Current Pest Management Systems for Pecan

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Summary. Pecans (*Carya illinoinensis*) are produced under a wide array of environmental conditions—from the warm humid southeastern states, to the continental climate of the central plains, to the arid climates of the American west. In addition, pecan cultural systems vary from the low-input management of native stands of seedling trees to the intensive management of single-cultivar pecan orchards. This wide diversity of pecan agroecosystems has fostered the development of innovative, site-specific approaches toward pecan pest management. Current pecan pest management programs require an intimate knowledge of orchard ecology. Growers use monitoring methods and prediction models to track pest populations. Biological control agents are conserved by habitat manipulation and/or augmented through inoculative releases. Selective pesticides are used to control target pests while conserving natural enemies. Four pecan cultural systems are described in detail to illustrate how ecological principles are applied to widely diverse pecan agroecosystems.

Pecan is a native American tree crop (Brison, 1974). The largest member of the hickory (*Carya*) genus, pecan is part of the native, riparian, forest ecosystem in south-central North America (Peterson, 1990). Today, the commercial pecan industry is the most widely distributed nut crop in the United States. Pecans are produced in 18 states: from the Carolinas westward across the south to California and from Texas northward to Kansas, Missouri and Illinois. Within this climatically diverse range, production systems and pest complexes vary widely, and as a result, integrated pest management (IPM) programs vary across the pecan belt. To help readers gain insight into the development of pecan IPM systems, I will review the major pests of pecan, discuss the newest strategies for managing those pests, and chart the integration of IPM techniques into the cultural programs of four distinctive pecan agroecosystems.

Pecan: A crop profile

Pecan is a recently domesticated crop. Today's newest pecan cultivars are only two to three generations removed from the wild (Sparks, 1992). In fact, roughly 30% of the pecans harvested today are still collected from groves of native (seedling) trees (Pollack, 2001). Pecan is a heterodichogamous, wind-pollinated tree crop that can grow to an extremely large size for an orchard tree [often 90 ft (27 m) in height]. In comparison to the other major nut crops, pecans grow the most wood (largest tree) while producing the lowest average seed yields/acre.

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Pecan orchards are established at low densities [36 to 48 trees/acre (89 to 118 trees/ha)] while mature orchards are often thinned down to as few as 4 trees/acre (10 trees/ha) (McEachern, 1997). Native pecan groves (natural stands of seedling trees) are created by selectively thinning a riparian forest (Reid and Olcott-Reid, 1985). Tree spacing in native groves is completely random; however, producers strive to maintain 30 ft^2 of cross-sectional trunk area per acre (6.9 $m^2 \cdot ha^{-1}$) (Hinrichs, 1958). Large tree size has a direct impact on the implementation of IPM programs. Assessing crop phenology or scouting for pecan pests often requires specialized equipment (such as a hydraulic lift) to reach even the lower portion of the pecan tree canopy. The application of crop protection chemicals requires large air blast sprayers that can penetrate a pecan tree canopy than may be as large as 120 ft (37 m) wide and 90 ft (27 m) tall.

Pecan trees require the entire growing season to set, fill, and ripen a seed crop (Wood, 1989). Pecan is among the latest leafing deciduous trees native to North America. Late leafing is an evolutionary adaptation to avoid late spring frosts common in the continental climate of pecan's native range. Flowering begins roughly 1 month after leaf burst. Male flowers or catkins are borne on 1-year-old wood while pistillate flowers appear at the terminals of the current season's growth. Planted orchards contain a mix of protandrous and protogynous cultivars to ensure cross-pollination. The enlargement phase of pecan fruit development is long—taking 2 to 3 months. Typically, the kernel filling process begins in mid-August and continues until late September. Shuck dehiscence completes the fruiting cycle and occurs in the fall—from September to early November depending on cultivar and geographic location. Throughout this long fruiting cycle, pecans are subjected to a myriad of insect and disease pests.

Insect pests

Over 270 species of insects have been collected from pecan tree canopies (Smith et al., 1996) yet only seven insects cause economic damage on a regular basis. Like their host, all pecan insect pests are native to North America and have coevolved with members of the genus *Carya* (Harris, 1988). In natural systems, the arthropod pests of pecan are kept in check by the genetic diversity of the host and a diverse array of naturally occurring predators, parasites, and entomopathogens (Reid, 1999). The bane of pecan producers, alternate or irregular bearing, depresses frugivorous insect populations by regularly depriving these insects of ovipostion sites during "off" years (Harris et al., 1996). Outbreaks of foliage-feeding pests occur at irregular intervals, often triggered by major weather events or by the influence of weather on naturally occurring biocontrol agents (Martinat, 1987).

Major nut-feeding pests. The creation of solid stands of pecan trees and their management for greater nut production increases the potential for the development of economically damaging pest populations. Primary fruit-feeding insects include: pecan nut casebearer (*Acrobasis nuxvorella*), hickory shuckworm (*Cydia caryana*), and pecan weevil (*Curculio caryae*).

The pecan nut casebearer is an early season pest that attacks young fruit shortly after fruit set. A single larva can destroy an entire fruit cluster (Ring and Harris, 1984). Damage by pecan nut casebearer is easily recognized by a mound of insect frass clustered at the base of damaged fruit and an abundance of silken webs attaching the fruit to peduncle. Subsequent generations of pecan nut casebearer mine pecan fruits but rarely occur at economically damaging levels.

Three to five generations of hickory shuckworm develop in pecan orchards each year, however, the late summer (August) generation poses the greatest threat to pecan producers (Payne and Heaton, 1975). During the critical kernel filling period of late August and early September, hickory shuckworm larvae mine shucks of pecan fruit, severing vascular tissues that supply kernels with carbohydrates (Calcote et al., 1984). Extensive shuck mining can impair shuck dehiscence and reduce kernel filling.

Where it occurs, pecan weevil is the most devastating insect pest of pecans. These large seed weevils emerge from their underground pupal cases in late July through September and move into the canopies of pecan trees in search of feeding and oviposition sites. Female weevils will puncture fruit until they find fruit that have started the kernel deposition process (gel stage) (Criswell et al., 1975). After identifying suitable fruit, females lay 5 to 7 eggs inside each fruit on kernel tissues. The white, legless larvae with red heads completely devour the kernel, then chew an exit hole through the shell. Larvae fall to the ground, burrow into the soil, and pupate. Weevils have a 2-year life cycle (10% of weevils have a 3-year life cycle), an adaptation to the alternate bearing cycle of pecans (Harris et al., 1996).

Major foliage- and stem-feeding pests. Major foliage-feeding insects include: fall webworm (*Hyphantria cunea*), walnut caterpillar (*Datana integerrima*), the yellow aphid complex (*Monellia caryella* and *Monelliopsis nigropuncta*), black pecan aphid (*Melanocallis caryaefoliae*), pecan stem phylloxera (*Phylloxera devastatrix*), and pecan leaf phylloxerans (*P. notabilis*, *P. russellae*, and *P. texana*). Populations of these insects vary considerably from year to year, requiring pecan producers to diligently monitor their orchards for signs of insect outbreaks.

The gregarious caterpillars, fall webworm and walnut caterpillar, have two generations per year. Small populations of these insects can be found in pecan orchards every year with serious outbreaks occurring at irregular intervals. During outbreak years, the gregarious caterpillars can cause significant defoliation if left untreated.

In many areas of the pecan belt, yellow pecan aphids are a pesticide-induced pest (McVay and Payne, 1987). Heavy use of broad-spectrum insecticides disrupts the natural balance between aphids and their predators. In addition, pesticide applications aimed at controlling aphids have led to the development of pesticide-resistant aphids. Heavy yellow aphid feeding severely damages the photosynthetic efficiency of pecan leaves (Tedders and Wood, 1985), reducing return bloom (Dutcher et al., 1984). Black pecan aphid is a sporadic but very damaging pest. Feeding by black aphids causes the development of angular yellow spots on foliage and premature defoliation.

The pecan stem phylloxera is a gall-forming insect that distorts and stunts growth of pecan shoots. Heavily infested trees do not bear fruit (Payne et al., 1979). In native pecan stands, stem phylloxera attacks less than 7% of seedling trees (Dinkins and Reid, 1985a) indicating a high degree of resistance to this insect in seedling populations. In addition, there is evidence that pecan cultivars vary in their susceptibility to stem phylloxera (Calcote and Hyder, 1982).

The galls formed by leaf phylloxerans are confined to the leaf blade. Seedling trees, in the juvenile phase of growth, are frequently more susceptible to attack by leaf phylloxera than mature trees. Genetic resistance to leaf phylloxerans has been noted (Calcote and Hyder, 1982; Calcote, 1985). In contrast to the stem phylloxera, leaf phylloxerans are generally not considered a serious pest (Ree and Knutson, 1997). However, heavily infested leaves often abscise causing premature defoliation. Like many of the insects that feed on pecan, populations of leaf phylloxerans are cyclic—years of high leaf phylloxera populations are often followed by years when the insect is barely present.

Pecan diseases

Pecan scab. In the humid regions of the pecan belt, pecan scab (*Cladosporium caryigenum*) is the most devastating disease of pecan (Latham and Goff, 1991). The pecan scab fungus can attack leaves, fruit, and twigs causing defoliation, nut abortion, poor kernel quality, and shuck indehiscence. Disease symptoms are expressed as blackened lesions on leaves, twigs and shuck. The scab fungus effectively colonizes rapidly expanding plant tissues. During the early part of the growing season, scab infects expanding leaves and elongating shoots (Gottwald, 1985). In early summer, rapidly expanding fruit are infected from fruit set to the initiation of shell differentiation (Gottwald and Bertrand, 1983). Disease prevention strategies in pecan orchards are primarily based on fungicide applications aimed at keeping scab in check (Littrell and Bertrand, 1981).

Some pecan cultivars are genetically resistant to scab infection, and development of new scab resistant cultivars is of paramount importance to pecan breeding efforts (Thompson et al., 1995). However, genetic resistance is not stable over the long term. Over the course of several decades, resistant cultivars lose their resistance to infection as the scab fungus mutates to take advantage of widely planted cultivars (Gottwald, 1989).

Leaf spot diseases. Five leaf spot fungi infect pecan trees. These include: downy spot (*Mycosphaerella caryigena*), zonate leafspot (*Cristulariella moricola*), vein spot (*Gnomonia nerviseda*), brown spot (*Sirosporium diffusum*), and liver spot (*Gnomonia caryae* var. *pecanae*). These leaf spot diseases only occur in the humid portions of the commercial pecan range and are usually controlled by fungicide applications made to control pecan scab. Leaf spot diseases can become a serious defoliation risk if growers rely solely on triphenyltin hydroxide or dodine in their disease management program (Johnson, 1997).

Bunch disease. Bunch disease is most often encountered in native pecan groves and is caused by a mycoplasma-like organism. Symptoms of the disease include a proliferation of shoots on a single limb, giving the branch a bunchy appearance. The disease is most easily diagnosed in the early spring when leaves on infected shoots emerge 7 to 10 d before healthy portions of the tree. Trees infected with bunch disease have lower yield and nut quality (Bertrand et al., 1984). Pecan cultivars vary in susceptibility to this disease and pruning provides effective control (Johnson, 1997).

Zinc deficiency. Zinc (Zn) deficiency is a common noninfectious disorder of pecan (Sparks, 1989). The correction of Zn deficiency has been called one of the major breakthroughs in the advancement of pecan culture (Sparks, 1987). Deficiency symptoms include a compaction of stem growth giving branch terminals a rosette appearance; smaller, chlorotic leaflets with wavy margins; and the appearance of brown spots on the leaves. In addition, Zn deficiency reduces flowering intensity thus severely decreasing nut production (Hu and Sparks, 1990). Zinc deficiency problems are most common in alkaline soils and low organic-matter soils, both of which are low in plant available Zn (Sparks, 1976). Soil treatments with zinc sulfate can be used to correct Zn deficiency in acidic soils (Wood and Payne, 1997), while foliar sprays of Zn containing solutions are used to correct the problem in alkaline soils (Smith et al., 1979). The wide spread use of foliar Zn treatments applied with conventional pest control equipment has made the correction of zinc deficiency an integral part of many commercial IPM programs.

Pecan IPM technology

Pecan producers use a full range of pest management tools to manage their crop. To employ these tools, growers must have an understanding of crop phenology, pest biology, and the ecology of their cropping system. Since the introduction of the IPM concept to pecan growers in the late 1970s (McVay and Ellis, 1979), extension educators have worked to increase the knowledge base of producers with the publication of IPM manuals for several states (Cooper, 1983; Ellis et al., 1984). After more than 20 years, growers have developed skills necessary to implement IPM technologies and reap the economic rewards of reducing pesticide use (Harris et al., 1998). Important IPM technologies currently used by pecan producers are reviewed below.

Pest monitoring. Determining the presence of economically damaging insect populations is a key component of any IPM system. Intensive scouting of fruit clusters, shortly after fruit set, is key for determining the optimum date for applying insecticides to control pecan nut casebearer. Growers survey at least 500 fruit clusters for the presence of casebearer eggs and/or first significant fruit entry by larvae. An action threshold of 2% cluster damage (2% of sampled fruit clusters with any signs of larval feeding) is used when the crop load is light to moderate, while 5% damage triggers control measures when the crop load is large (McVay et al., 1998). Growers time their scouting activities based on pecan nut casebearer pheromone trap catch data. First significant fruit entry occurs 12 to 16 d after the first males are captured in pheromone traps (Ree et al., 1998). Plotting out pheromone trap catch data can warn producers of a bimodal adult emergence caused by unusual weather conditions (Nesbitt and McVay, 1999).

Weekly orchard surveys are important for the detection of many pecan pests including fall webworm, walnut caterpillar, and pecan aphids. A complex of natural enemies and the application of insecticides for primary frugivores normally keep the gregarious caterpillars in check. However, outbreaks of these insects do occur and growers treat trees when they observe more than 5 colonies/acre (12 colonies/ha) to prevent serious defoliation. Natural enemies are also important for control of early season populations of pecan aphids (see biocontrol sections below). However, late season outbreaks of pecan aphids often require treatment, especially following carbaryl applications made to control pecan weevil that prove deleterious to beneficial arthropods. For the yellow pecan aphid complex (yellow pecan aphid and black margined aphid), growers treat their orchards when aphid counts average >20 aphids per compound leaf or when aphid honeydew becomes heavy (Ellis and Hudson, 2000).

A late season outbreak of black pecan aphids can be very serious, causing premature defoliation, poor kernel quality, and reduced return bloom. A sampling technique has been devised that predicts the onset of a black aphid outbreak (Dutcher, 1997). All leaves on 100 shoots per cultivar are inspected for the presence or absence of aphids. When aphids are found they are classed as single aphids or aggregates of two or more aphids. Control measures are taken when samples with aggregates outnumber samples with single aphids and >20% of shoots have black aphids.

Several trapping systems have been devised to monitor pecan weevil emergence (Mulder et al., 1997a); however, the Circle trap is currently the most effective weevil trap used by growers (Mulder et al., 1997b). Circle traps are funnel-shaped traps constructed of household screen wire and mounted to the tree trunk. Some emerging weevils crawl up the tree trunk and become trapped inside the Circle trap. Using this trap, growers can determine emergence periods and time control measures. Tools to determine a true economic threshold for pecan weevil populations have been devised (Eikenbary et al., 1978; Harris et al., 1981) but have proven difficult for growers to implement. In areas where pecan weevil occurs, the destructive potential is so great that growers maintain a near zero tolerance level for this pest.

Meteorological models. Temperature and rainfall have a dramatic influence on pest populations. Real time meteorological data can be used to forecast the development of first summer generation pecan nut casebearer (Ring et al., 1993) and to schedule fungicide applications to control pecan scab (von Broembsen et al., 1999). In states where weather data is available from an extensive system of meteorological monitoring stations, pecan producers actively use Internet access to pest prediction models.

Two weather-based, fungicide-scheduling systems have been devised to combat pecan scab in the southeastern U.S. (Bertrand et al., 1999; Sparks, 1995). The Sparks (1995) system is based on the 12+ h of leaf wetness required to initiate a scab infection. A rainfall event >0.5 inch (13 mm) triggers the application of a systemic fungicide. Additional fungicide applications are made only after the fungicide's protective period has elapsed and a subsequent rainfall event occurs. The AU-PECAN system (Bertrand et al., 1999) is based on recorded rain events and the 5-d average forecast of more rain. In this system, a rain event is 0.1 in. (2.5 mm) of rain in a 24-h period or fog forming before 8:00 PM. AU-PECAN starts with a fungicide application during parachute stage of leaf burst and ends at shell hardening. A fungicide protection interval of 10 to 14 d is used before pollination and 14 d postpollination. Following the parachute stage application, subsequent fungicide applications are made when the protection interval has past and when no rain has occurred but the 5-d forecast for rain is ≥50%, or one rain event has been recorded and the 5-d forecast is ≥40%, or two rain events have been recorded and the 5-d forecast is ≥20%, or immediately after three rain events.

Both weather-based scheduling systems have provided adequate scab control while decreasing the number of fungicides applied compared to calendar-based spray schedules (Brenneman and Bertrand, 2000).

Conserving biological control agents. Pecan orchards can harbor a rich diversity of arthropod species at all tropic levels. In Texas, the pecan nut casebearer is associated with 35 species of parasitoids and 6 hyperparasitoids (Gunasena and Harris, 1988; Harris and Li, 1996). Pecan tree canopies in Kansas provide refuge for 18 species of predaceous arthropods (Dinkins and Reid, 1985b). In addition, 25 species of arboreal spiders have been shown to feed on pecan aphids (Bumroongsook et al., 1992). In natural systems, predators and parasites hold populations of pecan aphids, gregarious caterpillars, and other secondary pecan pests in check. Outbreaks of secondary pests, especially aphids, have been associated with the use of broad-spectrum insecticides (Dutcher, 1983) that can destroy populations of common predaceous arthropods (Mizell and Schiffhauer, 1990).

Low-input and biorational approaches to insect pest management have been devised that focus attention on preserving indigenous biocontrol organisms (Reid and Eikenbary, 1990; McVay and Hall, 1998). These programs stress the need to limit insecticide use as much as possible and to choose insecticides that are target specific or at least less damaging to predators and parasites. New developments in pesticide chemistry are making the biorational approach increasingly feasible. Tebufenozide, an insect growth regulator that is specific for lepidopterous pests, provides excellent pecan nut casebearer and hickory shuckworm control (Buchert, 2001). Imidocloprid or potassium nitrate provides control of late-season yellow aphids without impacting predator populations (McVay and Hall, 1998; Wood et al., 1995).

Enhancements to biological control. In addition to conservation techniques, growers actively work to enhance biological control in pecan orchards. Specific ground covers are planted to help maintain endemic predator populations when populations of pecan aphids are low (Reid, 1999). Inoculative releases of lacewings (*Chrysoperla rufilabris*) and lady beetles (*Hippodamia convergens*) have proven successful (Ellington et al., 1995); however, the imported red fire ant (*Solenopsis invicata*) must be controlled to prevent ant feeding on beneficial insect eggs or larvae (Knutson and Ree, 1997). Two exotic lady beetles (*Coccinella septempunctata* and *Harmonia axyridis*) were released in the U.S. and have become established in pecan orchards. *C. septempunctata* is a voracious aphid predator but stays near the orchard floor and does not fly into tree canopies (Tedders, 1991). In contrast, *H. axyridis* is principally an arboreal species that has proved a very potent aphid predator in pecan orchards (Ree and Knutson, 1997).

Regional implementation of pecan IPM systems

Regional differences in climate, pest complex, and orchard systems have lead to implementation of agroecosystem specific IPM programs. I will highlight four pecan agroecosystems as examples of how the IPM technologies described above are integrated into innovative IPM strategies.

SOUTHEASTERN PECAN ORCHARDS. Although not originally native to the humid southeast, pecan has become naturalized in many parts of the southeastern U.S. Typically, orchards in the southeast are composed of large, spreading trees of classic pecan cultivars. All major insect pests occur in this area with native hickories and naturalized pecans providing a refuge for primary frugivores. Pecan scab control measures dominate the IPM program. Even with the development of strong IPM technologies, pecans in the southeast are the most intensively sprayed orchards in the U.S.

Careful research into pecan scab epidemiology (Gottwald and Bertrand, 1983) and the adoption of weather based spray schedules has reduced the average number of fungicide applications made per year from 11 to as low as 6 (Bertrand et al., 1999). Scab resistant pecan cultivars are being planted in the southeast but change comes slowly to an industry based on trees with a productive life span of over 100 years.

Decoupling insecticide applications from fungicide applications has been the greatest single advancement for insect IPM in this region. Thirty years ago, an insecticide was commonly added to the spray tank during a fungicide application just for insurance. This practice led to aphid outbreaks and the development of insecticide resistant strains of yellow aphids. Currently, early season insecticide use is limited to a single application of a target specific insecticide aimed at controlling pecan nut casebearer. The timing and justification for controlling casebearer is determined by assessing adult flight activity with pheromone traps and by scouting terminals to determine crop load and potential damage level.

Pecan weevil emergence is carefully monitored by one of several trapping schemes. Carbaryl is still the preferred weevil control material despite its propensity to flare aphid populations (Dutcher, 1983). Late-season aphid populations, especially black aphids, are monitored by weekly scouting trips. If conditions indicate an impending aphid outbreak, selective insecticides are used to control the outbreak.

SOUTH-CENTRAL PECAN ORCHARDS. Pecan is native to the south central U.S. (Texas and Oklahoma) and is found growing in major flood plains throughout the region. Pecan production is based on orchards of improved cultivars and native pecan groves (natural stands of seedling trees). All major insect pests occur in this area. As the climate becomes more arid in the western portion of this region, pecan diseases, including pecan scab, are less of a problem. Soils in many areas of south central U.S. tend to be alkaline, requiring 3 to 5 foliar treatments to alleviate Zn deficiency.

IPM programs for south central pecan orchards focus on control of major frugivores, treatment of Zn deficiency, and the prevention of late season aphid outbreaks. The control of Zn deficiency requires spraying of orchards beginning at leaf burst. IPM programs in this region stress that growers should not apply unnecessary insecticides with their Zn sprays to avoid early season aphid outbreaks.

Pecan nut casebearer is a perennial threat to the crop, and requires treatment almost every season. Growers use a combination of real time predictions of casebearer activity from pecan IPM websites, pheromone trap catch information, and field scouting to determine the optimum time for controlling casebearer. The IPM strategy for control of late season insect pests in south central pecan orchards is similar to strategies employed by southeastern growers.

WESTERN PECAN ORCHARDS. Pecan and all its hickory cousins are native to the eastern half of the American continent. When pecans were planted in the arid west most of the pests associated with pecan were left behind. Initially, western pecan growers had only three concerns—water, Zn, and aphids. Today, both the hickory shuckworm and the pecan nut casebearer have found their way into New Mexico and West Texas. Low humidity during the growing season eliminates the need to control pecan scab.

IPM programs in the west have concentrated on the control of pecan aphids and Zn deficiency. In some western orchards, the soil-applied insecticide, aldicarb, is used to suppress aphid populations. However, environmental and worker safety concerns limit the use of aldicarb in many areas. Biological control of pecan aphids with predacious insects has been very successful in New Mexico. Some growers allow their orchards to become weedy to provide beneficial insect habitat. Predacious insects (*C. rufilabris* and *H. convergens*) and an aphid parasite, *Troxys pallidus*, are released into the orchards. In California, the release of *T. pallidus* has not controlled aphid populations, leaving growers dependant on insecticides for aphid control. Foliar Zn sprays are applied during leaf and shoot expansion as part of the regular pecan management program in the west.

In New Mexico and West Texas, pecan nut casebearer has become established prompting the use of pheromone traps to monitor activity of adult insects. A target-specific insecticide is used to control damaging casebearer populations without disrupting the biological control system in place for aphid control. Hickory shuckworm populations in the west have not become damaging enough to cause the development of an IPM strategy for this pest.

NATIVE PECAN GROVES. The culture of native pecan stands is a unique agricultural enterprise that incorporates nut culture, livestock grazing, and wood production. Low yields and low nut prices limit the amount of capital that can be invested in the culture of a native nut crop (Reid and Eikenbary, 1990). Producers graze livestock in their groves to reduce the cost of mowing and to diversify farm income. The most important IPM tool native pecan producers use is a chainsaw—to remove trees highly susceptible to pecan diseases or pecan phylloxera during the tree thinning process. Trees thinned from pecan groves are used for firewood, charcoal, or wood pallets.

The genetic diversity within a native pecan grove works to slow the spread of certain pests. Pest resistant genotypes grow adjacent to susceptible genotypes making it difficult for pecan pests such as pecan scab, leaf spot diseases, and phylloxerans to spread from tree to tree. When coupled with the selective tree thinning process, native growers fully use genetic resistance to keep pecan pests in check. Fungicides are not routinely applied to native groves.

IPM strategies for native pecan groves concentrate on the control of two primary nut feeding pests—pecan nut casebearer and pecan weevil. Native growers use the same technologies employed by pecan orchardists to predict, monitor, and scout for pecan nut casebearer. Control measures for casebearer are confined to years of low or moderate crops, when casebearer damage can inflict significant economic damage. During masting years, when every pecan tree in the landscape bears a heavy crop, casebearer damage does not pose a significant economic threat and can be left untreated (Harris et al., 1996).

Pecan weevil traps are deployed to monitor adult emergence. The Circle pecan weevil trap is used in native groves because it can be mounted to the tree above the reach of curious cattle. One to three applications of carbaryl are needed to control pecan weevil. During many seasons, weevil sprays are the only pesticides applied in native groves. In the native pecan IPM program, grazing restrictions on pesticide use must be considered. Fortunately, the primary insecticide used in native groves, carbaryl, has no grazing limitations.

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