Progress **E**ducation **S**cience **T**echnology

Dec. 2013

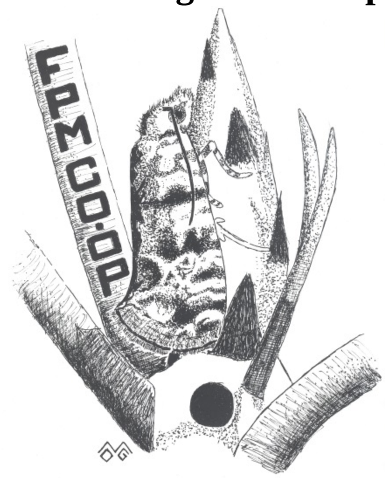
Quarterly Newsletter on Forest Pest Management Issues

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 in pine seed orchards and plantations. The newsletter focuses on, but is not limited to, issues occurring in the Western Gulf Region (including, Arkansas, Louisiana, Mississippi, Oklahoma, and Texas).

Announcement:

The Forest Pest Management Cooperative Executive Committee met in Lufkin on November 12, 2013, to review 2013 progress and accomplishments and discuss plans for 2014. The next meeting of the Executive Committee will take place on February 6, 2014 in Austin, TX. The meeting will be held from 10:00am till 3:00pm at the Texas A&M Forest Service, Austin Regional Office 6330 Hwy 290 East, Suite 115 Austin, TX 78723. Lunch will be provided. The primary objective will be to develop and approve a 5-year work plan for the FPMC.

Forest Pest Management Cooperative



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

Texas A&M Forest Service, Forest Health,
P.O. Box 310, Lufkin, Texas 75902-0310

FPMC Under New Leadership

In 1996, faced with limited state funding and little federal support for research on pests of seed orchards and young pine plantations, the Texas Forest Service (TFS, now Texas A&M Forest Service) established the Western Gulf Forest Pest Management Cooperative. Now known simply as the Forest Pest Management Cooperative (FPMC), this partnership is in its 17th year.

From its establishment until December 31, 2012, the coop operated under the direction of Coordinator Dr. Donald Grosman. Dues paid by members of the FPMC, financial support from TFS, and research grants from the US Forest Service and various chemical companies are used to support a small staff of full- and part-time TFS employees. After successfully leading the FPMC for 16 years, Don resigned to accept a position with Arborjet, Inc., a pest management company based in Woburn, MA. Following a nation-wide search, Melissa Fischer was selected to take over the role of FPMC Coordinator. She also holds both a Bachelor and Master of Science degree in forestry and forest health/silviculture from Northern Arizona University. She successfully completed her Ph. D degree in forest entomology at Virginia Tech University and began work as FPMC Coordinator in Lufkin in September, 2013. The mission of the FPMC is to conduct applied research on forest and urban pest problems with emphasis on those pests that coop members deem important, develop pest management recommendations, and transfer information and technology to members.

Membership in the coop has increased from an initial five members, mostly forest industries, to 12 in 2013. In recent years, as forest industries sold their lands, many dropped from the coop, to be replaced by the new landowners, various Timber Investment Management Organizations (TIMOs) and Real Estate Investment Trusts (REITs). The Texas A&M Forest Service, the only remaining charter member, and the US Forest Service, Forest Health Protection (a member since 1998), continue to support the coop.

When the coop began, research was focused on development of methods to protect valuable cone and seed crops in pine seed orchards and newly-planted pine seedlings in commercial plantations. One systemic chemical, emamectin benzoate, injected into selected seed orchard trees, proved particularly effective for reducing cone losses to coneworms, a major seed orchard pest. Up to six years of protection were achieved with a single injection.

But, getting a chemical company to pursue Environmental Protection Agency (EPA) registration of this promising new chemical faced a major road block. Cone and seed insect applications in pine seed orchards simply provided too small a market to justify the cost of EPA registration. Fortunately, subsequent FPMC field trials demonstrated the efficacy of this systemic insecticide for protection of trees against several species of *Dendroctonus* and *Ips* bark beetles in the southern and western U.S. These included the southern pine beetle in
field trials supported the registration of Bayer's SilvaShield™ Forestry Tablets (containing 20%

Alabama, Mississippi and Virginia, and the mountain pine beetle, western pine beetle, and the spruce beetle in the western U.S. and British Columbia.

In light of this greatly expanded number of target pests, the Environmental Protection Agency approved this systemic insecticide in December 2010 for operational use in seed orchards, forest, residential, and commercial landscape situations. Pest control operators now have another tool for protecting trees from a wide variety of forest pests. Since then, emamectin benzoate, sold under the trade name of Tree-age®, has gained a reputation as the "silver bullet" for protecting high-value trees. Among these are ash trees threatened by the invasive emerald ash borer in the Lake States, the Northeast and just recently in Georgia. One limitation is that emamectin benzoate is a restricted use insecticide. This means that the insecticide can only be purchased and applied by certified pesticide applicators.

In recent years, the FPMC also has evaluated emamectin benzoate for prevention of attacks by the invasive soapberry borer in central Texas, as well as chalcids on Afghan pine and saltcedar beetles attacking athel trees in west Texas. Additional studies are underway to evaluate injection treatments of various systemic pesticides for prevention of thousand cankers disease, conifer mites, black turpentine beetles, oak wilt, and hypoxylon canker.

FPMC research also has addressed the impact of Nantucket pine tip moth (*Rhyacionia frustrana*) on young pine plantations, developed tip moth hazard rating methods, and new insecticides for prevention. Results from FPMC

imidacloprid plus fertilizer) in 2006 for tip moth and other plantation pests. In 2007, further

FPMC research led to registration of PTM™ Insecticide (9% fipronil), a BASF product, for control of pine tip moth and aphids in young pine plantations. According to BASF, in August 2013 EPA approved the addition to the PTM™ label of fire ants and application to container seedlings using a novel plug injector system – more contributions of the FPMC. Billi Kavanagh, a research specialist with TFS and the FPMC, has headed up these tip moth studies since 2008. She recently resigned her full-time position to dedicate more time to a growing family, but the position is to be refilled shortly.

FPMC efforts have contributed to registration of an impressive number of other new insecticides to improve forest pest management. Among these are Volcano® (no longer available), Amdro® Ant Block, and PTM™ Insecticide for control of Texas leaf-cutting ants; Sporax™ for control of annosus root disease; and Pounce®, Waylay™ and Arctic™ 3.2 EC for control of regeneration weevils affecting pine seedlings. (Of the latter three, only Arctic 3.2 EC is currently registered).

As the FPMC forges ahead under new leadership, the dedicated FPMC staff and coop members are to be congratulated for making this pest research and technology transfer partnership a success.

Summary of 2012 FPMC Research Project:

Evaluation of PTM™ and Insignia®SC Rate for Bareroot Pine Seedlings

Objectives:

1. Evaluate the efficacy of PTM™ (fipronil) and Insignia®SC (pyraclostrobin) alone or combined applied to bareroot seedlings at different rates for reducing pine tip moth infestation levels and improving seedling health
2. Determine the duration of chemical activity

Bareroot seedlings were individually treated after planting using a PTM injection probe system. The seedlings were treated with PTM™ and/or Insignia®SC at different rates. Tip moth damage was evaluated after each tip moth generation. Measurements of tree health were collected at the end of each growing season. All PTM and PTM + Insignia treatments significantly reduced overall percent tip moth infestation compared to the control (by 78% and 75% respectively) (Table 1). Insignia treatments alone resulted in an overall reduction in pine tip moth infestation by only 2%.

None of the treatments resulted in a significant improvement in diameter (Table 2). All three PTM treatments and the PTM + Insignia low concentration treatment resulted in a significant improvement in height. Volume was only significantly improved in the case of the low and high concentration PTM treatments (Table 2).

Table 1. Effect of PTM and/or Insignia SC does and technique on pine tip moth infestation of containerized and bareroot loblolly pine shoots (top whorl) on five sites across the southeastern United States, 2012.

Year	Treatment #	Conc. PTM	Conc. Insignia	Dilute or Undilute	# of inj. Pts.	N	Gen 1	Gen 2	Gen 3	Gen 4	Gen 5 or Last	Overall Mean
							Mean Percent Top Whorl Shoots Infested by Tip Moth (**Pct. Reduction Compared to Check**)					
2012	1	High	X	dilute	2	30	0.0 **100**	0.0 **100** *	6.0 **78** *	15.5 **69** *	16.4 **67** *	5.4 **79** *
	2	Mid	X	dilute	2	30	3.33 **3**	1.1 **95** *	2.6 **90** *	18.4 **63** *	21.3 **58** *	6.4 **75** *
	3	Low	X	dilute	2	30	0.0 **100**	0.0 **100** *	4.2 **85** *	16.4 **67** *	15.3 **70** *	5.1 **80** *
	4	X	High	Undilute	4	30	1.3 **61**	21.0 **3**	19.8 **27**	64.7 **-28**	76.9 **-53** *	26.7 **-4**
	5	X	Mid	Dilute	2	30	0.0 **100**	18.1 **17**	30.6 **-13**	61.5 **-22**	70.1 **-39** *	27.5 **-7**
	6	X	Low	Dilue	2	30	0.0 **100**	5.1 **76** *	24.1 **11**	55.5 **-10**	59.2 **-18**	21.2 **18**
	7	High	High	Undilute	4	30	0.0 **100**	0.0 **100** *	1.2 **96** *	11.6 **77** *	13.7 **73** *	3.2 **88** *
	8	Mid	Mid	Dilute	2	30	1.1 **68**	3.4 **84** *	7.9 **71** *	23.5 **53** *	26.2 **48** *	9.0 **65** *
	9	Low	Low	Dilute	2	30	0.0 **100**	0.7 **97** *	1.2 **96** *	27.1 **46** *	13.0 **74** *	7.2 **72** *
	10	X	X	X	X	30	3.4	21.7	27.1	50.4	50.4	25.7

***** Means followed by an asterisk are significantly different from checks at the 5% level based on Fisher's Protected LSD.

Table 2. Effect of PTM[TM] and/or Insignia SC[TM] dose on bareroot loblolly pine growth on one site in East Texas, 2012.

Year	Treatment	Conc.	Dilute or Undilute	N	Height (cm)			Diameter (cm) [a]		Volume (cm^3)		
Treatment					Mean End of Season Loblolly Pine Seeding Growth Measurements (**Growth Difference (cm or cm3) Compared to Check)**							
2012	PTM Only	High	Dilute	29	63.8	*	**14.9**	1.32	**0.2**	130.5	*	**46.1**
	PTM Only	Mid	Dilute	29	58.0	*	**9.1**	1.18	**0.0**	93.0		**8.7**
	PTM Only	Low	Dilute	30	61.8	*	**13.0**	1.29	**0.1**	123.9	*	**39.5**
	Insignia Only	High	Undilute	29	54.4		**5.6**	1.13	**0.0**	84.1		**-0.3**
	Insignia Only	Mid	Dilute	29	50.2		**1.4**	1.11	**-0.1**	72.2		**-12.2**
	Insignia Only	Low	Dilute	29	53.4		**4.6**	1.12	**-0.1**	78.3		**-6.1**
	PTM&Insignia	High	Undilute	28	57.0		**8.2**	1.12	**0.0**	97.6		**13.2**
	PTM&Insignia	Mid	Dilute	28	58.0		**9.1**	1.21	**0.0**	115.7		**31.3**
	PTM&Insignia	Low	Dilute	28	61.5	*	**12.7**	1.29	**0.1**	127.2		**42.8**
	Untreated			28	48.8			1.17		84.4		

[a] Ground Line Diameter.

***** Means followed by an asterisk are significantly different from checks at the 5% level based on Fisher's Protected LSD.

New FPMC Project for 2014:

Identification and Control of Disease Affecting Pine Cone Crops

Objectives:

1) Evaluate the potential efficacy of injections of new and older formulations of systemic fungicides (propiconazole, phosphorous acid, and A13972A) in reducing cone losses due to pitch canker in pine seed orchards

2) Determine the duration of treatment efficacy

Justification:

A specific clone at Arborgen's seed orchards in Livingston and Woodville, TX and Bellemy, FL recently experienced significant cone mortality. Initially, the mortality was attributed to coneworm. However, an evaluation of several dead second-year cones at the Livingston orchard on November 22, 2013 found no evidence of coneworm-caused damage (entrance/exit holes, frass, webbing, pitch blisters, or hollow interior). Instead, cones were discolored (dark brown to black), showed some resin on portions of cone, and were clamped shut (had not released seeds). A couple of branches on one tree exhibited signs of pitch canker (*Fusarium moniliforme* var. *subglutinans*) infection (pitch on branch and dead needles were retained). We suspect that pitch canker may be causing the cone mortality instead of coneworm.

Arborjet has a few systemic fungicides [propiconazole, phosporous acid, and A13972A (Syngenta experimental) that may be effective against *Fusarium* fungi.

Research Approach:

Field Test (2013): Twenty-five (25) dead cones will be collected from 5-10 trees at Livingston, Woodville, and Bellamy orchard in early December 2013. Note: Cones will be randomly selected from different heights and directions on each tree. The cones will be evaluated by Texas A&M Forest Service personnel as to the likely cause of mortality (coneworm, disease, or other).

Laboratory Trial: Three (3) dead second-year cones (with attached 4" section of branch) will be collected in early December 2013 from five trees at Arborgen's Livingston, Woodville, and Bellamy seed orchards. Cones from individual trees will be placed in separate Ziploc bags and shipped to Arborjet's facility. All pathogens will be identified via the following method:

1. Collect disease samples from living branches that have both diseased and healthy tissue. With a sterilized knife, remove the outer bark, exposing the canker margin.
2. Using aseptic techniques, remove 1/4 inch (6 mm) square wood chips from the canker margin, briefly dip the chips in 95 percent ethanol, and shake off the excess alcohol. Flame sterilize the outer surface of the chip, being careful not to overheat the sample.
3. Transfer the surface-sterilized chips to potato dextrose agar or to a Fusarium-selective media. Incubate plates for 5 to 10 days under normal laboratory lighting and temperature conditions.
4. On the selective media, the pathogen appears as slow-growing, granular, white colonies. Transfer a portion of the colonies to fresh potato dextrose agar media or 2 percent water agar (supplemented with a washed, autoclaved, carnation leaf) for positive identification. The pitch canker fungus produces characteristic microconidia, macroconidia, and polyphialides (chlamydospores are absent).

Potential systemic fungicides (propiconazole, phosphorous acid, emamectin benzoate, and

A13972A) will be evaluated in vitro at different concentrations (10,000, 1,000, 100, 10, and 1 ppm). Two 0.5 cm circles of filter paper will be treated with selected rate of fungicide and placed on the surface of the media in plates. A line of inoculum is drawn between the discs. There will be 6 replicates per chemical and rate. The plates are incubated for 5-10 days as indicated above. The shortest distance between fungal mat and filter paper will be measured in each plate.

Field Trial (2014): The study will be conducted in 2014 at two loblolly pine orchards (Livingston and Bellamy). In April 2014, 24 ramets of the affected clone (previously treated with TREE-age in 2012) will be selected at each site. The treatments will be evaluated using a randomized complete block design, with sites as blocks. The treatments will include:

- Propiconazol (Propizol®, Arborjet), 0.86 g AI (=6.0 ml) per inch DBH
- Phosphorous acid (Phosphojet, Arborjet), 2.7 g AI (=6.0 ml) per inch DBH
- A13972A (experimental, Syngenta), 0.53 g AI (= 6.0 ml) per inch DBH
- Control

All injection treatments will be applied in April 2014 using the Arborjet Tree IV™ microinfusion system (Arborjet, Inc. Woburn, MA, http://www.arborjet.com/). Each treatment will be injected into eight points (depending on tree diameter) about 0.3 m above the ground.

Conelet and cone survival will be evaluated in 2014 and, if warranted, 2015 by tagging 6 to10 branches on each tree (50 conelets and 50 cones, if possible) at the time of injection. Counts of surviving conelets and cones from these branches will be made in September of each year. Reduction of coneworm and pitch canker damage will be evaluated by collecting all second year cones from each tree in October of 2014 and 2015. From the samples, counts will be made of healthy and coneworm-, and pitch canker-killed cones.

Pest Update

Southern Pine Beetle, *Dendroctonus frontalis*

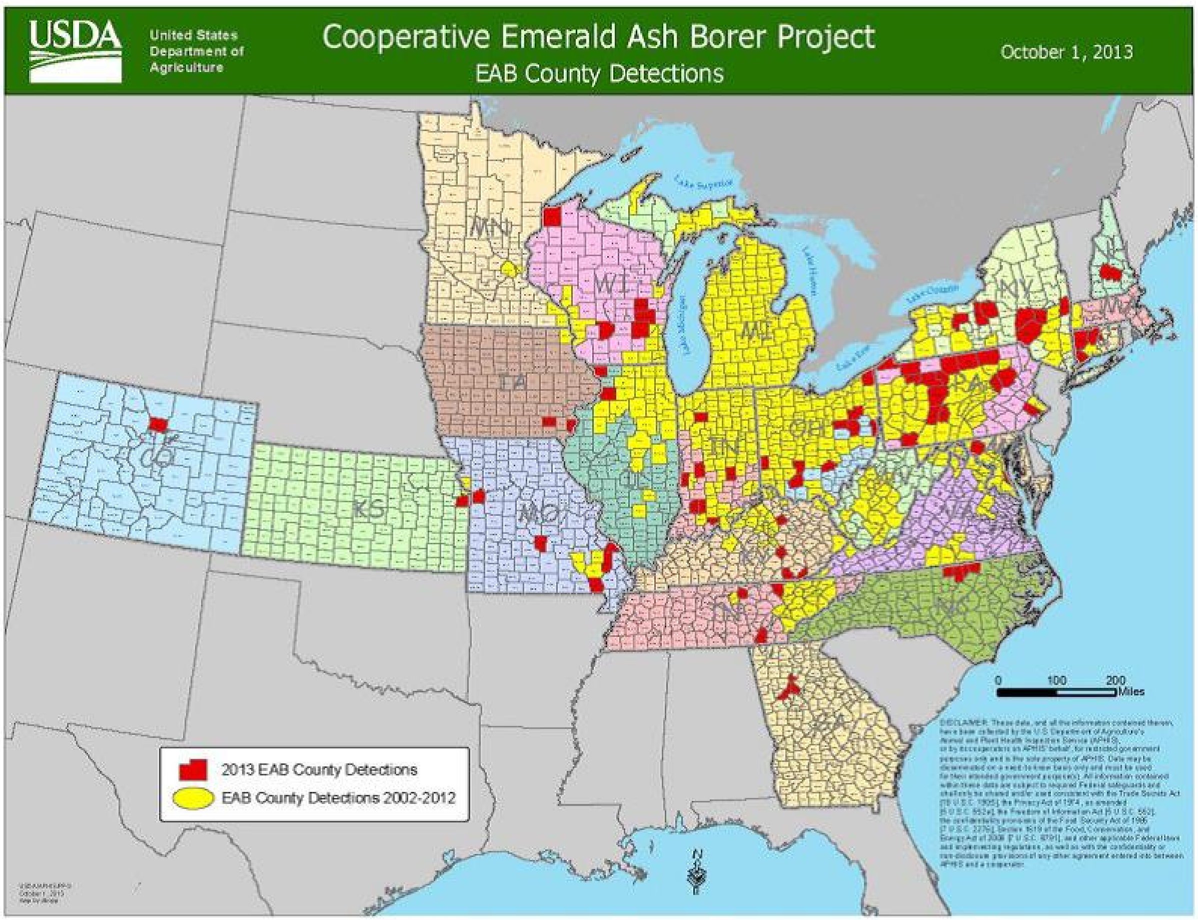
The annual southern pine beetle pheromone trap survey was conducted in 17 counties in East Texas in the spring of 2013. No SPB adults and more than 10,400 predator beetles (checkered or clerid beetles) were caught in 49 traps deployed in 17 counties, including the four National Forests (Angelina, Davy Crockett, Sabine, and Sam Houston) and the Big Thicket National Preserve. Based on these results, no SPB infestations were predicted in East Texas for 2013. These predictions proved valid, as not a single SPB spot was reported (for the 16th consecutive year). No SPB infestations were found in Louisiana, Arkansas or Oklahoma, either, as forecasted by early season pheromone traps. Across the South, only 276 SPB infestations were reported in 2013. These were distributed among four states: Mississippi (130 spots), Alabama (81 spots), Virginia (33 spots) and Florida (32 spots). The SPB outbreak continued in New Jersey for the third consecutive year in the Pinelands National Reserve.

The Southern Pine Beetle Prevention Project approved 73 new cases in FY 2013, amounting to 3,953 acres and $183,216 in federal cost shares. Since the SPB cost share program began in 2003, a total of 1,650 cases have been approved covering 105,334 acres and $6.1 million in federal cost shares in 35 counties of East Texas. Of this total, 1,500 cases (91%) have been completed on 97, 211 acres and nearly $5.6 million in federal cost shares have been paid out to participating small private landowners.

Pest Update

Emerald Ash Borer, *Agrilus planipennis*

The Texas A&M Forest Service, along with collaborators (Texas A&M Agrilife Extension Service, Sam Houston State University, Master Gardener groups) conducted a detection survey for the invasive emerald ash borer in East and Central Texas in 2013. Some 300 large, purple detection traps were deployed in 55 counties. Fortunately, no adult EAB were found, suggesting that this invasive pest has not yet arrived in Texas. Whether the detection survey will be repeated in 2014 is dependent on federal funding provided by the USDA Animal and Plant Inspection Service (APHIS).



The latest Emerald Ash Borer detections by county as of October 2013 (in red)

Pest Update

Soapberry Borer, *Agrilus prionurus*

One additional county was infested with the invasive Mexican soapberry borer - Grayson County north of Dallas and bordering Oklahoma. This was the only report received of an active infestation of soapberry borer in 2013, bringing the total number of infested counties to 52. There is no evidence this insect has spread to Oklahoma to date.

Fungi

Oak Wilt

The Oak Wilt Suppression Project, initiated in 1988, completed its 25th year in Central Texas. A total of 71,770 feet (13.6 miles) of trenches were installed to halt the spread of oak wilt in 54 centers. Since the program began, a total of 2,826 oak wilt centers have been treated with 3.96 million feet of trench (750 miles).

New in Town

Asian Citrus Psyllid, *Diaphorina citri*

Center for Invasive Species Research, University of California, Riverside

Asian citrus psyllid (ACP) is an efficient vector of the bacterial citrus disease huanglongbing (HLB), previously called citrus greening disease, which is one of the most destructive diseases of citrus worldwide. In the United States, the psyllid vector is found in Florida, Mexico, Louisiana, Texas, Georgia, South Carolina, Cuba, Belize and the Yucatan peninsula of Mexico. A federal quarantine restricts all movement of citrus and Rutaceae from into California in order to prevent introduction of the psyllid or the disease. The psyllid is under eradication in Southern California. If the psyllid and the disease were to become established in California, the disease would devastate the citrus industry.

Damage: ACP nymphs can only survive on the new flush tips of citrus. Because they produce a toxin, the flush tips die back or become twisted and the leaves do not expand normally. This problem can be reduced through pesticide control of the psyllid population or releases of natural enemies. A more important consequence of the introduction of ACP into California is its ability to vector the bacterial disease HLB. HLB causes assymetrical blotchy mottling of leaves (in contrast to Zinc deficiency that causes symmetrical blotching).

Fruit from HLB-infected trees are small, lopsided, poorly colored, and contain aborted seeds.

The juice from affected fruit is low in soluble solids, high in acids and abnormally bitter. The fruit retains its green color at the navel end when mature, which is the reason for the name citrus greening disease. The fruit is of no value because of poor size and quality. There is no cure for the disease and rapid tree removal is critical for prevention of spread.

Economic Impact: HLB is one of the most devastating diseases of citrus and since its discovery in Florida in 2005, citrus acreage in that state has declined significantly. Since the psyllid arrived in Southern California in 2008, the citrus nursery industry is rapidly moving its production under screenhouses. If the psyllid were to become established in citrus growing region, pesticide treatments for the psyllid would be instituted resulting in a direct cost of greatly increased pesticide use (3-6 treatments per year) and indirect costs due to disruption of the integrated pest management program. If the disease were to appear in California, a costly eradication program would need to be instituted to remove infected trees in order to protect the citrus industry.

Seen around town

Beech Blight Aphid, *Grylloprociphilus imbricator*

The beech blight aphid (*Grylloprociphilus imbricator*) is a small insect in the order Hemiptera that feeds on the sap of American beech trees. The aphids form dense colonies on small branches and the undersides of leaves. The aphids themselves are a light bluish color with bodies covered with long, white, waxy filaments giving them a woolly appearance.

They first become apparent in July and as populations continue to grow they become increasingly noticeable. Very high numbers can be seen on individual branches, sometimes extending onto leaves. Infested trees may appear to have their branches and twigs covered with snow.

This aphid has a defensive behavior in that it raises the posterior end of its body and sways from side to side when disturbed. Many aphids performing this action at the same time has led to this species being referred to as the "Boogie-Woogie Aphid".[http://en.wikipedia.org/wiki/Beech_blight_aphid - cite_note-UM-1](http://en.wikipedia.org/wiki/Beech_blight_aphid#cite_note-UM-1)

Deposits of sooty mold caused by the fungus *Scorias spongiosa* build up below the colonies growing on the copious amounts of honeydew the insects exude. The aphids do not usually cause much damage to overall tree health, but dieback is occasionally seen on very heavily infested branches. If infestations are heavy, twigs may die, but damage to the tree is usually minor. The aphids can be blasted off with a jet of water or can be controlled with any insecticides labeled for aphids. A wetting agent should be included to help penetrate the waxy body covering of the insect. Horticultural oil sprays and insecticidal soap have also been used successfully. Several parasites are known to attack this aphid and it is thought that they will in time be effective in reducing the population.

Pesticide Update

New Pesticide Labels to Better Protect Bees and Other Pollinators

Release Date: 08/15/2013

WASHINGTON – In an ongoing effort to protect bees and other pollinators, the U.S. Environmental Protection Agency (EPA) has developed new pesticide labels that prohibit use of some neonicotinoid pesticide products where bees are present.

“Multiple factors play a role in bee colony declines, including pesticides. The Environmental Protection Agency is taking action to protect bees from pesticide exposure and these label changes will further our efforts,” said Jim Jones, assistant administrator for the Office of Chemical Safety and Pollution Prevention.

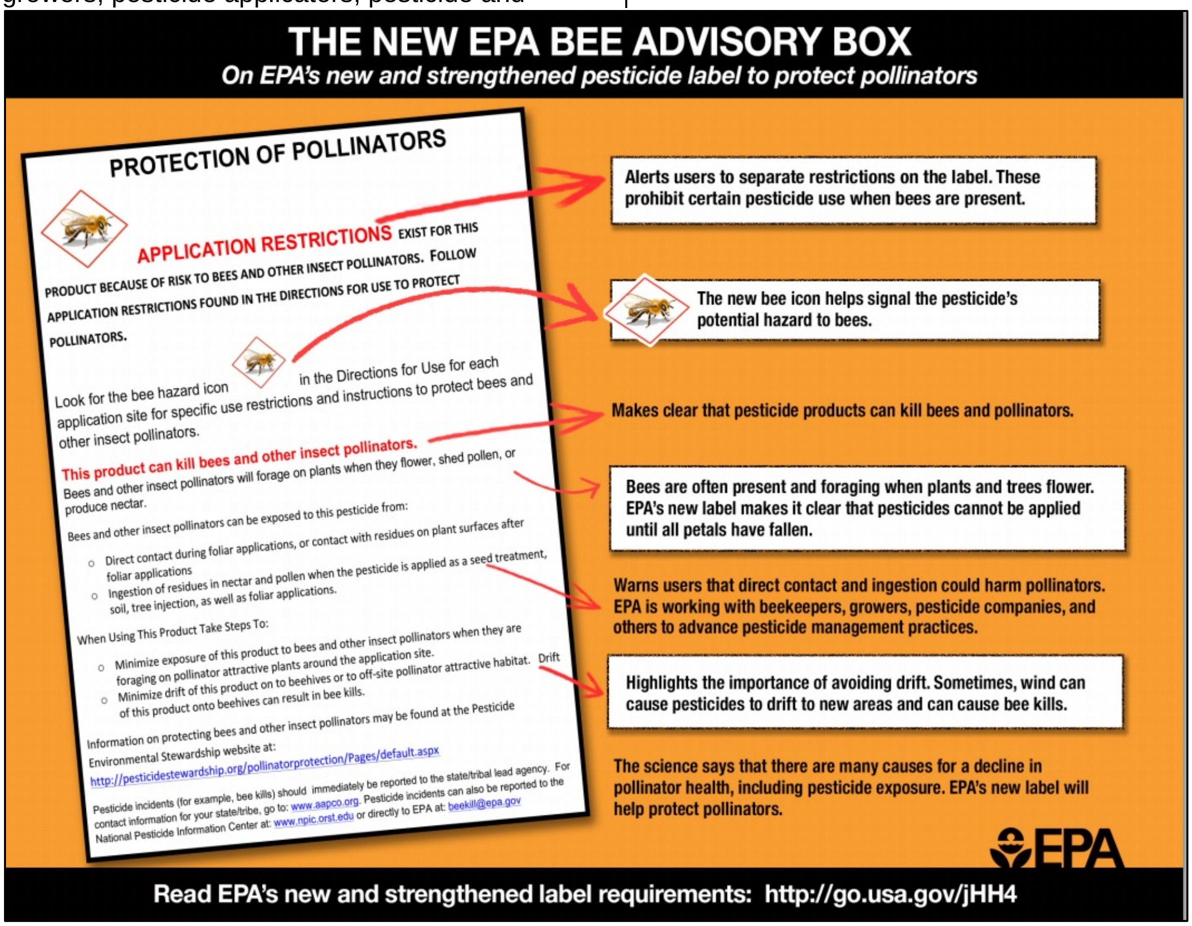
The new labels will have a bee advisory box and icon with information on routes of exposure and spray drift precautions. Today’s announcement affects products containing the neonicotinoids imidacloprid, dinotefuran, clothianidin and thiamethoxam. The EPA will work with pesticide manufacturers to change labels so that they will meet the Federal Insecticide, Fungicide, and

Rodenticide Act (FIFRA) safety standard.

In May, the U.S. Department of Agriculture (USDA) and EPA released a comprehensive scientific report on honey bee health, showing scientific consensus that there are a complex set of stressors associated with honey bee declines, including loss of habitat, parasites and disease, genetics, poor nutrition and pesticide exposure.

The agency continues to work with beekeepers, growers, pesticide applicators, pesticide and seed companies, and federal and state agencies to reduce pesticide drift dust and advance best management practices. The EPA recently released new enforcement guidance to federal, state and tribal enforcement officials to enhance investigations of beekill incidents.

More on the EPA's label changes and pollinator protection efforts: http://www.epa.gov/opp00001/ecosystem/pollinator/index.html



Future Pest Control Technology

RNA Interference

May 3rd, 2013 by Robert Arnason (The Western Producer)

Monsanto's chief technology officer hinted in a quarterly earnings call with financial analysts in January that the company might be onto something big. After running through routine updates on corn breeding, soybean yield improvements and other projects, Rob Fraley's enthusiasm spiked when he began talking about Monsanto's research and development work on RNA interference (RNAi) for pest management.

RNAi could prove to be an alternative to chemical pesticides in insect and disease control. "These (tools) can precisely target pests and can result in many of the same benefits we've seen with biotechnology traits," he said.

RNA interference is a process that turns down or shuts off the expression of certain genes, which suppresses the production of a specific protein in an organism. In the case of crop pests, RNAi could potentially shut down proteins related to metabolism or reproduction, thus killing or disabling target insects.

"We can actually feed these RNA molecules to insects, and they will just ingest them. It will get into the cell and do its job," said Eric Jan, associate professor of biochemistry and molecular biology at the University of British Columbia, where he is part of a team using RNAi to treat viruses that affect bees.

Monsanto and Syngenta have committed large sums of money to RNAi technology recently. Syngenta bought Devgen, a Belgian rice breeding company and a world leader in RNAi crop protection, for $523 million, while Monsanto paid $29.2 million for exclusive rights to use the intellectual property of Alnylam Pharmaceuticals, a major player in the RNAi industry. Monsanto spent $35 million to acquire Rosetta Green, an Israeli company that improves plant traits with RNA interference.

"I think it's very apparent to these companies … that this is a powerful technology, so investing early and getting a foothold in it (is essential)," said Doug Macron, who reports on gene silencing technology for GenomeWeb, an information service for scientists and tech professionals. "These companies know the science and they're careful with their money. There's a reason why they are spending millions of dollars."

Since the discovery of RNA interference in the late 1990s, biologists have primarily focused on gene silencing in humans and potential therapeutic treatments for diseases such as diabetes and cancer. Yet, applying RNAi to human health has proved difficult. "Delivery (of double stranded RNA) has been the biggest hurdle facing the human therapeutic side. Just getting these things into cells and functioning … is terribly complicated," Macron said.

"When you're dealing with insects and plants, that delivery hurdle is significantly lower. In certain types of insects, they can just eat the stuff." RNA interference is alluring because it can be tailored to a specific pest, unlike pesticides that kill harmful and beneficial insects alike.

Monsanto is expending a fair portion of its resources on RNAi applications for the western corn rootworm, which is slowly developing resistance to the B.t. corn trait. The company is also working on topical sprays to deliver RNA that impairs the metabolic functions of target insects. The company hopes to use the technology to protect crops from viruses and disease as well as insects.

Commercialization of the technology may be five to 10 years away, but critics are already lining up to condemn RNAi as dangerous. Greenpeace questions the safety of RNAi, suggesting it could suppress gene expression in other species, including humans. Defenders of the technology acknowledge that humans share genetic sequences with insects, but it should be possible to target certain genes in the target pest without risking human health.

"One of the big hurdles is, 'what effect would this have on other organisms? What effect would that have on humans?'" said Marcé Lorenzen, an entomology professor at North Carolina State University who is studying the potential of RNAi to control the red flour beetle. "We don't really expect off-target effects, but you have to go through all the (precautionary) steps."

FYI

How to Identify a Bed Bug Infestation

Derived from newsletters written by Dini M. Miller, Ph.D, Department of Entomology, Virginia Tech and the EPA

The common bed bug (*Cimex lecturlarius*) has long been a pest; feeding on blood, causing itchy bites and generally irritating their human hosts. Experts believe the recent increase in bed bugs in the U.S. may be due to more travel, lack of knowledge about preventing infestations, increased resistance to pesticides, and ineffective pest control practices.

Bed bugs can be brought home through several routes, such as in your luggage after a trip or on a piece of used furniture that you bought at a garage sale. For this reason, identifying a bed bug infestation is an important step to preventing a new one in your home.

The Bug

The adults can easily be seen with the naked eye. Adult bed bugs are reddish brown in color, wingless, and are about the size of an apple seed. Immature bed bugs (there are 5 immature or nymphal instar stages) can also be seen with the naked eye but they are smaller than adults, and translucent whitish-yellow in color. The most difficult life stage to see is the first instar nymph. This is the youngest life stage that hatches out of the egg. These nymphs are so small that they are difficult to see unless they are moving or have recently fed (bright red when full of blood). Bed bug eggs are also tiny, about the size of the head of a pin. The eggs are a pearl white color and have obvious eyespots if they are older than 5 days.

Bed bugs can look somewhat different depending on their feeding status. If an adult bed bug has not fed recently, it is approximately 3⁄16" long and oval in shape. In fact, an unfed bed bug can look like a flat disc. However, once it takes a blood meal the body blows up like a balloon. The bed bug elongates so that it looks more like a torpedo than a disc. The color also will be a bright red if the bed bug has fed within the last couple of hours. The bed bug will darken and flatten again over the next couple of days as it digests the blood meal. Bed bug nymphs also change in their appearance after a blood meal. A hungry bed bug nymph is almost completely pale white or yellowish. However, once it is fed it plumps up, becomes brilliant red, and looks like a plump raspberry seed. Nymphs are the easiest to see when they have recently eaten.

Immature bed bugs have to take a blood meal in order to grow, and molt to the next life stage. The molting process is where the bed bug has to shed its “skin”. Because all insects have their skeleton on the outside of their body, they have to shed it in order to grow larger in size. Because each bed bug has five immature stages before it becomes an adult, it will have to molt five times. After adulthood, the bed bug no longer grows or sheds its skin. In a large infestation there will be many thousands of these molted skins lying around where the bed bugs have left them behind. In a new infestation, say in a hotel room, bed bug evidence may be very hard to find. Yet, because the largest percentage of any bed bug population is always in an immature stage, there is always potential to find these cast skins.

The molted skins look similar to the bed bug itself. They are the same shape and generally translucent in color. However, you will notice that they look like an empty bed bug shell. They will be different sizes depending on the life stage of the bed bug that molted. In small infestations, molted skins can be found almost anywhere. In large infestations, most are found in areas where bed bugs aggregate together in groups.

Where to look for molted skins:

- Along mattress seems
- Behind head boards
- In ceiling/wall junctions
- Along baseboards
- Stuck to personal belongings

Bed bugs feed every 5-7 days if a host is present. On the days they are not feeding, they are spending their time digesting their previous meal. Blood contains a lot of water so the bed bugs must condense their meal right away and excrete some of the excess liquid as waste. This digested blood is then deposited wherever the bed bugs happen to go after feeding. The excreted waste comes out in a semi-liquid form and can easily be seen on the surfaces of mattresses, bed frames and other locations where the bed bugs travel or aggregate. These fecal spots are black in color (not red because the blood has already digested) and are often seen in groups of 10 or more. However, if the infestation is low, and the bed bug was just passing through the area, there may be only one or two spots in a particular location. Fecal spots can be found anywhere in a large infestation, but when the infestation is small, there are some places where fecal spots are more likely to be found.

Where to look for fecal spots:

- Along the mattress seams and on the tag
- On the wood frame of the box spring
- Behind the head board
- Along the tops of baseboards or the edge of carpeting
- Ceiling/wall junctions and behind pictures on the wall
- At electrical outlets
- In curtain seams where they gather at the rod

Identifying Bed Bug Aggregations

Looking for bed bug aggregations is similar to looking for fecal spots in that bed bugs often leave numerous fecal spots where they aggregate together after feeding. However, these aggregations also contain a variety of other bed bug evidence:

- Live bed bugs (multiple life stages)
- Fecal Spots
- Cast skins
- Live and hatched eggs

These aggregations are not easily identified if you do not look closely. For example, look at the photograph taken of an apartment ceiling below. At first glance it looks like mold or mildew. However, if you look more closely you can see that it is actually numerous aggregations of bed bugs on the ceiling. The black material is the fecal spotting described previously.

Where to look for bed bug aggregations:

- Along mattress seams, in the tufts and under the mattress tags
- Behind the headboard
- Inside the holes for set-in screws
- Along wood creases in the box springs or in bed frames
- Where the box spring's fabric is stapled to the wood frame
- Behind loose wallpaper
- Behind chipped paint
- Under the base of air conditioners
- Beneath the wood graming that holds the bar in the closet
- Behind baseboards
- Inside baseboard heaters
- Inside curtain rods, and on the curtains near the top where they are pleated
- In personal belongs, including books, stuffed animals, and picture frames

Forest Pest Management Cooperative's

P.E.S.T. Newsletter

Dr. Melissa J. Fischer, FPM Coop Coordinator
Dr. Ronald F. Billings, Administrative Coordinator
Mr. William W. Upton, Staff Forester II
Mr. Larry Spivey, Staff Assistant
Mrs. Billi L. Kavanagh, Seasonal Worker
Mr. Charlie Jackson, Seasonal Worker

Texas A&M Forest Service, Forest Health
P.O. Box 310, Lufkin, Texas 75902-0310
Phone: (936) 639-8170; Fax: (936) 639-8175
e-mail:mfischer@tfs.tamu.edu

FPMC Members

Anthony Forest Products Co.
ArborGen
The Campbell Group
Forest Investment Associates
Hancock Forest Management Inc.
International Forestry Co.

Plum Creek Timber Co.
Texas A&M Forest Service
Rayonier Inc.
U.S.D.A. Forest Service,
Forest Health Protection (R8)
Weyerhaeuser NR Co.

Texas A&M Forest Service
Forest Health
P.O. Box 310
Lufkin, TX 75902-0310

Non-Profit Organization
U.S. Postage
PAID
Lufkin, TX
75901
Permit No. 86