is susceptible to egg laying and attack by the developing larvae. During most years the major loss is due to larval damage, which completely destroys the kernels.

The adult is a brownish weevil about 3/8 inch long (Figure 8). The female's snout is as long as the body; the male's is somewhat shorter.

Weevils normally appear in greatest numbers during late August and early September. After nut kernels have hardened, the female chews a hole in the shell and deposits her eggs in little pockets in the nuts. Eggs are not deposited in nuts in the water stage. Creamy white grubs with reddish brown heads hatch and feed inside nuts during late summer and fall, completely consuming the kernel and ultimately attaining a length of about

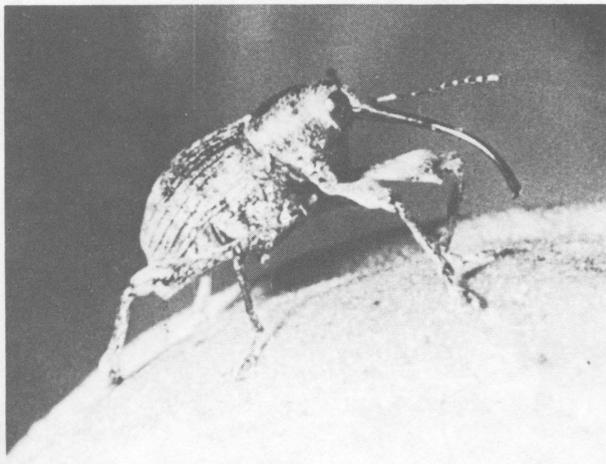


Fig. 8. Pecan weevil adult on pecan nut.

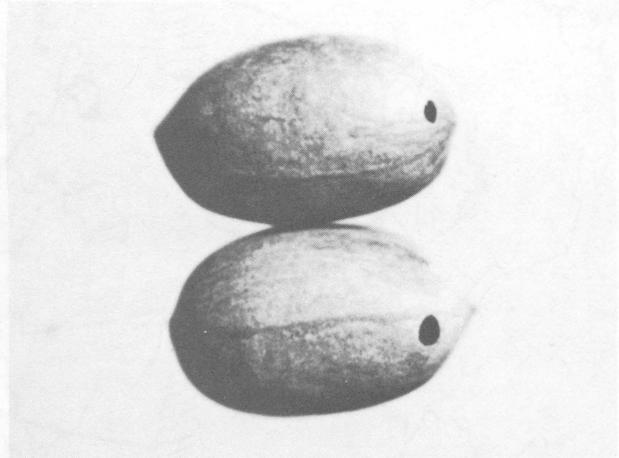


Fig. 9. Exit holes of pecan weevil larvae.

3/5 inch. Upon reaching maturity, grubs chew a hole about 1/8 inch in diameter in the shell, emerge from the nut and drop to the ground in late fall and early winter (Figure 9). They burrow 4 to 12 inches into the soil and construct a cell. Most weevils remain in the larval stage within the soil-cell for about 8 to 10 months, or until the following late summer or fall when pupation occurs. Other larvae do not transform to pupae until the second year. Adults appear during late summer following pupation. The entire life cycle requires 2 to 3 years, and most of this time is spent in the soil (Figure 10).

Control. Frequently, certain trees in orchards are more heavily infested than others, apparently because of differences in adult preference. Begin checking trees the first week in August to determine the need for weevil control. Weevil feeding may cause premature nut drop (or shedding) during the water-stage of nut development. Hence, although weevil grubs will not successfully develop in pecans until the soft dough stage of nut development, growers must assess the need for control when weevils are detected. Several methods of sampling weevil infestations can be used; this information should then be weighed against nut maturity to evaluate the potential damage. Jarring limbs gives an indication of weevils present in the trees at any given time. To accomplish this, place a large sheet under a tree and jar the limbs with a padded pole. Weevils will drop to the ground and remain motionless for a short period of time. Placing emergence cages under known infested trees and periodically recording catches has been a useful method of defining the period of adult emergence and the weevil population density. This information will aid in making correct decisions as to when and how long to continue protective spray applications in relation to the maturity of the crop.

YEAR I

YEAR II

YEAR III

YEAR IV

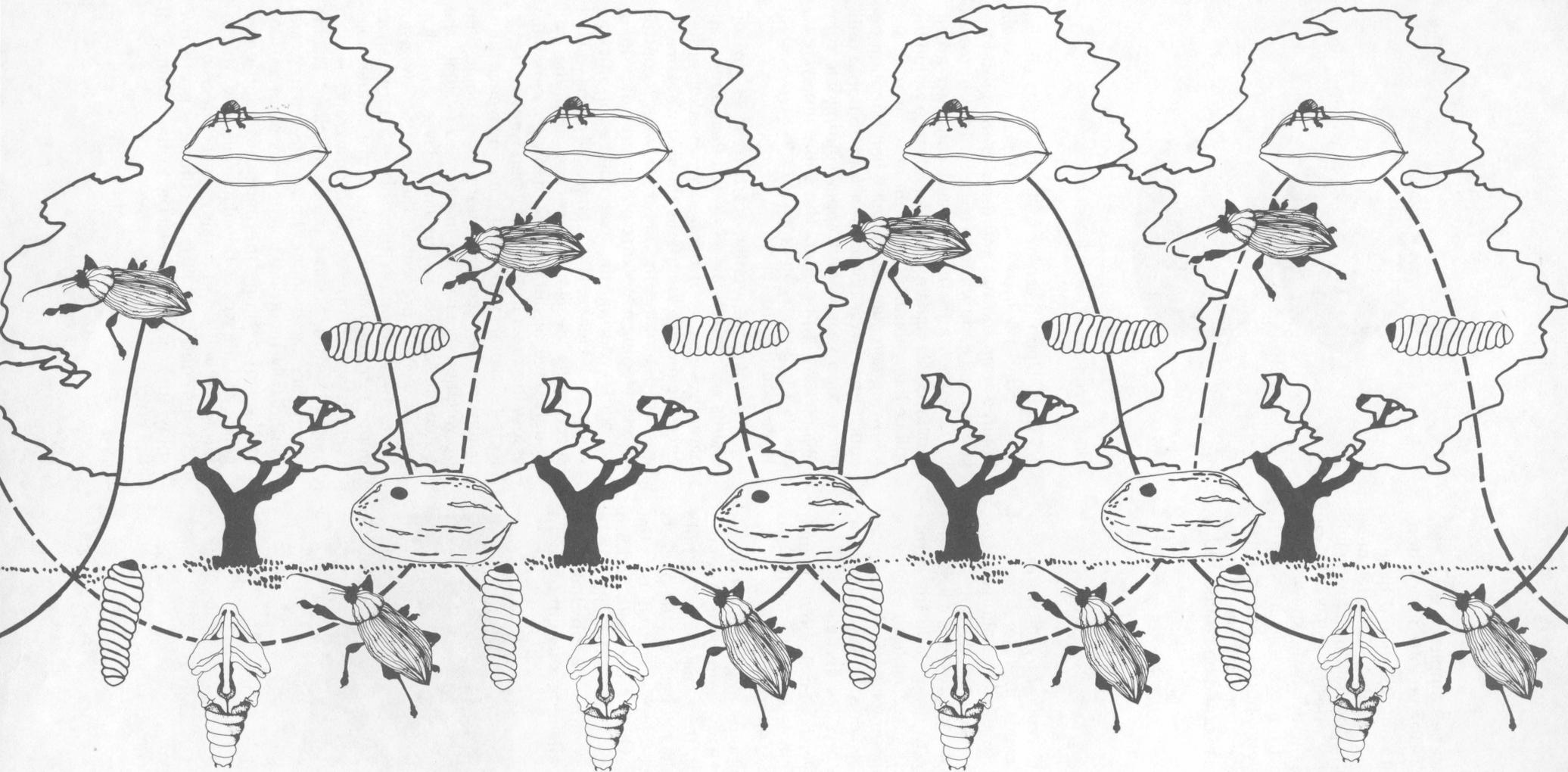


Figure 10. Typical Pecan Weevil Life Cycle

Completion of the pecan weevil life cycle may take 2 to 3 years. Because of the variation in weevil development, overlapping of weevil populations can be expected in heavily infested orchards. Therefore, control measures for weevils in "year 1" may not greatly reduce the number of weevils emerging in "year 2," but will affect the population in "year 3." Likewise, continued weevil control in "year 2" will reduce populations in "year 4." A precisely timed weevil control program is needed over several production seasons to effectively control weevil infestations.

STINK AND PLANT BUGS

The adults of several stink bug and plant bug species suck sap from young pecans and cause an injury known as black pit, characterized by blackening of the nut interior. Nuts injured before the shells harden fall from the trees. Insect feeding after shell hardening (Figure 11) produces brown or black spots on the kernels. Affected areas taste bitter, but the remainder of the kernel is unaffected.

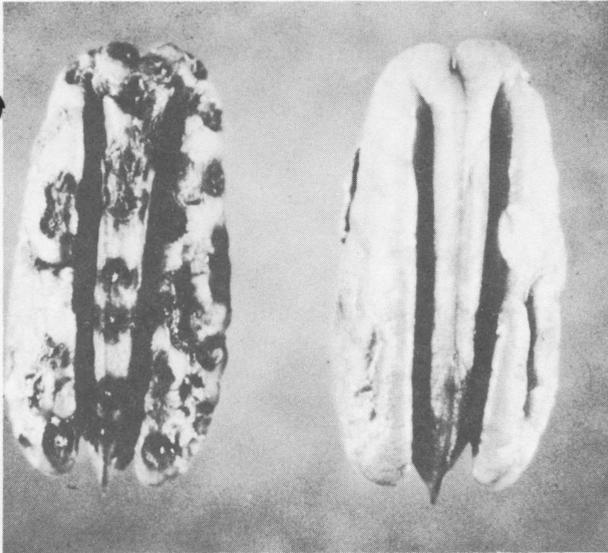


Fig. 11. Typical stink bug injury to pecan kernels.

Stink bugs are familiar to everyone. Plant bugs resemble them though they are smaller and narrower in body outline, and usually are shades of brown.

Plant bugs and stink bugs overwinter in the adult stage in ground debris. In spring, adults deposit eggs in growing vegetation such as cover crops or weeds. Immature bugs develop on low-growing vegetation. When they reach maturity, their wings are fully developed and they fly to pecan trees. A few eggs may be deposited on pecan trees, but young bugs apparently are unable to develop on them. Nymphs and adults occasionally are present in sufficient numbers to inflict economic injury. There may be as many as four generations of these pests per year.

Control. Although certain insecticides will control stink bugs and plant bugs, the number and frequency of spray applications necessary for control likely would not be economical.

Keep weeds down in the orchard during the growing season. Winter cover crops should be plowed down in early spring so they will not attract adults coming out of hibernation. If this operation is delayed, bugs will leave the cover crop

when it is removed and migrate to trees in large numbers.

APHIDS

These soft-bodied insects appear in largest numbers during mid-summer and early fall. They suck sap from leaves, causing them to turn yellow or brown and fall. Heavy infestations may cause defoliation in late summer, reducing the nut crop in both the current and succeeding year.

The black pecan aphid, *Tinocallis caryaefoliae* (Davis), is greenish-black and about 1/16 inch long when fully grown. Bright yellow blotches up to 1/4 inch in diameter appear around punctures produced by the aphid's feeding. These spots later turn brown and, under heavy attack, the leaves may shed.

Yellow aphids, *Monellia* spp., mainly the black-margined aphid *Monellia costalis* (Fitch), are similar to the black pecan aphid in their biology and development. However, large yellow blotches on leaves do not result from their feeding. These insects excrete a sticky substance called "honeydew," which provides an ideal medium for development of sooty mold fungus.

Both black and yellow aphids overwinter in the egg stage in bark crevices. In spring, eggs hatch and aphids begin feeding on leaves. Many generations are completed each year. Only females, which may be wingless or winged, are produced during the pecan growing season. The winged individuals fly to different parts of the tree or to other trees. In fall, both males and females appear and eggs are deposited on the bark.

Aphids usually are not present in sufficient numbers to cause serious injury until mid- or late summer. Infestations earlier in the season rarely reach damaging proportions. Aphid populations may increase after application of certain insecticides for pecan nut casebearer control, or after treatment with bordeaux mixture for pecan scab control.

Control. Refer to recommendations in L-1350, *Suggestions for Controlling Insects and Diseases on Commercial Pecans*.

MITES

These tiny pests usually feed on the undersides of leaves along the midribs, causing irregular brown areas. Heavily infested trees appear scorched and may lose their leaves in late summer or fall.

Mites are wingless, usually light green and just large enough to be seen without the aid of a hand lens. Mite colonies produce webs in which molted skins and eggs may be found. Their life cycle is very short and several generations occur each year. Large populations may develop during late summer and fall.

Use of certain insecticides for the pecan nut casebearer, or bordeaux mixture for scab control, frequently contributes to mite population increases later in the season.

Control. Refer to recommendations in L-1350.

PECAN LEAF CASEBEARER

Occasionally *Acrobasis juglandis* (LeB.) develops to damaging numbers and causes economic injury. In early spring the larva feeds on unfolding leaves and buds. It may prevent leaf development for weeks, resulting in a greatly decreased nut yield.

The adult is a dark gray moth marked with brown. Its forewings, which have a spread of about 2/3 inch, are gray with black blotches. There is a reddish mark near the base of the forewings.

The immature larva is brown, but changes to dark green as it develops to a length of 1/2 inch. It has a shiny, brownish-black head and is enclosed in a gray case which completely covers the body and is borne nearly perpendicular to the leaf on which the larva is feeding.

The pecan leaf casebearer overwinters as an immature larva in a hibernaculum around a bud. It emerges in late March or early April as buds

open. Larvae mature in April, May and June and transform into pupae within their gray cases. Moths are present from May until early August. During this time eggs are deposited on the undersides of leaves. Larvae hatching from these eggs develop slowly and do not attain a length of more than 1/16 inch during that season. They construct and live in little winding cases. Their feeding produces irregular blotches on leaf surfaces (Figure 12). Before leaves drop in the fall, larvae migrate to buds and construct their overwintering hibernacula. Only one generation is completed each year.

Control. Insecticides recommended for nut casebearer control also reduce infestations of the leaf casebearer.

LEAFMINERS

Several species of leafminers, such as *Nepiticula juglandifoliella* Clemens and *Lithocolletis caryaefoliella* Clemens, are commonly found on pecans in Texas, but seldom cause economic damage.

Leafminer larvae feed singly on the leaf tissue between the upper and lower surfaces of leaflets. This gives leaflets a "mined" appearance, and the shape of the mine is usually characteristic of the species (Figure 13). Adult moths deposit eggs on the leaves and several generations occur each year. The larvae are generally less than 1/4 inch long, and adult moths have a wing span of about 1/4 inch.

Control. Damaging numbers of these insects seldom occur, and leafminers are usually managed by insecticides used for other pecan pests.

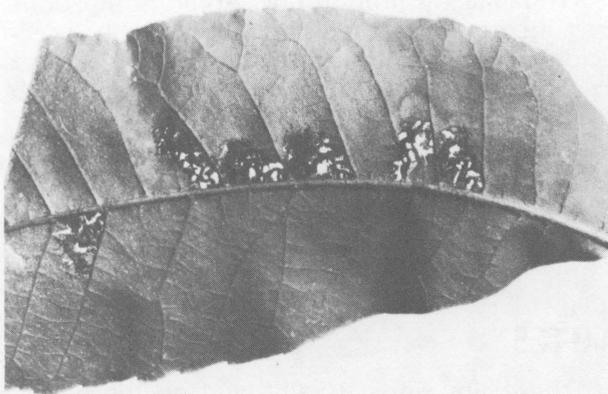


Fig. 12. Summer injury to pecan leaflet by pecan leaf casebearer. (Courtesy J. A. Payne, USDA Southeastern Fruit and Tree Nut Research Station.)



Fig. 13. Leafminer injury to pecan foliage. (Courtesy J. A. Payne, USDA Southeastern Fruit and Tree Nut Research Station.)

PECAN PHYLLOXERA

Pecan phylloxera, *Phylloxera devastatrix* (Perg.), and pecan leaf phylloxera, *P. notabilis* (Perg.), produce galls on new pecan growth. Leaves, twigs and nuts may be affected.

Galls are conspicuous swellings (Figure 14) which may be 1/10 to 1 inch in diameter. They are caused by a soft-bodied insect closely related to aphids.



Fig. 14. Phylloxera galls on pecan.

Phylloxera passes the winter in the egg stage in bark crevices. In spring the tiny nymph emerges and feeds on tender young growth, secreting a substance which stimulates plant tissue to develop into galls.

After maturing, the adult deposits numerous eggs inside the gall or on pecan leaves. Young nymphs of the succeeding generation develop within the gall, which splits in 1 to 3 weeks and liberates them. Several generations follow during summer and fall, as long as there is fresh, young growth on the tree. Each generation requires 4 to 5 weeks.

Control. Dormant oil spray recommended for obscure scale control will reduce infestation levels of phylloxera when thoroughly applied to tree trunks and major limbs. Avoid planting particularly susceptible varieties such as Texas Proflific. Refer to recommendations in L-1350.

SAWFLIES

Sawfly larvae, *Periclista* sp. and others, feed on pecan foliage during April and early May. The light green larvae chew holes in the leaves but

usually leave the midrib and veins intact, giving leaflets a lacy appearance (Figure 15).



Fig. 15. Sawfly larval feeding injury to pecan leaflets.

Adults closely resemble wasps, except that they are not "wasp-waisted." Larvae resemble caterpillars in shape and often are found in groups on the leaves.

Control. Refer to recommendations in L-1350.

MAY BEETLES

Many May beetle species may damage pecans in early spring. The beetles appear only at night and spend the day concealed beneath the soil surface or in ground trash. They feed on young leaves and prevent foliage development.

Beetles of the most common species are 1/2 to 3/4 inch long and shiny dark brown. They are attracted to lights and often are observed on porches or screen doors at night. Larvae are the grubworms, or white grubs, which feed on plant roots.

The female beetle deposits eggs in the soil, where the larvae develop. Most species require two summers for larval maturation. Pupation occurs in a cell constructed in the ground in the fall of the second year. Beetles emerge the following spring. Both larvae and adults may be found in the soil during winter.

Control. May beetles are usually a problem in uncultivated orchards because larvae feed on roots of the sod cover. Periodic orchard cultivation will reduce the grubs' food supply, and cause fewer adults to appear the following year. Where cultivation is not feasible, sprays will control the adults. Refer to recommendations in L-1350.

PECAN CIGAR CASEBEARER

The pecan cigar casebearer, *Coleophora caryaefoliella* (Clem), may be damaging in some years. The larva produces tiny holes in leaves as it feeds, and constructs a light brown, cigar-shaped case about 1/4 inch long which encases it throughout development.

Control. Insecticides used to control the pecan nut casebearer usually will prevent significant injury by the cigar casebearer.

FALL WEBWORM

The loosely woven, dirty-white webs produced by the fall webworm, *Hyphantria cunea* (Drury), are familiar to everyone (Figure 16). The adult is a white moth which may have black or brown spots on the forewings. Its wingspan is about 1 inch. Larvae are pale yellow, spotted with black. They attain a length of 1 inch when fully grown and are covered with long black and white hairs.

The insect overwinters as a pupa in a loosely woven cocoon in debris on soil or under bark. In spring adults emerge and lay masses of greenish-white eggs on leaves. Egg masses are covered with scales from the female's body. Caterpillars hatching from the eggs feed on leaves in colonies under the webs they construct. After feeding for a month to 6 weeks, larvae crawl down the tree and pupate in loose cocoons in debris, under bark or in loose soil. Adults appear during summer and deposit eggs for the second generation. Larvae of this generation feed extensively until fall, then crawl down the tree and pupate for winter.



Fig. 16. Fall webworm colony in pecan.

Control. Light infestations on a few trees can be eliminated by pruning out affected branches and burning them. If this control method is not practical, spray trees according to recommendations in L-1350.

WALNUT CATERPILLAR

During spring and summer the walnut caterpillar, *Datana integerrima* G.&R. and others, may strip leaves from branches or defoliate entire trees (Figure 17).



Fig. 17. Walnut caterpillar feeding injury on pecan. (Note lack of webbing.)

The adult is a moth with a wingspan of 1½ to 2 inches. The forewings are light brown with darker wavy lines; the hindwings are lighter without lines.

The immature larva is reddish-brown with narrow, yellowish lines that extend the length of the body. The fully-grown larva is almost black with two grayish lines on the back and two on the sides. Many long, soft, gray hairs are distributed over the body (Figure 18). Newly hatched larvae emerge approximately 10 days after egg deposition and begin to feed in a colony, but do not construct webs or tents. This makes early detection of walnut caterpillar colonies difficult. Larval feeding requires approximately 25 days for completion and approximately 85 percent of the foliage damage occurs in the last five days of the larval feeding period. Consequently, the grower has approximately 10 days in which to detect eggs and another 3 weeks in which to detect young larvae before a significant amount of feeding damage occurs. Upon completion of feeding, larvae crawl from the tree and pupate in the soil.

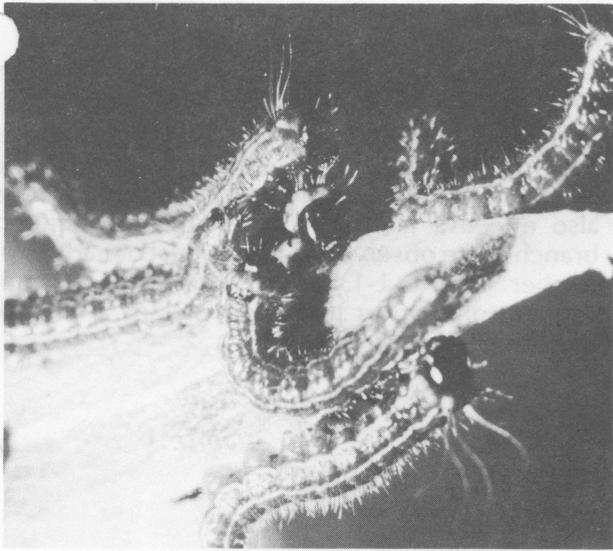


Fig. 18. Walnut caterpillar larvae on pecan.

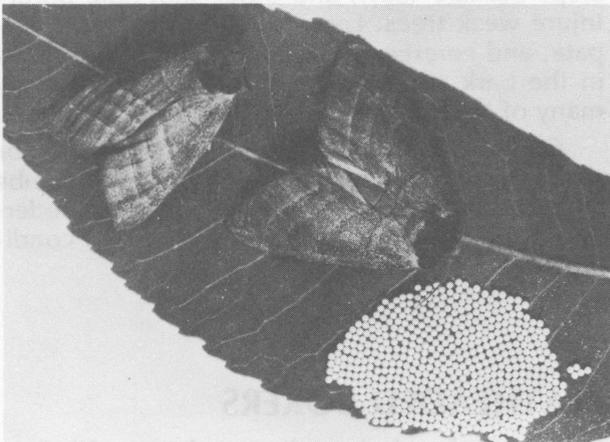


Fig. 19. Walnut caterpillar adults and egg mass on a pecan leaflet.

The adult emerges in spring and deposits masses of eggs on the undersides of leaves (Figure 19). As many as three generations of walnut caterpillars may develop each year, depending on environmental conditions. Larval populations usually increase in the spring, early summer and late summer. After the final summer generation, the walnut caterpillar overwinters in the pupal stage in the soil.

Control. When these insects become numerous enough to defoliate portions of the tree, they can be controlled by following the recommendations in L-1350.

PECAN CATOCALA

Several species of catocalas, among them *Catocala maestosa* Hlst., may strip pecan leaves in

spring, leaving only the midribs. The caterpillars are dark gray and about 3 inches long when fully-grown (Figure 20). They are active when disturbed and move with a looping motion. Both caterpillars and moths are well camouflaged; when they rest on trees during the day their color blends with the bark so that they are frequently overlooked.

Control. Although most catocala larvae reach maturity before time to spray for the pecan nut casebearer, many will be killed when the application is made.

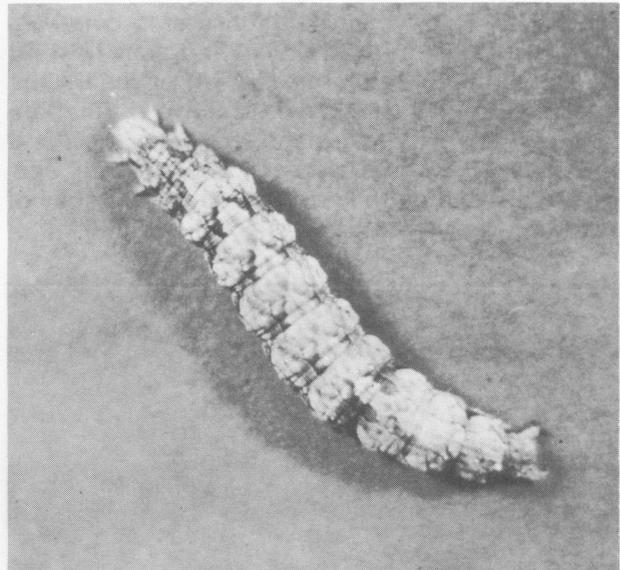


Fig. 20. Larva of the pecan catocala.

PECAN SPITTLEBUG

In spring and early summer numerous buds and small nuts may be covered with foamy, white masses. Inside these masses are several small insects called spittlebugs, *Clastoptera obtusa* (Say). The white froth is produced presumably to maintain an artificially high humidity required for development of the nymphs. Adults resemble leafhoppers and fly actively during summer. Although this insect is becoming more common in the state, it has not been known to cause significant injury to Texas pecans.

PECAN BUD MOTH

The pecan bud moth, *Gretchena bolliana* (Sling.), damages nursery stock and freshly top-worked pecans. Greenish larvae feed between

folded leaf surfaces in the axils of newly set buds and in terminals of young trees. This causes extensive branching, and limited defoliation may occur during certain years. There are several generations each year.

Control. Refer to recommendations in L-1350. Treatment of bud and graft wood at the time of budding and grafting may be required.

TWIG GIRDLER

The adult twig girdler, *Oncideres cingulata* (Say) or *O. texana*, girdles twigs and branches and weakens them so that they fall off or die on the tree (Figure 21). This insect is active during late summer and early fall. Many twigs may be found on the ground under a severely infested tree. Secondary branching may occur and the number of bearing twigs is reduced.

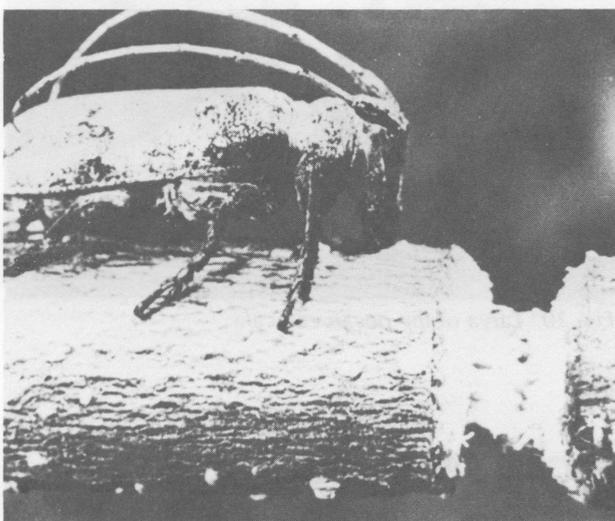


Fig. 21. Adult twig girdler and characteristic injury to twig.

The twig girdler is grayish-brown, 1/2 to 5/8 inch long, with a broad, gray band over the middle of the wing covers. Its head is reddish-brown with a pair of long antennae, which extend beyond the abdomen on the male.

The larva is a white, legless grub about 3/4 inch long just before pupation.

This insect overwinters as a partially grown larva in a twig on the tree or ground. It develops rapidly in spring, feeding in the twig. Following pupation the adult emerges in late August or early September. The female girdles twigs and deposits eggs in the severed portion, since larvae are unable to develop in healthy sapwood. Larvae hatch in a few weeks and remain small until the follow-

ing spring when they complete development pupate and emerge as adults in late summer or fall. There is one generation annually, although some individuals require 2 years to mature.

Control. Infestations may be reduced by removing girdled branches from trees and the ground and burning them. Chemical control is also effective if applied when the first injured branches are observed in late August or early September. Refer to L-1350 for recommended chemical control. Two or three applications at 2-week intervals may be required.

RED-SHOULDERED SHOT-HOLE BORER

The red-shouldered shot-hole borer, *Xylotiops basilaris* (Say), and other shot-hole borers injure weak trees. Larvae feed in the wood, pupate, and emerge as adults through round holes in the bark about 1/8 inch in diameter. Usually many of these holes can be seen close together.

Control. Since this insect feeds on dying or dead wood, remove prunings and dead limbs from the orchards and burn them. Adequate fertilizer and water will keep trees in healthy condition and prevent injury by this pest.

FLATHEADED BORERS

The flatheaded apple tree borer, *Chrysothrix femorata* (Oliv.), and other species of flatheaded borers attack unhealthy or recently transplanted pecan trees by burrowing in the bark and sapwood of trunks and large branches. Their presence is indicated by the appearance of darkened, depressed areas in the bark, from which traces of frass may protrude. When these areas of bark are removed, shallow, winding burrows packed with sawdust may be observed. Burrows usually are on the sunny side of the trunk or branch, but may encircle and penetrate the wood to a depth of 2 inches. The insect may girdle young trees.

The adult beetle is about 1/2 inch long, broad and blunt at the head and tapered to a point at the posterior. Its wing covers, which have a metallic sheen, are dark and corrugated.

The larva, or borer, which is legless and yellowish white, attains a length of 1 1/4 inches when fully grown. Immediately behind the head is broad, flattened, expanded area from which the insect takes its name.

Larvae pass the winter in varying stages of development within the tree. In spring, larvae change to pupae in their burrows and emerge as adults during spring and summer. Female beetles deposit eggs in cracks or bruises in the bark. Larvae which hatch from these eggs feed during the remainder of the season and then pass the winter. There is only one generation each year.

Control. The beetles are attracted to trees or areas of trees weakened by transplanting, disease, drought, sunscald, bruises or poor growing conditions. Keep trees in a healthy, vigorous condition through proper fertilization and watering. On young or transplanted trees, the only effective control known is wrapping the trunks in early spring before adults appear. Thoroughly wrap the entire trunk, from ground level to the branches, with heavy paper or other wrapping material. Wrapping should be tied securely with twine and kept on the tree for 2 years. Observe the tree regularly to see that the twine does not girdle the tree.

In older trees, remove borers with a sharp knife. Be careful not to injure healthy wood. If the wound is extensive, trim and paint it with a commercial tree paint or mixture of one part creosote and three parts coal tar. Remove dead and dying limbs and trees from the orchard each year, and burn before the following spring. If they are not burned, borers in them may mature and reinfest surrounding trees. Commercial tree borer preparations are of little value in controlling this insect.

OBSCURE SCALE

The obscure scale, *Chrysomphalus obscurus* (Comst.), is a pest of considerable importance, particularly in arid portions of the state. The tiny insect, under its scale covering, sucks sap from limbs and branches, causing them to lose their leaves and die back from the tips. The tree is so weakened by this insect's feeding that it becomes vulnerable to wood borer attack.

The scale covering of a fully-grown female, about 1/8 inch long, is usually dark gray and closely resembles tree bark. Infested limbs appear to have been sprinkled with wood ashes (Figure 22). Numerous pits appear in bark where these insects feed, which produces a roughened appearance.

Female scales overwinter on bark. Eggs laid in spring hatch into tiny, salmon-colored crawlers which move about for a short time, then settle down and insert their beaks into the bark. While they feed, a scale covering develops from secreted wax and cast skins.



Fig. 22. Severe infestation of obscure scale on a pecan limb.

SPRAY EQUIPMENT

A variety of spray machines for pesticide application are available. Hydraulic sprayers, composed of a high pressure pump and a hand gun, are satisfactory for smaller orchards where time or labor are not critical factors. Hydraulic sprayers use large volumes of water and high pressure nozzles to deliver the pesticide to the pecan canopy. When selecting a hydraulic sprayer, remember that the pump should deliver 20 to 30 gallons per minute and maintain a pressure of 400 to 600 pounds per square inch while operating. For safety and durability, use a high pressure rubber hose having an inside diameter of 3/4 inch with all high pressure spray machines. An adjustable spray gun, which produces a mist for spraying small trees or the lower canopies of large trees and a narrow stream to reach tall tree tops, is essential. Thorough coverage of foliage is important. Application should start at the top of the canopy and proceed downward to reduce pesticide waste. Hydraulic applications should be applied to the point of run-off to assure adequate pesticide protection for the foliage and nuts.

Timely and effective pesticide protection of large pecan orchards often requires equipment with greater capabilities than the hydraulic sprayer. Speed sprayers, available in a range of sizes, designs and prices, are best suited for large orchards. Speed sprayers may be tractor- or

trailer-mounted, and driven by the tractor power take-off or self-propelled by gasoline or diesel engines. A sprayer-mounted, high velocity fan produces an air blast that carries the pesticide solution to the pecan canopy. Therefore, speed sprayers save water and pesticide mixing time. Effective pest control is dependent on a uniform coverage of the foliage, since application is not made to run-off.

Aerial application, with fixed wing or helicopter aircraft, can be used when flooded or wet orchards prevent the use of ground equipment. Because lower volumes of water (approximately 15 gallons per acre) are used in aerial application, uniform coverage of large trees may not be achieved. Research indicates that aerial pesticide applications may be more erratic and less effective than ground applications, but do provide an acceptable stop-gap alternative.

PESTICIDE CALIBRATION

Effective pest control is dependent on the application of properly prepared pesticide solutions

and correct equipment calibration. The preparation of dilute or 1X concentration spray solution is discussed in L-1350. Large volumes of water are used to prepare dilute sprays; these represent the weakest pesticide concentration that will consistently control the target pest. Hydraulic sprayers are used for dilute spraying and application is made until the pesticide solution runs off the foliage. As a guideline, prepare approximately 1 gallon of spray mixture for each foot of tree height, or .0003 gallon per cubic foot of tree canopy area, when using a dilute spray mixture in a hydraulic sprayer.

Concentrate sprays are used in speed sprayers and aerial applications. The same amount of pesticide is applied on a per tree or per acre basis as with dilute sprays, but water volume is greatly reduced. Savings in water and time required to prepare dilute pesticide solutions are primary benefits of concentrate spraying.

More expensive equipment is required to make concentrate applications; this should be considered when determining the overall benefit of concentrate applications.

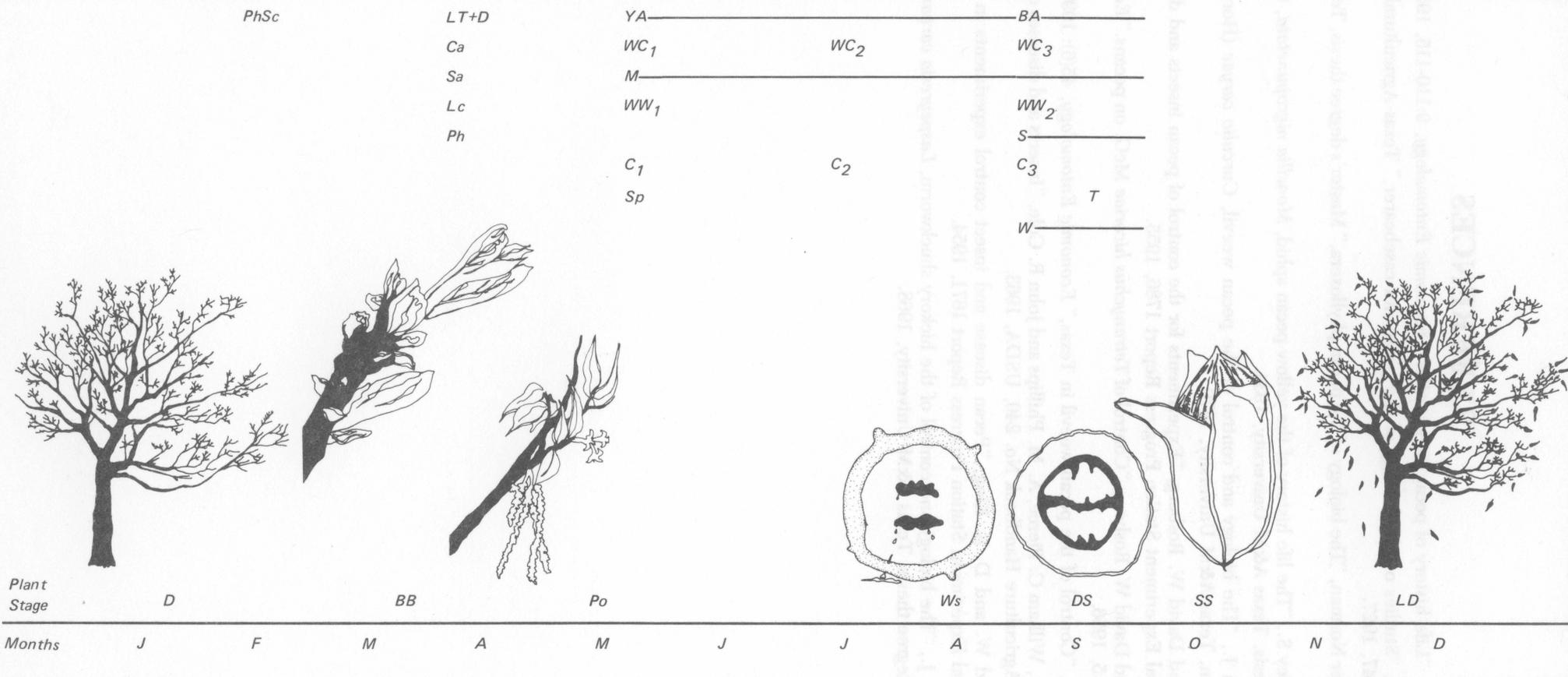
Table 1. Time savings obtained by reducing the number of trips for water in concentrate spraying (assuming that time to and from orchard and fill-up = 30 minutes and that 20 trips are required to spray the entire orchard with a dilute (1X) application).

Spray concentration	No. of trips	Time required	Time savings (compared to dilute solutions)
1X (dilute)	20	10 hrs.	0
2X (concentration)	10	5 hrs.	5 hrs.
4X (concentration)	5	2.5 hrs.	7.5 hrs.
10X (concentration)	2	1 hr.	9 hrs.

M. K. Harris, Texas Pecan Orchard Management Handbook, 1974.

Figure 23. Seasonal Pecan Pest Profile

The development of various pecan pests is usually closely related to the seasonal development of the pecan. Although the severity of insect problems cannot be predicted on a seasonal basis, producers should frequently determine tree and nut development to aid them in predicting insect problems and planning control strategies. The seasonal pecan pest profile indicates the possible insect problems associated with various developmental stages of the pecan.



Profile Legend

Ph - phylloxera
 Sc - scale
 LT+D - leaf tatterers + defoliators
 Ca - catacola
 Sa - sawfly
 Lc - leaf casebearer
 YA - yellow aphid
 BA - black aphid

WC - walnut caterpillar
 M - mites
 WW - fall webworm
 S - hickory shuckworm
 C - pecan nut casebearer
 Sp - spittlebug
 T - twig girdler
 W - pecan weevil

D - dormant
 BB - budbreak
 Po - Pollination
 WS - water stage
 DS - dough stage
 SS - shuck split
 LD - leaf drop

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HORT 3