Forest Pest Management Cooperative

2010 Research Project Proposals

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Forest Investment Associates
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Potlatch Forest Holdings, Inc.
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The Campbell Group
U.S.D.A. Forest Service - Forest Health Protection R8
Weyerhaeuser Company

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With the approval of the Executive Committee representatives, the Forest Pest Management Cooperative (FPMC) will address three primary research areas (trunk injection of systemic insecticides, tip moth impact/hazard rating/control, and ant control) in 2010. Results obtained this past year warrant further evaluations in these areas.

Proposed objectives and methods for the systemic injection, tip moth, and leaf-cutting and fire ant studies in 2010 are presented below. Three studies to test the efficacy of various pesticides for protection of trees against 1) pine bark beetles and 2) hardwood pests, and 3) seed bugs in pine seed orchards will be continued.

As a result of the outbreaks of Nantucket pine tip moth in the Western Gulf Region and other areas of the South and the perceived damage being caused by this insect, the FPMC initiated two projects in 2001 and will look to complete the projects in the next year or two. The first, a cooperative study with Dr. Dean Coble and Mr. Trevor Walker, Stephen F. Austin & State University, is to evaluate the impact of pine tip moth and develop hazard-rating models to assess the susceptibility of sites to this pest across the South. The second project area evaluates the potential of different systemic insecticides, applied to pine seedlings at or post planting, for reducing pine tip moth damage. As a result of the promising results shown by fipronil in the seedling treatment (2002 – 2008), evaluation of operational PTM™ SC Insecticide treatments and application techniques will be continued in 2010. The Bayer trials (2003 – 2008) showed that imidacloprid/fertilizer spikes and SilvaShield™ Forestry Tablets provide good protection of pine seedlings against tip moth. A couple of new trials will be established in 2010 to directly compare efficacy and duration of SilvaShield™ versus PTM™ Insecticide and evaluate the impact of SilvaShield™ relative to other management practices (fertilization and weed control).

PTM™ soil injection treatment was registered in 2009 to treat leaf-cutting ant colonies. In addition, a new formulation of bait (modified Amdro®) was evaluated in 2009 for attractiveness and efficacy against leaf-cutting ants. One or more efficacy trials will be established in 2010 to further test these new control options. Also, a preliminary trial showed that PTM™ was effective against imported fire ants. Two additional trials will be established this spring to confirm efficacy.

Continuation of these or initiation of other projects will be dependent upon approval by the FPMC Executive Committee. Extension of each project into 2011 will depend on the degree of success achieved in 2010 and remaining gaps in knowledge.

TEXAS LEAF-CUTTING ANT

Leaf-cutting Ant Control Evaluation - East Texas (Continued from 2009)

Justification: Currently, there is no safe and effective control option available for control of Texas leaf-cutting ants. Volcano™ (sulfluramid/citrus pulp bait) and methyl bromide were phased out in 2003 and 2005, respectively. In 2003, Grant Laboratories, CA, began marketing their Grant's Total Ant Killer bait. Trials conducted by the FPMC early in 2004, found that a single application only halted the activity of 25% of the treated colonies – about equal to the efficacy of the old Amdro® bait used in the mid-1990s. In late 2004, Ambrands (formerly American Cyanamid) began marketing a new Amdro® Ant Block bait. Additional trials conducted in early spring 2005 and later in 2006 found that a single application of this bait did not halt the activity of most treated colonies, but did reduce all colonies by 60% compared to untreated colonies. Grosman hypothesized that the poor efficacy of Amdro is at least in part due to the small particle size of the bait. Using a laboratory pellet mill, a modified (larger) Amdro® bait was created and tested in 2009. The modified baits (produced by FPMC and later by Schirm USA) were all significantly more effective in halting leaf-cutting ant compared to the standard Amdro Ant Block treatment. The new bait is being refined to optimize ant retrieval. Trials will be initiated in 2010 to confirm efficacy of the baits. As bait efficacy tends to change with season (Grosman, personal observation), there is a need to determine to what extent the optimal application rate varies with season.

PTM™ SC Insecticide (fipronil) was registered with EPA in December 2009 for soil injection use to control leaf-cutting ants. Trials conducted in winter, spring and fall showed excellent control. However, a trial during the summer resulted in less favorable control. A trial will be initiated this summer to evaluate different application techniques to improve efficacy of PTM™ (fipronil).

Objective: Evaluate the efficacies of a modified Amdro® Ant Block bait and PTM™ soil injection for control of the Texas leaf-cutting ant.

Cooperators:

Forest Pest Management Cooperative members
Private landowners

K. Dickinson & J. Gunning	Central Garden Control Group, N. Richland Hills, TX
Dr. H. Quicke	BASF Corporation, Auburn, AL

Study Sites: Active Texas leaf-cutting ant colonies (~200) will be selected in East Texas on lands owned by forest industries, investment organizations and private landowners.

Insecticide:

Hydramethylnon – undetectable, slow-acting poison

Amdro® Ant Block bait - concentration (0.88% a.i.); defatted corn grit carrier with soybean oil; packing (tight); color (yellow); size < 2 mm dia.

Modified Amdro® bait - concentration (0.88% a.i.); defatted corn grit carrier with soybean oil; packing (tight); color (yellow); size increased to 2.5 mm X 10 mm length and 0.04 g).

Fipronil – undetectable, slow-acting poison in liquid formulation
PTM™ Insecticide - concentration (2 % a.i. v/v).

Research Approach:

Efficacy Trial

Experiments will be conducted in East Texas; within 75 miles of Lufkin. In this area, Texas leaf-cutting ant colonies will be selected depending on the season. Those colonies larger than 30 m by 30 m, smaller than 3m by 3 m, adjacent to each other (within 100 m), and/or lacking a distinct central nest area will be excluded from this study. Treatments will then be randomly assigned to the selected ant nests with 2-11 replicates per treatment.

The central nest area (CNA) is defined as the above-ground portion of the nest, characterized by a concentration of entrance/exit mounds, surrounded by loose soil excavated by the ants (Cameron 1989). Scattered, peripheral entrance/exit and foraging mounds are not included in the central nest area. Application rates will be based on label rates and/or the area (length X width) of the central nest. Four trials are planned for 2010; the treatments will likely include:

Trial 1, 2, 3 & 4 (one per season):

1) Large Amdro® bait - bait will be spread uniformly over CNA at 10.0 g/m^2.
2) Large Amdro® bait - bait will be deployed in bait stations (22g/station) at an equivalent rate of 10.0 g/m^2.
3) Small Amdro® Ant Block (standard) - bait will be spread uniformly over CNA at 3/4 lb per colony.
4) PTM™ SC Insecticide – soil injection within CNA at 40.0 ml/entrance hole.
5) Untreated colony (Check)

Bait treatments will be made with a cyclone spreader to evenly spread amounts over the CAN or deployed in 3"X3"X5" corrugated plastic bait stations. PTM™ solutions will be applied using the PTM Spot Gun™. The lance will be inserted into each entrance hole so that the tip will be 3 inches below ground.

Data Collection: Procedures used to evaluate the effect of treatments on Texas leaf-cutting ant colonies will follow those described by Cameron (1990). The number of active entrance/exit mounds will be counted prior to treatment and periodically following treatment at 1, 2, 4, 8, and 16 weeks. Ten untreated colonies will be included as checks and monitored in both winter and summer treatments to account for possible seasonal changes in ant activity. For each colony, the percent of initial activity will be calculated as the current number of active mounds at each post-treatment check (X 100) divided by the initial number of active mounds.

Application Dates:

Trial 1: Late Winter 2010: Treatments applied to 10 colonies in February.
Trial 2: Spring 2010: Treatments applied to 10 colonies in May.
Trial 3: Summer 2010: Treatments applied to 10 colonies in August.
Trial 4: Fall 2010: Treatments applied to 10 colonies in November.

Project Support: The trial will be supported initially by FPMC funds.

Research Time Line:

February 2010

- Obtain new modified Amdro® baits from Schirm.
- Locate 50 leaf-cutting ant colonies.
- Randomly assign and treat colonies with baits.
- Reevaluate ant activity 2 weeks post treatment.

March - May, 2010

- Reevaluate ant activity 4 and 8 weeks post treatment.
- Obtain new modified Amdro® baits from Schirm.
- Locate 60 leaf-cutting ant colonies.
- Randomly assign and treat colonies with Amdro® bait or PTM™ solution.
- Reevaluate ant activity 2 weeks post treatment.

June - August 2009

- Reevaluate ant activity 16 weeks post treatment.
- Conduct statistical analyses of data.
- Obtain new modified Amdro® baits from Schirm.
- Locate 60 leaf-cutting ant colonies.
- Randomly assign and treat colonies with Amdro® bait or PTM™ solution..
- Reevaluate ant activity 2 weeks post treatment.

September - December, 2009

- Reevaluate ant activity 4 and 8 weeks post treatment.
- Reevaluate ant activity 16 weeks post treatment.
- Produce Amdro® bait.
- Locate 60 leaf-cutting ant colonies.
- Randomly assign and treat colonies with Amdro® bait or PTM™ solution..
- Reevaluate ant activity 2, 4, 8 & 16 weeks post treatment.
- Conduct statistical analyses of data.
- Prepare and submit reports to FPMC and BASF.

Literature Cited:

Cameron, R. S. 1989. Control of the Texas leaf-cutting ant, *Atta texana* (Hymenoptera: Formicidae) with thermal fog application of resmethrin, p. 236-244. *In* R.I. Alfaro and S. Glover [eds] Insects Affecting Reforestation: Biology and Damage. Proc. IUFRO Conference, XVIII International Congress of Entomol. Vancouver, B.C. July 3-9, 1988. Forestry Canada. Pacific Forestry Centre, Victoria, British Columbia, Canada. 256 pp.

Cameron, R.S. 1990. Potential baits for control of the Texas leaf-cutting ant, *Atta texana* (Hymenoptera: Formicidae), p. 628-637. *In* R.K. Vander Meer, K. Jaffe, and A. Cedeno [eds] Applied Myrmecology: A World Perspective.

IMPORTED FIRE ANT

Control Option Evaluation - East Texas and Louisiana

Justification: Red imported fire ants, *Solenopsis invicta* Buren, cause billion of dollars per year in various costs in across the southern United States. Individual mound treatments play an important role in fire ant management. Mound treatments are selective and often faster-acting than broadcast insecticide treatments (Merchant and Drees, 2000). One desirable characteristic of fire ant mound treatments is low toxicity. This test evaluates a relatively new, lower toxicity treatment: PTM SC Insecticide (9.1% fipronil) applied using a backpack soil injection probe to single fire ant mounds that have been established in a loblolly pine seed orchard next to orchard trees. The trial was designed to observe the effectiveness of PTM applied using different techniques in reducing fire ant activity over a 12-week period.

Objective: Evaluate the efficacy of PTM™ soil injection for reducing activity in imported fire ant colonies.

Cooperators:

Dr. Harry Quicke	BASF Corporation, Auburn, AL
Mr. Shannon Stewart	ArborGen, Livingston, TX
Mr. Jim Tule	Forest Capital Partners, Merryville, LA

Study Sites: Active colonies (240) were located in ArborGen's Woodville Seed Orchard.

Insecticide:

Fipronil (PTM™ Insecticide, BASF) – undetectable, slow-acting poison in liquid formulation

Research Approach:

Experiments were/will be conducted in east Texas and Louisiana; within 100 miles of Lufkin. In this area, 200 imported fire ant colonies will be selected in spring 2010. Study colonies will be at least 7m (23 ft) apart, 8 inches or more in diameter and with newly excavated soil. Mounds less than 12 inches apart will be considered a single colony. No other observable IFA colonies can occur within 2m (6 ft) of a study colony. Treatments will then be randomly assigned to the selected ant nests with 40 replicates per treatment.

<u>Treatments:</u>

A) <u>PTM™ solution 2% ai</u>, 1.5 oz (40 ml) total injected 3 inches below soil surface using Enviroquip's PTM Injection Probe at one (1) injection point (40 mls per point).
B) <u>PTM™ solution 2% ai</u>, 1.5 oz (40 ml) total injected 3 inches below soil surface using Enviroquip's PTM Injection Probe at two (2) injection points (20 mls per point).
C) <u>PTM™ solution 2% ai</u>, 3.0 oz (80 ml) total injected 3 inches below soil surface using Enviroquip's PTM Injection Probe at two (2) injection points (40 mls per point).
D) <u>PTM™ solution 2% ai</u>, 3.0 oz (80 ml) total injected 3 inches below soil surface using Enviroquip's PTM Injection Probe at four (4) injection points (20 mls per point).
E) <u>Check</u> – untreated

Data Collection: Procedures used to evaluate the effect of treatments on fire ant colonies will follow those described by Nester (2001a & b). Study colonies will be marked with a pin flag (see definition of central nest area above). Treatments were applied on December 9, 2009. At 0, 7, 14, 49, 87 and 117 days after treatment (DAT) each mound were/will be checked for presence or absence of fire ant activity and amount of recent soil excavation. First, a small diameter stick will be inserted into the mound. If no fire ants appear after 15 seconds, the mound is considered inactive (0). If fire ants are present within the allotted time period the mound activity will be assigned a 1 (< 10 fire ants or freshly worked soil), 2 (10-50 fire ants, not aggressive), or 3 (>50 aggressive fire ants). Second, amount of fresh excavation is determined. Mounds with no fresh excavation are considered inactive (0). Mounds with some level of fresh excavation were assigned a 1 (<1/4 of surface area), 2 (1/4 – 2/3 of surface area), or 3 (>2/3 of surface area). On day 87, the presence of "satellite" mounds, defined as small freshly-produced ant mounds within a foot of the treated mound, will be noted. At least ten untreated colonies will be included as checks and monitored to account for possible seasonal changes in ant activity. Results will be analyzed using Analysis of Variance (ANOVA) at $P < 0.05$ for active ant mound assessment data, with means separated using Tukey's Studentized Range test.

Project Support: The trial will be supported by BASF and FPMC funds.

Research Time Line:

April 2010

- Contact site manager.
- Select site.
- Ant colonies selected and treatments applied.
- Reevaluate ant activity 1 and 2 weeks post treatment.

May - June 2010

- Reevaluate ant activity 4 and 8 weeks post treatment.
- Conduct statistical analyses of data.
- Prepare and submit reports to FPMC and BASF.

Literature Cited:

US Environmental Protection Agency 1998. Product Performance Test Guidelines, OPPTS 810.3100 Soil Treatments for Imported Fire Ants, p. 1-2.

Nester, P.R. 2001 Evaluation of Fire Ant Insecticide Bait Products as Single Mound Treatments. Texas Agricultural Extension Service. http://fireant.tamu.edu/research/arr/category/individual/97-01pg24/97-01pg24.pdf.

Nester, P.R. 2001 Evaluation of Fire Ant Insecticide Products as Single Mound Treatments Along Hardscape Areas. Texas Agricultural Extension Service. http://fireant.tamu.edu/research/arr/category/individual/97-01pg27/97-01pg27.pdf.

SYSTEMIC INSECTICIDE INJECTION TRIALS

Potential Insecticides for Seed Bug Control in Pine Seed Orchards – TX, FL & AR (Continued from 2008 & 2009)

Justification: Repeatedly, cone and seed insects severely reduce potential seed yields in southern pine seed orchards that produce genetically-improved seed for regeneration programs. One of the most important insect pest groups is the seed bugs, *Leptoglossus corculus* (Say) and *Tetyra bipunctata* (Herrich-Schaffer) in the South and *L. occidentalis* Foote in the West, that suck the contents from developing seeds in conelets and cones (Ebel et al. 1980). Without a comprehensive insect-control program, this insect group commonly destroys 30% of the potential seed crop; 50% losses are not uncommon (Fatzinger et al. 1980).

The FPMC Systemic Insecticide Duration and Rate Studies have demonstrated that trunk injection of emamectin benzoate (Arise®, Denim® and TREE-age™) alone were effective in reducing coneworm damage by 80% for 6 years, but seed bug damage was reduced by only 34% for 2 years (Grosman et al. 2002, FPMC Annual Report 2001, 2002, and 2003). Trials with thiamethoxam, a neonicotinoid insecticide, applied alone or combined with emamectin benzoate did not improve efficacy against seed bugs.

The FPMC tested imidacloprid, another neonictinoid insecticide, in our seed orchard trials at low (2ml, Pointer® w/ Wedgle Tip injector in 1997) and high (30 ml, Admire® w/ STIT injector in 1999-2000) volumes. Generally, low volume injections were ineffective against coneworms and seed bugs. High volume injections of imidacloprid did significantly reduce coneworm damage (45%), but were not nearly as effective as emamectin benzoate (94%) in the first year after injection. In contrast, imidacloprid was more effective against seed bugs (82% reduction) than was emamectin benzoate (34% reduction). However, there was considerable variability in the efficacy against both groups of pests and efficacy against both coneworms and seed bugs declined markedly in the second year. One problem with imidacloprid is that it has a low solubility in water (0.4g/L). Thus, mixing currently-registered products (Merit® and Admire®) in water to create an injectable solution at an effective concentration that is easily injected is difficult. For these reasons, we elected to discontinue our evaluation of imidacloprid after 2000. However, recently Arborjet has developed a new formulation of 5% injectable imidacloprid (Ima-jet™). This formulation may be more effective against seed bugs. It was tested in 2007 and 2008, at Weyerhaeuser's Magnolia Orchard. Only imidacloprid high rate (0.4g/ inch DBH alone or combined with emamectin benzoate (0.4 g/ inch DBH) significantly reduced seed bug damage during the second year after injection.

New formulations of other systemic insecticides recently have been/are being developed: abamectin, azadiractin, chlorantraniliprole, dinotefuran, and fipronil. It is of interest to determine if any of these chemicals have activity against seed bugs and coneworms.

With the potential loss of currently-registered foliar insecticides, there is an obvious need for an effective alternative to control cone and seed insects in southern pine seed orchards. A chemical alternative that provides long term protection (> 1 year) and could by applied via a closed system to individual trees would be preferred by orchard managers because it could be easily applied, economical, and generally pose little hazard to the applicator. Trials conducted thus far indicate that injections of emamectin benzoate and fipronil into loblolly pine can significantly reduce coneworm-caused damage, but generally have little or no effect to against seed bugs. The purpose of this study is to 1) evaluate the potential efficacy of a new formulation of systemic insecticides against seed bugs in pine seed orchards and 2) determine the duration of treatment efficacy.

Objectives: The objectives of this research proposal are to: 1) to evaluate the potential efficacy of systemic injections of new formulations of systemic insecticides (abamectin, azadiractin, chlorantraniliprole, dinotefuran, emamectin benzoate, fipronil, imidacloprid, and indoxacarb) in reducing seed crop losses due seed bugs in pine seed orchards; and 2) determine the duration of treatment efficacy.

Cooperators:

Dr. Tom Byram	Western Gulf Tree Improvement Program
Mr. Steve Smith	Weyerhaeuser Company, Magnolia, AR
Mr. Early McCall	Rayonier, Yulee, FL
Mr. Joseph Doccola	Arborjet, Inc., Worchester, MA
Mr. Joe Meating	BioForest Technologies Inc., Sault Ste. Marie, ON
Dr. Harry Quicke	BASF, Auburn, AL
Mr. T.V. Smith	DuPont, Allen, TX
Ms. Marianne Waindle	JJ Mauget, Arcadia, CA

Research Approach: The first phase of the study was initiated in 2008 in a loblolly block (Rayonier's Fernandino Beach Seed Orchard, Florida. A second phase of the study was initiated in fall 2009 in a loblolly pine block (Weyerhaeuser's Magnolia Seed Orchard, Arkansas). A third phase of the study was initiated in fall 2009 in a loblolly pine block (ArborGen's Woodville Seed Orchard, Texas). A block in each orchard was selected that had not been sprayed with insecticide for 1 or more years prior to initiation of this experiment. In January 2008, 7 ramets from each of 6 loblolly clones were selected in Florida. In September 2009, 6 ramets from each of 6 clones were selected in Arkansas and 10 ramets from each of 7 clones were selected in Texas. The treatments were evaluated using the experimental design protocol described by Gary DeBarr (1978) (i.e., randomized complete block with clones as blocks). The treatments include:

Treatments:

FL Orchard (Loblolly pine)

1) Imidacloprid (Ima-jet®, Arborjet) (0.4 g AI per inch DBH) injection + 5X foliar spray.
2) Abamectin (Abacide® 2, Mauget) (0.4 g AI per inch DBH) injection + 5X foliar spray
3) Emamectin benzoate (TREE-äge™, Arborjet) (0.4 g AI per inch DBH) injection + 5X foliar spray.
4) Imidacloprid + abamectin (Arborjet) (0.2 g AI each per inch DBH) injection + 5X foliar spray
5) Imidacloprid + abamectin (Dutrex®, Mauget) injection + 5X foliar spray
6) Imidacloprid + emamectin benzoate (each at 0.2 g AI per inch DBH) injection + 5X foliar spray
7) Check (5X foliar spray only)

AR Orchard (Loblolly pine)

1) Imidacloprid (Ima-jet®) (0.4 g AI per inch DBH of tree) applied in fall 2009
2) Imidacloprid (Ima-jet®) (0.4 g AI per inch DBH of tree) applied in fall 2009 and spring 2010
3) Imidacloprid + Emamectin benzoate (each at 0.4 g AI per inch DBH of tree) applied in fall 2009
4) Imidacloprid + Emamectin benzoate (each at 0.4 g AI per inch DBH of tree) applied in fall 2009 and Imidacloprid applied again in spring 2010.
5) Dinotefuran + Emamectin benzoate (each at 0.4g AI per inch DBH of tree) applied in spring 2010.
6) Check

TX Orchard (Loblolly pine)

1) Imidacloprid (Ima-jet®, Arborjet) (0.4 g AI per inch DBH of tree) in Fall 2009
2) Emamectin benzoate (TREE-age, Arborjet) (0.4 g AI per inch DBH of tree) in Fall 2009
3) Dinotefuran (Valent/Mauget) 0.4 g AI per inch DBH of tree) in Spring 2010
4) Abamectin (Abacide2, Mauget) (0.4g AI per inch DBH of tree) in Fall 2009
5) Chlorantraniliprole (Acelepyrn, DuPont) 0.4g AI per inch DBH of tree) in Fall 2009
6) Azadiractin (TreeAzin, BioForest Tech.) (0.4g AI per inch DBH of tree) in Fall 2009
7) Acephate (Ace-jet, Arborjet) (0.4g AI per inch DBH of tree) in Spring 2010
8) Fipronil (BASF) 0.4g AI per inch DBH of tree) in Fall 2009
9) Emamectin benzoate (TREE-age, Arborjet) (0.4 g AI per inch DBH of tree) in Fall 2009 plus two Asana foliar sprays (1 in spring and 1 in late summer).
10) Check

Injection treatments will be applied in September 2008 (FL) or October 2009 and April 2010 (AR & TX) using the Arborjet Tree IV™ microinfusion system (Arborjet, Inc. Woburn, MA). Each treatment will be injected into four or more cardinal points (depending on tree diameter) about 0.3 m above the ground.

Spray treatments (Asana® XL in TX) will be applied to foliage beginning in April 2010 using a hydraulic sprayer from a bucket truck (if necessary) at 10 gal/tree. The distance between test trees will be ≥20 m to minimize the effects of drift.

Conelet and cone survival will be evaluated in 2010 and possibly 2011 by tagging 6 to 10 branches on each tree (50 conelets and 50 cones, if possible) in early April. Counts of surviving conelets and cones from these branches will be made in August (Florida and Texas) or September (Arkansas) of each year. Conelet and cone survival generally reflects protection from seed bugs and coneworms, respectively. In July and September, 50 conelets will be randomly sampled from each tree and evaluated for seed bug damage. Reduction of coneworm attacks will be evaluated by collecting all cones present on the south half of each tree in August (Florida & Texas) or September (Arkansas) of 2010 & 2011. From the samples, counts will be made of healthy- and coneworm-attacked cones. Each year, a subsample of 10 healthy cones/tree will be selected; seed lots from these cones will be radiographed to determine seed yield/cone and filled-seed yield/cone to measure the extent of seed bug and seedworm damage.

Data will be analyzed by GLM and the Fisher's Protected LSD test using the Statview statistical program.

Research Time Line:

September - December 2008

- Select orchard block, clones and ramets in FL (September).
- Inject study trees with assigned product(s) (October).

January - April 2009

- Treat FL study trees with standard (Asana®XL) foliar treatment (April).
- Flag 6-10 branches/tree and record number of conelets and cones on all treatment and check trees (April).

May - August, 2009

- Treat FL study trees with standard (Asana®XL) foliar treatment (May, June, July, August)
- Collect conelet sample (July) and evaluate for early season seed bug damage.

September - December 2009

- Evaluate conelet and cone survival on flagged branches (early September).
- Collect all cones and 50 conelet sample from sample trees for evaluation of coneworm and seed bug damage levels, respectively (late September).
- Select orchard block, clones and ramets in AR (September).
- Inject AR and TX study trees with assigned product(s) (October)
- Cleaning and radiographic analysis of seed lots (October – December).
- Conduct statistical analyses of data.
- Prepare and submit report to FPMC, Syngenta, Arborjet, and Mauget

January - April 2010

- Inject AR and TX study trees with assigned product(s) (March)
- Treat study trees with standard (Capture®, Asana®XL, Guthion®, or Imidan®) foliar treatment (April)
- Flag 6-10 branches/tree and record number of conelets and cones on all treatment and check trees (April).

May - August, 2010

- Treat study trees with standard (Capture®, Asana®XL, Guthion®, or Imidan®) foliar treatment (May, June, July, August)
- Collect conelet sample (July) and evaluate for early season seed bug damage.

September - December 2010

- Evaluate conelet and cone survival on flagged branches (early September).
- Collect all cones and 50 conelet sample from sample trees for evaluation of coneworm and seed bug damage levels, respectively (late September).
- Select orchards, clones and ramets (September).
- Inject study trees with assigned product(s) (October)
- Cleaning and radiographic analysis of seed lots (October – December).
- Conduct statistical analyses of data.

- Prepare and submit report to FPMC, Syngenta, BASF, Arborjet, BioForest Technologies, and Mauget

January - April 2011

- Treat study trees with standard (Capture®, Asana®XL, Guthion®, or Imidan®) foliar treatment (April)
- Flag 6-10 branches/tree and record number of conelets and cones on all treatment and check trees (April).

May - August, 2011

- Treat study trees with standard (Capture®, Asana®XL, Guthion®, or Imidan®) foliar treatment (May, June, July, August)
- Collect conelet sample (July) and evaluate for early season seed bug damage.

September - December 2011

- Evaluate conelet and cone survival on flagged branches (early September).
- Collect all cones and 50 conelet sample from sample trees for evaluation of coneworm and seed bug damage levels, respectively (late September).
- Cleaning and radiographic analysis of seed lots (October – December).
- Conduct statistical analyses of data.
- Prepare and submit report to FPMC, Syngenta, Arborjet, and Mauget

Literature Cited:

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Ebel, B.H., T.H. Flavell, L.E. Drake, H.O. Yates III, and G.L. DeBarr. 1980. Seed and cone insects of southern pines. USDA For. Serv. Gen. Tech Rep. SE-8. 44 p.

Fatzinger, C.W., G.D. Hertel, E.P. Merkel, W.D. Pepper, and R.S. Cameron. 1980. Identification and sequential occurrence of mortality factors affecting seed yields of southern pine seed orchards. USDA For. Serv. Res. Pap. SE-216. 43 p.

Grosman, D.M., W.W. Upton, F.A. McCook, and R.F. Billings. 2002. Systemic insecticide injections for control of cone and seed insects in loblolly pine seed orchards – 2 year results. So. J. Appl. For. 26: 146-152.

SYSTEMIC INSECTICIDE INJECTION TRIALS

Evaluation of Emamectin Benzoate (TREE-äge™) for Protection of Oaks Against Insect Pests (Continued from 2009)

Justification: Injection trials conducted by the Forest Pest Management Cooperative, Arborjet Inc. (Woburn, MA) and others from 1999 – 2008 have shown that different formulations of emamectin benzoate (EB, Shot-Wan™, Denim® & TREE-äge™), injected into conifers and hardwoods, are highly effective against coneworm, bark beetles, wood borers, forest tent caterpillar and winter moth. Syngenta submitted TREE-äge™ for registration by EPA in January 2008. Syngenta is interested in generating additional data in support of TREE-äge™ against foliar, bud and stem pests of hardwood. In 2009, EB injections reduced the occurrence and/or damage caused by a chrysomelid leaf beetle, leaf-rolling weevil, tussock moth, borers, and oakworm caterpillars on cherry bark and burr oak. We are interested determining the longevity of treatment efficacy.

Objective: Evaluate the potential for systemic injections of TREE-äge™ (emamectin benzoate) in reducing foliar, bud and stem insect pest damage on bur oak, cherrybark oak and water oak.

Cooperators:

Mr. Marvin Lopez	Western Gulf Tree Improvement Program, College Station, TX
Dr. Tom Byram	Western Gulf Tree Improvement Program, College Station, TX
Dr. Jackie Driver	Syngenta, Waco, TX
Dr. David Cox	Syngenta, Modesta, CA
Mr. Joseph Doccola	Arborjet, Inc., Worchester, MA

Study Site: Three 3-acre orchard block containing 30-year-old willow oak (*Quercus phellos)*, and 10 – 20-year-old cherrybark oak (*Q. pagoda*), and bur oak (*Q. macrocarp)* -- Texas Forest Service Hudson Hardwood Seed Orchard, Angelina Co., TX.

Insecticides:

Emamectin benzoate (TREE-äge™) -- avermectin derivative that has shown systemic activity against Coleoptera and Lepidoptera

Design:

Bur Oak - randomized complete block with clones as blocks. 2 treatments X 7 clones X 2 ramets per clone = 28 ramets used for study.

Cherrybark Oak - randomized complete block with clones as blocks. 2 treatments X 7 clones X 2 ramets per clone = 28 ramets used for study.

Willow Oak – 2 X 2 X 3 factorial design. 2 treatments X 2 felling dates X 3 evaluation periods X 10 replicates = 120 replicates used for study

Treatments:

Bur Oak Trial

1) Emamectin benzoate (TREE-äge™, 4% ai) applied undiluted at 10 ml of product per inch tree diameter at breast height (DBH) (0.4g active per inch DBH) (N = 14)
2) Check (untreated) (N = 14)

Cherrybark Oak Trial

1) Emamectin benzoate (TREE-äge™, 4% ai) applied undiluted at 10 ml of product per inch tree diameter at breast height (DBH) (0.4g active per inch DBH) (N = 14)
2) Check (untreated) (N = 14)

Willow Oak Trial

1) Emamectin benzoate (TREE-äge™, 4% ai) applied undiluted at 10 ml of product per inch tree diameter at breast height (DBH) (0.4g active per inch DBH); trees cut **2 months** after injection (N = 10)
2) Emamectin benzoate (TREE-äge™, 4% ai) applied undiluted at 10 ml of product per inch tree diameter at breast height (DBH) (0.4g active per inch DBH); trees cut **12 months** after injection (N = 10)
3) Check (untreated) (N = 20)

Application Methods:

In late April 2009, study trees were selected and measured for DBH to determine volume of insecticide to be injected. Eight (8) holes, 0.95 (3/8 in) in diameter and 4 cm (1.5 in) deep, will be drilled into the root flare of the tree bole (5 cm above ground). Arborplugs will be installed in each hole. The Arborjet QUIK-jet™ system will be used to inject an equal amount of product into each injection hole.

Data Collection:

Bur and Cherrybark Oak Trials

All study trees will be visibly inspected for insect damage at the time of treatment and monthly thereafter. Damage levels will be ranked on a scale of 1 to 10 (1=light & 10=heavy) and recorded. If damage is occurring to foliage, a sample will be collected for proper identification of the causal agent.

In the fall (mid September), 25 acorns from branch samples will be collected once per month. Acorns will be collected until mid-December when acorn drop ceased. After each collection all acorns will be dried for 24 hrs, counted and stored temporarily in refrigerators or coolers. Collected acorns will be split in half. The interior of each half will be evaluated for the presence of weevil larvae and/or feeding damage in excess of 5% of the acorn meat.

Willow Oak Trial

The injected trees were allowed 2 or 12 months to translocate the chemical. In June, a series of 10 trees per treatment were felled and 1.5 m bolts were taken from the 3, 4.5 and 6 m heights. The bolts were transported to a nearby hardwood plantation. Bolts were randomly placed 1 m from other bolts on discarded, hardwood bolts to maximize surface area available for colonization as well as to discourage predation by ground and litter-inhabiting organisms. To facilitate timely insect colonization, an amber bottle with wick, containing ethanol was attached to 1 m stakes evenly spaced in the study area.

A series of bolts (10 for each treatment) were/will be retrieved 4, 16 and 40 weeks after deployment, after many cerambycid egg niches are found on the bark surface of most bolts. In the laboratory, two 10 cm X 50 cm samples (total = 1000 cm^2) of bark were/will be removed from each bolt. The following measurements were/will be recorded from each bark sample:

1) Number of cerambycid egg niches on bark surface.
2) Percent of bark sample with cerambycid activity, estimated by overlaying a 100 cm^2 grid on the underside of each bark strip and counting the number of squares where cerambycid larvae had fed.
3) Number of adult bark beetle galleries and length.
4) Number of ambrosia beetle entry holes

Treatment efficacy was/will be determined by comparing the number of *cerambycid*, bark beetle and/or ambrosia beetle attacks, the number and total length of bark beetle egg galleries and the area of cerambycid feeding for each treatment and felling date. Data were/will be transformed by $\log_{10}(x + 1)$ if necessary to satisfy criteria for normality and homoscedasticity (Zar 1984) and analyzed by GLM and the Fisher's Protected LSD test using the Statview® statistical program (SAS Institute Inc.).

Project Support: Syngenta provided funding for the project and agreed to donate chemical product. Arborjet, Inc. has agreed to loan the FPMC injection equipment for the project.

Research Time Line:

CY 2009

April, 2009

- Select study trees
- Inject trees with assigned treatments

May - December, 2009

- Collect bur and cherrybark oak branch sample every other month (May, July, September & November) and record presence of insect attacks
- Cut water oak and deploy logs; check logs for colonization after 4, 8 and 12 weeks (June and August)
- Conduct statistical analyses of data (November)
- Prepare and submit report to FPMC Executive Committee, Syngenta and Tom Byram (December).

CY 2010

March - December, 2010

- Collect bur and cherrybark oak branch sample every other month (March, May, July, September & November) and record presence of insect attacks
- Cut water oak and deploy logs; check logs for colonization after 4, 8 and 12 weeks (June and August)
- Conduct statistical analyses of data (November)
- Prepare and submit report to FPMC Executive Committee, Syngenta and Tom Byram (December).

CY 2011 (if warranted, based on 2010 results)

March - December, 2010

- Collect bur and cherrybark oak branch sample every other month (March, May, July, September & November) and record presence of insect attacks
- Conduct statistical analyses of data (November)
- Prepare and submit report to FPMC Executive Committee, Syngenta and Tom Byram (December).

SYSTEMIC INSECTICIDE INJECTION TRIALS

Systemic Insecticide Treatment Timing, Rate and Duration for Protection of Loblolly Pine from Bark Beetles. (Continued from 2008)

Justification: In 2005, a trial was conducted to evaluate the efficacy of new formulations of fipronil for protection of loblolly pine against *Ips* engraver beetles. The results showed that injections of fipronil (BAS 350 UB) applied at 0.2 g/inch diameter were highly effective in preventing the successful colonization of treated bolts 1, 3 and 5 months after tree injection (see 2005 Accomplishment Report).

In 2006, a second trial was initiated to evaluate the effects of application rate (0.01, 0.1 and 0.4g/inch diameter) of fipronil on efficacy against *Ips* engraver beetles. Generally, efficacy of fipronil treatments did improve with increasing chemical rate. However, efficacy of the highest rate was reduced by the second year. It is of interest to determine if fipronil duration can be improved at higher rates (0.8 g/inch diameter).

A preliminary trial in 2008 showed that abamectin was highly effective in preventing the successful colonization of *Ips* engraver beetles and wood borers in loblolly pine bolts 5 months after injection.

Objectives: 1) Determine the efficacy of systemic injections of abamectin and fipronil for preventing colonization of loblolly pine by *Ips* engraver beetles, 2) determine the minimum application rate that yields efficacy, 3) determine the optimal timing of each application, and 4) determine the duration of treatment efficacy.

Cooperators

Mr. Ragan Bounds	Hancock Forest Management, Colmesneil, TX
Ms. Marianne Waindle	JJ Mauget, Arcadia, CA
Mr. Joseph Doccola	Arborjet, Inc., Worchester, MA

Treatments:

Trial 1: Established April 2008

Trt #	Chemical	Formulation	Application Timing	Rate (g ai/inch dbh)	No. of Trees Treated	Felling Dates
1	Abamectin	Abacide	Apr-08	0.4	40	Sept '08, July '09, '10 & '11
2	Abamectin	Abacide	Apr-08	0.8	40	Sept '08, July '09, '10 & '11
3	Abamectin	Abacide	Oct-08	0.4	30	Jul '09, '10 & '11
4	Abamectin	Abacide	Oct-08	0.8	30	Jul '09, '10 & '11
5	Fipronil	BAS 350 PW	Oct-08	0.4	30	Jul '09, '10 & '11
6	Fipronil	BAS 350 PW	Oct-08	0.8	30	Jul '09, '10 & '11
7	Untreated				40	Sept '08, July '09, '10 & '11

Research Approach and Evaluation:

This study was established in a loblolly pine plantation (about 20 years old) that was recently thinned near Diboll (Angelina Co.), TX. Test trees (240) ranging from 15 to 23cm dbh, were selected. The above abamectin treatments were applied to 40 trees in April 2008 and 30 more trees were treated with abamectin or fipronil treatments in October 2008. The insecticides were injected using the Arborjet Tree IV™ microinfusion system (Arborjet, Inc. Woburn, MA) into four cardinal points 0.3 m above the ground. The injected trees were allowed at least 3 months to translocate chemicals prior to being challenged by bark beetles.

In July 2010, 10 trees of each treatment will be felled and one 1.5 m-long bolt will be removed from the 5 m height of the bole. The bolts will be transported to a nearby plantation that had been recently thinned and contains fresh slash material. Bolts will be randomly placed 1 m from other bolts on discarded, dry pine bolts to maximize surface area available for colonization as well as to discourage predation by ground and litter-inhabiting organisms. To facilitate timely bark beetle colonization, packets of *Ips* pheromones (racemic ipsdienol and cis-verbenol; Synergy Semiochemicals, Delta, BC, Canada) will be attached to 1 m stakes evenly spaced in the study area.

Each series of bolts will be retrieved about 3 weeks after deployment, after many cerambycid egg niches are found on the bark surface of most bolts. In the laboratory, two 10 cm X 50 cm samples (total = 1000 cm^2) of bark will be removed from each bolt. The following measurements will be recorded from each bark sample:

1) Number of bark beetle pitch tubes and cerambycid egg niches on bark surface.
2) Number of unsuccessful attacks - penetration to phloem, but no egg galleries.
3) Number of successful attacks - construction of nuptial chamber and at least one egg gallery extending from it.
4) Number and lengths of egg galleries with larval galleries radiating from them.
5) Number and lengths of egg galleries without larval galleries.
6) Percent of bark sample with cerambycid activity, estimated by overlaying a 100 cm^2 grid on the underside of each bark strip and counting the number of squares where cerambycid larvae had fed.

Treatment efficacy will be determined by comparing the number of *Ips* beetle attacks, the number and total length of *Ips* egg galleries and the area of cerambycid feeding for each treatment and application timing. Data will be transformed by $\log_{10}(x+1)$ if necessary to satisfy criteria for normality and homoscedasticity (Zar 1984) and analyzed by GLM and the Fisher's Protected LSD test using the Statview® statistical program (SAS Institute Inc.).

Project Support: JJ Mauget has provided funding toward the project and donated chemical product. Arborjet, Inc. has agreed to loan the FPMC injection equipment for the project.

Research Time Line:

CY 2009

<u>July - August, 2009</u>

- Fell second series of trees, transport bolts to thinned stand, lay out bolts and install lures (July)
- Remove bolts and record attacks and gallery lengths (August)

September - December, 2009

- Conduct statistical analyses of data.
- Prepare and submit report to FPMC Executive Committee and JJ Mauget.

CY 2010

July - August, 2010

- Fell third series of trees, transport bolts to thinned stand, lay out bolts and install lures (July)
- Remove bolts and record attacks and gallery lengths (August)

September - December, 2010

- Conduct statistical analyses of data.
- Prepare and submit report to FPMC Executive Committee and JJ Mauget.

CY 2011

July - August, 2011

- Fell fourth series of trees, transport bolts to thinned stand, lay out bolts and install lures (July)
- Remove bolts and record attacks and gallery lengths (August)

September - December, 2011

- Conduct statistical analyses of data.
- Prepare and submit report to FPMC Executive Committee and JJ Mauget.
- Present results at annual Entomological Society of America meeting.

SYSTEMIC INSECTICIDE INJECTION TRIALS

Systemic Injections for Protection of Southern and Western Pines from Bark Beetles and Bluestain Fungi (Continued from 2009)

Justification: The southern pine beetle (SPB), *Dendroctonus frontalis*, is responsible for extensive pine mortality throughout southeastern North America. This species has a significant impact on timber, recreation, water, and wildlife resources as well as residential property values. The value of individual trees located in residential, recreational, or administrative sites, the cost of removal, and the loss of aesthetics may justify protecting these trees when local bark beetle populations are high. Protection of individual trees from bark beetles has historically involved insecticide applications to the tree bole using hydraulic sprayers. However, this control option can be expensive, time-consuming, of high risk for worker exposure and drift, and detrimental to natural enemies. The use of a newly developed injection technology to deliver systemic insecticides could reduce or eliminate many of the limitations associated with hydraulic spray applications.

Protection of individual trees from bark beetles has historically involved insecticide applications to the tree bole using hydraulic sprayers. However, they are a high risk for worker exposure and drift, and are detrimental to non-target insects (Billings 1980).

Systemic insecticides have been suggested as a potentially useful tool for protection of individual trees or forested areas. Trials have been conducted using acephate (Orthene®) (Crisp, Richmond, and Shea 1979 unpublished data, in Billings 1980), fenitrothion (Pestroy®) and dicrotophos (Bidrin®) (Dalusky et al. 1990), oxdydementon methyl (Inject-a-cide®) (Haverty et al. 1997), and azadirachtin (neem) (Duthie-Holt et al. 1999). Although attack success and tree mortality were not prevented in any of the trials, all trials showed some level of reduced brood development or production. Until very recently, no systemic insecticide had been field tested and determined capable of protecting individual trees from bark beetle attacks.

In 2004, two field trials conducted by the Texas Forest Service demonstrated that injections of emamectin benzoate and fipronil into loblolly pine were highly effective for preventing colonization of treated bolts by *Ips* engraver beetles, and the mortality of standing trees (Grosman and Upton, 2006). In 2005, a trial was initiated in the Chickasawhay Ranger District in the DeSoto National Forest to evaluate the efficacy of emamectin benzoate and fipronil against SPB. Unfortunately, SPB population declined in the study area to the extent that few baited trees died as a result of beetle attack. However, the level of attack on injected trees was markedly lower than on check trees, suggesting that the treatments did have an effect on SPB attack success. In 2006 and 2007, injection trials were established in the Oakmulgee R.D. and Bankhead R.D., respectively. Both trials demonstrated that emamectin benzoate could significantly reduce tree mortality compared untreated checks (Grosman et al, 2009). However, mortality of injected trees was attributed to numerous inoculations of blue stain fungi by the unsuccessful SPB. Recently, tree-injected propiconazole and thiobendazole have been found to reduce the size of blue stain lesions (Klepzig, unpublished data). Emamectin benzoate and the fungicide mix (propiconazole + thiobendazole) alone or combined needs to be tested for efficacy against SPB and bluestain fungi.

Objectives: 1) Evaluate the efficacy of trunk injections of emamectin benzoate and fungicide mix (propiconazole + thiobendazole) alone or combined for protection of southern yellow pines against SPB and blue stain fungi, and 2) to determine duration of treatment efficacy.

Cooperators

Dr. Steve Clarke,	USDA Forest Service – FHP R8, Lufkin, Texas
Ms. Cindy Ragland,	USDA Forest Service – Talladega National Forest, AL
Dr. Christopher J. Fettig,	USDA Forest Service – PSW Research Station, Davis, CA
A. Stephen Munson	USDA Forest Service – Ogden, UT
Mr. Joseph Doccola	Arborjet, Inc., Worchester, MA
Ms. Marianne Waindle	JJ Mauget, Arcadia, CA

Research Approach: This study is being conducted at 2 sites: 1) Talladega National Forest, Oakmulgee Ranger District in Bibbs and Perry Co., Alabama with southern pine beetle attacking loblolly pine; and 2) Uinta-Wasatch-Cache National Forest, Mountain View-Evanston Ranger District, Utah, with mountain pine beetle (MPB) attacking lodgepole pine. The treatments at each site included:

Trial 1

1) Emamectin benzoate (0.4g AI per inch; Tree-age, Arborjet Inc.) injection at 10 ml per inch DBH in April 2009,
2) Thiabendazole (13%) + Propiconazole (7%) (1:1) injection at 10 ml per inch DBH,
3) Emamectin benzoate + Thiabendazole + Propiconazole (2:1:1) injection at 20 ml per inch DBH,
4) Untreated (control) - used to assess beetle pressure during each summer (2009 - 2010)

Trial 2

1) Emamectin benzoate (0.4g AI per inch; Tree-age, Arborjet Inc.) injection at 10 ml per inch DBH in June 2009,
2) Emamectin benzoate (0.4g AI per inch; Tree-age, Arborjet Inc.) injection at 10 ml per inch DBH in September 2009,
3) Emamectin benzoate + Propiconazole injection at 20 ml per inch DBH in June 2009,
4) Emamectin benzoate + Propiconazole injection at 20 ml per inch DBH in September 2009,
5) Abamectin (0.4g AI per inch; Abacide2, Mauget Inc.) injection at 20 ml per inch DBH in September 2009,
6) Abamectin (0.4g AI per inch; ; Abacide2, Mauget Inc.) injection at 20 ml per inch DBH + Tebuconazole (0.4g AI per inch; Tebuject 16, Mauget Inc.) injection at 6 ml per inch DBH in September 2009,
7) Untreated (control) - used to assess beetle pressure during each summer (2009 - 2010)

Table 1. Scheduled injection, baiting and evaluation dates for three *Dendroctonus* bark beetle trials.

	MPB (CO)	SPB (AL)	MPB (UT)
Project Leader(s)	Doccola	Grosman & Clarke	Fettig
Injection Dates	Sep-06 May-07	Apr-09	Apr-09 Sep-09
Baiting Period	------	May - Jun 2009 Apr - Jun 2010	Jul - Aug 2009 Jul - Aug 2010
Prelim Evaluation	Nov 2007 Nov 2008	Jun - Nov 2009 May - Nov 2010	Oct 2009 Oct 2010
Final Evaluation	Aug 2009	Dec. 2009 Dec. 2010	Jun 2010 Jun 2010

SPB = Southern pine beetle; MPB = Mountain pine beetle

Test trees were located in areas with recent beetle activity and isolated from other sample trees. Trees selected were 23 to 52cm dbh, and within 75m of an access road to facilitate treatment. The spacing between adjacent treated trees was >100m to ensure that a sufficient number of beetles would be in the vicinity of each tree to rigorously test the efficacy of these treatments.

Each systemic insecticide treatment was injected with the Arborjet Tree IV™ microinfusion system (Arborjet, Inc. Woburn, MA) into 4 cardinal points 0.3 m above the ground on each of 30 - 35 trees. The treatments were applied in April 2009 (AL & UT) and September 2009 (UT) (Table 1). The injected trees were generally allowed one or more months (depending on water availability) to translocate chemicals prior to being challenged by the application of synthetic pheromone baits.

All test trees and the the set of untreated check trees will be baited with appropriate species-specific lures (Synergy Semiochemicals, Delta, BC) for 6 weeks in April (AL) and June (UT). The surviving treated trees in each treatment (if there are no more than 6 killed by the bark beetle challenge), and the second set of check trees were/will be baited again for the same length of time in 2010 (AL). Similarly, the treated trees and third set of check trees will be baited in 2011.

The only criterion used to determine the effectiveness of the insecticide treatment will be whether or not individual trees succumb to attack by bark beetles. Tree mortality will be assessed every other month (AL) or in the month of August (UT) for multiple, consectutive years until efficacy is diminished. The period between pheromone removal and mortality assessment will be sufficient for trees to "fade," an irreversible symptom of pending tree mortality. Presence of species-specific bark beetle galleries will be verified in each tree classified as dead or dying.

Treatments will be considered to have sufficient beetle pressure if at least 60% of the untreated control trees die from beetle attack. Insecticide treatments will be considered efficacious if less than seven treated trees die as a result of bark beetle attack. These criteria were established based on a sample size of 30 to 35 trees/treatment and the test of the null hypothesis, Ho:S (survival ≥ 90%). These parameters provide a conservative binomial test ($\alpha = 0.05$) to reject Ho when more than six trees die. The power of this test, that is the probability of having made the correct decision in rejecting Ho, is .84 when the true protection rate is 70% (Shea et al. 1984).

Project Support: The SPB trial is being funded by a grant from the Southern Pine Beetle Initiative. The WPB trials may be funded by grant from the Pesticide Impact Assessment Program. Syngenta, Mauget and Arborjet, Inc. are providing chemicals or injection equipment for the project.

Research Time Line:

CY 2009

<u>April, 2009</u>

- Identify and select study area in AL (April)
- Implementation (injection) of treatments (April)
- Bait trees (April)

<u>May - September, 2009</u>

- Monitor tree mortality (August and September)
- Evaluate logs from dead trees for beetle and bluestain fungi success (August and September)

<u>November - December, 2009</u>

- Conduct statistical analyses of data.
- Prepare and submit report to FPMC Executive Committee and Arborjet.

CY 2010

<u>March, 2010</u>

- Bait trees (March)

<u>April - September, 2010</u>

- Monitor for tree mortality (April - September)
- Evaluate logs from dead trees for beetle and bluestain fungi success (April - September)

<u>November - December, 2010</u>

- Conduct statistical analyses of data.
- Prepare and submit report to FPMC Executive Committee and Arborjet.

CY 2011 (if warranted)

<u>March, 2011</u>

- Bait trees (March)

<u>April - September, 2011</u>

- Monitor for tree mortality (April - September)
- Evaluate logs from dead trees for beetle and bluestain fungi success (April - September)

November - December, 2011

- Conduct statistical analyses of data.
- Prepare and submit report to FPMC Executive Committee and Arborjet.
- Present results at annual Entomological Society of America meeting.

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SYSTEMIC INSECTICIDE INJECTION TRIALS

Evaluation of Emamectin Benzoate (TREE-age™) for Protection of Trees Against Invasive Insect Pests (Continued from 2009)

Justification: Injection trials conducted by the Forest Pest Management Cooperative, Arborjet Inc. (Woburn, MA) and others from 1999 – 2008 have shown that emamectin benzoate (EB, TREE-äge™), injected into conifers and hardwoods, is highly effective against coneworm, bark beetles, wood borers, forest tent caterpillar and winter moth. Syngenta submitted TREE-äge for registration by EPA in January 2008. Partial approval has been granted for use on ash against emerald ash borer (EAB). It is of interest to know if the Tree-age™ formulation is effective in preventing/reducing damage by new pests, such as an unnamed chalcid wasp and the soapberry borer, a close relative of EAB.

Objectives: 1) To determine the efficacy of TREE-age™ for protecting individual afghan pines and western soapberry from damage and/or mortality attributed to different invasive insect pests; and 2) To determine the duration of protection provided by TREE-age™ against invasive insect pest.

Cooperators

Mr. Oscar Mestas	Urban Forester, Texas Forest Service, El Paso, TX
Mr. Randy Myers	Urban Forester, Midland, TX
Mr. Tom French	Private landowner, Rosharon, TX
Ms. Dennis Moore	City Forester, Allen, TX
Mr. Chad Krajca	District Park Supervisor, Mesquite, TX
Dr. David Cox	Syngenta, Modesta, CA
Mr. Joseph Doccola	Arborjet, Inc., Worchester, MA

Study Sites: The trials are being conducted at 5 sites:

1) Skyline Park, El Paso, TX with chalcid wasps attacking Afghan pine,
2) Municipal property, Midland, TX with chalcid wasps attacking Afghan pine,
3) Private property, Rosharon, TX with soapberry borer (SBB) attacking western soapberry,
4) Municipal property, Allen, TX with soapberry borer (SBB) attacking western soapberry.
5) Parschall Park, Mesquite, TX with soapberry borer (SBB) attacking western soapberry.

Research Approach:

Trial 1 (Chalcid)

1) Emamectin benzoate (0.4g AI per inch; TREE-äge™, Arborjet Inc.) trunk injection at 10 ml per inch DBH in March 2009,
2) Imidacloprid (8.7g AI tree; Merit 75 WSP, Bayer.) soil injection at 74 gal mix in 4-8 holes around drip line of tree,
3) Untreated (control)

This study is being conducted in an El Paso and Midland, TX. A number of afghan pine (age and size unknown) at each location have been under attack by insect (chacid wasp?) pests for several years. Test trees (10 - 15) were selected in early December 2008 in El Paso and in early

March in Midland. Five (5) were injected with a standard rate (10 ml per inch diameter) of TREE-age™ in the spring (late March) in each location. Five (5) trees were treated with imidacloprid via soil injection in El Paso only. Five trees serve as untreated controls at each location.

The imidacloprid application was performed (Dec. 2008 – Jan. 2009) by injecting the dilution about 12 inches into the ground with 45 lbs. PSI using a grid of 4-8 holes around the drip line in a zig-zag pattern. Prior to the injection of chemical the area around the tree was irrigated for several days and again after the irrigation process.

The TREE-äge™ treatment was injected with Arborjet Tree IV™ microinfusion system (Arborjet, Inc. Woburn, MA) into 4 cardinal points 0.3 m above the ground. First, a 3/8" diameter hole is drilled horizontally at each point. An Arbor –plug is installed into each hole. The Tree IV needle is inserted into the plug. Under pressure (60 psi), the TREE-age™ product was pumped into the chamber behind the plug and then out into the xylem tissue. The injected trees were allowed five months to translocate chemicals prior to being evaluated for efficacy.

In April (just after treatment) and late September 2009 and 2010, 3-4' long branches were collected from three heights (low, middle and top crown) on each study tree. In the laboratory, 2-3 inch sections were clipped off from each branch (12 inch total per branch). The diameter at each section was measured. The bark was pealed and the number of live and dead larvae, live and dead adults, current and last year's adult emergence holes were recorded. Calculated number of chalcids (larvae or adult) per 100 cm^2 of branch.

Trial 2 (Soapberry Borer)

1) Emamectin benzoate (0.4g AI per inch; TREE-äge™, Arborjet Inc.) trunk injection at 10 ml per inch DBH in June 2009,
2) Untreated (control)

This study is being conducted at three locations in Texas (Rosharon,TX, near Houston and Allen and Mesquite, TX near Dallas). Several (8 – 17) western soapberry (2 – 18" DBH) infested with soapberry borer larvae were selected in each location. Four to eight trees were injected with a standard rate (10 ml per inch diameter) of TREE-äge™ in the summer (late June and early July) using a QUIK-jet injection system (Arborjet, Inc. Woburn, MA). The trunk injection procedure was generally the same as that described for the previous trial. A similar number of trees serve as untreated controls at each location.

All study trees were evaluated in September and November, 2009 for relative health. Additional evaluations will be made summer and fall 2010 and 2011.

Research Time Line:

CY 2010

April, 2010

- Collect and evaluate Afghan pine branches (April)

June - October, 2010

- Evaluate soapberry trees for damage and mortality (June - October)
- Collect and evaluate Afghan pine branches (September)

November - December, 2010

- Conduct statistical analyses of data.
- Prepare and submit report to FPMC Executive Committee and Arborjet.

CY 2011 (if warranted)

April, 2010
- Collect and evaluate Afghan pine branches (April)

June - October, 2010
- Evaluate soapberry trees for damage and mortality (June - October)
- Collect and evaluate Afghan pine branches (September)

November - December, 2010
- Conduct statistical analyses of data.
- Prepare and submit report to FPMC Executive Committee and Arborjet
- Present results at annual Entomological Society of America meeting.

REGENERATION WEEVILS

Evaluation of Arctic™ and OnyxPro™ for Protection of Pine Seedlings Against Pine Regeneration Weevils (Continued from 2009)

Justification: The pales weevil, *Hylobius pales*, and pitch-eating weevil, *Pachylobius picivorus*, are two of the most 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 strategy 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 in the Texas Forest Service Forest Pest Management laboratory in 1998. Overall, the chemical caused better than 50% weevil mortality even after exposure to seedlings treated nearly four months earlier. It is clear that when seedlings are thoroughly covered with Pounce®-treated seedlings can be protected from weevils for as long as six months post-treatment. In addition, measurement of feeding areas on treated and untreated seedling sections showed that Pounce® is capable of significantly reducing the amount of feeding damage for eight months or longer.

FMC discontinued production of the EC formulation of Pounce® in 2005. Waylay™ and Arctic™ (permethrin, Winfield Solutions) were registered in 2006 to replaced Pounce®. Both of these new products contained similar concentrations of the active ingredient, but differ somewhat in their inert ingredients. Unfortunately, applicators had/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 are interested to know if the addition of a spreader/sticker to an Arctic™ solution may 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 when applied to pine seedlings in nursery beds.

Objectives:

1) Determine the efficacy of Arctic™ (permethrin) alone or combined with a spreader/sticker and OnyxPro™ (bifenthrin) in reducing weevil-caused seedling mortality.
2) Determine the longevity of Artic™ and OnyxPro™ residuals on treated pine seedlings.

Cooperators:

Mr. Shannon Stewart	ArborGen, Livingston, TX
Mr. Robert Cossar	Winfield Solutions, Crossett, AR
Mr. Brian Mount	FMC, Warren, AR

Insecticide:

Arctic™ 3.2 EC (permethrin) – pyrethroid insecticide
OnyxPro™ (bifenthrin) – pyrethroid insecticide.
Complex™ – self-emulsifiable spreader sticker and non-ionic surfactant

Research Approach:

The treatments include:

1) Arctic™ applied once to pine seedlings at 2 quarts / 100,000 seedlings just prior to lifting.
2) Arctic™ + Complex™ (spreader/sticker) applied once to pine seedlings at 2 quarts. / 100,000 seedlings just prior to lifting.
3) OnyxPro™ applied once to pine seedlings at 0.32 oz. / 1000 sq ft just prior to lifting.
4) Check

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 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™-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 3 gal pots (8 seedlings per pot; treatments separate) and placed outside for exposure to the elements. The soil was a 3:1 mix of plantation soil and potting soil. The seedlings were watered as needed.

At two week intervals for the first 2 months and once a month thereafter for 4 additional months, 20 seedlings (5 Arctic™ -treated, 5 Artic™ + Complex™-untreated, 5 OnyxPro™ -treated, and 5 untreated) were/will be pulled and the above-ground stem of each seedling clipped into 5 cm twig segments. Each twig was/will be placed in an individual moistened paper sleeve and placed separately in a petri dish. One weevil, starved for 24 hours, was/will be placed in each dish. All dishes were/will be placed in a dark room (temperature: ~70 ^{o}F) for 48 h. Paper towels sleeves was/will be remoistened after 24 h. The number of dead weevils and an estimate of weevil feeding on cambial tissue were/will be made after 24, 48 and 72 h for each twig. The amount of feeding was/will be measured with a transparent grid of 2 mm^2 squares transposed over the feeding sites on the twigs. Each treatment was/will be replicated 10 times for both male and females, on each of at least nine separate testing periods.

Project Support: The remainder of the trial will be supported by FPMC funds.

Research Time Line:

CY 2009

<u>October - December 2009</u>

- Treat seedlings in nursery bed with appropriate chemical.
- Lift and pot seedlings
- Initiate and maintain laboratory weevil colony.

- Conduct laboratory trial at 2 – 4 week intervals
- Conduct statistical analyses of all data; prepare and distribute final report to members (Grosman).

CY 2010

January - June 2010

- Continue to conduct laboratory trial at 4 week intervals.

December 2010 - January 2011

- Conduct statistical analyses of all data; prepare and distribute final report to members (Grosman).

PINE TIP MOTH

Impact Study
(Continued from 2001 -2009)

Justification: Pine tip moths, *Rhyacionia* spp., can cause significant damage in young pine plantations in the southern United States. Tip moth larval feeding causes bud and shoot mortality that results in tree deformation, reduced height and diameter growth, and occasionally tree mortality (Yates III 1960). The Nantucket pine tip moth (NPTM), *R. frustrana* (Comstock), is the most common and economically important tip moth species in the South (Berisford 1988). It may have three to five generations annually (Powell and Miller 1976).

The impact of tip moth attack on tree growth has not been clearly established. Beal (1967) showed that pine trees protected from tip moth attack grew significantly faster than unprotected trees during the first 6 years after planting on some sites, but not on others. At age 16, differences in height and volume growth between treated and untreated plots were still present, but had decreased considerably (Williston and Barras 1977). In contrast, volume differences between protected and unprotected trees were still increasing after 12 years in Georgia and North Carolina (Berisford et al., unpublished data). Ten years after planting on northeast Florida sandhills, unprotected loblolly pine trees were 2.8 m shorter in height, 3.81 cm smaller in dbh, and had about one forth as much wood as protected pines (Burns 1975). Cade and Hedden (1987) found that loblolly pine protected from tip moth attack for 3 years in Arkansas had ca 13 m^2/ha more volume than unprotected trees at age 12.

During the first year (2001) of the FPMC Tip Moth Impact Study, the unprotected seedlings in 16 study sites averaged 22% of shoots infested over five generations. The exclusion of tip moth from Mimic®-treated seedlings improved tree height, diameter and volume by 28%, 12% and 45%, respectively, compared to untreated trees. During the second year (2002) of the study, tip moth population showed a general decline in the Western Gulf Region with the percent of shoots infested on unprotected seedlings in 7 first-year (planted in 2002) and 15 second-year (planted in 2001) sites averaging 7% and 21%, respectively. However, the higher damage levels in second-year sites did significantly impact the growth of unprotected trees. After two years, the height, diameter, and volume of Mimic®-treated trees were improved by 11%, 12%, and 38%, respectively, compared to check trees. During the third year (2003) of the study, tip moth populations were again low with the percent of shoots infested on seedlings in 10 first-year (planted in 2003) and 7 second-year (planted in 2002) sites averaging 12% and 15%, respectively. The near complete exclusion of tip moth from Mimic®-treated seedlings improved tree height, diameter and volume by 13%, 14% and 25%, respectively, compared to untreated trees. Tip moth pressure and protection by Mimic® treatments was insufficient to produce an impact on second-year tree growth in 2003. However, the higher damage levels in second-year sites did significantly impact the growth of unprotected trees. After three years, the height, diameter, and volume of Mimic®-treated trees were improved by 10%, 17%, and 38%, respectively, compared to check trees. During the fourth year (2004) of the study, six additional sites were established for a total of 40 impact sites. Tip moth populations were again low with the percent of shoots infested on seedlings in 6 first-year and 10 second-year (planted in 2003) sites averaging 10% and 12%, respectively. Tip moth pressure was insufficient to result in an impact on first- or second-year tree growth in 2004. In 2005, four additional sites were established. Tip moth damage levels were the highest since 2001 with the percent of shoots infested on 4 first-year and 6 second-year sites averaging 13% and 16%, respectively. The relatively high tip moth pressure and the nearly complete exclusion of tip moth from first year Mimic®-treated seedlings improved tree height, diameter and volume by 16%, 20% and 58%, respectively, compared to untreated trees. Similarly, second-year sites saw a marked improvement in height (14%), diameter (2%) and volume (17%) compared to its previous years growth. In 2006, outstanding efforts by several Cooperative members resulted in twenty-nine additional sites being established. Tip moth damage levels were the similar to 2005 with the percent of shoots infested on 29 first-year and 4 second-year sites averaging 14% and 16%, respectively. The relatively high tip moth pressure and the exclusion of tip moth from most first year Mimic®-treated seedlings improved tree height, diameter and volume by 7%, 8% and 19%, respectively, compared to untreated trees. Similarly, second-year sites saw a marked improvement in height (10%), diameter (10%) and volume (28%) compared to its previous years growth.

In 2007, 2008 and 2009, we have observed substantial higher tip moth populations and damage compared to 2003 - 2006. High levels are expected for 2010. Therefore, it is proposed that we continue the establishment of several new sites in 2010 and continue the analysis of data already obtained to determine the effects of tip moth attacks on tree growth.

Objectives: 1) Continue evaluating the impact of Nantucket pine tip moth infestation on height, diameter, and volume growth and form of loblolly pine in the Western Gulf Region and 2) identify a pine tip moth infestation threshold that justifies treatment.

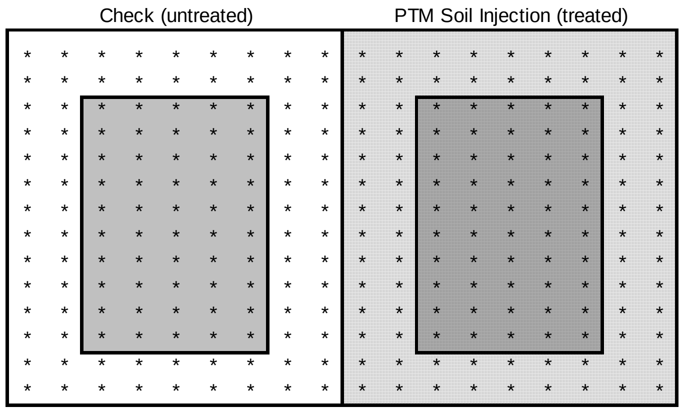
Cooperators

Forest Pest Management Cooperative members

Mr. Trevor Walker	Stephen F. Austin State University, Nacogdoches, TX
Dr. Dean Coble	Stephen F. Austin State University, Nacogdoches, TX

Research Approach: Most participating companies/organizations have established one or more impact sites from 2001 to 2008. We (TFS) will establish five new sites during each of the next two years (2009 & 2010). All sites were/will be planted with improved 1-0 bare-root loblolly pine seedlings. The study uses a randomized block design with 1-2 replications (blocks) per site. Two treatments (plots) were/will be established in each block. Each plot will contain 126 trees (9 rows X 14 columns (see below) spacing depending on landowner). The treatments include:

1) a check (standard company practices, i.e., site prep., herbicide, and fertilizer)
2) standard practices plus tip moth control (PTM™ Insecticide) applied at planting.



PTM™ Insecticide was/will be applied to plant holes using a PTM™ Spot Gun™ per label rates (1.4 ml / 15 ml of water) at planting.

Tip moth damage was/will be evaluated on 1st- and 2nd-year sites after the 1st, 2nd, 3rd and 4th (for sites north of the LA/AR border) and 5th (on sites south of the border) tip moth generations by 1) identifying if the tree is infested or not, 2) if infested, the proportion of tips infested on the top whorl and terminal will be calculated, and 3) separately, the terminal will be identified as infested or not.

Tree height and diameter (at 15cm or 6 in) will be measured at the end of the growing season on first- and second-year sites (established in 2010 and 2009, respectively); tree height, diameter (at breast height (DBH)), and form were/will be measured after year 3 (2008 planting), and 5 (2006 planting).

Tree form was/will be determined using the method of Berisford and Kulman (1967). Four form classes, based on the number of forks present per tree, was/will be recorded as follows: 0 = no forks, 1 = one fork, 2 = two to four forks, and 3 = five or more forks. A fork is defined as a node with one or more laterals larger than one half the diameter of the main stem. Height and diameter measurements will be used to calculate volume index (height X diameter^2).

Mr. Trevor Walker, graduate student in the College of Forestry at Stephen F. Austin State University, has agreed to run a cost/benefit analysis on the impact data. This may identify the threshold at which tip moth damage (% shots infested) would justify application of PTM or SilvaShield for protection of pine seedlings.

Data Analysis: Mr. Walker has provided the following outline for data analysis:

A) Dominant Height equation modifier:

Relate tree growth impact to infestation level (Hedden paper):

Predictor Variables - Years since treatment, identify others in Hazard-Rating part of study

B) Economic simulation:

Determine *willingness to pay* (Asaro 2006) for treatment:

Assume:

Real price increase and consumer price index

Fluctuate levels of, or numerically solve - Price per unit of forest product, Alternative rate of return.

Project Support: The remainder of the trial will be supported by FPMC funds.

Research Time Line:

CY 2009

January - February 2009

- Locate and establish new plots.
- Treat seedlings as they are planted with PTM™ SC Insecticide.

March - September 2009

- Treat plots on second-year sites with foliar sprays based on optimal spray timing recommended for each site location for 1st, 2nd, 3rd and 4th generations.
- Evaluate tip moth damage after 1st, 2nd, and 3rd generations in treated and check plots on second-year sites; photograph damage.

October - November 2009

- Evaluate tip moth damage after 4th and 5th (if present) generations on second-year sites; take growth measurements on 2nd, 3rd and 5th-year trees; evaluate tree form on three- and five-year old sites; photograph damage.

December 2009 - January 2010

- Conduct statistical analyses of all data; prepare and distribute final report to members (Grosman).

CY 2010

January - February 2010

- Locate and establish new plots.
- Treat seedlings as they are planted with PTM™ SC Insecticide.

March - September 2010

- Evaluate tip moth damage after 1st, 2nd, and 3rd generations in treated and check plots on second-year sites; photograph damage.

October - November 2010

- Evaluate tip moth damage after 4th and 5th (if present) generations on second-year sites; take growth measurements on 2nd, 3rd and 5th-year trees; evaluate tree form on three- and five-year old sites; photograph damage.

December 2010 - January 2011

- Conduct statistical analyses of all data; prepare and distribute final report to members (Grosman).

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PINE TIP MOTH

Hazard Rating Study
(Continued from 2001 - 2009)

Justification: Pine tip moths, *Rhyacionia* spp., can cause significant damage in young pine plantations in the southern United States. Tip moth larval feeding causes bud and shoot mortality that results in tree deformation, reduced height and diameter growth, and occasionally tree mortality (Yates III 1960). The Nantucket pine tip moth (NPTM), *R. frustrana* (Comstock), is the most common and economically important tip moth species in the South (Berisford 1988). It may have three to five generations annually (Powell and Miller 1976).

Several studies have evaluated the influence of stand management practices or growing conditions on tip moth infestation and tree damage levels. Tip moth levels have been observed to be higher in plantations compared to natural stands (Beal et al. 1952, Berisford and Kulman 1967), in plantations with the widest tree spacing (Hansbrough 1956), and are positively correlated with intensity of site preparation (Hertel & Benjamen 1977, White et al. 1984, Hood et al. 1988), weed control (Ross et al. 1990), and fertilization (Ross and Berisford 1990).

Technological developments in pine plantation management and tree improvement programs within the past two decades have dramatically increased rates of tree growth. Intensive management of southern pines typically includes thorough mechanical site preparation and/or one or more herbicide applications plus fertilization on most sites. Although these practices increase tree growth, sometimes dramatically, they can exacerbate tip moth attacks and prevent realization of potential tree growth (Ross et al. 1990). Over the past eight years (2001 – 2008), The FPMC has established and monitored 135 hazard-rating plots across the Western Gulf Region. A preliminary hazard-rating model, developed by Andy Burrow from 2001 – 2005 data, indicates (in order of increasing importance)- site index, percent sand, clay and silt in the soil, drainage class, texture of soil in B horizon, and depth to B horizon are primary factors that influence the occurrence and severity of tip moth damage. The remaining data from second-year sites (established in 2008) needs to be collected. Dr. Dean Coble and Trevor Walker, SFASU, has agreed to provide assistance in completing the tip moth hazard-rating model.

Objectives: 1) Complete data collections on sites established in 2008, 2) continue development of regression models using stand characteristics and other abiotic factors to predict future levels of tip moth damage, 3) identify factors which may facilitate hazard rating of stands for tip moth damage, and 4) develop GIS maps to show levels of tip moth risk across the Western Gulf Region.

Cooperators

Forest Pest Management Cooperative members

Mr. Trevor Walker	Stephen F. Austin State University, Nacogdoches, TX
Dr. Dean Coble	SFA & SU College of Forestry, Nacogdoches, TX

Research Approach:

From 2001 to 2009, 138 hazard-rating plots were established across the Western Gulf Region, many in association with the Impact Study. Each hazard-rating plot has/will be evaluated in the

1st and 2nd year after establishment, so the 3 plots established in 2009 need to be monitored in 2009.

Data will be collected for the following soil, tree, and site characteristics:

Soil - Drainage class
- Soil description/profile: depth of 'A' and to 'B' horizons; color of 'B' horizon; soil auger 5 samples (remove organic layer & keep next 3-5") between tree rows within plot; bulk and send pint subsample to Water's lab for standard soil analysis (minus N) plus pH and micronutrients
- Texture: soil auger 5 samples (remove top 5" & keep next 4") between tree rows within plot; bulk and send pint subsample to Water's lab for analysis
- Depth to hard-pan or plow-pan
- Depth to gleying

Tree - Age (1-2)
- Percent tip moth infestation of terminal and top whorl shoots
- Height and diameter at 6 inches (do not measure at root collar swell)
- Tree form (presence or absence of forks)
- Fusiform rust occurrence

Site - Previous history of stand
- Site Index (base 25 yrs)
- Silvicultural prescription *(*for entire monitoring period*)*
- Slope & aspect
- Competing vegetation- (see below for protocol)
- Presence or absence of well-developed sod
- Rainfall: install a rain gauge (11" capacity – available from Forestry Supply) on each site which will be read at least once per 2-4 weeks (once per week best); add 1/10" of antifreeze after each reading to reduce evaporation; a fallback would be from the nearest weather station (not recommended by climatologist).
- Proximity of susceptible loblolly stands in the 1-4 year age class (< 15 ft. tall) adjacent to or within 0.5 miles of study stand boundary: estimate total acreage in this class; record percent infestation in top whorl of 20 randomly encountered trees in closest proximal stand during winter or early spring

The 2nd year sample trees were/will be assessed for:

- Percent infestation of terminal and top whorl shoots after tip moth generations 1, 2, 3, and 4 (on sites north of LA/AR border) and 5 (on sites south of the border)
- Height and diameter (at 6 inches)
- Fusiform rust

Incidence of fusiform rust was/will be measured by counting the number of fusiform galls on the main stem and on branches within 12 inches of the main stem of each tree.

Competing vegetation was/will be estimated twice (after the 2nd and after the last tip moth generation) at each of the 5 random points within the 50 tree plot. At each point, an estimate was/will be made of the proportion of bare ground, grasses, forbes, and non-arborescent woody material occurring within a 0.5 meter radius of the point. The combined percentage of the four categories should equal 100%.

Data Analysis: Mr. Trevor Walker, SFA, has begun redeveloping the model. With a Bachelors' in Forestry and minor in statistics, Mr. Walker has the expertise the FPMC needs to get the job done. The data (eight years' worth; 2001- 2008) has been consolidated and sent to Mr. Walker by the end of February 2009. Additional data collected from 2009, was sent to Mr. Walker in April 2010.

The following is an outline provided by Mr. Walker for model development:

A) Choosing a response variable:
  - Percent infested => may require variance stabilizing transformation
    - By tree or plot/By generation or year => Measuring variability
      - -By plot using the first two generations may be the response that is most explained by the predictor variables

B) Identify predictor variables that explain the variation in the response variable:
  - Stepwise Regression: Multiple or Logistic
  - Regression and Classification Trees
    - - Test using subset of data and calculate APER
  - Single variable analysis (linear association)
    - - simple linear regression, pearson's correlation, graphs
  - Interactions between predictor variables - Multicollinearity
    - - Correlation Coefficient / Scatterplot Matrix
    - - Variable reduction - PCA/Factor Analysis

C) ANOVA – Fabricate a research design using the class variables
  - - Unbalanced sample size structure

D) Model infestation levels by generation.
  - - Line chart for infestation level by generation by site and both ages (1 and 2).
  - - Investigate correlations between infestation levels by generation with predictor variables

E) Develop hazard-rating map.
  - - Map rating class based on important predictor variables.
  - - Bayou Bleu Farms, LLC case study/poster.

Research Time Line:

CY 2010

<u>January - February 2010</u>

- Work with participating FPMC members to identify and receive all missing data from previously established hazard rating plots (2001 – 2008) (Grosman).

<u>March - July 2010</u>

- Evaluate tip moth damage after 1st and 2nd generations on first- and second-year sites; conduct competing vegetation assessment; photograph damage.

<u>August – October 2010</u>

- Evaluate tip moth damage after 3rd generation for all sites and 4th generation for sites south of the LA/AR border; photograph damage.
- Collect site information for hazard rating study.

November - December 2010

- Evaluate tip moth damage, conduct competing vegetation assessment after last generation (4^{th} for sites north of border or 5^{th} for sites south of the border) and evaluate for occurrence of fusiform rust on second-year sites.

CY 2011

January 2011

- Conduct statistical analyses of all data; prepare and distribute final report to members (Grosman, Walker and Coble).

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PINE TIP MOTH

Fipronil Operational Soil Injection Study (Continued from 2006)

Justification: The Technique and Rate Trials (2003 –2005) showed that fipronil (Regent®) applied in plant holes at planting or soil injection post planting was effective in reducing potential tip moth damage on several study sites during the first two years after planting. Also, the first Operational Planting Trial (2003 – 2005) showed that planting large areas with fipronil-treated seedlings deters tip moth from colonizing new plantations, subsequently populations are kept low within the treated area. Machine planter and hand systems can be used to apply fipronil solution at or after planting, respectively. Data collected from sites established in 2007 and 2008 indicate that machine-applied fipronil treatment was effective in reducing tip moth damage by an average of 58%. The duration of treatment efficacy in reducing pine tip moth infestation levels on loblolly pine seedlings needs to be continued.

Objective: 1) Determine the efficacy of fipronil in reducing tree-level and area-wide level of pine tip moth damage on loblolly pine seedlings; 2) evaluate this product applied via soil injection by machine planter; and 3) determine the duration of protection provided by this insecticide application.

Cooperators

Mr. Wilson Edwards	Weyerhaeuser Co., New Bern, NC
Mr. Peter Burk	Weyerhaeuser Co., Columbus, MS
Mr. Randy Winston	Private landowner, Lufkin, TX
Ms. Lou Ann Miller	Private landowner, Nacogdoches, TX
Mr. Jim Rogers & Lane Day	Precision Machine Services, Lufkin, TX
Mr. Justin Penick	Acorn Forestry Services, Lufkin, TX
Dr. Harold Quicke	BASF, Auburn, AL

Research Approach:

Two first-year plantations were selected in Texas near Lufkin and Nacogdoches in November 2006, one in AR near Oak Grove, in February 2007, and one in Louisiana near Many in December 2007 and another in Arkansas near Mineral Springs in March 2008.

The sites and cooperators included:

1) Lufkin, TX (Mr. Randy Winston provided and Texas Forest Service monitored)
2) Nacogdoches, TX (Ms. Lou Ann Miller provided and Texas Forest Service monitored)
3) Oak Grove, AR (Weyerhaeuser provided and monitored)
3) Many, LA (Weyerhaeuser provided and monitored)
4) Mineral Springs, AR (Weyerhaeuser provided and monitored)

A single family of loblolly pine bare-root seedlings was selected at Weyerhaeuser Nursery in Magnolia, AR for Sites 3, 4 & 5. Seedlings were lifted in a manner to cause the least breakage of roots, culled of small and large caliper seedlings, root-sprayed with clay slurry, bagged and stored briefly in cold storage. For sites 1 & 2, International Paper's containerized loblolly pine seedlings from Bullard, Texas were used.

When ready, seedlings were hand- or machine-planted (spacing is dependent on practices of participating members) in each plantation - preferably near a young (< 4 years old) plantation.

All tracts (40 - 80 acres in size) were selected in Arkansas, Louisiana or Texas based on uniformity of soil, drainage and topography in each pair of stands. All tracts were intensively site prepared, i.e., subsoiled, bedded, and/or treated with herbicide.

At sites 1, 2 & 3, four replicates of 4 – 0.5 acre plots (16 plots total) were established in 2007 (Figure 1). A C&G planter (owned by Acorn Outdoor Services, Lufkin, TX) was fitted with a 50-gallon tank, electrical pump, tubing and valves (designed by Lane Day and Jim Rogers, Precision Machine Services, Lufkin, TX). On 4 preselected plots, the fitted machine planter injected fipronil solution (0.3% ai in 37 ml volume) into the soil as each seedling was placed in the planting furrow. In all other plots, seedlings were machine planted at the same spacing. Afterward, in 4 plots each, seedlings were treated with fipronil by hand using a Kioritz soil injector or modified cattle drencher or with a foliar spray (5X / year).

To evaluate the effects of treatment on large area tip moth damage levels a randomized complete block design, with sites as blocks, was used in 2008 (Figure 2). Sites 4 & 5 plantations were divided in half. One half was operationally machine planted without additional treatment. On the other half, the fitted C&G planter was again used to treat containerized seedlings with PTM™ SC Insecticide (fipronil) as they were planted in furrows. To further evaluate the effects of treatment on tip moth damage levels, a 5 – 0.5 acre subplots were established in the check main plot half. Each treatment was randomly assigned to one of the five subplots.

Treatments:

Site 1, 2 & 3

1) MF = seedlings machine planted with fipronil applied at 0.1 – 0.14g active ingredient (in 37 ml water) per seedling as they are planted.
2) MHF = seedlings machine planted; afterwards fipronil applied at 0.1g ai (in 12 ml water) per seedling by Kioritz soil injector.
3) MFS = seedlings machine planted; afterwards foliar spray (Mimic®2LV (0.6 ml / liter of water)) applied (5X)
4) MC = seedlings machine planted; no additional treatment (Check).

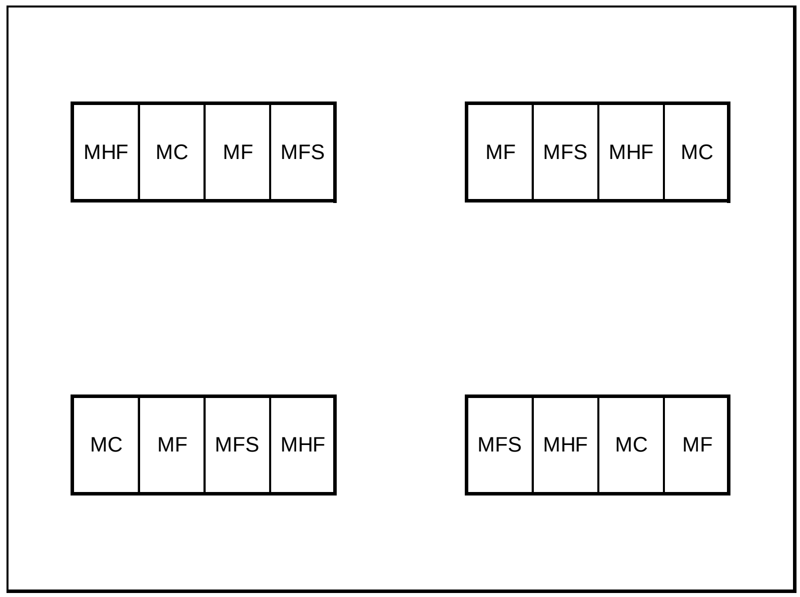
Site 4&5

Main Plot (40 acres each)

1) PTM™ applied at 0.14g active ingredient (in 37 ml water) per seedling by machine planter.
2) Check –seedlings planted by machine planter (no water added).

Sub-plots (0.5 acres each)

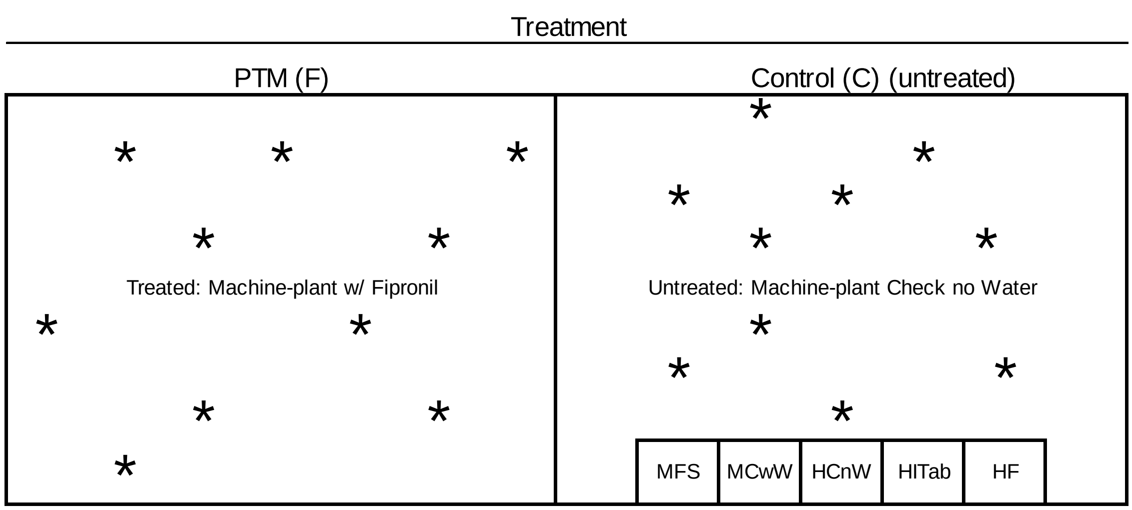
3) Seedlings planted by machine planter (no water added) plus foliar spray application (5X) with Mimic®2LV (0.6 ml / liter of water)
2) Seedlings planted by machine planter plus water (37 ml) added.
3) Seedlings planted by hand (no water added)
4) Seedlings planted by hand (no water added) with 1 SilvaShield™ tablet
5) Seedlings planted by hand plus PTM™ applied at 0.14g active ingredient (in 12 ml water) per seedling by Kioritz soil injector.



Site = 40 - 50 acres each; Internal treatment plots = 0.5 acres each

MF = Machine Fipronil; MC = Macine Check; MHF = Machine Hand Fipronil; MFS = Machine Foliar spray

Figure 1. Generalized Plot Design for two Texas sites established in December 2006 and one Arkansas site established in February 2007.



Main treatment plots = 40 acres each; Internal treatment subplots = 0.5 acres each; ten 10-tree plots (*) evenly spaced within each main plot

Sub-Plot Treatments:

MFS = Machine-plant + Foliar spray;
MCwW = Machine-plant Check with Water;
HCnW = Hand-plant Check no Water;
HITab = Hand-plant + Imid Tablet;
HF = Hand-plant + PTM

Figure 2. Generalized Plot Design for one Louisiana site established in December 2007 and one Arkansas site established in March 2008.

Tip moth damage was evaluated at all sites after each tip moth generation (3-4 weeks after peak moth flight) by 1) identifying if the tree is infested or not, 2) if infested, the proportion of tips infested on the top whorl and terminal was calculated; and 3) separately, the terminal was identified as infested or not. Observations also were made as to the occurrence and extent of damage caused by other insects, i.e., coneworm, aphids, sawfly, etc. Each tree was measured for diameter (@ 6") and height in the fall (December) for two years following planting. At the end of year three, diameter will be measured at breast height (dbh; 147 cm) and tree will be ranked as to form. Form ranking of the seedling or tree will be categorized as follows: 0 = no forks; 1 = one fork; 2 = two to four forks; 3 = five or more forks. A fork is defined as a node with one or more laterals larger than one half the diameter of the main stem (Berisford and Kulman 1967). Data will be analyzed by GLM and the Fisher's Protected LSD test using Statview or SAS statistical programs.

Project Support: Weyerhaeuser and BASF had provided extra funds toward the rental and fitting of a machine planter with application equipment. BASF donated chemical product. The remainder of the project will be funded by a Forest Service Pesticide Impact Assessment Program grant and FPMC funds.

Research Time Line:

CY2010

<u>January – February 2010</u>

- Begin trap monitoring of tip moth populations near each site
- Apply foliar spray to appropriate plots prior to 1st generation

<u>March – October 2010</u>

- Apply foliar spray to appropriate plots prior to each of generations 2 - 5.
- Evaluate tip moth damage after 1st through 4th generations; photograph damage.

<u>November – December 2010</u>

- Evaluate tip moth damage after 5th generations; measure diameter and height of seedlings.
- Select research sites.
- Fit machine planter with injection equipment
- Lift, plant and treat seedlings in plantation sites
- Conduct statistical analysis of 2010 data.
- Prepare and submit report to FSPIAP sponsor, FPMC Executive Committee, BASF.
- Present results at annual Entomological Society of America meeting.

Literature Cited:

Berisford, C.W., and H.M. Kulman. 1967. Infestation rate and damage by the Nantucket pine tip moth in six loblolly pine stand categories. For. Sci. 13: 428-438.

Lashomb, J.H., A.L. Steinhauer and G. Dively. 1980. Comparison of parasitism and infestation of Nantucket pine tip moth in different aged stands of loblolly pine. Environ. Entomol. 9: 397-402.

PINE TIP MOTH

Fipronil/PTM™ Treatment Trials
(Continued from 2007)

Justification

Several recent trials (2003 - 2005) have shown that fipronil applied to bare root seedlings before or after planting is highly effective in reducing tip moth damage for 2+ years. EPA recently approved the registration and use of PTM™ SC Insecticide for tip moth control. Operationally, it also is desirable to apply chemical solutions to containerized seedlings because of their higher value and there is less restriction on the amount of active ingredient that could be applied to each seedling. A trial was established to determine the efficacy of fipronil applied at different rates to containerized seedling.

A hazard-rating model to predict if a site is at risk is being developed. In the mean time, it is possible that a landowner may not wish to treat for tip moth at the time of planting. However, later in the first growing season tip moth becomes a significant problem. The landowner may then wish to treat to protect trees during the second growing season. A trial was established to determine the efficacy of fipronil applied to pines before the second growing season using different application techniques.

Objectives: 1) Evaluate the efficacy of fipronil applied using different rates and techniques for reducing pine tip moth infestation levels, and 2) determine the duration of chemical activity.

Cooperators

Mr. Bill Stansfield	Campbell Group, Diboll, TX
Ms. Fances Peavy	Private landowner, Hudson, TX
Mr. Ragan Bounds	Hancock Forest Management, Colmesneil, TX
Dr. Harold Quicke	BASF, Auburn, AL

Research Approach:

Trial 1 (2007):

Two families of loblolly pine containerized and bare-root seedlings were selected at the Temple Inland Nursery, Jasper, TX.

Treatments**:**

1 =	Containerized Fipronil (1X - 3 ml/seedling) -	Injection into cell in July
2 =	Containerized Fipronil (5X - 15 ml/seedling) -	Injection into cell in July
3 =.	Containerized Single Pounce® Foliar -	Pounce® applied (2qts/100K) 1X/ seedling
4 =	Containerized Check (untreated)	
5 =	Bare Root Fipronil (3 ml/seedling) -	Soil injection next to transplant in Nov.
6 =.	Bare Root Single Pounce® Foliar -	Pounce® applied (2qts/100K) 1X/ seedling
7 =	Bare Root Check (untreated)	Resident seedling

Containerized seedlings were individually treated using a small syringe in July 2006. The seedlings were treated at 1X and 5X the rate designated for transplanted bare root seedlings (1X

= 0.13 lbs AI/acre/year = 0.118 g AI/seedling at 500 seedlings/acre). All bare root seedlings were operationally lifted by machine in March 2007, culled of small and large caliper seedlings, treated with Terrasorb™ root coating, bagged and stored briefly in cold storage. Each family was planted on each of two plantation sites. At each site, treatments were randomly assigned to 1 of 7 plot areas. One hundred seedlings were planted per plot at 7' X 12' spacing (518 TPA) (see layout below).

Trials 2 (2008) and 3 (2009):
Two plantations containing one-year old (trees beginning their second year in January 2008 or January 2009) loblolly pine were selected in the East Texas area. Treatments included**:**

Trial 2 (2008):

1 =	PTM™ (1.4 ml in 12 ml/tree solution) -	single injection into soil 4" deep
2 =	PTM™ (1.4 ml in 12 ml/tree solution) -	double injection (6 ml ea.) into soil 4" deep
3 =	PTM™ (1.4 ml in 12 ml/tree solution) -	single injection into soil 8" deep
4 =	PTM™ (1.4 ml in 12 ml/tree solution) -	double injection (6 ml ea.) into soil 8" deep
5 =.	Foliar spray -	Mimic® applied 5X/ seedling
6 =	Check (untreated) -	Resident seedling

Trial 3 (2009):

1 =	PTM™ (1.4 ml in 15 ml/tree solution) -	double injection (7.5 ml ea.) into soil 4" deep
2 =	PTM™ (1.4 ml in 30 ml/tree solution) -	double injection (15 ml ea.) into soil 4" deep
3 =	PTM™ (2.8 ml in 15 ml/tree solution) -	double injection (7.5 ml ea.) into soil 4" deep
4 =	PTM™ (2.8 ml in 30 ml/tree solution) -	double injection (15 ml ea.) into soil 4" deep
5 =.	SilvaShield™ Tablet -	1 tablet in each of 2 locations 4" deep
6 =	Check (untreated) -	Resident seedling

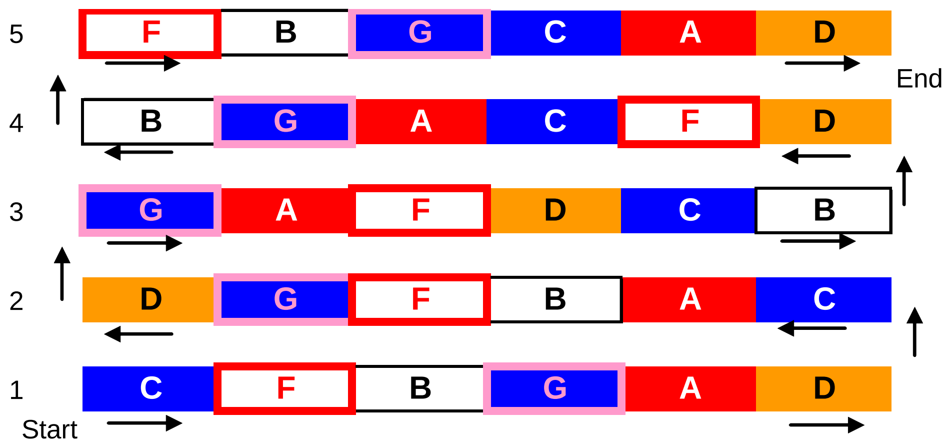
A 1 acre (approximate) area within each site was selected. A randomized complete block design was established with beds (or rows of trees) serving as blocks, i.e., each treatment was randomly selected for placement along a bed. Fifty trees for each treatment were selected on each site. Ten trees were assigned a given treatment on each of five beds. (Figure 3). If the length of bed is problematic (too long), it is acceptable to start laying the first group of treatments along the first bed and wrap the remaining treatments along the second bed. The second group of treatments would start on the second bed but then wrap onto the third bed, etc.

The plot corners were marked with PVC pipe and the individual trees with different color pin flags and tags. It may be necessary to apply herbicide over the area in the spring to ensure that the seedlings remain exposed to tip moth attack throughout the year.

Treatment Evaluation:

Tip moth damage was/will be evaluated by determining percent of trees infested, percent of infested shoots in top whorl and percent terminals infested about 4 weeks after peak moth flight of each generation for at least the first 2 years. Observe and record presence and extent of damage caused by other insects, i.e., weevils, coneworm, webworm, aphids, etc. All study trees

Figure 3. Randomized Block Design Layout for a 6 Treatment Trial.



A = Red (single inj 4" deep)
B = White (double inj 4" deep)
C = Blue (single inj 8" deep)
D = Orange (double inj. 8" deep)
F= Rd&Wht (Pounce Foliar)
G = Pk&Bl (Check)

were measured (height & diameter @ 6 inches) at the beginning of the study (when treatments are first applied). Measurements also will be taken when tree growth has stopped in mid- to late November for at least the first 2 years of the study. Tree form will be evaluated at end of year 3. Form ranking of the seedling or tree will be categorized as follows: 0 = no forks; 1 = one fork; 2 = two to four forks; 3 = five or more forks. A fork is defined as a node with one or more laterals larger than one half the diameter of the main stem (Berisford and Kulman 1967). Data will be analyzed by GLM and the Tukey's Compromise test using Statview or SAS statistical programs.

Research Time Line:

CY 2010

January - February 2010

- Begin trap monitoring of tip moth populations near each site

March - October, 2010

- Evaluate tip moth damage after 1st through 4th generations; photograph damage.

November - December 2010

- Evaluate tip moth damage after 5th generations; measure seedling and height of seedlings.
- Conduct statistical analysis of 2010 data.
- Prepare and submit report to FPMC Executive Committee, BASF.
- Present results at annual Entomological Society of America meeting.

PINE TIP MOTH TRIALS

Imidacloprid/Silvashield™ Trials – Western Gulf (Continued from 2008)

Justification

Imidacloprid, a neonicotinoid insecticide, is highly systemic in plants and is known to have activity against several Lepidopteran pests including pine tip moth.

In 2003 and 2004, imidacloprid plus fertilizer spikes (Bayer 2 – N – 1 Plant Spikes®) reduced tip moth damage for three generations (2^{nd}, 3^{rd} and 4^{th}) in both years. The treatments also resulted in significant improvements in height, diameter and volume index compared to check trees. We propose to continue evaluating the residual effects of imidacloprid on tree growth.

Bayer Environmental Science has been developed tablets containing imidacloprid. The tablets have been used operationally in Australia to control chrysomelid beetles and lepidopteran larvae on eucalyptus and pine. Mr. Nate Royalty (Bayer Environmental Science) asked the FPMC in 2004 and 2005 to evaluate the efficacy of tablets containing several different concentrations of imidacloprid alone or combined with fertilizer. Trials established on two sites showed that all imidacloprid treatments provided good to excellent protection from tip moth during the 2^{nd} through the 5^{th} generation. The absence of control in the first generation indicates that the tablets were slow to release the insecticide. On the other hand, a slower than expected release of chemical from the tablets may have prolonged the treatment effects into the second year. Bayer had developed a new FXT Ball formulation that may provide early and extended protection against tip moth.

In January 2007, Bayer announced that the label for the SilvaShield™ Forestry tablet had been approved by EPA. State registrations have been approved in all states except CA. We are interested in further evaluating the efficacy of these tablets in the Western Gulf region.

Objectives: 1) Determine the efficacy of imidacloprid/ SilvaShield™ in reducing pine tip moth infestation levels on loblolly pine seedlings; and 2) determine the duration of chemical activity.

Cooperators:

Mr. Bill Stansfield	The Campbell Group, Diboll, TX
Mr. Conner Fristoe	Plum Creek Timber Co., Crossett, AR
Mr. Ragan Bounds	Hancock Forest Management, Silsbee, TX
Dr. Nick Chappell	Potlatch Forest Holdings, Warren, AR
Mr. Peter Birks	Weyerhaeuser Co., Columbus, MS
Mr. Doug Long	Rayonier, Lufkin, TX
Dr. Tom Macom	Bayer Environmental Science, Research Triangle Park, NC

Study Sites: In 2003, one second-year plantation was selected near Huntington, TX as part of the Fipronil Technique and Rate Trial (see Fig. 36). In 2006, a second year site was selected near Winnfield, LA. Second-year plantations were used in the study because tip moth populations are usually well established at this age, increasing the likelihood that significant tip moth pressure would be placed on treated seedlings. The plots contained 3 - 10 treatments with 50 trees per treatment.

Insecticides:

Imidacloprid – highly systemic neonictinoid with activity against Lepidoptera.
Disufoton – systemic organophosphate with activity against Lepidoptera.
Fipronil – a phenyl pyrazole with some systemic activity against Lepidoptera.

Design: Randomized complete block design at each site with beds or site areas serving as blocks, i.e., each treatment was randomly selected for placement along a bed. Ten seedlings from each treatment were planted on each of five beds.

Year & Treatments:

2003	1)	2.5% imidacloprid spike + Fertilizer -	3 spikes in soil next to transplant
	2)	1% disulfoton spike + Fertilizer-	3 spikes in soil next to transplant
	3)	Bare root Check -	Treat w/ Terrasorb™ and plant bare root
2006	1)	20% Merit (Imid.) FXT Std. tablet -	1 tablet in soil next to transplant
	2)	20% Merit FXT Std. tablet -	2 tablets in plant hole
	3)	20% Merit FXT Std. tablet -	1 tablet in plant hole
	4)	20% Merit FXT 'Burst' tablet -	1 tablet in plant hole
	5)	Fertilizer -	On soil surface next to transplant
	6)	Gel (5% Imid.) -	In plant hole
	7)	Combo gel (5% Imid.+1% Fipronil) -	In plant hole
	8)	Merit (Imid.)70 WG -	In plant hole
	9)	Mimic® or Pounce® Foliar -	Apply Mimic® (0.6 ml/L water) 5X / season
	10)	Bare-root Check -	Treat w/ Terrasorb™ and plant bare-root
2007	All 6 study sites had:		
	1)	20% Merit® FXT Std. tablet -	1 tablet in plant hole
	2)	20% Merit® FXT Std. tablet -	1 tablet in soil next to transplant
	3)	Mimic® or Pounce® Foliar -	Apply Mimic® (0.6 ml/L water) 5X / season
	4)	Bare-root Check -	Treat w/ Terrasorb™ and plant bare-root
	Two sites also had:		
	5)	10% Merit® (Imid.) FXT Std. tablet -	1 tablet in plant hole
	6)	15% Merit® FXT Std. tablet -	1 tablet in plant hole
2008	Trial 1:		
	1)	SilvaShield™ (20% Imid.) tablet -	1 tablet in plant hole
	2)	SilvaShield™ (20% Imid.) tablet -	1 tablet in soil (4") next to transplant
	3)	SilvaShield™ (20% Imid.) tablet -	2 tablets in plant hole
	4)	SilvaShield™ (20% Imid.) tablet -	3 tablets in plant hole
	5)	PTM™ Insecticide (fipronil) -	Soil injection at planting
	6)	Bare-root Check -	Treat w/ Terrasorb™ and plant bare-root

2008 Trial 2:

1) SilvaShield™ (20% Imid.) tablet - 1 tablet in soil (4”) next to transplant
2) SilvaShield™ (20% Imid.) tablet - 2 tablets in soil (4”) next to transplant
3) SilvaShield™ (20% Imid.) tablet - 3 tablets in soil (4”) next to transplant
4) SilvaShield™ (20% Imid.) tablet - 1 tablet in soil (8”) next to transplant
5) SilvaShield™ (20% Imid.) tablet - 2 tablets in soil (8”) next to transplant
6) SilvaShield™ (20% Imid.) tablet - 3 tablets in soil (8”) next to transplant
7) SilvaShield™ (20% Imid.) tablet - 1 tablet in plant hole
8) Bare-root Check - Treat w/ Terrasorb™ and plant bare-root

Treatment Evaluation: Tip moth damage will be evaluated after each tip moth generation (3-4 weeks after peak moth flight) by 1) identifying if the tree was infested or not, 2) if infested, the proportion of tips infested on the top whorl and terminal will be calculated; and 3) separately, the terminal will be identified as infested or not. Observations also will be made as to the occurrence and extent of damage caused by other insects, i.e., aphids, weevils, coneworm, etc. Second-year trees will be measured for diameter and height (at 6”) in the fall (November) following planting. If warranted, third-year trees will be measured for height and diameter (at DBH) and ranked for form. Form ranking of the seedling or tree will be categorized as follows: 0 = no forks; 1 = one fork; 2 = two to four forks; 3 = five or more forks. A fork is defined as a node with one or more laterals larger than one half the diameter of the main stem (Berisford and Kulman 1967). Data will be analyzed by GLM and the Fisher’s Protected LSD test using Statview or SAS statistical programs.

Research Time Line:

CY 2010

May - October, 2009

- Evaluate tip moth damage after 1st through 4th generations; photograph damage.

November - December 2010

- Evaluate tip moth damage after 5th generations; measure diameter and height of each seedling.
- Conduct statistical analysis of 2009 data.
- Prepare and submit report to Bayer Environmental Science, FPMC Executive Committee.

CY 2011

November - December 2011

- Measure tree height and DBH.
- Conduct statistical analysis of 2010 data.
- Prepare and submit report to Bayer Environmental Science, FPMC Executive Committee.
- Present results at annual Entomological Society of America meeting.

Reference:

Berisford, C.W., and H.M. Kulman. 1967. Infestation rate and damage by the Nantucket pine tip moth in six loblolly pine stand categories. For. Sci. 13: 428-438.

Fettig, C.J., J.T. Nowak, D.M. Grosman and C.W. Berisford. 2003. Nantucket pine tip moth phenology and timing of insecticide spray applications in the Western Gulf region. USDA Forest Service So. Res. Stat. Res. Pap. SRS-32. 13pp.

SilvaShield™ Operational Treatment of Loblolly Pine Seedlings At or After Planting for Control of Pine Tip Moth
(Continued from 2008)

Justification: The Nantucket pine tip moth, *Rhyacionia frustrana* (Comstock) (Lepidoptera: Tortricidae), is a serious pest in young pine plantations of the southeastern United States. Foliar applications of Pounce®, Warrior T®, dimethoate, and Mimic® have proven effective in reducing volume losses by this insect. However, there are several concerns about the use of insecticides in commercial forests, including cost effectiveness, public perceptions, and impact on nontarget organisms, including biological control agents. We propose to evaluate the efficacy and duration of SilvaShield™ (imidacloprid + fertilizer) tablets applied to the soil reducing volume losses caused by pine tip moth in first and second-year pine seedlings.

Objectives:
The objectives of this research proposal are to 1) determine the efficacy of SilvaShield™ tablets in reducing area-wide pine tip moth infestation levels on loblolly pine seedlings; 2) evaluate this product applied after planting to bedded or unbedded areas; and 3) determine the duration of protection provided by this insecticide application.

Cooperators

Ms. Frances Peavy	Private landowner, Hudson, TX
Mr. Steve Anderson	Texas Forest Service, Hudson, TX
Mr. Ragan Bounds	Hancock Forest Management, Colmesneil, TX
Dr. Tom Macom	Bayer Environmental Science, Research Triangle Park, NC

Research Approach:
A single family of loblolly pine containerized seedlings will be selected from the cooperator's nursery, Magnolia, AR. They are expected to be available for planting in November.

One recently-planted tract East of Lufkin, TX, and one one-year old tract near Hudson, TX, each 80 acres in size, were selected in 2008 and cleared tract near Rockland, TX was selected in 2009 based on uniformity of soil, drainage, topography and susceptibility to tip moth infestation (based on FPMC Tip Moth Hazard-Rating Model, Andy Burrow, Potlatch Forest Holdings).

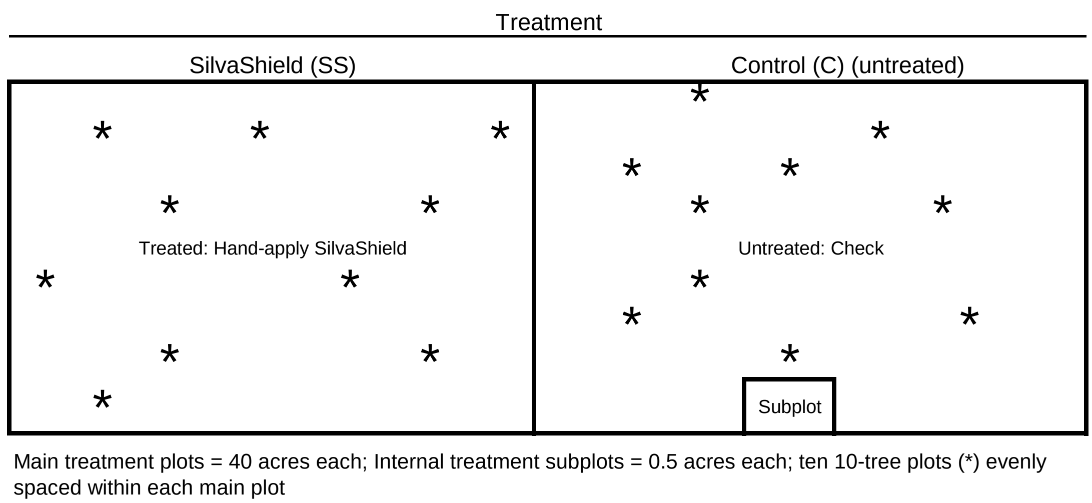


Figure 4. Generalized Plot Design

Treatments 2008:

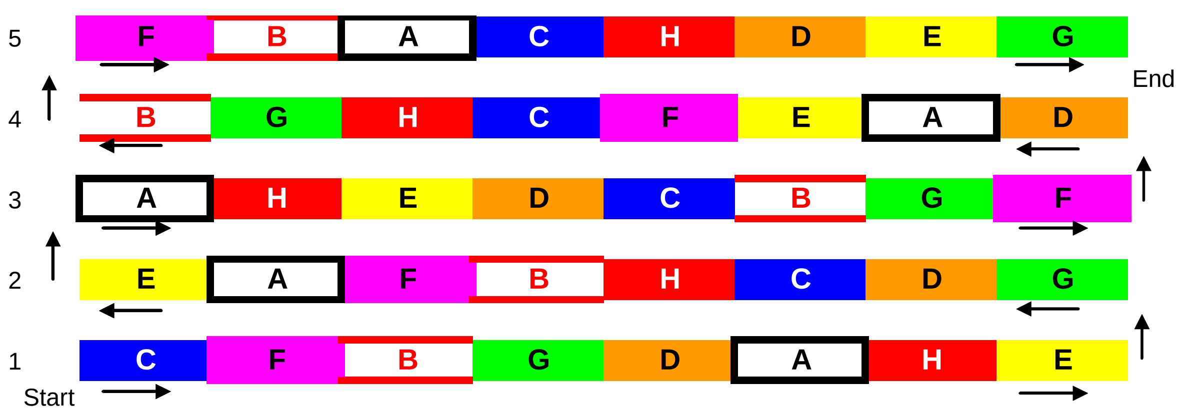
Main Plot (40 acres each) (2008)

1) SilvaShield™ (one tablet) applied after planting next to each seedling to a depth of 8 inches.
2) Check –seedlings planted by hand

Sub-plot (0.5 acres)

3) Check
4) SilvaShield™ (one tablet) applied after planting next to each seedling to a depth of 4 inches.
5) SilvaShield™ (two tablets) applied after planting next to each seedling to a depth of 4 inches.
6) SilvaShield™ (three tablets) applied after planting next to each seedling to a depth of 4 inches.
7) SilvaShield™ (one tablet) applied after planting next to each seedling to a depth of 8 inches.
8) SilvaShield™ (two tablets) applied after planting next to each seedling to a depth of 8 inches.
9) SilvaShield™ (three tablets) applied after planting next to each seedling to a depth of 8 inches.
10) SilvaShield™ (one tablet) applied at planting in plant hole with seedling (depth of ~8 inches).

Figure 5. Randomized Block Design Layout for an 8 Treatment Trial.



A = White (Check)
B = Rd&Wht (1 tablet after planting 4"
C = Blue (2 tablet after planting 4")
D = Orange (3 tablets after planting 4")
E = Yellow (1 tablet after planting 8")
F= Pink (2 tablets after planting 8")
G = Green (3 tablets after planting 8")
H = Red (1 tablet in plant hole 8")

Treatments 2009:

Main Plot (40 acres each)

3) SilvaShield™ (one tablet) applied into plant hole at planting.
4) Untreated control (Check) – seedling planted without tablet

To evaluate the effects of treatment on large area tip moth damage levels a randomized complete block design, with sites as blocks, was used. Each plantation was hand or machine-planted. On one half of the plantation, the applicator applied one SilvaShield™ tablet into plant hole at planting (2009) or to each seedling after planting (2008) (Figure 4.). If after planting, a lance was used to create a 4 inch deep hole in the soil, angled toward the seedling. The tablet was then dropped into the hole and covered up. In the other half of the plantation, seedlings were hand or machine planted at the same spacing.

Additionally in 2008, 0.75 acre subplot was installed within check main treatment plot. Each treatment was randomly assigned to ten trees on each of five rows (Figure 5).

In both years, ten 10-tree plots were spaced equally within each main plantation half (but outside the internal treatment plots) to evaluate tip moth damage levels in these area. A 50-tree plot was positioned within each internal treatment subplot to evaluate tip moth damage levels in these areas. All stands were treated with herbicide after planting to minimize herbaceous and/or woody competition.

Tip moth damage will be evaluated after each tip moth generation (3-4 weeks after peak moth flight) by 1) identifying if the tree is infested or not, 2) if infested, the proportion of tips infested on the top whorl and terminal will be calculated; and 3) separately, the terminal will be identified as infested or not. Observations also will be made as to the occurrence and extent of damage caused by other insects, i.e., coneworm, aphids, sawfly, etc. Each tree will be measured for diameter (at ground line) and height and ranked as to form in the fall (November) of the second year following planting. Form ranking of the seedling or tree will be categorized as follows: 0 = no forks; 1 = one fork; 2 = two to four forks; 3 = five or more forks. A fork is defined as a node with one or more laterals larger than one half the diameter of the main stem (Berisford and Kulman 1967).

Efficacy will be evaluated by comparing treatment differences for direct and indirect measures of insect-caused losses. Direct treatment effects include reduction in pine tip moth damage. Indirect treatment effects include increases in tree growth parameters (height, diameter and volume index). Data will be subjected to analyses of variance using Statview software (SAS Institute, Inc. 1999). Percentage and measurement data will be transformed by the arcsine % and log transformations, respectively, prior to analysis. Costs of treatment per acre also will be calculated.

If one or more treatments continue to be successful in reducing tip moth damage by > 75% in the 4th generation in 2010, the "best" treatment(s) will be followed into 2010 to continue evaluating duration of treatments.

Research Time Line:

CY2010

January – February 2010

- Begin trap monitoring of tip moth populations near each site

May - October, 2010

- Evaluate tip moth damage after 1st through 4th generations; photograph damage.

November - December 2010

- Evaluate tip moth damage after 5th generations; measure diameter and height of seedlings.
- Conduct statistical analysis of 2009 data.
- Prepare and submit report to FPMC Executive Committee and Bayer Crop Science.
- Present results at annual Entomological Society of America meeting.

PINE TIP MOTH

SilvaShield™ Forestry Tablet – Input Comparison Trials
(Continued from 2009)

Justification

Several recent trials (2003 - 2008) have shown that imidacloprid + fertilizer tablets applied to bare root and containerized seedlings during or after planting are highly effective in reducing tip moth damage for 18+ months. EPA recently approved the registration and use of SilvaShield™ Forestry tablet for tip moth control. The product has been shown to produce significant growth benefits in the years subsequent to planting. With a few exceptions, all testing has been done in a small plot, randomized complete block design. Large plots may impact significantly the insect pressure that a pine plantation or a nursery may experience. Large plots make a more compelling case for the value of the product to large landowners, and we'll pick up practical experience on application from planting crews. The impact of the fertilizer load in the SilvaShield™ tablet, relative to at-plant applications of DAP, have not been described. The impact of SilvaShield™ relative to the different input types (alone or combined), has not been described.

Objectives: 1) determine the efficacy of SilvaShield™ tablets in reducing pine tip moth infestation levels on loblolly pine seedlings when applied at planting to bedded areas with and without fertilizer and/or herbaceous weed control; and 2) determine the duration of protection provided by this insecticide application.

Cooperators

Mr. Bill Stansfield	The Campbell Group, Diboll, TX
Dr. Tom Macom	Bayer Environmental Science, Research Triangle Park, NC

Research Approach:

A recently site prepared tracts was selected in Texas.

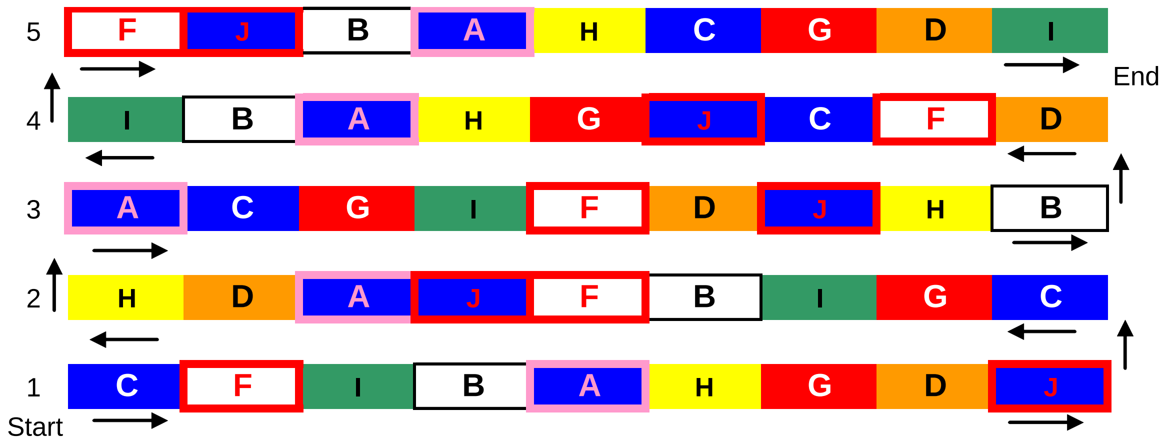
Treatments**:**

1 =	Check (untreated) -	seedling planted by hand
2 =	SilvaShield™ (SS, 1 tablet) -	in plant hole (PH) under seedling
3 =	Diamm. phosphate (DAP 1X) -	applied (125 lb/A) after planting around seedling
4 =	SS (1 tablets) + DAP 1/2X -	tablet in PH and fert. after plant
5 =	Herb. weed control (HWC) only-	banded application of Oustar (12)
6 =	SS (1 tab) + HWC -	tablet in PH + Oustar
7 =	SS (1 tab) + DAP 1/2X + HWC -	tablet in PH + fert after plant + Oustar
8 =	SS (1 tab) + DAP 1X + HWC -	tablets in PH + fert after plant + Oustar
9 =	DAP 1X + HWC -	fert after plant + Oustar

A 1 acre (approximate) area was selected within each selected site. A randomized complete block design was established with beds (or rows of trees) serving as blocks, i.e., each treatment was randomly selected for placement along a bed. Fifty trees for each treatment were selected on each site. Ten trees were assigned a given treatment on each of five beds (Figures 6).

All plot corners were marked with PVC pipe and the individual trees with different color pin flags and tags. **NO** additional herbicide applications were made over the area in the spring so as not to interfere with trial results. Site index, soil classification and weather/rainfall information was/will be collected for all sites. An overview of site preparation and post-plant management will be provided.

Figure 6. Randomized Block Design Layout for a 9 Treatment TX Trial.



A (1) = Pk&Bl (Check)
B (2) = White (1 SS tablet in PH)
C (3) = Blue (DAP 1X)
D (4) = Orange (SS + DAP 1/2X)
F (5) = Rd&Wht (HWC only)
G (6) = Red (SS + HWC)
H (7) = Yellow (SS + DAP 1/2X + HWC)
I (8) = Green (SS + DAP 1X = HWC)
J (9) = Rd&Blue (DAP 1X + HWC)

Damage and Tree Measurements

Tip moth damage will be evaluated by determining percent of trees infested, percent of infested shoots in top whorl and percent terminals infested about 4 weeks after peak moth flight of each generation for at least the first 2 years. Quantify the severity of attack. Observe and record presence and extent of phytotoxicity, if any, to the seedling and damage caused by other insects, i.e., weevils, coneworm, webworm, aphids, etc. Quantify seedling survivorship at the end of 2009 (and 2010). All study trees will be measured (height & diameter @ 6 inches) when tree growth has stopped in mid- to late November for at least the first 2 years of the study. Tree form will be evaluated at end of year 3. Form ranking of the seedling or tree will be categorized as follows: 0 = no forks; 1 = one fork; 2 = two to four forks; 3 = five or more forks. A fork is defined as a node with one or more laterals larger than one half the diameter of the main stem (Berisford and Kulman 1967). Data will be analyzed by GLM and the Tukey's Compromise test using Statview or SAS statistical programs.

Research Time Line:

CY 2010

January - February 2010

- Select research sites
- Treat seedlings with SilvaShield tablets
- Begin trap monitoring of tip moth populations near each site
- Apply DAP (fertilizer) to designated treatment trees.

March - October, 2010

- Apply herbaceous weed control to designated treatment areas.
- Evaluate tip moth damage after 1st through 4th generation; photograph damage.

November - December 2010

- Evaluate tip moth damage after 5th generation; measure height and diameter of seedlings.
- Conduct statistical analysis of 2010 data.
- Prepare and submit report to WGFPMC Executive Committee, Bayer.

CY 2011 (if warranted based on results in 2010)

January - February 2011

- Begin trap monitoring of tip moth populations near each site

March - October, 2011

- Evaluate tip moth damage after 1st through 4th generation where possible.

November - December 2011

- Measure height and diameter of trees.
- Conduct statistical analysis of 2011 data.
- Prepare and submit report to WGFPMC Executive Committee, Bayer.
- Present results at annual Entomological Society of America meeting.

PINE TIP MOTH

PTM™ and SilvaShield™ Comparison Trial
(Initiated in 2010)

Justification

Both fipronil (PTM™, BASF) and imidacloprid (SilvaShield™ Forestry Tablets, Bayer Environmental Science) have been proven effective in protecting pine seedlings against pine tip moth. A few cursory comparisons between these two products have been made in the past. We are interested in a more formal comparison in the Western Gulf region.

Objectives: 1) Evaluate the efficacy of PTM™ and SilvaShield™ Forestry tablets in reducing pine tip moth infestation levels on loblolly pine seedlings; 2) evaluate these products applied at different rates and timing to seedlings; and 3) determine the duration of treatment activity.

Cooperators

Mr. Ragan Bounds	Hancock Forest Management, Silsbee, TX
Mr. Tom Macom	Bayer Environmental Science, Research Triangle Park, NC
Mr. Bruce Monkey	Bayer Environmental Science, Waco, TX

Insecticides:

PTM™ (fipronil) –

SilvaShield™ Forestry tablet (Imidacloprid + fertilizer) – highly systemic neonictinoid with activity against Lepidoptera and fertilizer with NPK ratio of 12:9:4.

Research Approach:

A recently-harvested tract, 121 acres in size and owned by The Campbell Group, was selected NW of Jasper, TX (Jasper Co.).

Fifty seedlings for each treatment (A – O, see below) will be hand planted (standard spacing 8' X 8') on a first-year plantation site. The site has received an intensive site preparation and the soil was disked. A randomized complete block design will be used with beds or site areas serving as blocks, i.e., each treatment will be randomly selected for placement along a bed. Ten seedlings from each treatment will be planted on each of five beds. Treatments A, D, F, H, K & M will be applied as the seedling is planted. Just after seedling transplant, Treatments B, G, I, & N will be applied (pushed into the soil 4" deep and 2 cm from each assigned seedling [SS] or poured into one 4" deep probe hole near each seedling [PTM]. For treatments C, D, J & K, one tablet or solution will be applied to each seedling in Fall 2010. The remaining treatments (E,F,G, L, M & N) will be applied in early Spring 2011.

Treatments and Layout

Code	Treatment	Color
A	PTM in plant hole at planting (Dec. '09)	red
B	PTM post plant at 1 pt next to seedling (Dec. '09)	blue
C	PTM post plant at 2 pt next to seedling (Sep. '10)	orange
D	PTM at planting + PTM post plant (2 pts, Sep. '10)	pink/blue
E	PTM post plant at 2 pt next to seedling (Feb. '11)	white
F	PTM at planting + PTM post plant (2 pts, Feb. '11)	red/white
G	PTM post plant (1 pt, Dec. '09) + PTM post plant (2 pts, Feb. '11)	yellow/blue
H	SS in plant hole at planting (Dec. '09)	yellow
I	SS post plant next to seedling (Dec. '09)	green
J	SS post plant next to seedling (Sep. '10)	pink
K	SS at planting + SS post plant (Sep. '10)	blue/white
L	SS post plant next to seedling (Feb. '10)	green/orange
M	SS at planting + SS post plant (Feb. '11)	yellow/green
N	SS post plant (Dec. '09) + PTM post plant (Feb. '11)	blue/red
O	Check (lift and plant bare root seedlings)	green/white

Bed 1	Bed 2	Bed 3	Bed 4	Bed 5
J	G	L	I	K
E	H	E	O	E
F	J	C	H	I
L	E	H	G	O
A	C	J	E	H
N	B	M	M	A
K	L	B	B	F
O	F	F	K	M
B	M	A	A	N
D	I	K	C	C
G	A	D	N	G
C	N	I	F	J
I	D	G	L	D
M	K	O	D	B
H	O	N	J	L

Treatment description:

1) PTM solution (1.4ml product in 13.6 ml water) applied into plant hole at planting (Dec. ’09).
2) PTM solution (1.4ml product in 13.6 ml water) applied post plant at 1 point next to seedling (Dec. ’09).
3) PTM solution (0.7ml product in 14.3 ml water) applied post plant at 2 points next to seedling (Sept. ’10).
4) PTM solution (1.4ml product in 13.6 ml water) applied to plant hole at planting (Dec. ’09) and (0.7ml product in 14.3 ml water) applied post plant at 2 points next to seedling (Sept. ’10).
5) PTM solution (0.7ml product in 14.3 ml water) applied post plant at 2 points next to seedling (Feb. ’11).
6) PTM solution (1.4ml product in 13.6 ml water) applied to plant hole at planting (Dec. ’09) and (0.7ml product in 14.3 ml water) applied post plant at 2 points next to seedling (Feb. ’11).
7) PTM solution (1.4ml product in 13.6 ml water) applied post plant at 1 point next to seedling (Dec. ’09) and (0.7ml product in 14.3 ml water) applied post plant at 2 points next to seedling (Feb. ’11).
8) SilvaShield (SS) (1 tablet) applied into plant hole at planting (Dec. ’09).
9) SS (1 tablet) applied post plant next to seedling (Dec. ’09).

10) SS (1 tablet) applied post plant next to seedling (Sept. '10).
11) SS (1 tablet) applied into plant hole at planting (Dec. '09) and SS (1 tablet) applied post plant next to seedling (Sept. '10).
12) SS (1 tablet) applied post plant next to seedling (Feb. '11).
13) SS (1 tablet) applied to plant hole at planting (Dec. '09) and SS (1 tablet) applied post plant next to seedling (Feb. '11).
14) SS (1 tablet) applied post plant next to seedling (Dec. '09) and SS (1 tablet) applied post plant next to seedling (Feb. '11).
15) Check –seedlings planted by hand without additional treatment.

Treatment Evaluation: Tip moth damage will be evaluated after each tip moth generation (3-4 weeks after peak moth flight) by 1) identifying if the tree was infested or not, 2) if infested, the proportion of tips infested on the top whorl and terminal will be calculated; and 3) separately, the terminal will be identified as infested or not. Observations also will be made as to the occurrence and extent of damage caused by other insects, i.e., aphids, weevils, coneworm, etc. Second-year trees will be measured for diameter and height (at 6") in the fall (November) following planting. If warranted, third-year trees will be measured for height and diameter (at DBH) and ranked for form. Form ranking of the seedling or tree will be categorized as follows: 0 = no forks; 1 = one fork; 2 = two to four forks; 3 = five or more forks. A fork is defined as a node with one or more laterals larger than one half the diameter of the main stem (Berisford and Kulman 1967).

Tip Moth Damage Assessment or Tree Measurement Times for Jasper Co., TX site:
Generation 1: week of April 27
Generation 2: week of June 22
Generation 3: week of August 10
Generation 4: week of September 21
Generation 5: November 15 – December 31

Efficacy will be evaluated by comparing treatment differences for direct and indirect measures of insect-caused losses. Direct treatment effects include reduction in pine tip moth damage. Indirect treatment effects include increases in tree growth parameters (height, diameter and volume index). Data will be
subjected to analyses of variance using Statview software (SAS Institute, Inc. 1999). Percentage and measurement data will be transformed by the arcsine % and log transformations, respectively, prior to analysis.

Research Time Line:

CY 2009

November - December 2009

- Select research sites
- Lift, plant and treat seedlings in plantation sites

CY 2010

January - February 2010

- Begin trap monitoring of tip moth populations near each site

March - October, 2010

- Evaluate tip moth damage after 1st through 4th generations; photograph damage.
- Treat seedlings in September.

November - December 2008

- Evaluate tip moth damage after 5th generations; measure seedling and height of seedlings.
- Conduct statistical analysis of 2010 data.
- Prepare and submit report to BASF and Bayer, FPMC Executive Committee.

CY 2011

January - February 2011

- Begin trap monitoring of tip moth populations near each site
- Treat seedlings in February.

March - October, 2011

- Evaluate tip moth damage after 1st through 4th generations; photograph damage.

November - December 2011

- Evaluate tip moth damage after 5th generations; measure seedling and height of seedlings.
- Conduct statistical analysis of 2011 data.
- Prepare and submit report to BASF and Bayer, FPMC Executive Committee.
- Present results at ETFES.

CY 2012 (if warranted based on CY 2011 results)

January - February 2012

- Begin trap monitoring of tip moth populations near each site

March - October, 2012

- Evaluate tip moth damage after 1st through 4th generations; photograph damage.

November - December 2012

- Evaluate tip moth damage after 5th generations; measure seedling and height of seedlings.
- Conduct statistical analysis of 2012 data.
- Prepare and submit report to BASF and Bayer, FPMC Executive Committee.
- Present results at annual Entomological Society of America meeting.

Reference:

Berisford, C.W., and H.M. Kulman. 1967. Infestation rate and damage by the Nantucket pine tip moth in six loblolly pine stand categories. For. Sci. 13: 428-438.

Fettig, C.J., J.T. Nowak, D.M. Grosman and C.W. Berisford. 2003. Nantucket pine tip moth phenology and timing of insecticide spray applications in the Western Gulf region. USDA Forest Service So. Res. Stat. Res. Pap. SRS-32. 13pp.

Forest Pest Management Cooperative
Activity Time Line - CY2010

January
- Contact FPMC members to arrange meeting to discuss pest management program.
- Deploy pheromone traps for tip moth impact, hazard rating, and control (fipronil) studies.
- Monitor tip moth populations for tip moth studies.
- Continue development of leaf-cutting ant bait, establish efficacy trial.

February
- Establish new tip moth research plots.
- Treat selected tip moth impact plots with insecticides.
- Monitor tip moth populations for tip moth studies.
- Monitor leaf-cutting ant colonies for efficacy of bait formulations.

March
- Monitor tip moth populations and rainfall for tip moth studies.
- Make selection of study sites and trees for bark beetle injection studies.
- Establish new test efficacy bait and soil injection for leaf-cutting ants.
- Prepare FPMC accomplishment report for 2009 and proposals/budget for 2010.

April
- Treat study trees with designated treatments for Seed Orchard Injection Studies (AR & TX).
- Flag 6-10 branches/tree and record number of conelets and cones on all treatment and check trees for Injection Trial at each seed orchard.
- Monitor pest occurrence on oak.
- Girdle trees for Oak Pest Injection Trial.
- Collect site information and soil samples and conduct vegetation evaluation for hazard rating study.
- Monitor tip moth populations for tip moth studies.
- Monitor leaf-cutting ant and fire ant colonies for efficacy of bait formulations and PTM.
- Finalize FPMC 2009 accomplishment report and 2010 proposals/budgets.
- FPM Cooperative Executive Committee Meeting
- Present results at East Texas Forest Entomology Seminar.

May
- Evaluate tip moth damage after 1st generation for all tip moth studies; photograph damage.
- Treat study trees with standard foliar treatment for Seed Orchard Injection Studies.
- Fell trees, deploy bolts, traps and bark beetle pheromones for *Ips* Bark Beetle Injection Trial.
- Retrieve and evaluate bolts for *Ips* Bark Beetle Injection Trial.
- Monitor tip moth populations for tip moth studies.
- Monitor oak pests for seed orchard trial.
- Continue monitoring leaf-cutting ant colonies for efficacy of bait formulations.

Forest Pest Management Cooperative
Activity Time Line - CY2010

<u>June</u>

- Retrieve and evaluate bolts for *Ips* Bark Beetle Injection Trial.
- Fell trees, deploy bolts, for Oak Pest Injection Trial.
- Evaluate tip moth damage after 2nd generation for all tip moth studies; conduct competing vegetation assessment for hazard rating study; photograph damage.
- Monitor tip moth populations and rainfall for tip moth studies.
- Monitor oak pests for seed orchard trial.
- Test efficacy of leaf-cutting ants to bait formulations.

<u>July</u>

- Fell trees, deploy bolts, traps and bark beetle pheromones for *Ips* Bark Beetle Injection Study.
- Retrieve and evaluate bolts for Oak Pest Injection Trial.
- Treat selected tip moth impact plots with insecticides.
- Monitor tip moth populations for tip moth studies.
- Monitor oak pests for seed orchard trial.
- Monitor leaf-cutting ant colonies for efficacy of bait formulations.
- Present results at Southern Forest Insect Work Conference.

<u>August</u>

- Treat study trees with standard foliar treatment for Seed Orchard Injection Studies.
- Evaluate tip moth damage after 3rd generation for all tip moth studies; photograph damage.
- Retrieve and evaluate bolts for *Ips* Bark Beetle Injection Study.
- Fell trees, deploy bolts, for Oak Pest Injection Trial.
- Retrieve and evaluate bolts for Oak Pest Injection Trial.
- Treat selected tip moth impact plots with insecticides.
- Monitor tip moth populations and rainfall for tip moth studies.
- Monitor oak pests for seed orchard trial.
- Monitoring leaf-cutting ant colonies for efficacy of bait formulations.

<u>September</u>

- Evaluate loblolly pine conelet and cone survival on flagged branches (early September).
- Retrieve and evaluate bolts for Oak Pest Injection Trial.
- Evaluate tip moth damage after 4th generation for all tip moth studies; photograph damage.
- Monitor tip moth populations and rainfall for tip moth studies.
- Monitor oak pests for seed orchard trial.
- Collect all cones from sample trees for Seed Bug Injection trial.
- Monitoring leaf-cutting ant colonies for efficacy of bait formulations.

Forest Pest Management Cooperative
Activity Time Line - CY2010

October

- Treat selected tip moth impact plots with insecticides.
- Evaluate coneworm damage for Pine Seed Orchard studies.
- Retrieve and evaluate bolts for Oak Pest Injection Trial.
- Monitor tip moth populations and rainfall for tip moth studies.
- Monitor oak pests for seed orchard trial.
- Test efficacy of leaf-cutting ants to bait formulations.
- Monitoring leaf-cutting ant colonies for efficacy of bait formulations.

November

- Evaluate tip moth damage and tree form after last generation for all tip moth studies; collect tree height and diameter measurements; photograph damage.
- Monitor tip moth populations and rainfall for tip moth studies.
- Retrieve and evaluate bolts for Oak Pest Injection Trial.
- Conduct vegetation evaluation for hazard rating study.

December

- Extract, radiograph and evaluate seed samples for Seed Orchard studies.
- Conduct statistical analyses of 2010 data.
- Prepare and submit reports to FPMC Executive Committee, Syngenta, Bayer, BASF, Mauget, Arborjet, FSPIAP and SPB Initiative.
- Monitor tip moth populations and rainfall for tip moth studies.
- Continue monitoring leaf-cutting ant colonies for efficacy of bait formulations.
- Take a few days off to celebrate Christmas.

2009 Expenditures vs. Budget

Expenditures to operate the FPMC for CY 2009 totaled $231,105 (Table 1). This was $6,704 less than the projected $237,809 budget (Table 2) primarily due to a reduced need for seasonal assistance. Sources of funding to cover expenses were derived from membership dues (36%), the SPBI and FSPIAP federal grants and industry grants from BASF, Syngenta, Bayer, Fort Dodge and Coats (23%), and the Texas Forest Service (41%). Of this total, 85% was devoted to professional salaries, fringe benefits, and seasonal wages, and the remainder (15%) to equipment, operating expenses, and indirect costs. Overall, FPMC account funds exceeded expenditures by $3,118. Due to the 2009 federal and corporate grants ($39,040), we currently have a surplus of $84,050 in these accounts at the end of CY 2009.

Emergency funds totaling $39,300 (recovered FPMC funds from FY2006 – FY2009) are being held in a separate account awaiting the need to spend them.

2010 Proposed Budget

The proposed budget for CY 2010 totals $261,136 (Table 3). The proposed budget includes an increase of $4,981 for proposed raises for salary workers and support of a graduate student at Stephen F. Austin State University. Monies budgeted for operating expenses increased $5,602 primarily in response to rising fuel costs. Current membership dues ($86,000) plus $21,900 from the FPMC surplus and $1,000 for seed analysis work for WGTIP will provide $108,200 (41%). An additional $77,489 (30%) is available from gifts/grants ($51,713) provided by BASF, Syngenta, Bayer, Fort Dodge, Coats and Mauget, as well as funds available from SPBI (injection) and FSPIAP (tip moth) grants ($25,773). The remaining (29%) will be borne by the Texas Forest Service and any new members that join during the year (Figure 3). The addition of a new member(s) to the FPMC will serve to reduce the TFS contribution to the FPMC. A summary by project or activity for CY 2010 is given in Table 4.

2011 Proposed Budget

A proposed budget for CY 2011 is given in Table 5 by source of funding. A total of $262,851 is proposed for CY 2011. No dues increase is anticipated. Assuming that membership stays at 8 full members and two associate members in 2010, $109,500 (42%) would be provided by membership dues, $11,500 from the FPMC surplus and anticipated funds from WGTIP for seed analysis. The remainder of the budget, 58%, will come from other sources (new member dues, federal grants, chemical industry contributions and the Texas Forest Service).

The proposed budget summary by project or activity for CY 2011 is given in Table 6. We anticipate that one or more small projects will terminate at the end of CY 2010, allowing the funding of one new applied research or technology transfer project in CY 2011.

Table 7 and Figure 8 provide a summary of funding sources and expenditures since the FPMC was initiated in 1996. Figure 9 illustrates FPMC sources of funding as a percentage of total expenditures. Finally, Figure 10 is a graph of the number of FPMC members and dues levels for the period 1996 – 2011.

Table 1. FPMC Expenditures by Source of Funding - CY 2009

	Source				% of
	FPMC	TFS	Fed./Ind. Grants *	Total	Total
A. Salaries and Wages					
Principal Investigator (Grosman) (100%)	$ 17,292 (26%)	$ 49,216 (74%)	$ 0	$ 66,508	
Research Specialist (Kavanagh) (100%)	13,637 (40%)	0	20,503 (60%)	34,140	
Staff Forester (Upton) (78%)	15,697 (30%)	25,116 (48%)	0	40,813	
SPB Specialist (Murphrey) (9%)	652 (9%)	0	0	652	
Staff Assistant (Spivey) (20%)	3,813 (20%)	0	0	3,813	
1 Seasonal Technician (two 4 mo. periods)	1,240	0	8,568	9,808	
Total Salaries and Wages	$ 52,331	$ 74,332	$ 29,071	$ 155,734	
B. Fringe Benefits / TFS Matching	$ 13,389	$ 19,326	$ 6,059	$ 38,774	
	65,720	93,658	35,130	194,508	85%
C. Operating Expenses					
Supplies	$ NA	$ NA	$ NA	$ NA	
Vehicle Use and Maintainance	NA	NA	NA	NA	
Travel	NA	NA	NA	NA	
Telecommunications (15% of PCS)	NA	NA	NA	NA	
Utilities (15% of PCS)	NA	NA	NA	NA	
Other Services (rentals, publications, postage, etc.)	NA	NA	NA	NA	
Total Operating Expenses	$ 18,162	$ 1,356	$ 15,521	$ 35,039	15%
Indirect Costs (26%)			1,557	1,557	
Grand Total	$ 83,882	$ 95,014	$ 52,208	$ 231,105	
% of Total	36%	41%	23%	100%	100%

* Grant/Gift funds remaining from 2008; grants awarded to TFS from the Southern Pine Beetle Initiative; BASF, Bayer, Mauget, and Syngenta in CY2009.

	FPMC	TFS	Fed./Ind. Grants *
Funding Available from January 1 - December 31, 2009	$ 87,000		$ 122,078

Table 2. FPMC Proposed Budget by Source of Funding - CY 2009

		Source: FPMC	Source: TFS and Others*	Total	% of Total
A.	**Salaries and Wages**				
	FPMC Coordinator (Grosman) (100%)	$ 16,743 (26%)	$ 47,605 (74%)	$ 64,348	
	Research Specialist (Kavanagh) (100%)	24,480 (75%)	8,160 (25%)	32,640	
	Staff Forester (Upton) (75%)	15,097 (30%)	22,646 (45%)	37,743	
	Staff Assistant (Spivey) (20%)	4,576 (20%)		4,576	
	3 Seasonal Technician (4.5 mo.)		19,980	19,980	
	Total Salaries and Wages	$ 60,897	$ 98,390	$ 159,287	
B.	**Fringe Benefits (26% of Salaries & 8% of Wages)**	$ 15,833	$ 21,985	$ 37,818	
		76,730	120,376	197,105	83%
C.	**Operating Expenses**				
	Supplies	$ 6,639	$ 6,000	$ 12,639	
	Vehicle Use and Maintainance	7,000	6,000	13,000	
	Travel	4,000	3,000	7,000	
	Telecommunications (15% of PCS)	1,300	0	1,300	
	Utilities (15% of PCS)	0	1,300	1,300	
	Other Services (rentals, publications, postage, etc.)	2,331	3,134	5,465	
	Total Operating Expenses	$ 21,270	$ 19,434	$ 40,704	17%
	Grand Total	$ 98,000 **	$ 139,810	$ 237,809	
	% of Total	41%	59%	100%	100%

* includes $50,196 remaining from '07 & '08 grants and any new members, federal grants or gifts.

** member dues at $10,000/yr for eight members; $3,500/yr for two members, $10,000 FPMC surplus and $1,000 for WGTIP seed analysis. = $98,000

Table 3. FPMC Proposed Budget by Source of Funding - CY 2010

		Source			% of
		FPMC	TFS and Others*	Total	Total
A.	**Salaries and Wages**				
	FPMC Coordinator (Grosman) (100%)	$ 17,275 (26%)	$ 49,118 (74%)	$ 66,393 **	
	Research Specialist (Kavanagh) (100%)	25,394 (75%)	8,465 (25%)	33,859 **	
	Staff Forester (Upton) (75%)	15,527 (30%)	23,290 (45%)	38,816 **	
	Staff Assistant (Spivey) (20%)	4,713 (20%)		4,713 **	
	Graduate Student (Walker) (100%)	10,200 (20%)		10,200	
	3 Seasonal Technician (4.5 mo.)		26,973	26,973	
	Total Salaries and Wages	$ 73,109	$ 107,845	$ 180,954	
B.	**Fringe Benefits (26% of Salaries & 8% of Wages)**	$ 16,356	$ 23,185	$ 39,541	
		89,466	131,030	220,495	84%
C.	**Operating Expenses**				
	Supplies	$ 6,534	$ 6,773	$ 13,307	
	Vehicle Use and Maintainance	5,000	7,000	12,000	
	Travel	3,500	3,500	7,000	
	Telecommunications (15% of PCS)	1,400	0	1,400	
	Utilities (15% of PCS)	0	1,500	1,500	
	Other Services (rentals, publications, postage, etc.)	2,300	3,134	5,434	
	Total Operating Expenses	$ 18,734	$ 21,907	$ 40,641	16%
	Grand Total	$ 108,200 ***	$ 152,937	$ 261,136	
	% of Total	41%	59%	100%	100%

* includes $21,920 SPB grant and any new members or federal grants.

** includes 3% salary increase

*** member dues at $10,000/yr for seven members; $9,000/yr for one member; $3,500/yr for two members, $21,200 FPMC surplus and $1,000 for WGTIP seed analysis. = $108,200

Table 4. FPMC Proposed Budget by Source of Project - CY 2010

	Activity					
	Administration	Tip Moth Studies		Systemic	LCA or Other	
	Site Visits/Service	(Impact & HR)	(Systemic Trt)	Injection Studies	Study	Total
A. Salaries and Wages						
FPMC Coordinator (100%)	$ 26,557 (40%)	$ 9,959 (15%)	$ 9,959 (15%)	$ 9,959 (15%)	$ 9,959 (15%)	$ 66,393
Research Specialist (100%)	0	13,544 (40%)	13,544 (40%)	3,386 (10%)	3,386 (10%)	33,859
Staff Forester (75%)	0	5,176 (10%)	5,176 (10%)	15,527 (30%)	12,939 (25%)	38,816
Staff Assistant (20%)		1,178 (5%)	1,178 (5%)	1,178 (5%)	1,179 (5%)	4,713
Graduate Student (100%)		10,200 (100%)				10,200
3 Seasonal Technician (4.5 mos.)	0	6,743 (25%)	9,441 (35%)	8,092 (30%)	2,697 (10%)	26,973
B. Fringe Benefits (26% of Salaries & 8.4% of Wages)	$ 6,905	$ 9,341	$ 9,557	$ 12,191	$ 10,414	$ 39,541
C. Operating Expenses						
Travel and Vehicle Use	$ 4,000	$ 3,500	$ 3,500	$ 3,500	$ 3,500	$ 18,000
Supplies & Postage	4,577	2,990	2,990	2,990	2,990	16,537
Other Operating Expenses	1,104	1,000	2,000	1,000	1,000	6,104
Grand Total	$ 43,143	$ 63,631	$ 57,344	$ 57,822	$ 48,064	$ 261,136

Table 5. FPMC Proposed Budget by Source of Funding - CY 2011

	Source				
	FPMC	TFS and Others*	Total	% of Total
A. Salaries and Wages				
FPMC Coordinator (Grosman) (100%)	$ 17,283 (26%)	$ 49,190 (74%)	$ 66,473	
Research Specialist (Kavanagh) (100%)	25,574 (75%)	8,525 (25%)	34,099	
Staff Forester (Upton) (75%)	15,551 (30%)	23,326 (45%)	38,876	
Staff Assistant (Spivey) (20%)	4,713 (20%)		4,713	
Graduate Student (Walker) (100%)	11,475 (20%)		11,475	
3 Seasonal Technician (4.5 mo.)		26,973	26,973	
Total Salaries and Wages	$ 74,595	$ 108,014	$ 182,609	
B. Fringe Benefits (26% of Salaries & 8% of Wages)	$ 16,411	$ 23,228	$ 39,640	
	91,007	131,242	222,249	85%
C. Operating Expenses				
Supplies	$ 6,293	$ 6,975	$ 13,268	
Vehicle Use and Maintainance	5,000	7,000	12,000	
Travel	3,500	3,500	7,000	
Telecommunications (15% of PCS)	1,400	0	1,400	
Utilities (15% of PCS)	0	1,500	1,500	
Other Services (rentals, publications, postage, etc.)	2,300	3,134	5,434	
Total Operating Expenses	$ 18,493	$ 22,109	$ 40,602	15%
Grand Total	$ 109,500 **	$ 153,351	$ 262,851	
% of Total	42%	58%	100%	100%

* includes any new members or federal grants.

** member dues at $10,000/yr for eight members; $3,500/yr for two members, $11,500 FPMC surplus and $1,000 for WGTIP seed analysis. = $109,500

Table 6. FPMC Proposed Budget by Source of Project - CY 2011

	Activity					
	Administration	Tip Moth Studies		Systemic	LCA or Other	
	Site Visits/Service	(Impact & HR)	(Systemic Trt)	Injection Studies	Study	Total
A. Salaries and Wages						
FPMC Coordinator (100%)	$ 26,589 (40%)	$ 9,971 (15%)	$ 9,971 (15%)	$ 9,971 (15%)	$ 9,971 (15%)	$ 66,473
Research Specialist (100%)	0	13,640 (40%)	13,640 (40%)	3,410 (10%)	3,410 (10%)	34,099
Staff Forester (75%)	0	5,184 (10%)	5,184 (10%)	15,551 (30%)	12,959 (25%)	38,876
Staff Assistant (10%)		1,178 (5%)	1,178 (5%)	1,178 (5%)	1,179 (5%)	4,713
Graduate Student (100%)		11,475 (100%)				11,475
3 Seasonal Technician (4.5 mos.)	0	6,743 (25%)	9,441 (35%)	8,092 (30%)	2,697 (10%)	26,973
B. Fringe Benefits (26% of Salaries & 8.4% of Wages)	$ 6,913	$ 8,332	$ 8,548	$ 8,476	$ 7,371	$ 39,640
C. Operating Expenses						
Travel and Vehicle Use	$ 4,000	$ 3,500	$ 3,500	$ 3,500	$ 3,500	$ 18,000
Supplies & Postage	4,577	2,990	2,990	2,990	2,990	16,537
Other Operating Expenses	1,065	1,000	2,000	1,000	1,000	6,065
Grand Total	$ 43,144	$ 51,359	$ 55,273	$ 52,989	$ 45,077	$ 262,851

Table 7: List of Funding Sources and Expenditures by Calendar Year

Year	No. Full / Assoc. Members **	Membership Dues: Full / Assoc. / Year	Membership Dues: Total Revenue	Grants/Gifts	TFS	Total	Dues % of Total	TFS % of Total	
1996	3 / 1	$6K / ----	$18,000		$54,800	$72,800	25%	75%	
1997	4 / 1	$6K / $2K	$26,000	$16,600	$36,571	$79,171	33%	46%	
1998	5 / 0	$6K / $2K	$31,000	$18,300	$55,560	$104,860	30%	53%	
1999	5 / 0	$7K / $2.5K	$35,000	$31,000	$43,285	$109,285	32%	40%	
2000	7 / 1	$7K / $2.5K	$51,000	$24,488	$44,621	$120,109	42%	37%	***
2001	6 / 1	$7K / $2.5K	$44,500	$19,356	$77,600	$141,456	31%	55%	
2002	6 / 1	$8K / $2.5K	$50,500	$20,356	$69,512	$140,368	36%	50%	
2003	7 / 1	$8K / $2.5K	$58,500	$20,468	$62,206	$141,174	41%	44%	
2004	7 / 1	$8K / $2.5K	$58,500	$75,195	$68,301	$201,996	29%	34%	
2005	7 / 1	$8K / $2.5K	$58,500	$66,054	$76,517	$201,071	29%	38%	
2006	7 / 1	$8K / $2.5K	$58,500	$129,000	$82,847	$270,347	22%	31%	
2007	7 / 2	$9K / $3K	$69,000	$74,755	$85,156	$228,911	30%	37%	
2008	8 / 2	$9K / $3K	$69,552	$60,938	$90,974	$221,464	31%	41%	
2009	8 / 2	$10K / $3.5K	$87,000	$49,091	$95,014	$231,105	38%	41%	
2010 *	9 / 3 *	$10K / $3.5K	$100,500	$70,500	$90,136	$261,136	38%	35%	***
2011 *	9 / 3 *	$10K / $3.5K	$100,500	$70,000	$92,351	$262,851	38%	35%	***
Mean			$57,285	$49,740	$70,341	$174,257	32%	44%	

* estimated
** Not including TFS
*** Years TFS not paying more than members.

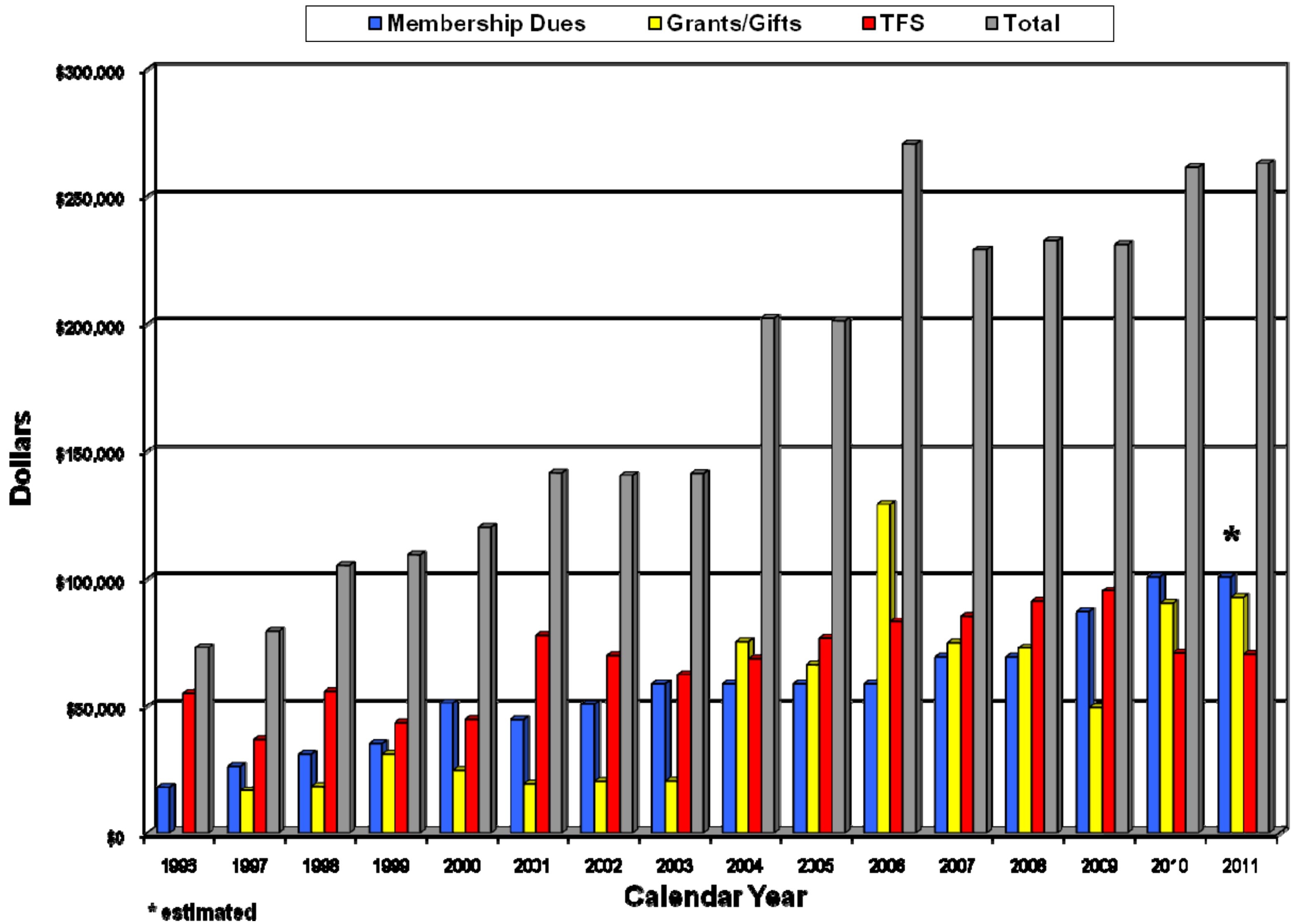


Figure 8: Forest Pest Management Cooperative budget by source.

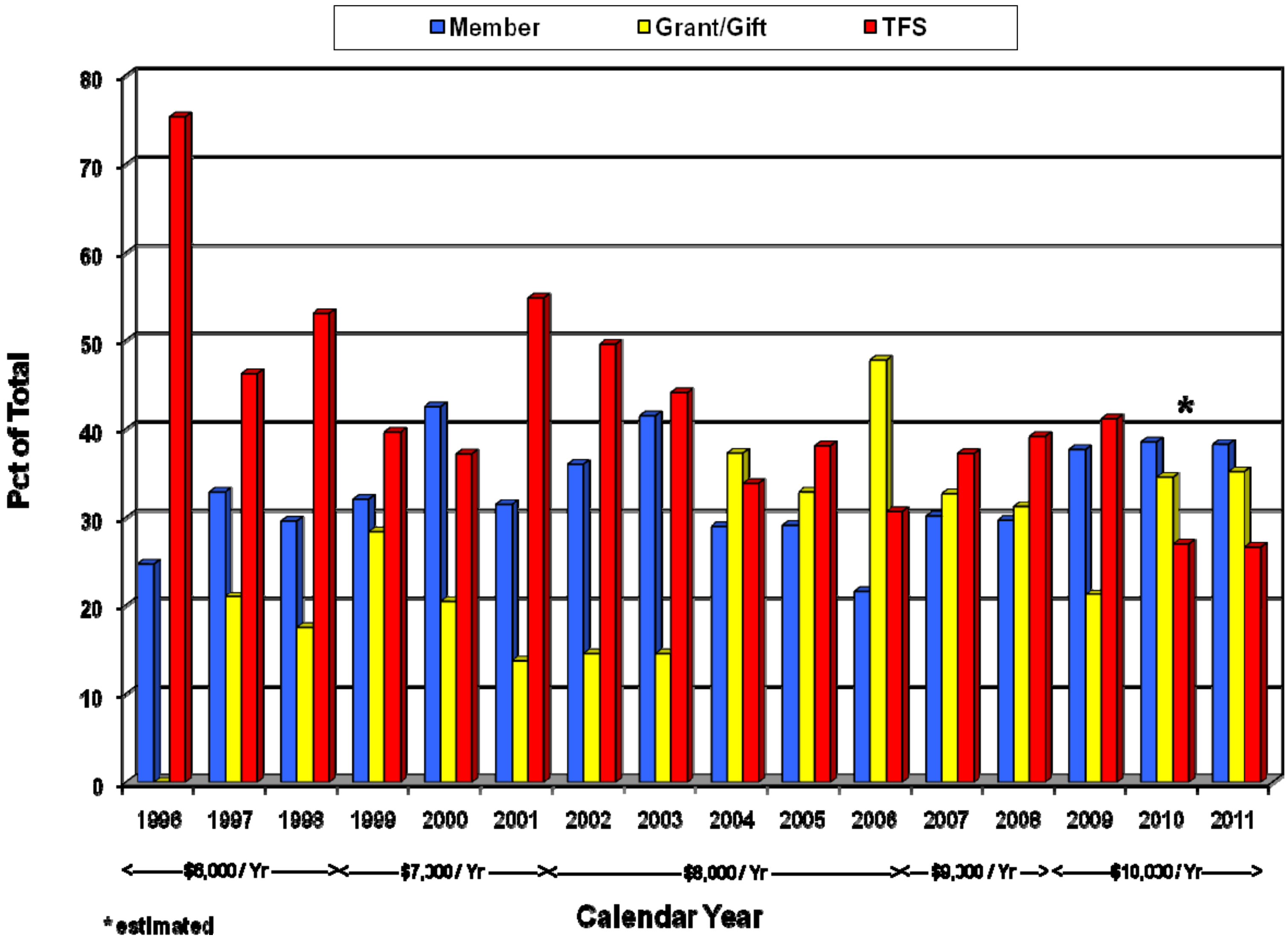


Figure 9. Forest Pest Management Cooperative membership dues, grants/gifts and TFS as percentage of total expenditures.

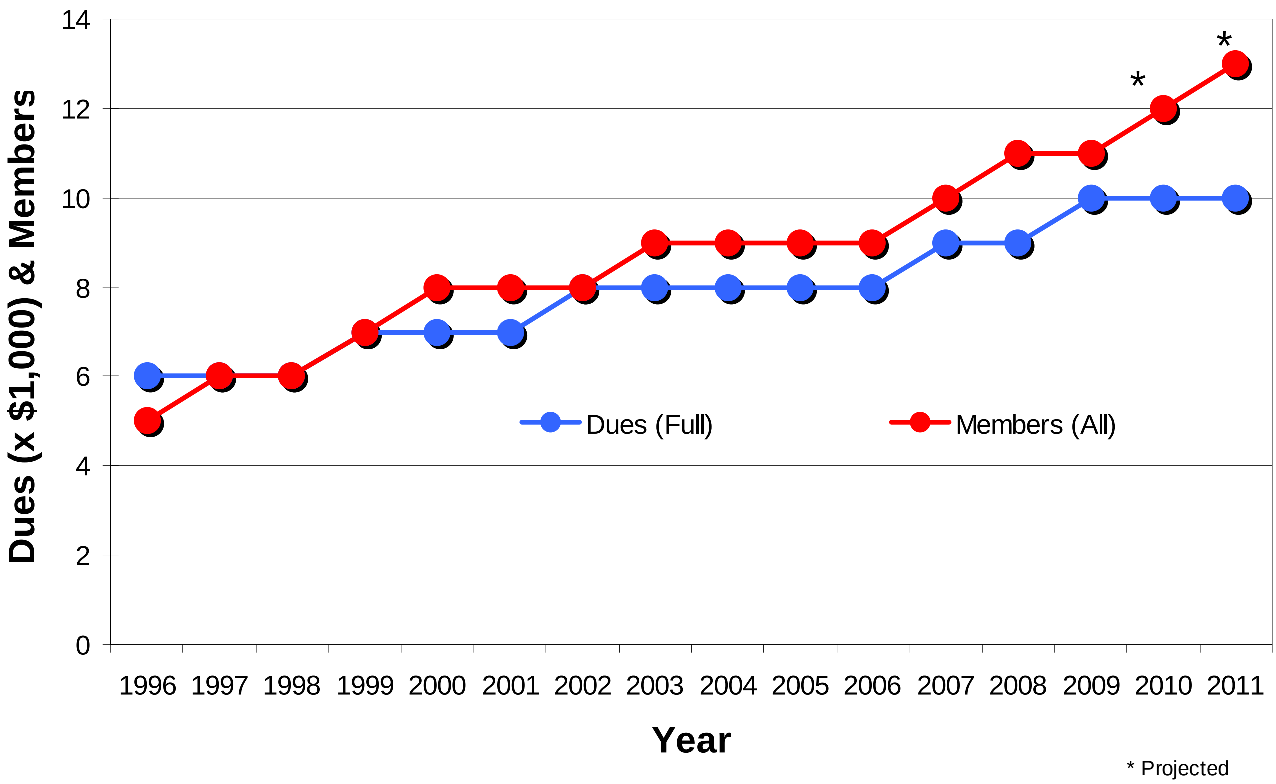


Figure 10. Forest Pest Management Cooperative membership levels and dues from 1996 to 2011 (projected).

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