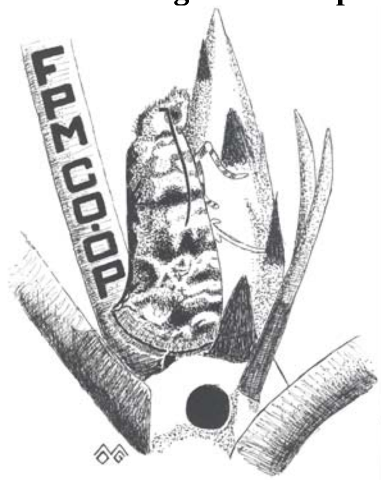
Progress Education Science Technology

Vol. 16 No. 1 Apr. 2011

Quarterly Newsletter on Forest Pest Management Issues

Forest Pest Management Cooperative



Nantucket Pine Tip Moth, *Rhyacionia frustrana* (Comstock)

Texas Forest Service, Forest Pest Management,
P.O. Box 310, Lufkin, Texas 75902-0310

PEST is a quarterly newsletter that provides up-to-date information on existing forest pest problems, exotic pests, new pest management technology, and current pesticide registrations related to seed orchards and plantations. The newsletter focuses on, but is not limited to, issues occurring in the South (Texas to Florida to Virginia,).

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Announcement:

Little "Ladybug" Kavanagh has arrived – Billi (FPMC Research Specialist) and Brendan Kavanagh celebrate the arrival of their daughter, Aubry Lynn Kavanagh, on January 20th. Aubry weighed in at 8 lbs 7 ozs and 21.5 inches long. Mom said "She's a keeper."

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Summary of 2010 FPMC Research Projects

In 2010, three primary research project areas – leaf-cutting ant, tip moth, and systemic injection - were continued from 2009. We also evaluated control options for regeneration weevils and fire ants. Summaries of the results from the leaf-cutting ant, fire ant, and weevil studies are presented below. Results from systemic injection and tip moth impact, hazard-rating and control studies will be presented in the next two *PEST* newsletters (June and Sept. 2011).

Ant Control

Leaf-cutting Ants: Until December 2009, Amdro® Ant Block bait was the only product labeled for control of the Texas leaf-cutting ant (TLCA). Unfortunately, Amdro treatment results were less than satisfactory, ~30% effective with a single application. Now however, based on FPMC trials, PTM™ Insecticide (BASF) also has been approved by EPA for use against these ants (*PEST* 14.4).

A new potential TLCA bait has being developed and evaluated by FPMC in cooperation with Central Garden & Pet. The new bait (Amdro™ LCA or Schirm 4) is created by running the Amdro™ Ant Block bait with a small amount of water through a pellet mill and then allowing it to dry over two days. This new bait, along with PTM™, was tested for effectiveness in eight trials during winter, spring, summer, and fall of 2009 and 2010.

During each season, 19 - 41 TLCA colonies were selected in east Texas on land owned by Hancock Forest Management, The Campbell Group, Rayonier and private landowners. Five to thirteen colonies were treated with new bait at 10g/ m^2 in each seasonal trial. Three to six were treated with Amdro Ant Block (0.75 lbs for colonies <600 ft^2 and 1.5 lbs for larger colonies). Six to eight more colonies were treated with PTM™ at 40ml per entrance hole in the other seasons. Additional (4-8) colonies

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Leaf-cutting Ant Control – Continued from Page 1

were monitored as untreated checks. All colonies were evaluated for ant activity at 0, 2, 4, 8 and 16 weeks post-treatment.

The PTM™ treatment was highly effective in halting ant activity during the winter and spring trials of both years, but less effective in summer and fall trials (Figures 1 & 2). It is unclear what caused the reduced efficacy in the latter trials. One hypothesis is that during the heat of the summer leaf-cutting ants tend to reduce their level of activity to help regulate temperatures within the colony. There is a tendency to underestimate size of the colony during summer months, thus insufficient chemical is applied.

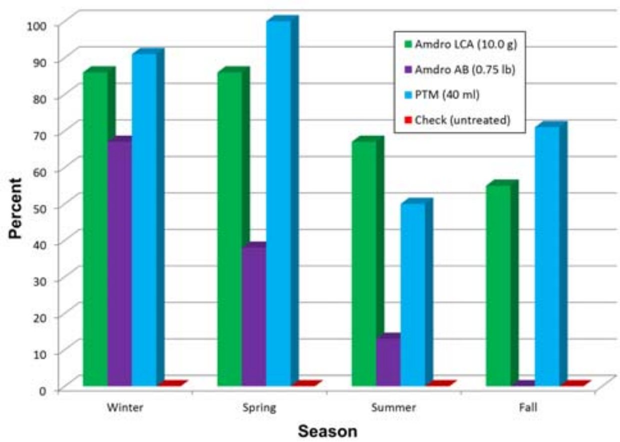

Figure 1. Seasonal efficacy (% colonies inactive) of modified (large), unmodified (Ant Block) Amdro™, and PTM™ soil injections for reducing and halting Texas leaf-cutting ant activity 16 weeks after treatment, East Texas, **2009.**

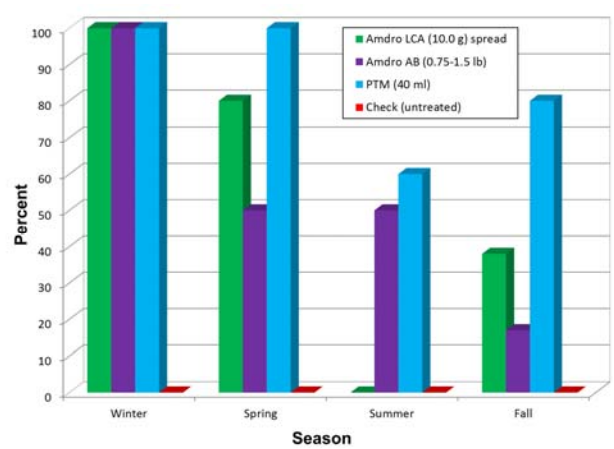

Figure 2. Seasonal efficacy (% colonies inactive) of modified (large), unmodified (Ant Block) Amdro™, and PTM™ soil injections for reducing and halting Texas leaf-cutting ant activity 16 weeks after treatment, East Texas, **2010.**

The modified baits (Amdro™ LCA and Schirm 3 & 4) were often quickly retrieved by the ants on most colonies and reduced ant activity 70 - 100% compared to initial activity within 2 weeks after treatment. Bait treatments were highly effective (80 – 100%) in halting activity even after 16 weeks in the winter and spring trials for both years. However, similar treatments were less effective (0 - 67%) in the summer and fall (particularly in 2010) when the bait was competing for the ant's attention with other plant sources and drought conditions reduced ant activity. Central Garden & Pet expects to make a decision to submit a registration request for the modified Amdro LCA bait to EPA in the near future. If a request is submitted, the turn-around time for EPA is expected to be 4 months and an additional 1-2 months to get approval by the states (TX and LA). Thus, the bait is expected to be available by fall 2011.

Imported Fire Ants: The red imported fire ant (IFA), *Solenopsis invicta* Buren, is a major nuisance pest across the southern United States including in seed orchards and progeny test sites. A test was initiated to evaluate a relatively new, lower toxicity treatment: PTM™ Insecticide (9.1% fipronil) applied using a backpack soil-injection probe to single fire ant mounds that have become established in loblolly pine seed orchards next to orchard trees. Orchard blocks were selected at Arborgen's Woodville (TX) orchard in December 2009 and Texas Forest Service's Hudson (TX) orchard and Forest Capital Partner's Merryville (LA) orchard in April 2010. In each block, 200 - 240 IFA colonies were selected; colonies were at least 7m (23 ft) apart, 8 inches or more in diameter and with newly-excavated soil. Treatments were randomly assigned to the selected ant nests with 40 replicates per treatment. An additional 40 - 120 nests were monitored as untreated checks.

Winter 2009 Treatments:

A) PTM™ solution 2% ai, 40 ml total injected 3 inches below soil surface at one (1) injection point.
B) PTM™ solution 2% ai, 40 ml total injected at the base of the colony (12 – 18" deep).
C) PTM™ solution 2% ai, 40 ml injected 3 inches below soil surface and 40 ml injected at the base of the colony (80 mls total).
D) Check – untreated

Spring 2010 Treatments:

A) PTM™ solution 2% ai, 40 ml total injected 3 inches below soil surface at one (1) injection point.
B) PTM™ solution 2% ai, 22 ml injected 3 inches below soil surface at two (2) injection points; 45 ml total.
C) PTM™ solution 2% ai, 45 ml injected 3 inches below soil surface at two (2) injection points; 90 ml total.
A) PTM™ solution 2% ai, 22 ml injected 3 inches below soil surface at four (4) injection points; 90 ml total.
D) Check – untreated

The effect of treatments on fire ant colonies was evaluated at 0, 14, 30, 49, 80 and 117 days after

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treatment (DAT). Each mound was checked for presence or absence of fire ant activity by inserting a small diameter stick into the mound. If no fire ants appeared after 15 seconds, the mound was considered inactive (0). If fire ants were present within the allotted time period, the mound activity was assigned a 1 (< 10 fire ants or freshly worked soil), 2 (some fire ants, not aggressive), or 3 (many aggressive fire ants).

The PTM™ treatments, particularly those applied three inches below ground, quickly reduced ant activity by more than 50% compared to checks in winter 2009 (Figure 6). However, most colonies did not become inactive for 7 weeks post treatment (Figure 3). This was due in part to extended cold temperatures (<50^{o}F) that also reduced ant activity in the treated areas of the nest.

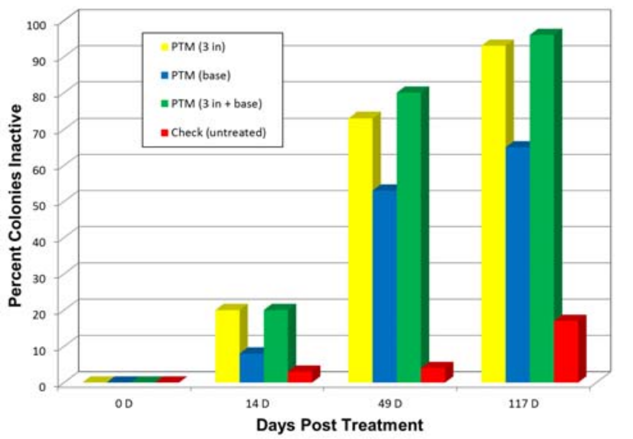

Figure 3. Efficacy of PTM™ soil injections at different depths (3", base or both) for halting imported fire ant activity 14 - 117 days after treatment, Arborgen's Woodville Seed Orchard, **Winter 2009.**

In the spring trials, 40-60% of the colonies went inactive within 2 weeks after treatment (Figure 4). However, at both sites severe drought condition reduced ant activity and subsequent exposure to the chemical. Once the area received rain in late June additional colonies went inactive (80 days after treatment). BASF has submitted a request to EPA to add imported fire ant to the PTM™ Insecticide label. A decision by EPA is pending.

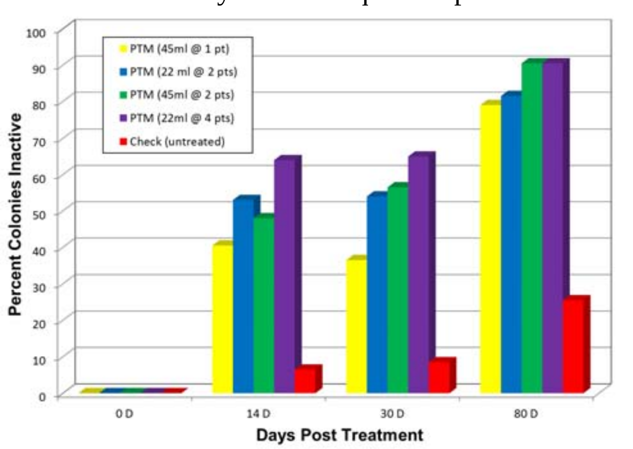

Figure 4. Mean efficacy of PTM™ soil injections at different rates for halting imported fire ant activity 7 - 87 days after treatment at two sites (TX and LA), **Spring 2010.**

Regeneration Weevils: The pales weevil, *Hylobius pales*, and pitch-eating weevil, *Pachylobius picivorus*, are two serious insect pests of pine seedlings in the eastern United States. Adult weevils of both species are attracted to freshly-harvested pine sites where they breed in logging slash, stumps and old root systems. Seedlings planted in freshly-cut areas are injured or killed by adult weevils that feed on the stem bark. It is not uncommon to have 30 to 60 percent weevil-caused mortality among first-year seedlings in the South, and mortality of 90 percent or more has been recorded.

One tactic to reduce losses caused by reproduction weevils is the use of seedling protective treatments. Pounce® 3.2EC (permethrin, FMC) had been used extensively through the 1990s. The longevity of Pounce® on treated seedlings was evaluated by the FPMC in 1998. Overall, the chemical provided protection against weevil-caused mortality even after exposure to seedlings treated six months earlier.

FMC discontinued production of the EC formulation of Pounce® in 2005. Waylay and Arctic™ (permethrin, Winfield Solutions) were registered in 2006 to replace Pounce®. Both of these new products contained similar concentrations of the active ingredient, but differ somewhat in their inert ingredients. Unfortunately, applicators have indicated that the Waylay or Arctic™ treatments have not been performing (repellency/duration) as well as Pounce® (Note: Waylay was discontinued in 2008). We were interested to know if the addition of a spreader/sticker (Complex™) to an Arctic™ solution would improve duration of protection of seedlings against weevils. Additionally, another product, OnyxPro® (bifenthrin, FMC) is already registered for use in nurseries but has not been tested for effectiveness and duration of protection against weevils when applied to pine seedlings in nursery beds.

A laboratory colony consisting of pales weevils only was established during the winter of 2009. Weevils, from the field, were collected once a week using pit traps baited with a 5:1 mix of ethanol and turpentine and set up in recently harvested tracts. In the

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laboratory, collected weevils were housed in clear plastic containers containing a layer of vermiculite, split bolts, and foliage. The plant material and vermiculite were changed every two weeks.

Two hundred seedlings (50 Arctic™-treated, 50 Arctic™ + Complex™ [sticker-treated], 50 OnyxPro®-treated, and 50 untreated) were obtained from the ArborGen's Livingston Nursery in mid-October. Treated seedlings were treated prior to lifting with Arctic 3.2 EC per label recommendations (2 qt / 100,000 seedlings) or OnyxPro® (13.9 oz / acre). All seedlings were planted in 1/2 gal pots (treatments separate) and placed outside for exposure to the elements.

At 3-8 week intervals, 3-4 seedlings for each treatment were pulled and the above-ground stem of each seedling clipped into 5 cm twig segments. Each twig was placed in an individual moistened paper sleeve and placed separately in a petri dish (Figure 5). One weevil, starved for 24 hours, was placed in each dish. All dishes were placed in a dark room (temperature: ~70°F) for up to 72 h. The number of dead weevils and an estimate of weevil feeding on cambial tissue were made at 24 h intervals for each twig. Each treatment was replicated 8 times for both male and female weevils on each of ten separate testing periods.

Figure 5. Pales weevil exposed to treated or untreated pine twigs.

Both Arctic™ treatments significantly reduced weevil feeding, by more than 90% compared to checks during each of the first seven evaluation periods (Figure 6). Weevil feeding on Arctic™-treated seedlings was significantly less than checks even 12 months after treatment. Weevil mortality was ≥88% for nearly all test periods through 7 months post treatment (Figure 7). The addition of Complex™ (spreader/sticker) did not improve the efficacy of Arctic™. The OnyxPro® treatment was only marginally effective in reducing feeding damage and causing weevil mortality.

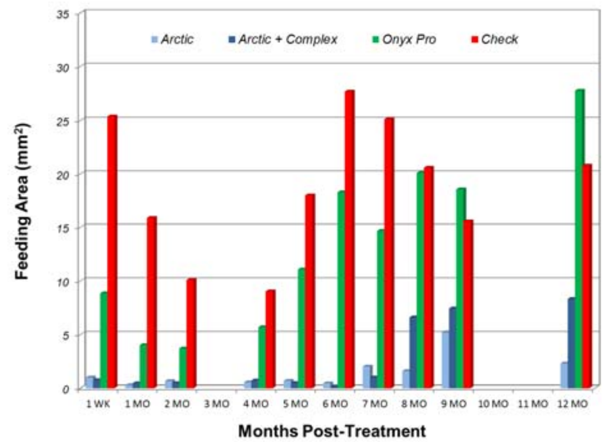

Figure 6. Feeding area by pales weevils after exposure to Arctic™ and OnyxPro®-treated pine seedlings from Arborgen's Livingston Nursery.

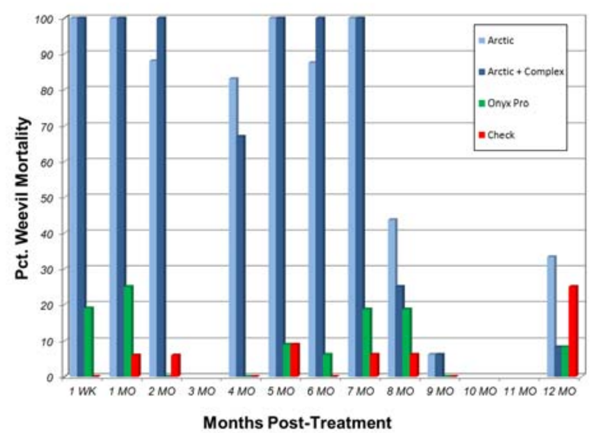

Figure 7. Mortality of pales weevils after exposure to Arctic™ and Onyx Pro®-treated pine seedlings from Arborgen's Livingston Nursery.

Based on the above results, Arctic™ appears to provide extended (7+ months) protection against regeneration weevils. **It is important that care be taken to ensure that seedlings receive full pesticide coverage during application in the nursery.** One option to improve coverage may be to position a horizontal bar in front of the spray nozzles so that seedlings are bent to expose the lower stem to the spray. Two passes, in opposite directions, should be made to assure complete coverage. Alternatively, two sets of nozzles could be used; one set in between the drills to spray the lower stems while the other set to spray down over the top of the seedlings. In this case, a single pass should be all that is necessary to provide complete coverage.

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Thought You Might Be Interested to Know . . .

Fast-growing Plants Linked to Poor Pest Resistance

(*Env. News Network*, 2/8/11 via Chemically Speaking, February 2011)

The idea that breeding plants for faster growth and higher yield may lead to a generation of crops vulnerable to pests and disease has been supported by new research. By using “knockout” mutations, researchers have disabled one gene at a time and found that genes for high yield and fast growth are closely linked to defense against pests. Plants are able to put more resources into growth by shutting down some defense genes.

For decades farmers have selectively bred crops for their yield, but Tobias Züst, lead author and a researcher at the University of Zurich, in Switzerland, said the new research shows that “you cannot just select for fast growth and high yield if you don't want your plants to be completely defenseless.” Züst's team grew the model plant *Arabidopsis thaliana* with the genes for trichomes (leaf hairs that discourage herbivores) and glucosinolate (a chemical toxic to certain pests) disabled. They introduced aphids to show the effect of removing the plant's defenses and measured the growth of the plants and the aphids' rate of reproduction. Most of the mutants had significantly higher growth rates than normal plants in early life, but the aphids reproduced faster on these plants compared with those on slow-growing plants with intact defenses.

Züst believes that breeding for higher yields has led to greater susceptibility to pests and pathogens, resulting in increased pesticide use worldwide. Zeyaur Khan, an entomologist at the International Centre of Insect Physiology and Ecology in Nairobi said that since the Green Revolution, “breeders bred plants for high yield and did not pay much attention to insect or disease resistance". Farmers had used pesticides to defeat the pests and diseases that attacked their crops because lower oil prices made them cheaper, and farmers were not aware of the environmental costs, said Khan. The problem is more acute in the developing world where the large scale use of pesticides is too expensive, he added.

But Eric Danquah, director of the West Africa Centre for Crop Improvement in Ghana, said that researchers at the centre “have in the past successfully bred early maturing and disease resistant varieties which are [also] high yielding. A generalization that faster growth will always compromise plant defense needs to be treated with caution,” he warned. Mark Laing, director of the African Centre for Crop Improvement in South Africa, does not think farmers should move away from high-yield crops completely. "Farmers mix their risk by planting a mixture of high yield potential varieties with high yield stability varieties,” he said. In a good year, with fewer pathogens and pests, the plants with high yield potential produce a bumper crop and those with high yield stability provide a stable, moderate crop. But in a bad year, where plants with high yield potential produce very little, farmers can rely on the more resistant plants to provide a stable, moderate crop.

Molasses as a Methyl Bromide Replacement for Florida Farmers

(Chemically Speaking, April 2011)

United States Department of Agriculture (USDA) scientists at the U.S. Horticultural Research Laboratory in Fort Pierce, Fla., are investigating replacements for the popular fumigant, methyl bromide. Since the 1930s, farmers have used methyl bromide to control a broad spectrum of nematodes, pests, and other pathogens. However, the EPA banned all uses of the fumigant in 2005 due to the chemical’s ability to deplete the earth’s stratospheric ozone layer. Farmers worldwide are now required to find alternatives to methyl bromide use, which for Florida farmers, has particularly been a challenge because the area’s sandy soils limit organic alternatives, and mild winters serve as a safe harbor for many nematodes, weeds and other pathogens. The Fort Pierce scientists are examining bell pepper and eggplant cropping systems that employ a combination of composted broiler litter, molasses obtained as a waste product of the sugar cane processing industry, and anaerobic soil disinfestation (ASD). ASD involves water saturated topsoil that is covered with a plastic tarp. Molasses is added as a carbon source to stimulate microbial activity. Solarization heats up the tarp and kills weed seeds in the soil, while the molasses and water creates

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conditions conducive to pest control. Variable levels of the organic materials and water amounts were evaluated. Results indicate nematode populations were reduced in the molasses and poultry litter treated soils, and grass weeds obtained the same amount of control that occurred with methyl bromide. Solarized treatments heated the soil to levels that were at or just below levels lethal to many soil pathogens. For more information, http://www.ars.usda.gov/is/AR/archive/mar11/pathways0311.pdf

The Original Pesticide Manufacturers

(LiveScience, 11/24/10 via Chemically Speaking, January 2011)

Leaf-cutter ants, which use leaves to raise a fungal crop to support a colony of millions, seem to have discovered farming long before humans evolved. They may also have been the first organism to use natural pesticides. The results of a new study suggest that fungus-cultivating ants may have co-evolved with bacteria whose antibiotic compounds help them protect their crop.

There are 230 species of fungus-farming ants, all of which cultivate fungus for food. However, their fungal crop is often attacked by a parasitic fungus, called *Escovopsis*. To prevent infections, the ants have adopted special defenses against the parasite, including fungus grooming, in which they run their mouthparts over their crops and lap up the parasite's spores, according to senior researcher Cameron Currie, an evolutionary biologist and microbiologist at the University of Wisconsin-Madison. Currie discovered leafcutter ants carried bacteria around with them, visible as fuzzy white patches on their exoskeletons. He and colleagues identified the bacteria as *Pseudonocardia* (part of a group *Actinobacteria*) that is a source of human antibiotics. There was evidence that the bacteria helped the ants maintain their fungus gardens.

Currie and his team found that of the roughly six types of *Pseudonocardia* bacteria, certain types are associated with certain species of ants and their agricultural systems. For instance, among ants that raise fungus on cut leaves, the vast majority of the symbiotic bacteria present belong to two closely related groups. The researchers also tested how effective different *Pseudonocardia* strains were in suppressing fungal growth, particularly that of the ants' nemesis *Escovopsis.* Here, they found that the parasite was more susceptible to the antibiotics produced by *Pseudonocardia* than were other fungi. They also noticed that strains of *Pseudonocardia* found dwelling on ants were more effective against the parasite than free-living strains.

Currie estimates that ants have been growing fungus gardens for up to 50 million years. Relatives of the parasitic fungus are known to attack other fungi, including relatives of the fungal crops. This suggests that when ants domesticated the fungus, they probably acquired the pathogen as well, he said. It's hard to put a date on when the ants recruited the bacteria to help, but this study suggests the bacteria have been associated with this system for long periods as well, he said. In fact, some fungus-growing ants house *Pseudonocardia* within cavities in their workers' exoskeletons, and may even feed them from specialized glands. On their nuptial flight, queens carry a pellet of the fungal crop in their mouths and the bacteria on their exoskeletons to their new colony. To have such a specialized partnership suggests a long period of evolution. A piece of 20+ million-year-old amber from the Dominican Republic provides evidence as bacteria are visible on an ant trapped within it. It's not clear; however, which type of bacteria is associated with the preserved ant, according to Currie.

New Systemic Insecticide Approved for Pest Control in Conifers and Hardwoods

(*The Forestry Source, Vol. 16, No. 3, March 2011 via*
County Forest Landowner Association Newsletter, 2nd Quarter, 2011)

Pest management specialists now have a new tool for protecting high-value trees from insect pests. The Environmental Protection Agency (EPA) has approved the use of emamectin benzoate (EB), sold by Syngenta Crop Protection under the trade name TREE-äge® for "control of mature and immature arthropod pests of deciduous, coniferous and palm trees, including, but not limited to, those growing in residential and commercial landscapes, parks, plantations, seed orchards, and forested sites (in private, municipal, state, tribal and national areas)."

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Bringing EB to the market as a registered pesticide was a long process involving many collaborators. Dr. Don Grosman, coordinator of the Texas Forest Service Forest Pest Management Cooperative (FPMC), first started working with Dr. David Cox, Syngenta Crop Protection, in 1997 and then later with Joe Doccola, Arborjet Inc. (2003), to test tree injections of EB as a systemic treatment for control of cone and seed insects, bark beetles, wood borers, and other forest pests. In nearly all trials, this chemical has provided excellent extended protection against these pests both in conifers and hardwoods.

In early trials (1998), EB almost completely eliminated coneworm damage for two years in loblolly pine seed orchards in Texas. The effect against seed bugs, another group of seed orchard pests, was moderate. A second trial ultimately showed that a single injection of EB reduced average coneworm damage by 80% over a 6-year period. Unfortunately, the seed orchard market alone (just 9,000 acres in the South) is insufficient to justify the cost of EPA registration.

In an attempt to expand the potential market, the FPMC began tests in 2003 on other forest pests. A laboratory test showed that substantially fewer pine regeneration weevils survived when they fed on EB-treated branches compared to those fed on untreated branches. A second trial in 2004 looked at chemical effects against pine bark beetles, forest pests closely-related to weevils. Surprisingly, EB completely prevented the successful attack and colonization of *Ips* engraver beetles on cut logs and standing loblolly pine trees. Subsequent trials showed that single injections of EB could significantly reduce mortality of loblolly and ponderosa pines attacked by southern pine beetle and western pine beetle, respectively, for 3 years. Other researchers also have found EB to be effective against several species of defoliators (gypsy moth, spruce budworm, tent caterpillars, winter moth, bagworm, fall and mimosa webworm, tussock moth, leafminers and sawfly), borers (clearwing, flat-headed and roundheaded), pine needle scale, red palm mite, and pinewood nematode. With the larger potential market, Syngenta decided to pursue EPA registration of this systemic insecticide.

In 2009, EPA approved the use of emamectin benzoate on ash trees for protection against emerald ash borer and other insects, but postponed a decision on other tree species. More recently, EPA has approved the use of TREE-äge (by injection) on additional trees, including conifers, other hardwoods, and palms.

The FPMC currently is evaluating the efficacy of TREE-äge® against several invasive insects such as the soapberry borer (a cousin of emerald ash borer) on western soapberry in central Texas and a chalcid wasp attacking Afghan pine in west Texas. Preliminary results are favorable. In addition, along the Rio Grande River in Texas and Mexico, populations of a leaf beetle introduced to control saltcedar have also infested athel, an important shade tree closely related to saltcedar. A new trial was established in 2010 to evaluate the effect of TREE-äge® injections for protection of valued athel trees from beetle-caused defoliation.

TREE-äge® is applied as a trunk injection treatment at very low rates (0.1 – 0.6 g per inch DBH) near the base of target trees. The FPMC has demonstrated that several injection systems (Arborjet's Tree I.V., QUIK-jet and VIPER™ Hydraulic Device, http://www.arborjet.com/; ArborSystem's Portal System http://www.arborsystems.com/; and the Sidewinder (http://www.treeinjectors.com/) can be used to effectively apply this product into conifers and hardwoods. Once EB is injected into the sapwood, the chemical is translocated throughout the tree (foliage, cones, branches, stem and roots). The rate of movement within the tree is dependent on tree species, tracheal system type, and water availability. Generally, it is recommended that injections are made at least 4 weeks prior to target insect appearance to allow insecticide distribution throughout the tree.

Applications of TREE-äge® can be made at nearly any time of the year. However, uptake of the product is dependent upon the tree's rate of transpiration. For optimal uptake, apply when soil is moist, soil temperatures are above 45°F, ambient temperatures are between 40° and 90°F, and during the day when transpiration is greatest, typically before 2:00 PM. Applications to drought- or heat-stressed trees may result in injury to tree tissue, poor treatment and ineffective control. Injection treatment is most effective on trees having a full canopy of leaves and a healthy vascular system.

TREE-äge® insecticide is a Restricted Use Pesticide and must only be sold to and used by a state certified applicator or by persons under their direct supervision. TREE-äge® is currently registered in 38 states (blue in map below) including TX, OK, AR, LA, GA, FL, NC, SC, TN

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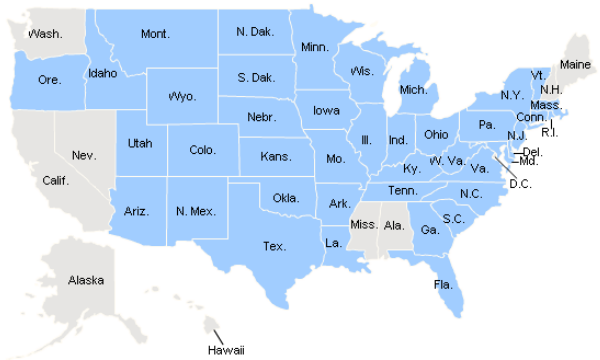

and VA in the South. Approval in other states is pending. It is important that all users read the label and follow all precautions and guidelines.

TREE-äge® is currently available in 1-liter containers from two distributors: Rainbow Treecare Scientific - contact Dean Morris at (952) 252-0506, (612) 280-9038 or dmorris@trecarescience.com) and John Deer Landscapes (to find the branch location nearest you, go to http://www.johndeerelandscapes.com/storelocator/bullseyepro/search.asp, or contact Chad Schnicter at (972) 881-0205 or Tim Kline (972) 681-5511. The latest price quote is $525 per liter (discounts are available when purchasing a case of 8 liters or more). Thus, the cost to treat a 10 inch DBH tree at a medium rate (0.2 g AI per inch DBH) would be about $28 while a treatment of a large (25 inch DBH) tree would be about $68 (labor excluded).

For additional information, contact Dr. Don Grosman, Texas Forest Service, Forest Health, P.O. Box 310, Lufkin, TX 75902-0310; (936) 639-8170; dgrosman@tfs.tamu.edu.

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Pest Spotlight: White-tailed deer (*Odocoileus virginianus*)

(Source: http://wildlifecontrol.info/pubs/Documents/Deer/Deer_factsheet.pdf)

The white-tailed deer *(Odocoileus virginianus)* is the most widespread and abundant member of the deer family and one of the best recognized large mammals in North America. White-tailed deer are a valuable component of our wildlife heritage and are avidly sought by hunters, photographers, and nature observers. However, deer cause more damage to North American crops than any other wildlife species. Foraging deer can severely hinder regeneration of newly-stocked stand.

Biology

The buck, or male deer, stands 3 to 3 1/2 feet tall at the shoulder, weighs 125 to 200 pounds, and grows antlers that are shed annually. Does are smaller and lighter than males and lack antlers.

White-tailed Deer

Deer are red-brown during summer and grow brown-gray winter coats each fall. Fawns (deer that are less than one year old) typically weigh 4 to 8 pounds at birth and have red-brown hair with white spots, which they lose as they grow their first winter coat.

White-tailed deer breed from mid- September through late February, and the peak of the breeding season, or rut, occurs in November. Fawns are born in the early summer after a 200-day gestation period. In their first pregnancy, does usually give birth to a single fawn, though twins are common in later years if food is abundant.

Bucks begin to develop antlers in April, and the antlers grow until August or early September. The size of the antlers depends primarily on age and nutrition; older bucks typically have larger antlers. Growing antlers are covered with a skin called "velvet." This skin is covered with soft hairs and contains blood vessels that supply nutrients to the growing antlers. When the antlers stop growing the velvet dries and is shed or rubbed off by the buck as he polishes his antlers on saplings, shrubs, or rocks. Bucks shed their polished antlers each winter in preparation for the growth of a new set.

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Habitat and Food Habits

Deer live on the forest edge rather than in continuous areas of mature forest. They prefer mixed conifer-hardwood forests, shrublands, and old fields with active cropland nearby. This rich mixture of vegetation produces abundant food and cover. Deer are very adaptable, however, and greater numbers are living in suburban neighborhoods, which have a combination of open lawn, succulent summer gardens, plentiful ornamental shrubs, and patches of forest cover.

Deer feed primarily on grasses, forbs, crops, leaves, twigs, and buds during late spring and summer. They forage on mast (e.g., beechnuts, wild cherry seeds, and acorns) during fall and concentrate almost entirely on twigs and buds during winter and early spring.

The amount of food that a deer must consume daily depends on its gender and body weight and the season. In general, deer consume 3 percent of their body weight each day. Therefore, a buck weighing 125 to 250 pounds requires from 4,000 to 6,000 calories each day, which can be obtained from 4 to 10 pounds of grass, forbs, and twigs.

Description of Damage

Deer frequently feed on flowers, fruits, and vegetables and the buds and twigs of fruit trees and ornamental shrubs. Damage to landscape plantings and ornamentals may occur at any time of year but is usually most severe in the late winter and early spring when other food supplies are limited. Damage to fruit trees may cause both the immediate loss of the crop and residual tree injury that leads to reduced yields in the future. Deer browsing may permanently disfigure ornamental trees.

Deer can also affect their own habitat and the abundance of other wildlife species. Overpopulation can profoundly influence the presence, absence, and abundance of plants and other wildlife. In many forests, over-browsing of tree seedlings creates open, park-like stands that have little or no vegetation near ground level. Instead of a diversity of woody and herbaceous plants, the ground surface may be dominated by ferns, grass, and woody shrub or tree species that are not preferred by deer. Wildflowers preferred by deer, such as various species of *Trillium* and Canada mayflower, may be reduced in abundance or eliminated completely from forests where deer densities are high.

Reduction of the understory, which gives forests a park-like appearance, removes important nesting and feeding sites for some forest songbirds. Nesting in more open forests can make bird eggs and nestlings easier for predators to detect. Some species may leave the area, whereas others will be less abundant than they once were. In addition, other wildlife, such as squirrels and chipmunks, must compete for acorns, a food preferred by deer.

Deer prefer certain plant species over others and frequently feed on economically valuable tree species. For example, they prefer oak and sugar maple seedlings, as well as acorns, over less palatable species like American beech and striped maple. Thus, less marketable species are more likely to survive to maturity, replacing more valuable trees. This change in species composition will have dramatic effects on our future forests and forest-related industries.

Economic Impacts

Annual estimates of deer damage are reported to exceed $2 billion nationwide, including $1 billion in car damages, more than $100 million in agricultural crop damage, $750 million in damage to the timber industry, and more than $250 million in damage to metropolitan households (e.g., landscape plantings). These estimates are conservative, and it is often difficult to obtain reliable statistics for wildlife-related losses.

Identifying Damage

Deer feeding damage is readily distinguished from that caused by rabbits or rodents. Whereas rabbits or rodents leave a clean-cut surface, deer lack upper incisors and leave a ragged, broken end on browsed branches. Another indication is the height of the damage from the ground (up to 6 feet), which often rules out smaller mammals.

Laws and Regulations

Deer are classified as game animals and may be killed only during legal hunting seasons by persons holding a valid big game license. Check with the state wildlife agency about obtaining a permit allowing landowners to kill deer when they become a nuisance or harm property. If sufficient damage is evident, some states may issue crop damage permits for the harvest of a specified number of deer outside the regular hunting season. The use of damage permits can be time-consuming, however, and often doesn't greatly reduce the damage.

Preventing Damage

Although repellents and fencing are the primary techniques used to address site-specific deer damage

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problems, these methods will not decrease damage on a community-wide scale. Deer population will increase if mortality is low and food is abundant, and they can double in size every two to three years. Although the annual hunting season is an effective way to reduce deer populations and thus damage in rural areas, buck-only harvests cannot reduce or stabilize deer numbers. Where possible, landowners suffering damage should encourage or require hunters to harvest sufficient numbers of does (within the legal limits). Harvesting female deer is essential to reducing deer numbers and deer damage. In suburban areas where hunting may not be practical, some other form of mortality may be required to stabilize herd growth. Reproductive inhibitors are currently experimental and difficult to apply across areas of several square miles.

Choice of Landscape Plantings

In some cases damage can be reduced by selecting plant species that deer don't prefer. When deer densities are high or natural foods are limited, especially in the winter or early spring, deer may browse on species they otherwise would not eat. When planting species that deer find desirable, be aware that they will almost certainly require protection if deer are present in the landscape. A detailed listing of woody plants and their relative resistance to deer browsing is available in the Cornell Cooperative Extension fact sheet *Resistance of Woody Ornamental Plants to Deer Damage (http://www.mycce.org/monroe/horticulture/factsheets/fs_deerresist.pdf)*. No plants are completely deer-proof, and hungry deer will consume plants that have little nutritional value.

Scare Devices

A variety of frightening devices, including lights, whistles, loud noises, and scarecrows, has been used to prevent deer damage. Audio and visual scare devices are not recommended around the home or near urban or suburban areas, however, because of disturbance to neighbors, possible violation of noise ordinances, and lack of effectiveness. Deer habituate to scare devices after a few days of exposure.

Repellents

Repellents can help prevent deer from feeding on crops or landscaping plants and are most effective when integrated in a damage abatement program that includes one or more other techniques such as fencing and population management. Repellents are best for small orchards, gardens, and ornamental plantings around the home. Their utility is limited for row crops, forages, and other large acreages because of high costs, limitations on use, and variable results. Apply repellents at the first sign of damage to prevent deer from establishing a feeding pattern.

Repellents fall into two broad categories— those that repel by taste and those that repel with a disagreeable odor. Most deer repellents can be applied as a spray to ornamental shrubs and nonbearing fruit trees. Hinder, an ammonium soap-based repellent, and Deer-Off, a product that incorporates putrescent egg solids, are the only repellents currently approved for use on garden vegetables and fruit-bearing trees during the growing season.

The effectiveness of repellents depends on the number of deer, feeding habits, and environmental conditions. If deer are very hungry and other food supplies are limited, repellents may not work. Some damage must be tolerated with the use of repellents, even if browsing pressure is low. Young trees should be treated completely. On older trees, treat only terminal growth that is within reach of deer (up to 6 feet above ground). Growth that appears after treatment may need to be sprayed again. Repellents should be applied when precipitation is not expected for 24 hours and temperatures will remain between 40° and 80° F for that period. Research trials have shown that odor-based products usually outperform taste-based materials. No commercial repellent is 100 percent effective, and under heavy deer browsing pressure the best materials must be reapplied about every five weeks. This may limit their use in areas that have deep snow and below freezing temperatures during winter.

The deer repellents listed in Table 1 are grouped by active ingredient and include a brief description of use, application rates, and costs. Product labels provide all necessary information on use and must be followed to meet legal requirements and achieve maximum success. The active ingredients are shown in parentheses after the trade names. Cost estimates are provided for comparative purposes. "Home remedies" such as tankage, soap, bobcat urine, and human hair may act as repellents. However, because both state and federal regulatory agencies prohibit the commercial use of products not registered by the Environmental Protection Agency (EPA), we do not recommend them.

Fencing

If deer densities are high, tolerance of damage is minimal, or particularly valuable plants need to be protected, fencing alone or fencing plus repellents may be the best option. Many different fence designs are available; the one you select may be based on cost-effectiveness, aesthetic considerations, or ease of construction.

Table 1. Repellents

Repellent	Formulation	Plants for Which Registered	How to Apply	Length of Effectiveness	Cost	Remarks
Deer Sway Big Game Repellent (37% commercial putrescent egg solid)	Primarily odor-based; available as spray and powder	Fruit trees before flowering, ornamental and Christmas trees	Spray on all susceptible plant parts	Minimum of five weeks with heavy feeding pressure	1- gallon liquid kit: ~$26	Used extensively in western conifer plantations. Has been reported to be >85% effective in some field studies.
Deer-Off Repellent Spray (3.1% egg solids, 0.0006% capsaicin, and 0.0006% garlic)	Combination of odor- and taste-based product; available as spray	Flowers, grasses, bullbs, ornamental shrubs, edible crops, plants, seedlings, trees	Apply to all leaves, stem and branches at onset of deer damage	About five weeks with heavy feeding pressure	1-pint kit: ~$28; makes about 1 gallon of spray	
Hinder (ammonium soaps of higher fatty acids, 13.8%)	Odor-based	Home gardens, ornamentals, annual and perennial flowers, fruit trees until one week before harvest	Apply directly	About four weeks; varies owing to weather and application technique; reapplication may be necessary after heavy rains.	1 gallon liquid: ~$40	One of the few repellents registered for use on edible crops. Can be painted full strength on the bark of trees to prevent rabbits from chewing the bark. Compatible with most pesticides.
Miller's Hot Sauce Animal Repellent (2.5% capsaicin)	Taste-based	Ornamentals, fruit and nut trees, bushes, vines, and hay bales stored in the field; can also protect vegetable crops if sprayed before development of edible parts.	Backpack or hand-pump spray on all susceptible plant parts	Two weeks	Hot Sauce (~$80/gal) and Vapor Gard (~$30/gal)	Weatherability can be improved by adding an antitranspirant (Nu-Film-17, Vapor Gard). The 10X and 100X concentrations approved for ornamentals have preveented deer and elk damage to trees. Do not apply to frit-bearing plants after fruit set.
Nott's Chew-Not and Deer Pro (20% thiram)	Fungicide that acts as a taste-based repellent; liquid formulation	Dormant trees and shrubs	Spray or paint on individual trees.	About six weeks	2 gallon 42% thiram: ~$50	Add adhesive (Latex 202-A or Vapor Gard) to mixture to increase resistance to weathering. Thiram also provides protection of trees against rabbits and voles.
Tree Guard (0.2% dentonium benzoate)	Taste-based; ready-to-use spray	Shrubs, ornamental plants, conifers, and non-bearing deciduous trees; not intended for use on food or feed crops	Spray on all susceptible plant parts	About two weeks with heavy feeding pressure	1 quart: ~$20; 1 gallon: ~$40	This product may not protect yews from deer damage during winter.

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