Biological Control of Pecan Nut Casebearer and Aphids in New Mexico Pecans

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A. Insecticide Resistance

Insecticide resistance is one of the most difficult problems facing insect control in agriculture, sometimes even causing entire farming communities to halt production. Insecticide resistance is genetically based, and its frequency in pest populations increases dramatically as growers increase use of ineffective insecticides. Also, genes that permit survival of one insecticide confer resistance to other chemically similar insecticides. Finally, the genes for resistance remain in animal populations for many years and can be reexpressed easily if similar insecticides are used intensively again.

In 1987, some of the pecan growers with the largest acreages in the Mesilla Valley (Doña Ana County, N.M.) experienced severe black-margined aphid resistance to seven different insecticides: Temik, Pydrin, Ammo, Disyston, Cymbush, Thiodan, and Lorsban. In response, biological control programs began in spring 1988 in cooperation with commercial producers on some of the most severely affected orchards. Since then, some blocks of pecans (approximately 10 percent of the Mesilla Valley acreage) have been left unsprayed or sprayed at minimum levels. Unsprayed, minimally sprayed and organic and backyard unsprayed trees act as a refuge for aphids, which are susceptible to insecticides. A refuge consisting of 10 percent of the total production area is enough to maintain susceptibility in an insect population; therefore, as long as the percentage remains relatively constant, resistance probably can be controlled.

There are several ways to deal with insect resistance. Some options growers can try include:

- Rotating insecticides applied in different years and even within the same season.
- Using predator-friendly insecticides.
- Raising the threshold for treatment.
- Controlling insects biologically. The more diverse the controls used to reduce a given population, the less likely resistance will occur or increase.
- Maintaining enough untreated or minimally treated areas to dilute the effects of resistance.

B. Biological Control Programs

Biological control (using parasitoids, predators, or microorganisms) is gaining popularity with producers of cultivated crops, including pecans, not only because it can be more economical but also because it can be more efficient and environmentally friendly. Most insect problems in the world have resulted from introducing harmful, foreign species without their natural enemies. In their native range, the density of these harmful species often is maintained below the economic threshold (the density at which control measures should be applied to prevent economic damage) by the native parasitoids and predators. Since the early 1900s, some 164 harmful insect species in the United States have been completely controlled by introduced natural enemies. Another 14 have been substantially controlled and 15 have been partially controlled. There have been 384 such successful projects worldwide.

In addition to introduced of parasitoids and predators, native parasitoids and predators often respond to harmful foreign insects by increasing their numbers to take advantage of the new food source. Because these natural processes take time, a successful program for introducing and adapting biological control agents may take several years. This publication covers some aspects of biological control in pecan orchards.

Efforts should be made to preserve or protect natural enemies by using only narrow spectrum insecticides, such as Confirm or Spintor, for pecan nut casebearer (PNC) control or nonchemical insecticides, such as Surround, for aphid control. Managing the habitat with ground covers to furnish hosts and nectar for parasitoids and predators also can help.

Typically, in predator/prey systems, the initial buildup of the plant-eating host species is strong and vigorous. Next comes an increase in the beneficial complex, which is initially weak and delayed but may become overpowering and controlling, reducing the pest species. These cycles may be repeated in various ways, depending on the biology of the interacting species and mortality factors, such as weather and diseases. If the cycles occur below the economic threshold, the pest species is not considered economically important. But if the cycles occur above the economic threshold, losses can occur. The importance of the pest species depends on the degree and period of time spent under the respective population curve.

The beneficial complex can be completely effective, partially effective, or ineffective for controlling pests, depending on a variety of factors, such as the presence of key beneficials, effectiveness of beneficials due to alternate hosts, weather, insecticides, nectar sources and continuity of alternate hosts. If the beneficial insect populations can be induced to increase sooner by using an appropriate ground cover that supports aphids, the pest species density should decrease appropriately. The theoretical sequence of events in the buildup of economically harmful or plant-feeding insect species (such as pecan aphids and PNC) and the response of the beneficial complex is shown (fig. 1).

The densities of individual insect populations are not uniform between and within farms. This variation is caused by environmental, biological, cultural and individual insect control practices and is often difficult to predict. Therefore, it is necessary to take multiple samples in order to estimate the average density of insects on trees or tree parts consistently within the same section of the orchard. Because this sampling can be expensive and time-consuming, spot or indicator samples often are used to get a feel for the dynamics of the insect populations. The better and more frequent the sampling, the better the prediction.

PECAN NUT CASEBEARER

It is difficult to establish an economic threshold for pecan nut casebearer eggs because of a variety of factors, including spring and fall nut drop, density of the beneficial complex, pollination, nut set, and price. If the beneficial insect densities are high, it is not uncommon for 95 percent of the pecan nut casebearer eggs to be eaten. As a rule of thumb, the economic threshold for pecan nut casebearer eggs in orchards treated with insecticides should not be greater than 5 percent. However, organic orchards have experienced 30 percent egg densities with less than 2 percent final nut damage.

Pecan nut casebearers go through three or four generations per year in New Mexico. Each generation is composed of an egg, larvae, pupae and adult stage. Grown larvae from the last generation overwinter and feed on plant terminals in the spring. These larvae pupate and give rise to the first adult generation. Adults are small (1/3 inch long), gray to black, night-flying moths. These moths lay small (barely visible to the naked eye), flat oval, yellowish eggs on the terminal end or side of nutlets or at the base of the calyx lobes. Eggs hatch in four to five days to olive-gray larvae. The larval stage can last three to four weeks in the spring. First generation larvae may destroy several nutlets, while later generation larvae usually destroy one nutlet each. The first generation adults and larvae occur as discreet generations while later generations may overlap.

The following table shows the PNC control by six different parasitoids on an unsprayed orchard.

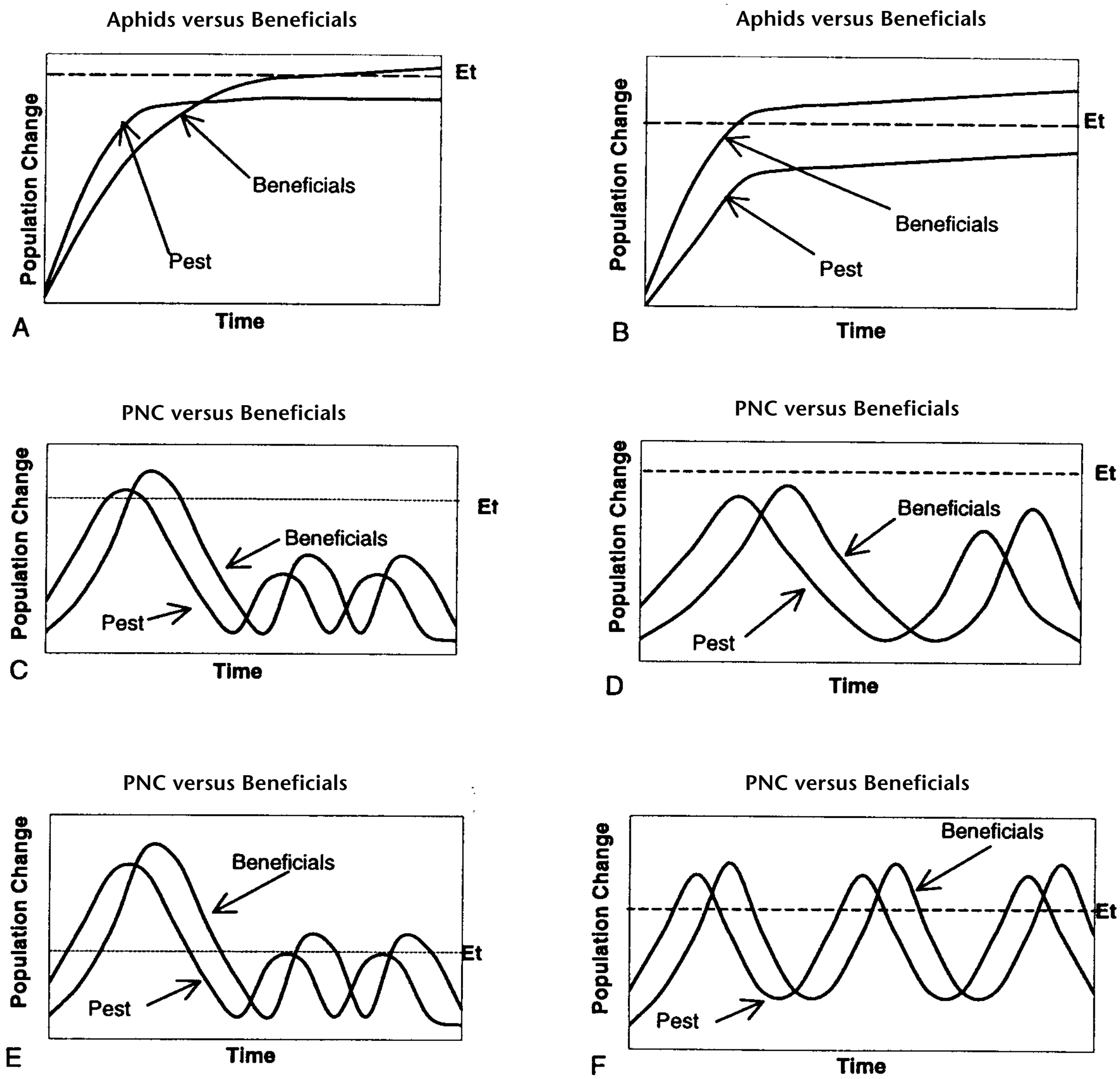

Figure 1. Typical boom or bust cycles of harmful insect species and the reaction of the beneficial insects. Aphids overwinter as eggs on tree trunks, but during the spring and fall their populations increase as females give birth to living young. These aphid populations may be controlled by the beneficial complex (a), or they might exceed the economic threshold, if the density of the beneficial complex is low (b). PNC, however, go through a complete change: egg, larvae, pupae and adult. Their populations cycle approximately every 30 days in the summer. Population cycles may take various forms, depending on the beneficial population density and other factors. A variety of scenarios are possible. In (c), the first and succeeding generations are controlled by the beneficial complex. In (d), the population dynamics are similar, but the insect densities are different. Populations in (e) and (f) are similar. However, PNC populations are not controlled below the economic threshold by the beneficial complex in either case.

It clearly indicates the excellent control obtained with native wasps, especially *Basus acrobasidis.*

Table 1. Parasitoids recovered from PNC larvae in a young, unsprayed orchard in the Mesilla Valley in 2000.

Parasitoid	% PNC Control
Basus acrobasidis	33
Barachymeria hammeri	2
Goniozus legneri	5
Cremastus sp.	<5
Clarkinella sp.	<5

Additional PNC eggs may die from *Trichogramma* spp. parasitization.

PECAN APHIDS

Three aphid species—the black, black-margined and yellow pecan aphids—attack pecans in New Mexico. Black pecan aphids are more damaging than the yellow aphids, because they can cause yellow, angular, chlorotic spots between leaf veins, ultimately resulting in defoliation in late summer or early fall. The black, pear-shaped adults may be found with immatures feeding on both sides of the leaves. Females give birth to live young in the summer, but deposit eggs that overwinter on the bark in the fall.

Winged adults of black-margined aphids hold their wings flat over their bodies, while yellow aphids hold their wings rooflike over their bodies. Black-margined aphids have black veins along the outside edges of their wings. These aphids often are referred to as the yellow aphid complex. Both species feed primarily on the undersides of leaves and excrete a sticky, sugary substance known as honeydew. Both aphid species reproduce by giving birth to live young during the summer months, and overwinter as eggs deposited on bark.

The factors that affect the economic threshold of pecan nut casebearer also affect the economic threshold of pecan aphids. As a rule, the economic threshold of yellow aphids is set at 35 aphids per compound leaf in the spring and 25 aphids in August and September. Because black pecan aphids cause chlorotic blotches on leaves from their feeding, the economic threshold is set at five per compound leaf.

Lady beetles, lacewings and specific wasp parasitoids have been successful in controlling yellow and black-margined pecan aphids. However, biological control of black pecan aphids has been unpredictable.

In years of high nut set, photosynthates (plant energy) might become limiting. Photosynthate loss from high yellow aphid populations in these years can reduce quality. A host-specific control measure (one which affects only aphids) like a beneficial-friendly insecticide could be used to improve quality under such conditions.

BIOLOGICAL CONTROL OPTIONS

Using broad-spectrum insecticides in agricultural cropping systems initially results in the quick, complete knockdown of harmful species. But, ultimately, they can lead to loss of the beneficial complex, increased insecticide use, buildup of resistance, increased cost, loss of control and loss of the insecticide itself to resistance.

There are a number of biological ways to control pest insect populations:

- Eliminate the use of broad-spectrum insecticides.

- Build up the beneficial complex when the harmful species begin to increase by releasing appropriate beneficial insects or cutting cover crops. Alfalfa harbors approximately 150 parasitoid and predator species. Alfalfa is the only extensively planted perennial that supports a diverse insect fauna in New Mexico. It is the primary crop for producing beneficial insects, which disperse to annual field and tree crops after cutting. Planting natural insectaries like alfalfa around the outside of pecan orchards or appropriate cover crops within pecan orchards can be useful. As these cover crops bloom throughout the season, aphid populations increase and attract lady beetles. In Carlsbad, most growers have not, sprayed their pecan orchards for aphids in the last five years, mainly because alfalfa borders most orchards.

- Partially control the plant-eating species with host-specific control measures (like Surround) and cut ground covers to allow the beneficial complex to catch up with the harmful species.

- Use biorational insecticides (insecticides that do minimal damage to the beneficial complex), such as growth regulators and attractants. Although systemics (insecticides that travel inside plants) typically are less damaging, they may kill some predators that have piercing-sucking mouthparts (*Deraeocori* spp and *Orthotylus* spp).

- Prune trees to allow more light to penetrate to discourage black aphids.

- Don't overfertilize with nitrogen, because it may encourage aphids.

BIOLOGICAL CONTROL SYSTEMS

Presently, we have no universal formula for converting intensively sprayed pecan orchards to biologically controlled orchards, because insect densities vary within and between orchards and it is difficult to obtain representative samples.

Work is ongoing to determine which combinations of cultural practices and biological control agents work best for New Mexico growers. Some procedures are suggested in this publication, none of which have been thoroughly tested under New Mexico conditions. A number of indigenous or introduced biological control agents at work in New Mexico pecan orchards are listed in (table 2).

PRESENT AND FUTURE CONTROL OPTIONS

New biological control and host-specific chemical options are being evaluated at NMSU for pecan pests in New Mexico. These include:

Aphid complex

Apply as a spray. Surround (kaolin clay). Initial trials look promising, but additional testing is needed.

Mass release. Convergent lady beetles (a native lady beetle, may not stay in release fields). Cage these lady beetles aboveground, cover overnight and feed a sugar solution (Sprite) to help them adapt and survive.

Introduce or release to increase populations. Asian lady beetles (exotic lady beetle, established in the Mesilla Valley).

Plant ground covers. Small grain, hairy vetch, sanfoin. Cut with a sickle mower to force beneficials into the trees.

Pecan nut casebearer

Apply as a spray.
- Spintor looks promising but may affect some nontarget species.
- Confirm is effective.
- Attract and kill (droplets of pheromone plus insecticide) is effective but not labeled.
- Pheromones are effective but not labeled.
- *Bacillus thuringiensis* is effective but timing is important.
- Azadirachtin (neem) has not been tested in New Mexico and may be expensive.

Introduce or release to increase populations.

- *Harmonia axyridis:* Asian lady beetle; exotic, established in the Mesilla Valley.
- *Goniozus legneri*: exotic wasp, available from commercial sources.
- *Bassus acrobasidis*[a]: exotic wasp established in the Mesilla Valley but not in culture.
- *Cremastus sp.*[a]: exotic wasp established in the Mesilla Valley but not in culture.
- *Clarkinella sp.*[a]: exotic wasp established in the Mesilla Valley but not in culture.
- *Brachymera hammeri*: exotic wasp established in the Mesilla Valley but not in culture.
- *Trichogramma minutum* or *plateri:* established in the Mesilla Valley, available from commercial sources, timing is important. Not yet proven to be effective here.

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[a]Needs to be distributed from field colonies.

Table 2. Common insects associated with pecans in New Mexico.

Pest	Specific Wasp Parasitoids	General Predators
Black-margined pecan aphid and yellow pecan aphid	*Aphelinus peripallidus* and *Trioxys pallidus*	**Lady beetles** *Hippodamia convergens* (Convergent lady beetle) *Olla v-nigrum*[1] (Ash gray lady beetle) *Harmonia axyridis*[2] (Asian lady beetle) *Coccinella spetempunctata* (Seven-spotted lady beetle) *Chilocorus stigma* (Twice-stabbed lady beetle)
Black pecan aphid		**Lacewings** *Chrysoperla carnea* *Chrysopa rufilabris* *Chrysopa nigrocornis*
Pecan nut casebearer	*Trichogramma* spp. *Goniozus legneri*[2] *Bassus ascrobasidis*[3] *Brachymyera hammeri* *Cremastus* sp. *Clarkinella* sp. *Calliephialtes opapholitha*[2]	**True Bugs** *Deraeocoris nigrocornis* *Orthotylus nebulosus* *Nabis* spp. (Nabid bug) *Oris* spp. (Minute pirate bug) *Geocoris* spp. (Big-eyed bug)
	Phaneratoma fasciata[2] *Liyophaga mediocoris*[2]	**Spiders** *Hibana incursa*[1] *Anyphaena* sp.[1] *Cheiracanthium inclusum*[1]
	Macrocentrus instalilis[2] *Agathis acrobasidis*[2]	**Mites** *Allothrombium* sp. *Thrombididae* sp.

[1]Overwinter on tree trunks.
[2]Released by NMSU.
[3]May give as much as 33 percent control of PNC in some orchards.

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