Agricultural Innovations Fact Sheet

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Biological Control of Pecan Weevils in the Southeast: A Sustainable Approach

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Photo by Peggy Greb, courtesy ARS, USDA

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Geographic Applicability:

The techniques discussed here are applicable to pecans grown in areas of the southeastern U.S. where pecan weevil is a key pest.

Introduction

Pecan (*Carya illinoensis*) is the most valuable nut crop native to North America. There are more than 492,000 acres of managed pecans in the United States, with major production in the Southeast, Southwest and parts of the Midwest. Total annual value of the crop to U.S. growers generally exceeds $300 million.

Insects and mites can cause severe crop losses in pecans. Of major concern is the pecan weevil, *Curculio caryae* (Fig. 1). This weevil attacks the pecan nut in late season, causing serious crop losses in many areas of the Southeast, Texas and Oklahoma. It is considered a key pecan pest, as damaging populations occur year after year. Without insecticide treatments, crop losses can exceed 75 percent.

Our research goal was to provide an alternative control strategy for pecan growers who, for a variety of reasons, find conventional spraying of insecticides unsuitable. This includes organic growers, and owners of dooryard trees, small orchards and commercial orchards who have concerns regarding spray drift. We attempted to sort and identify naturally occurring fungal strains that were effective at killing pecan weevils and provided improved fungal persistence in the orchard, thus extending the effective period of control. We also sought to develop an efficient and practical method of applying the fungal formulations in pecan orchards. This fact sheet provides information about the life cycle of the pecan weevil and its impacts on pecan crops; identifies fungal pathogens that can control pecan weevils; and outlines methods for application of these fungal pathogens in orchards.

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Fig. 1. Healthy pecan weevil on pecan nut.

Pecan Weevil Life Cycle and Impacts on Crops

Throughout most of the southeastern United States, adult weevils emerge from the soil over a period of about six weeks beginning in late July, with peak emergence in early- to mid-August. In Texas and Oklahoma, emergence is somewhat later. The weevils crawl or fly up into the trees and feed on immature nuts. Once the nuts reach the stage where the shells begin to harden, female weevils chew holes in the shuck and through the shell, and deposit their eggs. Larvae feed on the developing kernels until they reach maturity and drop to the ground. They dig down 4-12 inches in the soil and construct a pupal cell where they remain for 2-3 years before emerging as adults. Nuts damaged by early-season feeding usually fall prematurely, while those damaged after shell hardening remain on the tree until harvest or natural drop occurs.

Direct pecan damage results from adult feeding prior to and after shell hardening, and by grub feeding in the partially mature kernel after shell hardening. Indirect damage is caused by the insecticides used to control the weevils because these materials—carbaryl and a variety of pyrethroid insecticides—tend to encourage outbreaks of pecan aphids and pecan leaf scorch mites. These secondary pests have the potential to cause significant leaf damage and even premature defoliation. While both can be reduced effectively with available insecticides, controlling these late-season outbreaks will add significantly to both production costs and the amount of pesticide introduced into the orchard environment.

Identifying new and sustainable pecan weevil management methods is vital to the industry for these reasons, and also because the carbamate and pyrethroid classes of insecticides are older chemicals scheduled for re-registration review and are likely, in the near future, to have more stringent restrictions placed on their use in pecan orchards. Growers need new approaches and materials that will provide acceptable control of weevils without the environmental and non-target effects of the insecticides currently used.

Fungal Pathogens for Pecan Weevil Suppression

A highly promising management alternative for pecan weevils is the use of fungal pathogens from the entomopathogenic Hypocreales fungus group, particularly *Beauvaria bassiana* and *Metarhizium anisopliae*. These are among the best known and most studied insect pathogens, and specific strains of both species are commercially produced for pest control in many crops worldwide. Native strains of these fungi occur naturally in the soil of pecan orchards, where they attack and kill a variety of insects in both the adult and immature stages. The different strains can vary widely in virulence to different target insects. Earlier work has shown that the commercial strain of *B. bassiana*, particularly, has potential for controlling adult pecan weevils.[1, 2]

In laboratory experiments, we screened several strains of both *Beauveria bassiana* and *Metarhizium anisopliae* for virulence against pecan weevil adults and for persistence in soil. Two promising strains were selected for further study under field conditions: *Beauveria bassiana* GHA strain and *Metarhizium anisopliae* F52 strain. Additionally, laboratory experiments were conducted to determine the effect of soil amendments (e.g., compost, manure, etc.) on fungal persistence and virulence. Composted peanut hulls were most promising and chosen for further testing in the field. We conducted field studies using *B. bassiana* and *M. anisopliae* over three growing seasons.

Fig. 2. Pecan tree with fiber band treated with fungus.

Fig. 3a. Weevil cadaver infected with *Beauveria bassiana*.

We tested a variety of application approaches under field conditions:
1) bare ground applications
2) a cloth band treated with the fungus stapled to the tree (Fig. 2)
3) ground application with a cover crop (Sudan grass)
4) ground application with cultivation
5) application directly to the trunk
6) trunk application with a UV-protecting adjuvant and a combination of ground and tree band application.

Following treatment, naturally occurring weevils were trapped as they climbed into test trees and assessed for fungal infection. All studies were conducted in an orchard at the U.S. Department of Agriculture Agricultural Research Service station at Byron, Ga., except in the last season (2006), when three commercial pecan orchards were added (two in Georgia and one in Texas).

The most successful treatment was spraying *B. bassiana* directly to the trunk, resulting in a rate of more than 75 percent mortality of weevils (Fig. 3a)—comparable to trunk application with the insecticide carbaryl. Adding a UV protectant did not improve results.

Grower trials with *B. bassiana* trunk sprays in Georgia were also very successful: 90-100 percent mortality occurred in weevils collected from two commercial orchards. Band application of *M. anisopliae* was tested at a single Georgia location, but did not provide significant control. Trials in Texas were inconclusive, possibly due to low weevil populations.

Using Fungal Pathogens to Manage Pecan Weevils

Trunk Applications

Trunk applications of any insecticide are better than ground applications for controlling weevils. Application to the trunk is straightforward. Virtually any type of sprayer can be used, from pump-up garden sprayers to commercial orchard sprayers with handgun attachments. The product should be mixed in water according to label directions (formulations vary, but mix at the strength recommended for a spray application) and applied to the trunk in a band 3-5 feet wide, all the way around the tree. It is important to wet the bark thoroughly so any weevils crawling up the tree will contact the fungal spores.

Timing of application depends on weevil emergence patterns. These depend on weather and other factors, but a good rule of thumb is to plan an application in the first week of August with a second application 2-3 weeks later. For help with precise timing for your area, contact your local Cooperative Extension office.

Fiber Band Applications

Fig. 3b. Weevil cadaver infected with *Metarhizium anisopliae*.

We also found that treating a fiber band with *M. anisopliae* and stapling the band around the trunk produced higher mortality than ground application of fungal pathogens (Fig. 3b). Any porous absorbent material can be used for the trunk band, as long as it will soak up the fungal solution and wrap around the tree. Burlap has traditionally been used for this purpose, but synthetic fabrics are also effec-

tive. We used a woven fiber material that was impregnated with the fungus by the fungus producer, Novozymes Biologicals of Salem, Va.[3] The bands are not yet available commercially but can be ordered from the producer. They can be secured to the tree with staples, rope, cord, strapping or any other method. Place the band anywhere on the trunk below the first scaffold limbs so that weevils crawling up the trunk will contact the fungus. If there are pets or other livestock in the area, it is probably best to attach it high enough that the animals will not be tempted to chew or pull it from the tree. Bands should be placed on trees in early August in most years. For more information about implementing these techniques and assistance with precise timing for your area, contact your local Cooperative Extension office.

There are a number of producers of fungal materials containing *B. bassiana* and *M. anisopliae* worldwide, but only a few have products registered in the United States. Two producers of Beauveria products are Laverlam-International Corp. of Butte, Mont., (Botanigard®) and Troy Biosciences of Phoenix, Ariz. (Naturalis®: note that this product contains a different strain of *B. bassiana* than the one we tested and may not perform in the same ways).[4,5] *Metarhizium anisopliae* is produced in the United States by Novozymes Biologicals of Salem, Va. These products are sold by many garden centers in larger markets and through Internet suppliers of biological control products worldwide.

Economic Considerations of Trunk Applications

In addition to providing environmentally benign control of a serious pecan pest, trunk applications allow a grower to treat effectively without the expense of an air-blast sprayer, and to apply material only to the trees, reducing the problem of off-target drift of spray solution common with standard orchard sprayers. Air-blast sprayers typically cost $50,000 or more, making the purchase difficult to justify for growers with smaller orchards. Contract spraying may be employed, but this also adds cost to production of the crop. Additionally, sprayers employ powerful fans that propel the spray up into the canopy in a fine mist which can cause the applied materials to drift onto nearby property. Near residential areas, growers typically leave several rows unsprayed as a buffer to avoid conflict with neighbors, often allowing weevil damage to occur in these outside rows. The increase in time and hand labor required to apply the fungal materials to individual trunks throughout an orchard should be economically offset by reduction in border rows damage.

Growers with small orchards, organic producers and homeowners are likely to be the first adopters of fungal applications, as the added expense of trunk application will initially deter most commercial producers from adopting this technique. However, any changes in availability of the standard insecticides currently used for weevil control will almost certainly make fungal pathogens more competitive in cost. With efficacy comparable to most chemical insecticides and without the tendency to induce secondary pest outbreaks, the fungal alternative should be attractive to larger-scale growers as well. Leaving orchards untreated is simply not an option for a commercial operation.

Other Advantages of Trunk Applications

For small-scale pecan producers—those with only a few trees, often around a home—whole-tree spraying is not economically feasible, and raises the additional concern of pesticide exposure for homeowners, children and pets. Trunk application of fungal pathogens provides an effective weevil control alternative that has the benefit of being essentially non-toxic to everything except insects. The combination of safety and efficacy will be very attractive for people with a few pecan trees near their homes.

Organic pecan production is rising and these farmers have shown the most interest in using the fungus for weevil control. We anticipate the fungus applications will be incorporated as part of sustainable Integrated Pest Management (IPM) programs in orchards where other biocontrol methods are being used (such as releasing predatory mites for scorch mite control, using fungi to control aphids or complementing fungus applications for weevil control with beneficial nematodes). Additional research should include studies of the efficacy on crop damage of the weevil control methods presented here.

SARE Research Synopsis

In laboratory experiments, multiple strains of two pathogenic fungus species (*B. bassiana* and *Metarhizium anisopliae*) were screened for virulence and persistence. Two promising strains of fungi were the subject of additional studies under field conditions: *Beauveria bassiana* GHA strain, and *Metarhizium anisopliae* F52 strain. Additionally, experiments were conducted to determine the effect of soil amendments (e.g., compost, manure, etc.) on fungal persistence and virulence. The amendment deemed most promising (composted peanut hulls) was tested further in field experiments.

A variety of application approaches were tested under field conditions in pecan orchards from 2004 to 2006.

For *B. bassiana* GHA strain, treatments included:
(1) application to bare ground;
(2) ground application with a cover crop (Sudan grass);
(3) ground application with cultivation;
(4) application directly to the trunk; and
(5) trunk application with a UV-protecting adjuvant.

For *M. anisopliae*, trial treatments included:
(1) a cloth band containing the fungus stapled onto the tree trunk;
(2) a ground application; and
(3) a combined ground application and tree band.

All experiments also contained a non-treated control. The compost amendment was tested in 2006. All experiments were conducted on the USDA-ARS research station in Byron, Ga., except in 2006 when three commercial pecan grower fields were also included (two in Georgia and one in Texas).

In field experiments focusing on *B. bassiana* GHA strain in 2005 and 2006, experiments in Georgia indicated that all fungal treatments showed significant weevil mortality relative to the control. Weevil mortality reached 80 percent during 10-14 day periods. In 2006, when analyzed by sample date, some evidence indicated trunk applications were superior to ground applications. In field experiments focusing on *M. anisopliae* application, 2006 results indicated the trunk band method caused significantly greater weevil mortality than the control, whereas direct ground application with or without compost amendment failed to cause a significant effect. Results in 2005 also indicated a significant effect of the band application approach, but only at 15-day post-application.

In grower trials (2006), the trunk application approach with *B. bassiana* caused 90-100 percent mortality (in two Georgia locations), yet the *M. anisopliae* treatment did not provide significant control (tested in one location). The grower trial in Texas showed variable effects of the fungus, possibly due to low weevil counts. Overall, the results indicate that using fungus as a biological control measure for pecan weevil management is promising, particularly the trunk-spray approach. The cover crop and the trunk band (cloth impregnated with fungus) control methods also appear to have potential.

References

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3. Novozymes Biologicals, http://www.nvozymes.com/en/MainStructure/Biologicals.

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