INSECT PEST MANAGEMENT SYSTEMS FOR NATIVE PECANS[1]

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ABSTRACT

The production of nuts from stands of naturally occurring pecan trees (native or seedling pecans) is a significant component of the U.S. pecan industry. Native pecan producers have adopted a low-input management system whose outputs include nuts, cattle, and pecan wood products. Inputs are limited to nitrogen fertilization, insecticides, and animal care products. During the last decade, dramatic fluctuations in prices paid for native pecans have destabilized the marketplace and have forced growers to carefully examine all input expenditures. In response to market pressures, IPM programs for native pecans have shifted from questions of 'when should I spray?' to questions of 'can I afford to spray at all?' In addition, native pecan producers concentrate their pest control expenditures on just two fruit feeding pests, pecan nut casebearer and pecan weevil. All available IPM tools are utilized to manage these key frugivores including pest monitoring traps and pest prediction models.

INTRODUCTION

Pecan, *Carya illinoinensis* (Wang.) K. Koch, is a native North American crop with an endemic pest complex. Pecan is a recently domesticated crop, with today's new cultivars only two to three generations removed from their wild ancestors (Sparks 1992). However, pecan is somewhat unique among major tree crops; nearly 30% of the nation's pecans are still produced from native stands of seedling trees (Pollack 2001). The production of pecans from native stands is a new-world adaptation of traditional European silvopastoral systems (the grazing of livestock in groves of tree crops). European silvopastoral systems were based on native chestnuts, *Castanea sativa* Mill., and walnuts, *Juglans regia* L., and provided many of the staples of the rural economy: milk, meat, hides, wood, and nuts (Auda 1999). When European settlers discovered vast acreages of pecan-rich, riparian forests in America, they developed pecan groves by thinning out unwanted trees and introducing livestock to keep competing vegetation under control (Brison 1974). Today's native pecan groves look very similar to the groves cut from riparian forests during the early 1900's. However, three modern advances have significantly increased pecan productivity: nitrogen fertilization, mechanization of nut harvest, and insect control.

In the wild, pecan trees bear nuts at irregular intervals. Natural pecan stands tend to bear crops every other year; with large crops every 3–4 years (Chung et al. 1995).

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Ecologists have proposed that this masting behavior is an evolutionary response to frugivory (LaLonde and Roitberg 1992), but nut growers view alternate bearing as a cultural problem requiring a remedy. The addition of nitrogen fertilizers has been one such remedy. Nitrogen fertilization stimulates growth and increases the tree's ability to manufacture and store carbohydrates. The long-term affects of annual nitrogen fertilization are increased yields and diminished alternate bearing (Worley 1990). Under natural conditions, pecans fall freely from the tree over an extended period of time during the late fall and early winter. As dehiscent shucks dry, nuts are blown out of the tree by strong winds. This natural progression of seed dispersal extends the risk of crop loss to predation by birds and mammals. Modern machinery enables the quick and efficient harvest of pecans. During harvest, trunk shakers dislodge nuts from the trees and harvesters sweep up nuts out of the groundcover long before seed predators can significantly destroy the crop.

The conversion of pecan from forest to orchard tree changes the balance between trees and their insect pests. Populations of fruit-feeding insects, such as pecan nut casebearer, *Acrobasis nuxvorella* Neunzig, and pecan weevil, *Curculio caryae* (Horn), increase in response to greater and more regular nut production (Harris et al. 1996). The development and utilization of insecticides to protect seed production preserves gains in pecan productivity. The challenge of implementing an IPM program for native pecans has been, and continues to be, controlling populations of the primary frugivores without disrupting the natural biocontrol systems that keep secondary pests in check (Reid 1999).

ECONOMIC TRENDS FOR NATIVE PECANS

The culture of native pecans has always been a low-input form of agriculture. Profitability is determined by the landowner's ability to market a diverse array of products from the same acreage while keeping input costs low. Pecans, cattle, and wood are primary products. Annual inputs include nitrogen fertilizer, insecticides, and animal health products. In most years, income generated from the sale of pecans dominates the ledger sheet. Under optimum care, native pecan groves can average as much as 1000 lbs/acre (Fig. 1). However, the typical (i.e., sub-optimal care) native pecan grove produces 390 lbs/acre (Harris et al. 1998). Since 1990, an average price of native pecans of $0.71/lb. translates into a gross return of $710/acre for well maintained trees and $277/acre for marginal growers. These seemingly rosy figures disguise the true nature of today's native pecan industry.

During the late 1980's, the pecan shelling industry started a decade-long trend towards consolidation. Since native pecans are valued strictly as a shelled product, the decrease in number of buyers (markets) dramatically changed the marketplace. During the early 1990's, pecan trees across the United States were synchronized into the same alternate bearing pattern by a strong El Niño weather pattern. The combination of these two events led to higher average prices paid for native pecans, but prices were far more variable during the decade of the 1990's compared to the previous decade (Fig. 2). These elevated price fluctuations have significantly increased the financial risks borne by growers managing native pecans. During 'on' years, pecan prices are depressed, forcing growers to clean and harvest large volumes of product at small profit margins. In contrast, 'off' years feature high pecan prices but growers harvest barely enough crop to cover production costs.

Uncertainty in the marketplace causes grower reluctance to invest in key crop promoting inputs. In addition, input investment decisions are made increasingly difficult by the escalating prices of farm chemicals, including fertilizers and pesticides. After the cost of harvest, pest control is the largest investment a native pecan producer makes in his crop. Today's market forces have shifted the focus of native pecan IPM from the question 'when should I spray?' to the question 'can I afford to spray at all?'

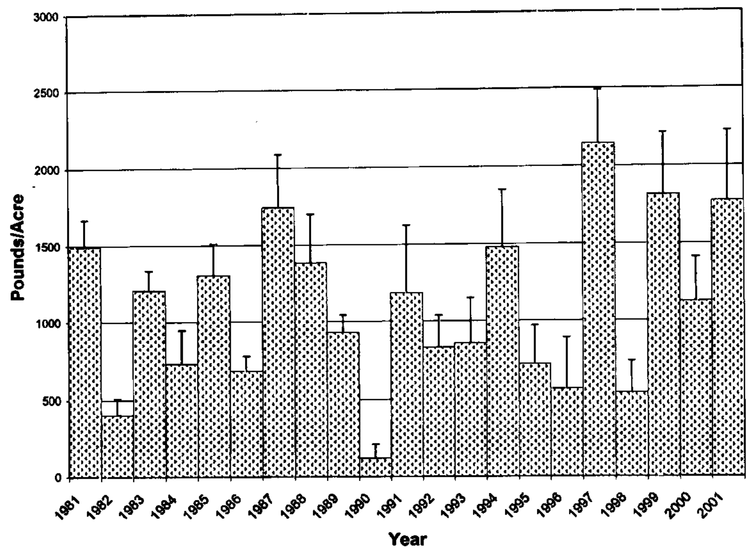

FIG. 1. The yield of six one-half-acre plots of native pecans growing near Chetopa, KS during the years 1981-2001. Error bars indicate the standard deviation of yield/acre.

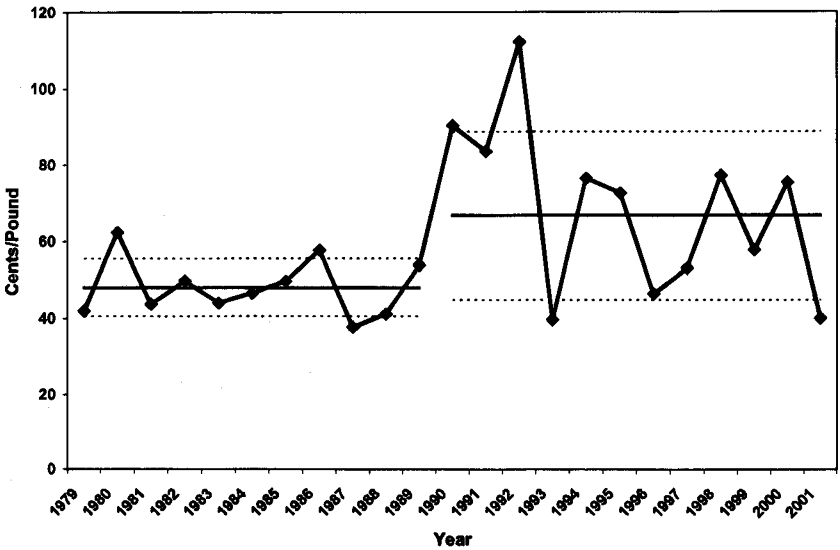

FIG. 2. Prices paid for native pecans during the years 1979-2000 (bold line marked with diamonds) (Data from Pollack 2001). Average price from 1979-1989 was 48.0 ± 7.5 cents/lb. while the average price from 1990-2000 was 71.3 ± 20.9 cents/lb. Average prices are shown as solid horizontal lines while the standard deviation of those average prices is shown as horizontal dashed lines.

NATIVE PECAN IPM TODAY

Native pecan producers concentrate their pest control expenditures on the two frugivores that pose the greatest threat to crop production: pecan nut casebearer and pecan weevil (Reid and Eikenbary 1990). All other insect pests are controlled by passive means that do not require additional inputs by the grower.

Pecan Nut Casebearer. Pecan nut casebearer is an early season pest that attacks the fruit shortly after fruit set. A degree-day predictive model developed in the early 1980's (Ring et al. 1983) has proven an effective tool for timing scouting efforts and/or control measures. Growers have access to real time predictions over the internet (http://blaze.ocs.ou.edu/agwx/models/pecan/pnc). Although effective timing is critical for efficacious control of pecan nut casebearer, growers first must determine if a pesticide application is warranted at all.

Pecan trees have a strong tendency to alternate bear even in the most well-managed groves. The pattern of alternate bearing is usually initiated by extreme weather conditions that affect both managed groves and adjacent unmanaged pecan trees found in both forest and pasture. During 'off' years, managed groves have low or moderate crops while unmanaged trees have little to no pecans. It is during these 'off' years that casebearer damage can be most devastating (Harris et al. 1996). Female moths fly into managed groves from surrounding non-managed areas in search of oviposition sites. The percentage of clusters damaged by casebearer larvae may exceed 50%. In stark contrast, 'on' years offer plentiful oviposition sites throughout the landscape when both 'wild' and managed pecan trees set an ample nut crop. In this scenario, casebearer populations become dispersed and rarely cause more than 10% damage, a level that does not justify pesticide application. Scientific studies have yet to quantify the crop level at which pecan nut casebearer ceases be a potential economic pest. Growers, though, find it easy to distinguish between 'on' years and 'off' years in the alternate bearing cycle by simply observing both trees in their groves and non-managed trees in the area.

The recent registration of an insect growth regulator, tebufenozide (Confirm ™), has made a significant impact on native pecan IPM. Tebufenozide is an effective insecticide for casebearer control (Buchert 2001) and offers two advantages over competing synthetic pyrethroids and organophosphates. Tebufenozide is effective over a long time period and only affects lepidopterous insects. A single application of tebufenozide timed to control pecan nut casebearer persists on pecan tree foliage long enough to provide control of the first generations of fall webworm, *Hyphantria cunea* (Drury), and walnut caterpillar, *Datana integerrima* Grote & Robinson (Reid, unpublished data). Fall webworm and walnut caterpillar are cyclic pests of pecan and do not outbreak to economic pest status every year. However, by using tebufenozide for casebearer control, native growers can ensure fall webworm and walnut caterpillar suppression and eliminate a possible early-summer pesticide application specifically aimed at controlling a caterpillar outbreak.

Early season use of broad-spectrum insecticides can damage natural biocontrol systems and cause outbreaks of yellow aphids, *Monellia caryella* (Fitch) and *Monelliopsis nigropuncta* Granovsky (McVay and Payne 1987). Because tebufenozide only affects lepidopterous insects, the use of this insecticide for casebearer control has limited impact on non-target arthropods, helping to preserve native biocontrol systems.

Pecan Weevil. Pecan weevil poses the most serious threat to native pecan producers and is the target of annual insecticide treatments. Unfortunately, the importance of this pest has not fostered the development of practical, easily adopted IPM strategies. That is not to say that university researchers have ignored pecan weevil but rather pecan weevil has proven to be a formidable adversary. Currently, native pecan producers employ a weevil control program that can best be described as 'trap and spray'.

The two-year life cycle of pecan weevil starts with the emergence of adults from the soil in early August. Adults fly or walk up into the tree canopy to mate and lay eggs within pecan fruit. Developing larvae hatch and devour the kernel of the nut before chewing their way out of the shell in early fall. Larvae drop to the ground, burrow into the soil, and form a protective cell. The larvae pupate the following year and adults emerge during August of year two. Obviously, the pecan weevil evolved to synchronize its life cycle with the natural irregular bearing pattern of pecan.

Several methods have been devised to trap emerging pecan weevil adults (Mulder et al. 1997b). Many of these trapping methods did not work well in native pecan groves where livestock are part of the total farm management program. Grazing animals often knocked down or damaged traps rendering them useless as insect monitoring tools. The recently devised Circle Trap has provided native growers with an effective monitoring tool that is easy to build, install, and is cattle proof (Mulder et al. 1997a). Circle traps are basically a funnel shaped trap constructed of household screen wire and mounted to the tree trunk (above the reach of cattle). Use of the Circle Trap has allowed producers to 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 are rarely implemented. To most producers, the destructive potential of pecan weevil is so great that they maintain a zero tolerance for weevil damage.

Native pecan producers, like all pecan producers that must battle pecan weevil, have one effective insecticide choice—carbaryl (Knutson and Ree 1997). Carbaryl is a broad spectrum insecticide that is harsh on beneficial arthropods (Mizell and Schiffhauer 1990). However, there are positive aspects of utilizing a broad spectrum insecticide during the month of August for pecan weevil control. Damaging populations of hickory shuckworm, *Cydia caryana* (Fitch), fall webworm, and walnut caterpillar can also occur in August but are kept in check by insecticide applications aimed at pecan weevil.

The current review of carbaryl by the U.S. Environmental Protection Agency has many growers concerned that their only effective tool for reducing pecan weevil populations may be regulated out of existence. Alternatives to carbaryl, either chemical or biological, should be developed to reduce pecan grower reliance on a single pesticide.

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