Forest Pest Management Cooperative

2009 Research Project Proposals

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Forest Pest Management Cooperative

2009 Research Project Proposals

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 Texas leaf-cutting ant control) in 2009. Results obtained this past year warrant further evaluations in these areas.

Proposed objectives and methods for the systemic injection, tip moth, and leaf-cutting ant studies in 2009 are presented below. Arborjet/Syngenta, BASF and Mauget have developed new formulations of emamectin benzoate, fipronil and abamectin, respectively, for injection use. Four studies to test the efficacy of the emamectin benzoate, fipronil and abamectin for protection of trees against pine bark beetles, evaluate different insecticide injection systems for application of these new formulations for protection of trees against bark beetles, and to evaluate potential insecticides for control of seed bugs in pine seed orchards will be continued. In addition, two new studies are proposed, one to evaluate abamectin for control of seed bugs in pine seed orchards and the other to evaluate emamectin benzoate for protection of oaks against insect pests.

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 extend/expand them in 2009. The first, a cooperative study with Bill Stansfield, Campbell Group, and Dr. Dean Coble, 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 2009. The Bayer trials (2003 – 2008) showed that imidacloprid/fertilizer spikes and SilvaShield™ Forestry Tablets provide good protection of pine seedlings against tip moth. New trials will be established in 2009 to also evaluate operational use of SilvaShield™ and evaluate the impact of SilvaShield™ relative to other management practices (fertilization and weed control).

Two new formulations of bait (Advion® and Amdro®) were evaluated in 2008 for attractiveness to leaf-cutting ants. In addition, it is hypothesized that the PTM™ soil injection treatment could be modified to treat leaf-cutting ant colonies. One or more efficacy trials will be established in 2009 to test these new control options.

Continuation of these or initiation of other projects will be dependent upon approval by the FPMC Executive Committee. Extension of each project into 2010 will depend on the degree of success achieved in 2009 and remaining gaps in knowledge.

TEXAS LEAF-CUTTING ANT

Leaf-cutting Ant Control Evaluation - East Texas
(Initiated 2009)

Cooperators:

Forest Pest Management Cooperative members

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

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

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. Perhaps modifying the bait to increase the size of the bait particle would improve performance. The goal of the proposed research is to evaluate the potential of a modified (larger) Amdro® or Advion® bait as an effective alternative to methyl bromide fumigation and Amdro® Ant Bock, for control of the Texas leaf-cutting ant in forestry applications. 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 recently registered with EPA for soil injection use for protection of pine seedlings from pine tip moth. Fipronil is also a well known insecticide for control of termites (Termidor®) and ants (Over and Out®). Upon contact with fipronil in the soil these social insects will retrieve and pass this active ingredient throughout the colony. A trial will be initiated to determine the efficacy of PTM™ (fipronil) applied at different volumes to colony entrance holes.

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:

Indoxacarb – undectable, slow-acting poison

Advion® fir ant bait - concentration (0.045% a.i.); corn carrier with soybean oil; packing (tight); color (yellow); size (3 mm dia. & 3-12 mm long.).

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 modified from 2 mm dia. to 2.5 mm X 7 mm length).

Fipronil – undetectable, slow-acting poison in liquid formulation

PTM™ SC Insecticide - concentration (2 % a.i. v/v).

Research Approach:

Advion® fire ant bait and Amdro® Ant Block bait will be run through a laboratory pellet mill to create larger pellets (3 mm dia. X 3-12 mm length).

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 2009; the treatments may include:

Trial 1:

1) Large Advion® bait - bait will be spread uniformly over CNA at 3 lbs per colony.
2) Large Advion® bait - bait will be spread uniformly over CNA at 1.5 lbs per colony.
3) Small Advion® fire ant bait - bait will be spread uniformly over CNA at 3/4 lbs per colony.
4) Large Amdro® bait - bait will be spread uniformly over CNA at 2 lbs per colony.
5) Large Amdro® bait - bait will be spread uniformly over CNA at 3/4 lb per colony.
6) Small Amdro® Ant Block - bait will be spread uniformly over CNA at 3/4 lb per colony.
7) PTM™ SC Insecticide – soil injection into entrance holes within CAN at 1 gallon per 300 sq ft.
8) Untreated colony (Check)

Trial 2 & 3:

1) Large Amdro® bait - bait will be spread uniformly over CNA at 2.5 g/m^2.
2) Large Amdro® bait - bait will be spread uniformly over CNA at 5.0 g/m^2.
3) Large Amdro® bait - bait will be spread uniformly over CNA at 10.0 g/m^2.
4) Large Amdro® bait - bait will be spread uniformly over CNA at 20.0 g/m^2.
5) Small Amdro® Ant Block - bait will be spread uniformly over CNA at 3/4 lb per colony.
6) PTM™ SC Insecticide – soil injection within CNA at 10.0 ml/entrance hole.
7) PTM™ SC Insecticide – soil injection within CNA at 20.0 ml/entrance hole.
8) PTM™ SC Insecticide – soil injection within CNA at 40.0 ml/entrance hole.
9) PTM™ SC Insecticide – soil injection within CNA at 80.0 ml/entrance hole.
10) Untreated colony (Check)

Bait treatments will be made with a cyclone spreader to evenly spread amounts over the CNA. 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: Mid-Winter 2008/2009: Treatments applied to 10 colonies in January.
Trial 2: Late Winter 2009: Treatments applied to 10 colonies in February & March.
Trial 3: Summer 2009: Treatments applied to 10 colonies in June.
Trial 4: Fall 2009: Treatments applied to 10 colonies in September & October.

Project Support: The trial will be supported initially by FPMC funds. A proposal has been submitted for funding through the Forest Service Pesticide Impact Assessment Program.

Research Time Line:

<u>January 2009</u>

- Produce modified (large) Advion® and Amdro® baits.
- Locate 60 leaf-cutting ant colonies.
- Randomly assign and treat colonies with baits.
- Reevaluate ant activity 2 weeks post treatment.

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

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

<u>June - July 2009</u>

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

August - 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 DuPont.

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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.

SYSTEMIC INSECTICIDE INJECTION TRIALS

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

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

Objectives: The objectives of this research proposal are to: 1) evaluate the potential efficacy of systemic injections of new formulations of imidacloprid and abamectin and foliar sprays of rynaxypyr in reducing seed crop losses due to seed bugs and coneworms, respectively, in pine seed orchards; and 2) determine the duration of treatment efficacy.

Justification: Repeatedly, cone and seed insects severely reduce potential seed yields in southern pine seed orchards that produce genetically-improved seed for reforestation 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 extract 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® and Denim®) 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 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.

Abamectin (1.9%; Mauget) is a mixture of avermectins: B1a (80%) and B1b (20%). It was tested by FPMC using the Wedgle Tip™ system at 0.01g AI per inch diameter. This chemical had limited effects against seed bug but no apparent effect against coneworm, so it was dropped in favor of emamectin benzoate. Mauget is interested in testing its effects against bark beetles and retesting at higher rates for effects against cone and seed insects.

Rynaxypyr® (Coragen® 18.4%, DuPont) is a new anthranilamide insecticide that provides long-lasting, broad spectrum chewing insect control.

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 against seed bugs. The purpose of this study is to 1) evaluate the potential efficacy of a new formulation of imidacloprid and abamectin and foliar sprays of rynaxypyr against seed bugs and coneworms in pine seed orchards and 2) determine the duration of treatment efficacy.

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 will be initiated in spring 2009 in a loblolly pine block (TFS's Magnolia Spring Seed Orchard, Texas and Plum Creek's Hebron Orchard, Louisiana). A third phase of the study will be initiated in fall 2009 in a loblolly pine block (Weyerhaeuser's Magnolia Seed Orchard, Arkansas). A block in each orchard was/will be selected that has 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 March 2009, 6 ramets from each of 6 clones were selected in both Texas and Louisiana. In September 2009, 10 ramets from each of 5 clones will be selected in AR. 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 will 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)

TX and LA Orchard (Loblolly pine)

1) Rynaxypyr (Coragen, DuPont) foliar spray in April, June, and August 2009
2) Check – untreated

AR Orchard (Loblolly pine)

1) Imidacloprid (Ima-jet®, Arborjet) (0.4 g AI per inch DBH of tree) in Fall 2009
2) Imidacloprid (Ima-jet®) (0.4 g AI per inch DBH of tree) in both Fall 2009 and Fall 2010
3) Imidacloprid (Ima-jet®) (0.4 g AI per inch DBH of tree) in Spring 2010
4) Imidacloprid (Ima-jet®) (0.2 – 0.4 g AI per inch DBH of tree) in spring 2010 and Spring 2011.
5) Check – untreated

Injection treatments will be applied in September 2008 (FL) or October (AR) 2009 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 FL or Rynaxopyr in TX and LA) will be applied to foliage beginning in April 2009 using a hydraulic sprayer from a bucket truck (if necessary) at 10 gal/tree. The distance between test trees will be $\geq$20 m to minimize the effects of drift.

Conelet and cone survival was/will be evaluated in 2009, 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 2009, 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:

<u>September - December 2008</u>

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

<u>January - April 2009</u>

- Select orchard block, clones and ramets in TX (March).
- Treat FL study trees with standard (Asana®XL) foliar treatment (April) or TX and LA study trees with Rynaxopyr®.
- 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) or TX and LA study trees with Rynaxopyr® (June, 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 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 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, and Valent

January - April 2011

- Inject AR 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, 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

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SYSTEMIC INSECTICIDE INJECTION TRIALS

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

Cooperators:

Mr. Joe Hernandez	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

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.

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.

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 **4 months** after injection (N = 10)
3) Check (untreated) (N = 20)

Application Methods:

In late April 2009, study trees will be 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 that had dropped within a 6-foot radius of each tree trunk and 25 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 will be allowed 2 or 4 months to translocate the chemical. In June and August, a series of 10 trees per treatment will be felled and 1.5 m bolts will be taken from the 3, 4.5 and 6 m heights. The bolts will be transported to a nearby hardwood plantation. Bolts will be 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 will be attached to 1 m stakes evenly spaced in the study area.

A series of bolts (10 for each treatment) will be retrieved 4, 8 and 12 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 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 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 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 has provided funding toward 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

<u>April, 2009</u>

- Select study trees
- Inject trees with assigned treatments

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

- 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 (if warranted, based on 2009 results)

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

- 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)

Cooperators

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

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.

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.

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 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 2009, 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 agreed to donate 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

Evaluation of Emamectin Benzoate and Fipronil for Protection of High-Value Southern and Western Conifers from Bark Beetles – AL, CA, & CO (Continued from 2005)

Cooperators

Dr. Steve Clarke,	USDA Forest Service – FHP R8, Lufkin, Texas
Dr. Christopher J. Fettig,	USDA Forest Service – PSW Research Station, Davis, CA
Mr. Gary Severson	Private landowner, Breckenridge, CO
Dr. David Cox	Syngenta, Modesta, CA
Dr. Harold Quicke	BASF, Auburn, AL
Mr. Joseph Doccola	Arborjet, Inc., Worchester, MA

Objectives: 1) Evaluate the efficacy of systemic injections of emamectin benzoate and fipronil for preventing mortality of high value conifers by several species of *Dendroctonus* bark beetles found in the southeastern and western regions of the United States and 2) determine the duration of treatment efficacy.

Justification: Bark beetles (Coleoptera: Curculionidae, Scolytinae) such as the southern pine beetle (SPB), *Dendroctonus frontalis* Zimmermann, mountain pine beetle (MPB), *D. ponderosae* Hopkins, western pine beetle (WPB), *D. brevicomis* LeConte, and spruce beetle (SB), *D. rufipennis* (Kirby), are responsible for extensive conifer mortality throughout North America including Alaska. These species do not just affect the timber industry; they also have a significant impact on recreation, water, and wildlife resources as well as residential property values.

The 2004 FPMC injection trial in East Texas showed that both emamectin benzoate and fipronil were highly effective in preventing both the successful colonization of treated bolts by *Ips* engraver beetles 3 and 5 months after tree injection and the mortality of standing trees (see 2004 Accomplishment Report). Trials are needed to confirm efficacy against SPB, MPB, WPB, SB and other bark beetle species as well as to determine duration of treatment efficacy. Final data from the SPB (Mississippi and Alabama) and WPB (California) indicate that again emamectin benzoate and fipronil are effective in preventing mortality by bark beetles, (see 2006 & 2007 Accomplishment Report). In contrast, data from the MPB (Idaho) and SB (Utah) indicate that the treatments were largely ineffective in the first year after treatment; treatments were effective in protecting trees in Idaho during the second year. Mortality of injected trees was likely due to infection of blue stain fungi. The trials need to be continued to determine the duration of treatment efficacy (Alabama, California and Colorado).

Research Approach: This study is being continued at 4 sites: 1) Talladega National Forest, Oakmulgee Ranger District in Bibbs and Perry Co., Alabama with southern pine beetle attacking loblolly pine; 2 & 3) private land owned by Gary Severson in Summit Co., Colorado and State Forest State Park in Jackson Co., Colorado with MPB attacking lodgepole pine; and 4) Brownsville, California with western pine beetle attacking ponderosa pine. There were 3-4 treatments at each site:

Site 1 & 4:

1) Fipronil (PW) injection at 0.2 g AI per inch DBH,
2) Fipronil (PW) injection at 0.4 g AI per inch DBH,
3) Fipronil (UK) injection at 0.2 g AI per inch DBH,
4) Fipronil (UK) injection at 0.4 g AI per inch DBH,
5) Untreated (control) - used to assess beetle pressure during each summer (2009)

Sites 2 & 3:

1) Emamectin benzoate injection at 0.4 g AI per inch DBH applied in Fall 2007,
2) Emamectin benzoate injection at 0.2 g AI per inch DBH applied in Spring 2008,
3) Emamectin benzoate injection at 0.4 g AI per inch DBH applied in Spring 2008,
4) Untreated (control) - used to assess beetle pressure during each summer (2009)

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 August2007 (CO), April 2008 (CA & AL) and May 2008 (CO), usually after a heavy rain event or snow melt. The injected trees were generally allowed one to two 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 2 to 4 weeks in April (AL) and June (CA). 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 (CA) 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. BASF, Syngenta and Arborjet, Inc. are providing chemicals or injection equipment for the project.

Research Time Line:

CY 2009

April, 2009

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

May - September, 2009

- Bait CA, CO trees (May and June)
- Monitor tree (loblolly, ponderosa and lodgepole pines) mortality (August and September)

November - December, 2009

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

Literature Cited:

Shea, P.J., M.I. Haverty and R.W. Hall. 1984. Effectiveness of fenitrothion and permethrin for protecting ponderosa pine from attack by western pine beetle. Journal of the Georgia Entomological Society 19: 427-433.

SYSTEMIC INSECTICIDE INJECTION TRIALS

Evaluation of Injection Systems for Application of Emamectin Benzoate in Loblolly Pine (Continued from 2007)

Cooperators

Dr. David Cox	Syngenta, Modesta, CA
Mr. Joseph Doccola	Arborjet, Inc., Worchester, MA
Mr. Jason Ellis	Texas Forest Service, Jacksonville, TX

Objective: 1) Continue evaluating duration of emamectin benzoate for protection of loblolly pine logs from attack and colonization by *Ips* engraver beetles.

Justification: Injection trials conducted by the Forest Pest Management Cooperative from 1999 – 2005 have shown that different formulations of emamectin benzoate (EB) such as Shot-Wan™, Denim® & Ava-jet™ when injected into loblolly pine, are highly effective against several forest insects including coneworm and/or bark beetles. Arborjet, Inc (Woburn, MA) in cooperation with Syngenta has developed a new EB formulation (TREE-äge™) that will be submitted for registration by EPA in the near future. Applications of TREE-äge™ have been made almost exclusively through the use of Arborjet's Tree IV system. Syngenta, the AI manufacturer, is interested in knowing if the TREE-äge™ (EB) formulation can be applied to pine trees using other available injection/infusion systems and are these applications effective in preventing/reducing insect damage.

Research Approach: Seven injection/infusion systems were evaluated:

Tree IV™ System (Arborjet, Inc.; contact: Joe Doccola) – high volume (125+ ml/inj pt); moderate pressure (60 psi)

Quik-jet™ System (Arborjet, Inc.; contact: Joe Doccola) – moderate volume (5 – 20+ ml/inj pt); moderate pressure (50+ psi)

Wedgle Tip™ Portal System (ArborSystems; contact: Chip Doolittle) – moderate volume (10 – 20+ ml/inj pt); high pressure (500+ psi)

Sidewinder™ System (Sidewinder; contact: Geoff Eldridge) high volume (50+ ml/inj pt); high pressure (500+ psi)

Information about the systems was requested from each manufacturer. In particular, information was requested on the recommended procedures for installation and injection of trees. Each system was ranked on the following criteria with potential points in parentheses:

1) system cost (10 pts)
2) need for peripheral parts (plugs, needles, battery chargers) (5 pts)
3) system capacity (volume of product) (3 pts)
4) Is system disposable or reusable? (2 pts)
5) Does chemical come prepackaged; can you inject product undiluted or is it necessary to dilute with water? (5 pts)
6) Time and ease to fill system with chemical product (5 pts)
7) Time and ease to install system on tree (5 pts)
8) Number of injection points required per tree (5 pts)

9) Can the system be left alone on tree or does the applicator need to manually operate system continuously? (5 pts)
10) Time and ease to inject X amount of product. (10 pts)
11) Cumulative time applicator spends at each tree. (10 pts)
12) Potential for chemical exposure. (10 pts)
13) Time and ease to clean system. (10 pts)
14) Weather restrictions (moisture, temperature) (5 pts)
15) Effectiveness of treatment 1 month after treatment (10 pts)

Treatment Methods and Evaluation:

This study is being conducted in a loblolly pine plantation (about 20 years old) that had been recently thinned in Texas. Test trees (135), ranging from 15 to 23cm dbh, were selected. Fifteen (15) trees were each injected with the same AI concentration (0.2g/ inch diameter of tree) but at one of two volume rates (low = 5ml/in dia. or high = 10ml/in dia) of TREE-äge™ (Arborjet, Inc.) using each system in late March 2007. Fifteen trees serve as untreated controls. The application procedure used to inject TREE-äge™ will be based on the recommendations of each system manufacturer. The injected trees was allowed at 1 month to translocate chemicals prior to being challenged by bark beetles.

The third series of five (5) trees for each treatment will be felled at 2 years (April 2009) after injections. 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; Phero Tech, Inc., Delta, BC, Canada) will be attached to 1 m stakes evenly spaced in the study area.

The 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.).

Research Time Line:

CY 2009

April - July

- Fell third series of trees and transport bolts to thinned stand, lay out bolts and install lures (April)
- Remove bolts and record attacks and gallery lengths (May)
- Conduct statistical analyses of data (June)
- Prepare and submit report to FPMC Executive Committee, Syngenta and System manufacturers (July).
- Present results at annual Entomological Society of America meeting.

SYSTEMIC INSECTICIDE INJECTION TRIALS

Systemic Injections for Protection of Southeastern Pines from Southern Pine Beetle and Bluestain Fungi (Initiated in 2009)

Cooperators

Dr. Steve Clarke,	USDA Forest Service – FHP R8, Lufkin, Texas
Ms. Cindy Ragland,	USDA Forest Service – Talladega National Forest, AL
Mr. Joseph Doccola	Arborjet, Inc., Worchester, MA

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.

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.

Research Approach: This study likely will be conducted in the Talladega National Forest, Oakmulgee Ranger District, Alabama. The treatments include:

1) Emamectin benzoate (0.4g AI per inch = 10 ml per inch); TREE-äge™, Arborjet Inc.) injection at 10 ml per inch DBH,
2) Thiobendazole (13%) + Propiconazole (7%) (1:1) injection at 10 ml per inch DBH,
3) Emamectin benzoate (0.4g AI per inch = 10 ml per inch) + Thiobendazole + Propiconazole (1:1) injection at 10 ml per inch DBH,
4) Untreated (control) - used to assess beetle pressure during each summer (2009 - 2010)

Each insecticide/fungicide injection treatment will be applied to 30 randomly-assigned trees (n = 120 per site). A similar number of trees will be used for each set of the untreated checks (3 sets (by year) total). Test trees (15 to 52cm dbh) will be located in areas with recent beetle activity, spaced >10 m from other potential host trees, and within 50m of an access road to facilitate treatment. Trees will be selected in stands with wide spacing (seed-tree or escape trees in old SPB spots) to prevent the development of infestations during the trial.
Each systemic insecticide/fungicide treatment will be injected with Arborjet Tree IV™ microinfusion system (Arborjet, Inc. Woburn, MA) into 4 cardinal points 0.3 m above the ground. The injected trees will be allowed one to two months (depending on water availability) to translocate chemicals prior to being challenged by the application of synthetic pheromone baits.

All test trees and the first set of untreated check trees will be baited with frontalin, alpha-pinene and endo-brevicomin lures (Synergy Semiochemicals, Delta, BC) for 6 weeks in 2009. 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 will be baited again for the same length of time in 2010 and 2011.

One criterion used to determine the effectiveness of the insecticide/fungicide treatment will be whether or not individual trees succumb to attack by bark beetles. Tree mortality will be assessed in the month of August 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 tree mortality. Presence of species-specific galleries and bluestain fungi will be verified in each tree classified as dead or dying.

Treatments will be considered to have sufficient beetle pressure if ≥60% of the untreated control trees die from beetle attack during each year. Insecticide treatments will be considered efficacious if <7 treated trees die as a result of bark beetle attacks. These criteria were established based on a sample size of 30 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 (Shea et al., 1984).

Project Support: The trial is being funded by a grant from the Southern Pine Beetle Initiative. Arborjet is providing chemicals and injection equipment for the project.

Research Time Line:

CY 2009

April, 2009

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

May - September, 2009

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

November - December, 2009

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

CY 2010 (if warranted)

March, 2010

- Bait trees (March)

April - September, 2010

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

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PINE TIP MOTH

Impact Study
(Continued from 2001 -2008)

Cooperators

Forest Pest Management Cooperative members
Mr. Bill Stansfield — The Campbell Group, Diboll, TX

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.

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).

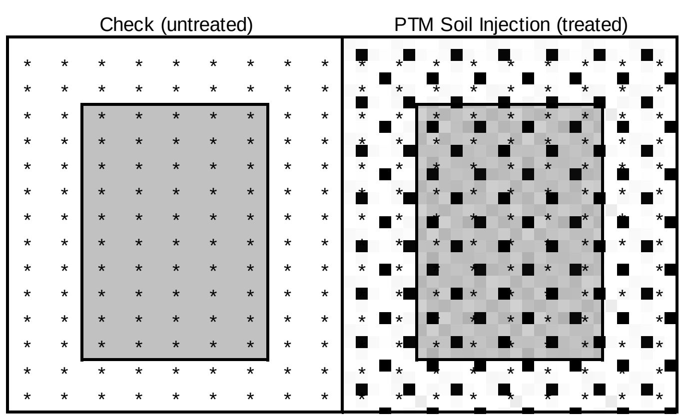
The impact of tip moth attack on tree growth has not been clearly established. Beal (1967) showed that pine trees protected from tip moth attack grew significantly faster than unprotected trees during the first 6 years after planting on some sites, but not on others. At age 16, differences in height 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 and 2008, we have observed substantial increases in tip moth populations and damage. Similar levels are expected for 2009. Therefore, it is proposed that we continue the establishment of several new sites in 2009 and continue the analysis of data already obtained to determine the effects of tip moth attacks on tree growth.

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 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) 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™ SC INsecticide) applied at planting.



PTM™ SC Insecticide 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 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 6 inches) will be measured at the end of the growing season on first- and second-year sites (established in 2009 and 2008, respectively); tree height, diameter (at breast height (DBH)), and form will be measured after year 3 (2007 planting), and 5 (2005 planting).

Tree form will be determined using the method of Berisford and Kulman (1967). Four form classes, based on the number of forks present per tree, 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. Bill Stansfield, biometrician with The Campbell Group, 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.

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

Research Time Line:

CY 2009

<u>January - February 2009</u>

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

<u>March - September 2009</u>

- 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.

<u>October - November 2009</u>

- 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.

<u>December 2009 - January 2010</u>

- 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 - 2008)

Cooperators

Forest Pest Management Cooperative members
Dr. Dean Coble SFA & SU College of Forestry, Nacogdoches, TX

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.

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, SFA & SU, has agreed to provide assistance in completing the tip moth hazard-rating model.

Research Approach:

From 2001 to 2008, 135 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 15 plots established in 2008 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 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 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 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 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%.

Research Time Line:

CY 2009

January - February 2009

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

March - July 2009

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

August – October 2009

- 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 2009

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

CY 2010

January 2010

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

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PINE TIP MOTH

Fipronil Operational Soil Injection Study
(Continued from 2006)

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

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.

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.

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).

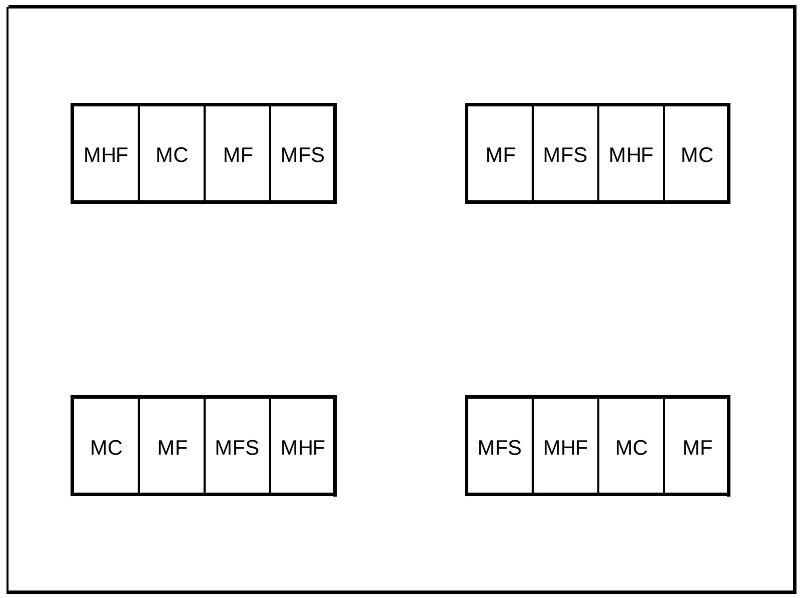
Site 4&5

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)

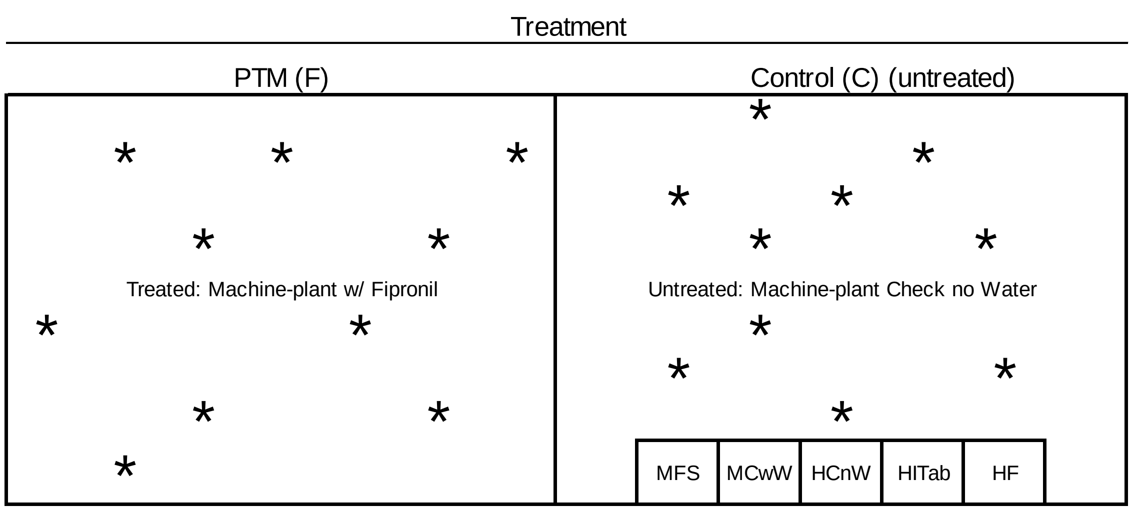
3) Seedlings planted by machine planter (no water added) plus foliar spray application (5X) with Mimic®2LV (0.6 ml / liter of water)
2) Seedlings planted by machine planter plus water (37 ml) added.
3) Seedlings planted by hand (no water added)
4) Seedlings planted by hand (no water added) with 1 SilvaShield™ 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:

CY2009 and CY2010 (if warranted)

<u>January – February 2009</u>

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

<u>March – October 2009</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 2009</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 2009 data.
- Prepare and submit report to FSPIAP sponsor, FPMC Executive Committee, BASF.
- Present results at annual Entomological Society of America meeting.

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PINE TIP MOTH

Evaluation of Fipronil Treatments for Containerized Pine Seedlings (Continued from 2007)

Cooperators

Mr. Bill Stansfield	Campbell Group, Diboll, TX
Dr. Harold Quicke	BASF, Auburn, AL

Objectives: 1) Evaluate the efficacy of fipronil applied to containerized seedlings at different rates for reducing pine tip moth infestation levels, 2) evaluate the fipronil efficacy on containerized versus bare root seedlings; and 4) determine the duration of chemical activity.

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. 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.

Research Approach:

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

<u>Treatments</u>**:**

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).

Treatment Evaluation: Tip moth damage will be evaluated on 50 internal trees within each plot after each tip moth generation (3-4 weeks after peak moth flight) of the second year 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. The trees will be measured for height and diameter (at DBH) in the fall (December). Data will be analyzed by GLM and the Tukey's Compromise test using Statview or SAS statistical programs.

Research Time Line:

CY 2009

January - February

- Begin trap monitoring of tip moth populations near each site

March - October

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

November - December

- 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 FPMC Executive Committee, BASF.

PINE TIP MOTH

Evaluation of PTM™ SC Insecticide Treatments Applied by Hand to Second-Year Pine Trees (Continued from 2008 and Initiated in 2009)

Cooperators

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

Objectives: 1) Evaluate the efficacy of PTM™ SC Insecticide (fipronil) applied to second-year pine seedlings for reducing pine tip moth infestation levels, 2) evaluate PTM™ efficacy using different soil injection techniques ; and 4) determine the duration of PTM™ activity.

Justification

Several recent trials (2003 - 2007) have shown that fipronil applied to bare root and containerized 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. 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/will be established to determine the efficacy of fipronil applied to pines before the second growing season using different application techniques.

Research Approach:

Two plantations containing one-year old (trees beginning their second year in January 2008 or January 2009) loblolly pine was/will be selected in the East Texas area. Treatments will include**:**

Trial 1 (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 2 (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

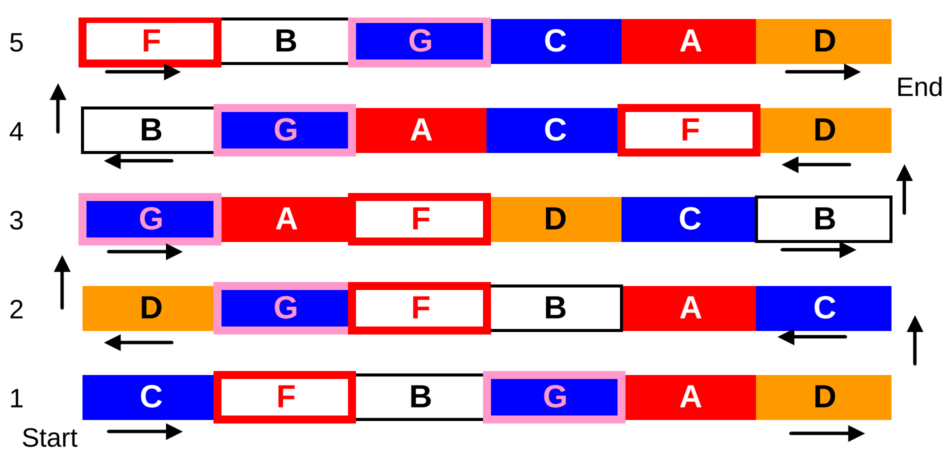
A 1 acre (approximate) area within each site was/will be selected. A randomized complete block design will be established with beds (or rows of trees) serving as blocks, i.e., each treatment will be randomly selected for placement along a bed. Fifty trees for each treatment will be selected on each site.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

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. Observe and record presence and extent of damage caused by other insects, i.e., weevils, coneworm, webworm, aphids, etc. All study trees will be 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.

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)

Research Time Line:

CY 2009

<u>January - February 2009</u>

- Select research site for Trial 2
- Treat one-year old seedling with fipronil via soil injection
- Begin trap monitoring of tip moth populations near each site

<u>March - October, 2009</u>

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

<u>November - December 2009</u>

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

CY 2010 (if warranted based on results in 2009)

<u>January - February 2010</u>

- Begin trap monitoring of tip moth populations near each site

<u>March - October, 2010</u>

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

<u>November - December 2010</u>

- 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 (Spike, Tablet or Gel) Trials – Western Gulf (Continued from 2008)

Cooperators:

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

Objectives: 1) Determine the efficacy of imidacloprid (spikes, tablets and gels) in reducing pine tip moth infestation levels on loblolly pine seedlings; 2) evaluate this product applied at different rates to transplanted or resident seedlings; 3) determine the effect of imidacloprid alone or combined with fertilizer on seedling growth; and 4) determine the duration of chemical activity.

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 (2nd, 3rd and 4th) 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 2nd through the 5th 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.

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

Research Approach:

In both research years (2003 & 2006), a single family of loblolly pine bare root seedlings was selected at the TFS Indian Mounds Nursery, Alto, TX or ArborGen SuperTree Nursery, Livingston, TX. All seedlings were operationally lifted by machine in January or February, culled of small and large caliper seedlings, treated with Terrasorb™ or clay slurry root coating, bagged and stored briefly in cold storage.

Fifty seedlings for each treatment were planted (1.8 X 3 m (= 6 X 10 ft) spacing) on one-year-old (entering 2nd growing season) plantation sites – to ensure a high level of tip moth pressure on the treatment trees. At each site, resident trees were removed and replaced with treatment trees. A randomized complete block design was used 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. Just after seedling transplant, three plant spikes (2003) or one treatment tablet (2006) was pushed into the soil 6 cm deep and 4 cm from each assigned seedling. In 2006, one tablet was dropped into the plant hole just prior to placement of the seedling in the same hole.

Treatment Evaluation: Each tree will be measured for diameter at breast height (DBH) and height in the fall (December). Tree form also will be evaluated at the end of each year. 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 2009

November - December 2009

- Measure tree height and DBH of trees treated previously.
- Conduct statistical analysis of 2009 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.

PINE TIP MOTH

SilvaShield™ Forestry Tablet Trials
(Continued from 2007 & 2008)

Cooperators

Ms. Peter Burk,	Weyerhaeuser Co., Columbus, MS
Mr. Ragan Bounds	Hancock Forest Management, Silsbee, TX
Nick Chappell	Potlatch Forest Holdings, Warren, AR
Conner Fristoe	Plum Creek Timber Co., Crossett, AR
Mr. Nate Royalty	Bayer Environmental Science, Research Triangle Park, NC
Mr. Bruce Monke	Bayer Environmental Science, Waco, TX

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

Justification

Bayer Environmental Science has 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 CropScience) 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 2nd through the 5th 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 has 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.

Insecticides:

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

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.

Research Approach:

In 2007, a single family (Advanced Generation) of loblolly pine bare-root seedlings was selected at the TFS Indian Mounds Nursery, Alto, TX (or member nursery if available). All seedlings were operationally lifted by machine in February 2007, culled of small and large caliper seedlings, treated with Terrasorb™ root coating, bagged and stored briefly in cold storage.

In 2007, 6 second-year sites were selected in Texas (2 near Colmesneil), Mississippi (near Millard) and Arkansas (1 each near Crossroads, Warren and Crossett). 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 4 - 11 treatments with 50 trees per treatment. In 2008, two separate trials were established on three sites in TX.

Fifty seedlings for each treatment (1-4, see below) were planted (standard spacing depending on member) on each of six second-year plantation sites – to ensure a high level of tip moth pressure on the treatment trees. Treatments 5&6 were added at two of the six sites. At each site, resident trees were removed and replaced with treatment trees. A randomized complete block design was used at each site 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 were planted on each of five beds. Treatments 1, 5 & 6 were applied as the seedling was planted. Just after seedling transplant, one tablet (Treatment B) was pushed into the soil 6 cm deep and 4 cm from each assigned seedling or liquid formulations poured onto the surface of the ground around each seedling. For treatment 3, a Mimic foliar spray was applied by backpack sprayer to each seedling 4 – 5 times per season based on location and recommendations of Fettig et al. (2003).

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 2009

May - October, 2009

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

November - December 2009

- 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 2010

November - December 2010

- 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)

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. Nate Royalty	Bayer Environmental Science, Research Triangle Park, NC

Objectives:

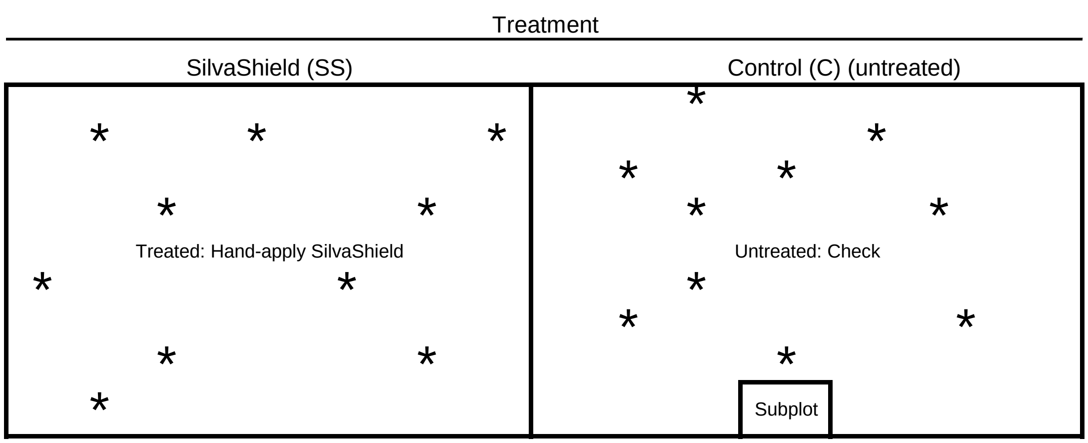
The objectives of this research proposal are to 1) determine the efficacy of SilvaShield™ tablets in reducing area-wide pine tip moth infestation levels on loblolly pine seedlings; 2) evaluate this product applied after planting to bedded or unbedded areas; and 3) determine the duration of protection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

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.

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).



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

Figure 4. Generalized Plot Design

Treatments 2008:

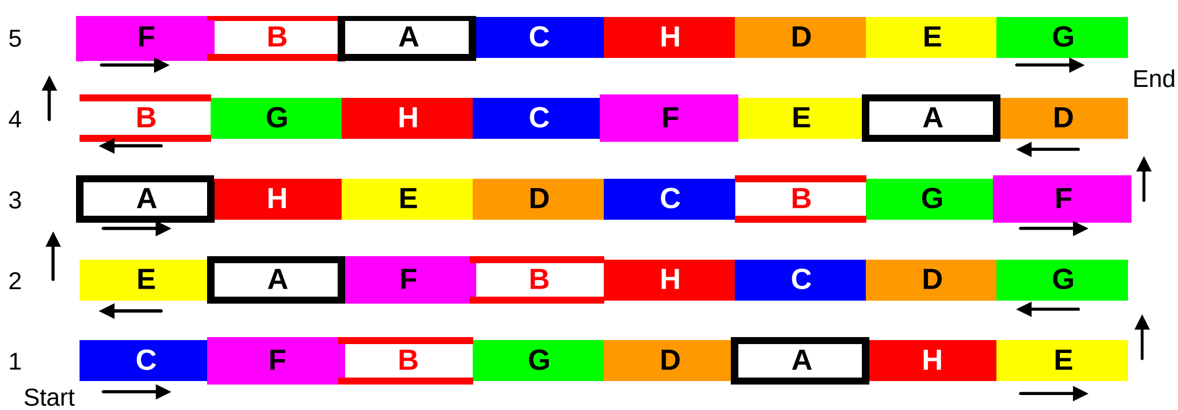
<u>Main Plot (40 acres each) (2008)</u>

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

<u>Sub-plot (0.5 acres)</u>

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:

<u>Main Plot (40 acres each)</u>

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, will be used. Each plantation will be hand or machine-planted. On one half of the plantation, the applicator will apply 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/will be 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 will be positioned within each internal treatment subplot to evaluate tip moth damage levels in these areas. All stands will be 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 2009, the "best" treatment(s) will be followed into 2010 to continue evaluating duration of treatments.

Research Time Line:

CY2009

<u>January – February 2009</u>

- Begin trap monitoring of tip moth populations near each site

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

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

<u>November - December 2009</u>

- 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
(To be Initiated in 2009)

Cooperators

Dr, Nick Chapell	Potlatch Forest Holdings, Warren, AR
Mr. Bill Stansfield	The Campbell Group, Diboll, TX
Dr. Nate Royalty	Bayer Environmental Science, Research Triangle Park, NC

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.

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.

Research Approach:

Two recently site prepared tracts will be selected; one in Texas and one in Arkansas

<u>Treatments at TX site</u>**:**

1 =	Check (untreated) -	seedling planted by hand
2 =	SilvaShield™ (SS, 1 tablet) -	in planthole (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

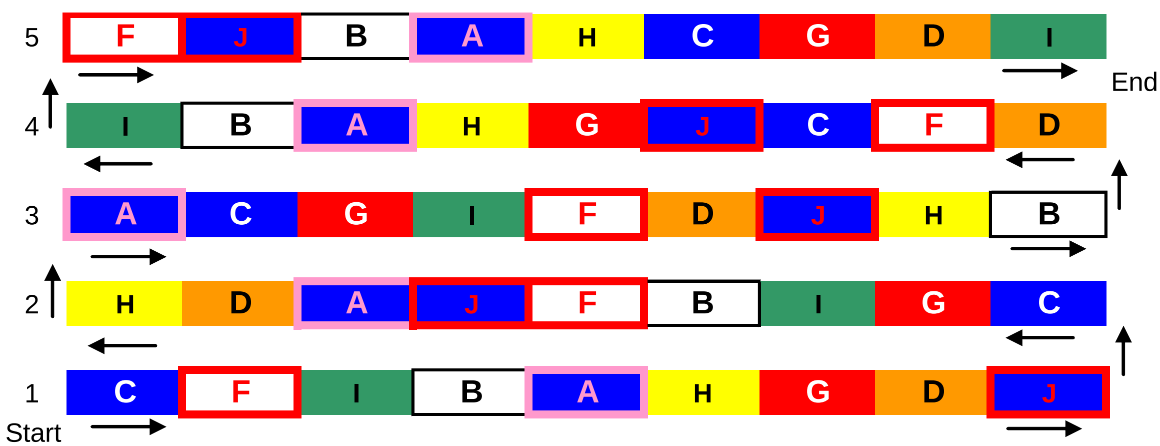
<u>Treatments at AR site</u>**:**

1 =	Check (untreated) -	seedling planted by hand
2 =	SilvaShield™ (SS, 1 tablet) -	in planthole (PH) under seedling
3 =	SS (2 tablets) -	in PH
4 =	Herb. weed control (HWC) only-	banded application of Oust (2) + Arsenal AC (4)
5 =	SS (1 tablet) + HWC -	tablet in PH + Oust + Arsenal
6 =	SS (2 tablet) + HWC -	tablets in PH + Oust + Arsenal

A 1 acre (approximate) area will be selected within each selected site. A randomized complete block design will be established with beds (or rows of trees) serving as blocks, i.e., each treatment will be randomly selected for placement along a bed. Fifty trees for each treatment will be selected on each site. Ten trees will be assigned a given treatment on each of five beds. (Figures 6 & 7). 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.

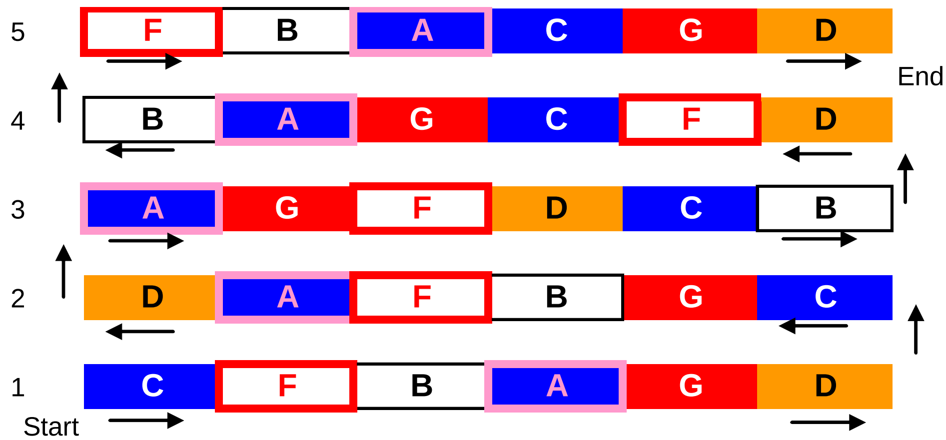
All plot corners will be marked with PVC pipe and the individual trees with different color pin flags and tags. **<u>NO</u>** additional herbicide applications should be made over the area in the spring as they will interfere with trial results. Site index, soil classification and weather/rainfall information 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)

Figure 7. Randomized Block Design Layout for a 6 Treatment AR Trial.



A (1) = Pk&Bl (Check)
B (2) = White (1 SS tablet 4" deep)
C (3) = Blue (2 SS tablets 4" deep)
D (4) = Orange (HWC only)
F (5) = Rd&Wht (1 SS + HWC)
G (6) = Red (2 SS + 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 2009

<u>January – February 2009</u>

- 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.

<u>March - October, 2009</u>

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

<u>November - December 2009</u>

- Evaluate tip moth damage after 5th generation; measure height and diameter of seedlings.
- Conduct statistical analysis of 2009 data.
- Prepare and submit report to WGFPMC Executive Committee, Bayer.

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 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.

Forest Pest Management Cooperative
Activity Time Line - CY2009

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 and rainfall for tip moth studies.
- Continue development of leaf-cutting ant bait, establish efficacy trial.

February
- Establish new tip moth research plots.
- Monitor tip moth populations and rainfall for tip moth studies.
- Monitor leaf-cutting ant colonies for efficacy of bait formulations.

March
- Treat selected tip moth impact plots with insecticides.
- 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 2008 and proposals/budget for 2009.

April
- 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.
- Treat study trees with standard or Rynaxopyr foliar treatment for Seed Orchard Injection Studies.
- Inject oak trees with emamectin benzoate treatment for oak pest Injection Trial.
- Collect site information and soil samples and conduct vegetation evaluation for hazard rating study.
- Monitor tip moth populations and rainfall for tip moth studies.
- Monitor leaf-cutting ant colonies for efficacy of bait formulations.
- Finalize FPMC 2008 accomplishment report and 2009 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 selected tip moth impact plots with insecticides.
- 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 and rainfall 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 - CY2009

June

- Treat study trees with standard or Rynaxopyr foliar treatment for Seed Orchard Injection Studies.
- 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.

July

- 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 Study.
- 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.
- Monitor leaf-cutting ant colonies for efficacy of bait formulations.
- Present results at Southern Forest Insect Work Conference.

August

- 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 study trees with standard or Rynaxopyr foliar treatment for Seed Orchard Injection Studies.
- 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.

September

- 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.
- FPM Cooperative Contact Meeting

Forest Pest Management Cooperative
Activity Time Line - CY2009

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.
- Treat study trees with injection treatments for new Seed Bug Injection Study.
- 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 2009 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.

2008 Expenditures vs. Budget

Expenditures to operate the FPMC for CY 2008 totaled $221,464 (Table 1). This was $13,105 less than the projected $234,569 budget (Table 2) primarily due to a reduced need for seasonal assistance. Sources of funding to cover expenses were derived from membership dues (26%), the SPBI and FSPIAP federal grants and industry grants from BASF, Syngenta, Bayer, Fort Dodge and Coats (33%), and the Texas Forest Service (41%). Of this total, 83% was devoted to professional salaries, fringe benefits, and seasonal wages, and the remainder (17%) to equipment, operating expenses, and indirect costs. Overall, FPMC account funds exceeded expenditures by $11,666. Due to the 2008 federal and corporate grants ($122,799), we currently have a surplus of $50,195 in these accounts at the end of CY 2008.

Emergency funds totaling $20,571 (recovered FPMC funds from FY2006 – FY2008) are being held in a separate account awaiting the need to spend them.

2009 Proposed Budget

The proposed budget for CY 2009 totals $237,809 (Table 3). The proposed budget includes an increase of $14,128 for system-mandated raises for salary that took effect in 2008 and increase in time allocation of the staff assistant and seasonal. Monies budgeted for operating expenses increased $3,775 primarily in response to rising fuel costs. Current membership dues ($87,000) plus $10,000 from the FPMC surplus and $1,000 for seed analysis work for WGTIP will provide $98,000 (41%). An additional $69,211 (29%) is available from gifts/grants ($44,075) provided by BASF, Syngenta, Bayer, Fort Dodge, Coats and Mauget, as well as funds available from SPBI (injection) and FSPIAP (tip moth) grants ($25,136). The remaining (30%) 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 2008 is given in Table 4.

2010 Proposed Budget

A proposed budget for CY 2010 is given in Table 5 by source of funding. A total of $243,473 is proposed for CY 2010. No dues increase is anticipated. Assuming that membership stays at 8 full members and two associate members in 2009, $98,000 (40%) would be provided by membership dues, $10,000 from the FPMC surplus and anticipated funds from WGTIP for seed analysis. The remainder of the budget, 60%, 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 2010 is given in Table 6. We anticipate that one or more small projects will terminate at the end of CY 2009, allowing the funding of one new applied research or technology transfer project in CY 2010.

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 – 2010.

Table 1. FPMC Expenditures by Source of Funding - CY 2008

	Source: FPMC	Source: TFS	Source: Fed./Ind. Grants *	Total	% of Total
A. Salaries and Wages					
Principal Investigator (Grosman) (100%)	$ 16,509 (26%)	$ 46,630 (74%)	$ 0	$ 63,139	
Research Specialist (Kavanagh) (100%)	3,465 (10%)	0	21,872 (90%)	25,337	
Research Specialist (Helvey) (100%)	310 (10%)	0	4,851 (90%)	5,161	
Staff Forester (Upton) (78%)	12,428 (30%)	23,503 (48%)	0	35,931	
SPB Specialist (Murphrey) (9%)	652 (9%)	0	0	652	
Staff Assistant (Harrell) (20%)	1,730 (20%)	0	0	1,730	
3 Seasonal Technicians (4 - 6 mos. ea.)	1,135	0	12,063	13,198	
Total Salaries and Wages	$ 36,230	$ 70,133	$ 38,786	$ 145,149	
B. Fringe Benefits / TFS Matching	$ 10,039	$ 19,485	$ 8,304	$ 37,829	
	46,269	89,618	47,090	182,977	83%
C. Operating Expenses					
Supplies	$ 2,153	$ 0	$ 9,083	$ 11,236	
Vehicle Use and Maintainance	2,750	0	9,128	11,879	
Travel	2,060	0	3,781	5,841	
Telecommunications (15% of PCS)	646	0	0	646	
Utilities (15% of PCS)	0	1,356	0	1,356	
Other Services (rentals, publications, postage, etc.)	4,007	0	1,964	5,972	
Total Operating Expenses	$ 11,617	$ 1,356	$ 23,957	$ 36,929	17%
Indirect Costs (26%)			1,557	1,557	
Grand Total	$ 57,886	$ 90,974	$ 72,604	$ 221,464	
% of Total	26%	41%	33%	100%	100%

* Grant/Gift funds remaining from 2007; grants awarded to TFS from the Southern Pine Beetle Initiative; and gift donations from BASF, Bayer, Coats, Fort Dodge Mauget, and Syngenta.

	FPMC		Fed./Ind. Grants
Funding Available from January 1 - December 31, 2009	$ 69,552		$ 122,799

Table 2. FPMC Proposed Budget by Source of Funding - CY 2008

		Source			
		FPMC	TFS and Others*	Total	% of Total
A.	**Salaries and Wages**				
	FPMC Coordinator (Grosman) (100%)	$ 16,005 (26%)	$ 45,504 (74%)	$ 61,509	
	Research Specialist (Kavanagh) (100%)	16,000 (50%)	16,000 (50%)	32,000	
	Staff Forester (Upton) (75%)	13,231 (30%)	19,846 (45%)	33,077	
	Staff Assistant (10%)	1,335 (10%)		1,335	
	3 Seasonal Technician (4.5 mo.)		29,970	29,970	
	Total Salaries and Wages	$ 46,571	$ 111,320	$ 157,891	
B.	**Fringe Benefits (26% of Salaries & 8% of Wages)**	$ 12,108	$ 23,549	$ 35,657	
		58,679	134,869	193,548	83%
C.	**Operating Expenses**				
	Supplies	$ 9,353	$ 8,000	$ 17,353	
	Vehicle Use and Maintainance	4,000	4,000	8,000	
	Travel	3,200	4,800	8,000	
	Telecommunications (15% of PCS)	1,300	0	1,300	
	Utilities (15% of PCS)	0	1,400	1,400	
	Other Services (rentals, publications, postage, etc.)	2,468	2,500	4,968	
	Total Operating Expenses	$ 20,321	$ 20,700	$ 41,021	17%
	Grand Total	$ 79,000 **	$ 155,569	$ 234,569	
	% of Total	34%	66%	100%	100%

* includes $66,741 remaining from '06 & '07 grants and any new members, federal grants or gifts.

** member dues at $9,000/yr for eight members; $3,000/yr for two members, and $1,000 for WGTIP seed analysis. = $79,000

Table 3. FPMC Proposed Budget by Source of Funding - CY 2009

		Source				
		FPMC	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 &**	$ 15,833	$ 21,985		$ 37,818	
	8% of Wages)	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	2,331	3,134		5,465	
	(rentals, publications, postage, etc.)					
	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 4. FPMC Proposed Budget by Source of Project - CY 2009

	Activity					
	Administration Site Visits/Service	Tip Moth Studies (Impact & HR)	Tip Moth Studies (Systemic Trt)	Systemic Injection Studies	LCA or Other Study	Total
A. Salaries and Wages						
FPMC Coordinator (100%)	$ 25,740 (40%)	$ 9,652 (15%)	$ 9,652 (15%)	$ 9,652 (15%)	$ 9,652 (15%)	$ 64,348
Research Specialist (100%)	0	13,056 (40%)	13,056 (40%)	3,264 (10%)	3,264 (10%)	32,640
Staff Forester (75%)	0	5,032 (10%)	5,032 (10%)	15,098 (30%)	12,581 (25%)	37,743
Staff Assistant (20%)		1,144 (5%)	1,144 (5%)	1,144 (5%)	1,144 (5%)	4,576
3 Seasonal Technician (4.5 mos.)	0	4,995 (25%)	6,993 (35%)	5,994 (30%)	1,998 (10%)	19,980
B. Fringe Benefits (26% of Salaries & 8.4% of Wages)	$ 6,692	$ 7,909	$ 8,069	$ 8,061	$ 7,087	$ 37,818
C. Operating Expenses						
Travel and Vehicle Use	$ 4,400	$ 3,900	$ 3,900	$ 3,900	$ 3,900	$ 20,000
Supplies & Postage	4,144	2,640	2,640	2,640	2,640	14,704
Other Operating Expenses	1,000	1,000	2,000	1,000	1,000	6,000
Grand Total	$ 41,976	$ 48,184	$ 51,342	$ 49,609	$ 43,266	$ 237,809

Table 5. FPMC Proposed Budget by Source of Funding - CY 2010

		Source			
		FPMC	TFS and Others*	Total	% of Total
A.	**Salaries and Wages**				
	FPMC Coordinator (Grosman) (100%)	$ 17,275 (26%)	$ 49,118 (74%)	$ 66,393 **	
	Research Specialist (Kavanagh) (100%)	25,334 (75%)	8,445 (25%)	33,779 **	
	Staff Forester (Upton) (75%)	15,586 (30%)	23,380 (45%)	38,966 **	
	Staff Assistant (Spivey) (20%)	4,713 (20%)		4,713 **	
	3 Seasonal Technician (4.5 mo.)		19,980	19,980	
	Total Salaries and Wages	$ 62,909	$ 100,922	$ 163,831	
B.	**Fringe Benefits (26% of Salaries & 8% of Wages)**	$ 16,356	$ 22,643	$ 39,000	
		79,265	123,565	202,831	83%
C.	**Operating Expenses**				
	Supplies	$ 6,535	$ 6,773	$ 13,308	
	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	$ 18,735	$ 21,907	$ 40,642	17%
	Grand Total	$ 98,000 ***	$ 145,472	$ 243,473	
	% of Total	40%	60%	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 eight members; $3,500/yr for two members, $10,000 FPMC surplus and $1,000 for WGTIP seed analysis. = $98,000

Table 6. 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	13,512 (40%)	13,511 (40%)	3,378 (10%)	3,378 (10%)	33,779
Staff Forester (75%)	0	5,195 (10%)	5,195 (10%)	15,587 (30%)	12,989 (25%)	38,966
Staff Assistant (10%)		1,178 (5%)	1,178 (5%)	1,178 (5%)	1,179 (5%)	4,713
3 Seasonal Technician (4.5 mos.)	0	4,995 (25%)	6,993 (35%)	5,994 (30%)	1,998 (10%)	19,980
B. Fringe Benefits (26% of Salaries & 8.4% of Wages)	$ 6,905	$ 8,159	$ 8,319	$ 8,306	$ 7,311	$ 39,000
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	1,105	1,000	2,000	1,000	1,000	6,105
Grand Total	$ 43,144	$ 49,310	$ 52,467	$ 50,714	$ 44,304	$ 243,473

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	$98,000	$69,211	$70,598	$237,809	41%	30%	***
2010 *	9 / 3 *	$10K / $3.5K	$100,500	$69,211	$73,762	$243,473	41%	30%	***
Mean			$55,137	$49,638	$66,154	$167,620	32%	44%	

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

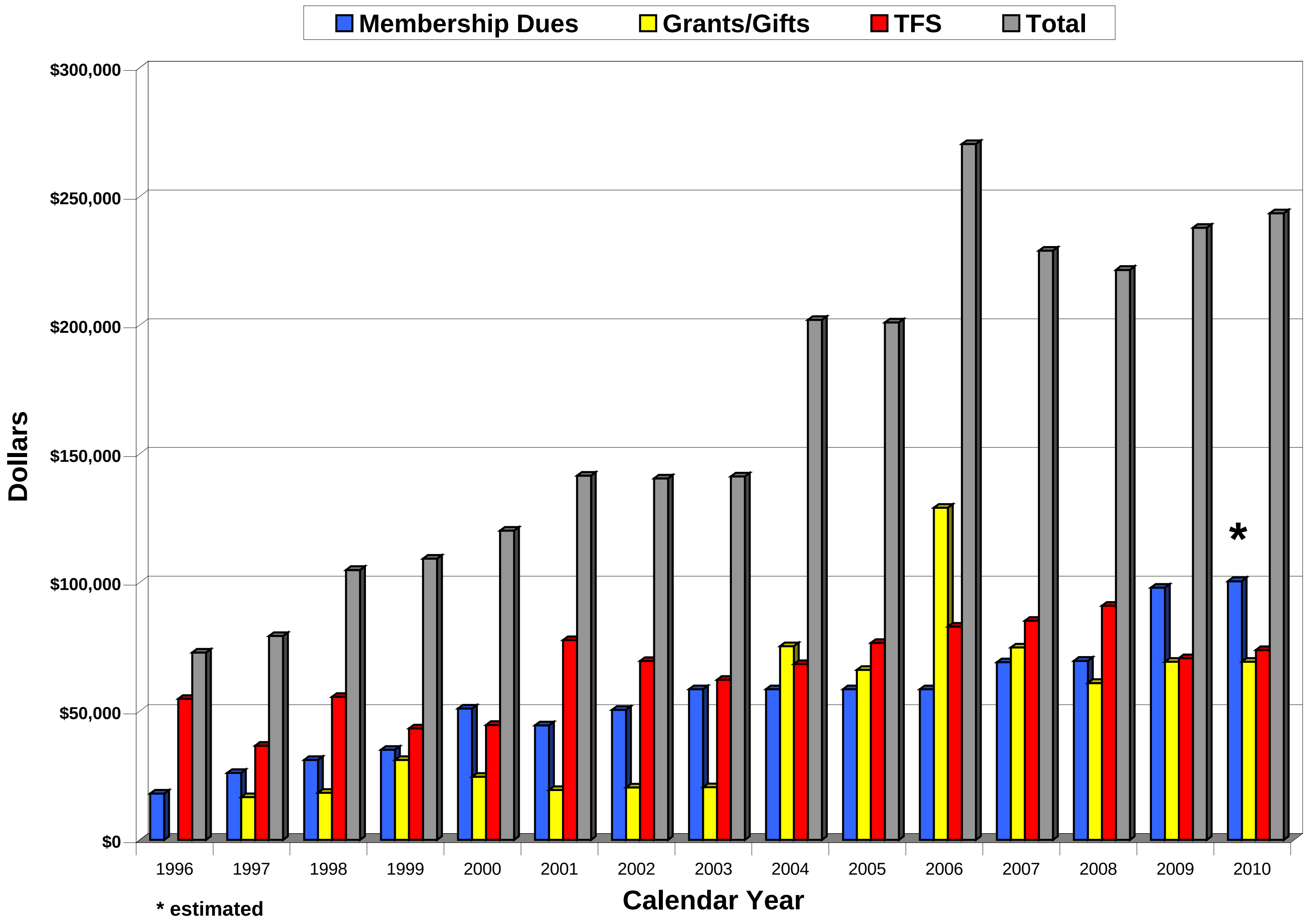


Figure 8: Forest Pest Management Cooperative budget by source.

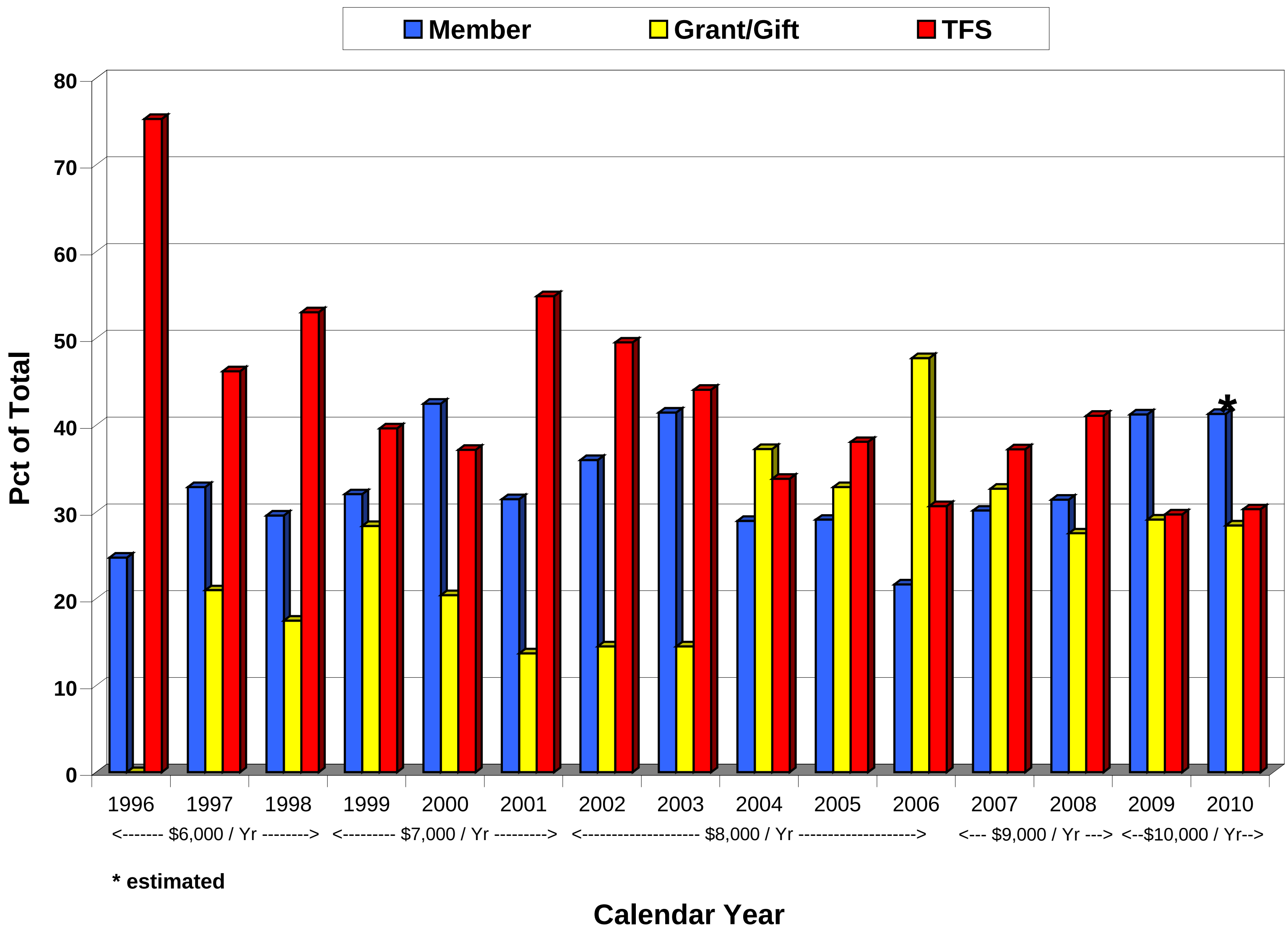


Figure 9. Forest Pest Management Cooperative membership dues, grants/gifts and TFS as percentage of total expenditures.

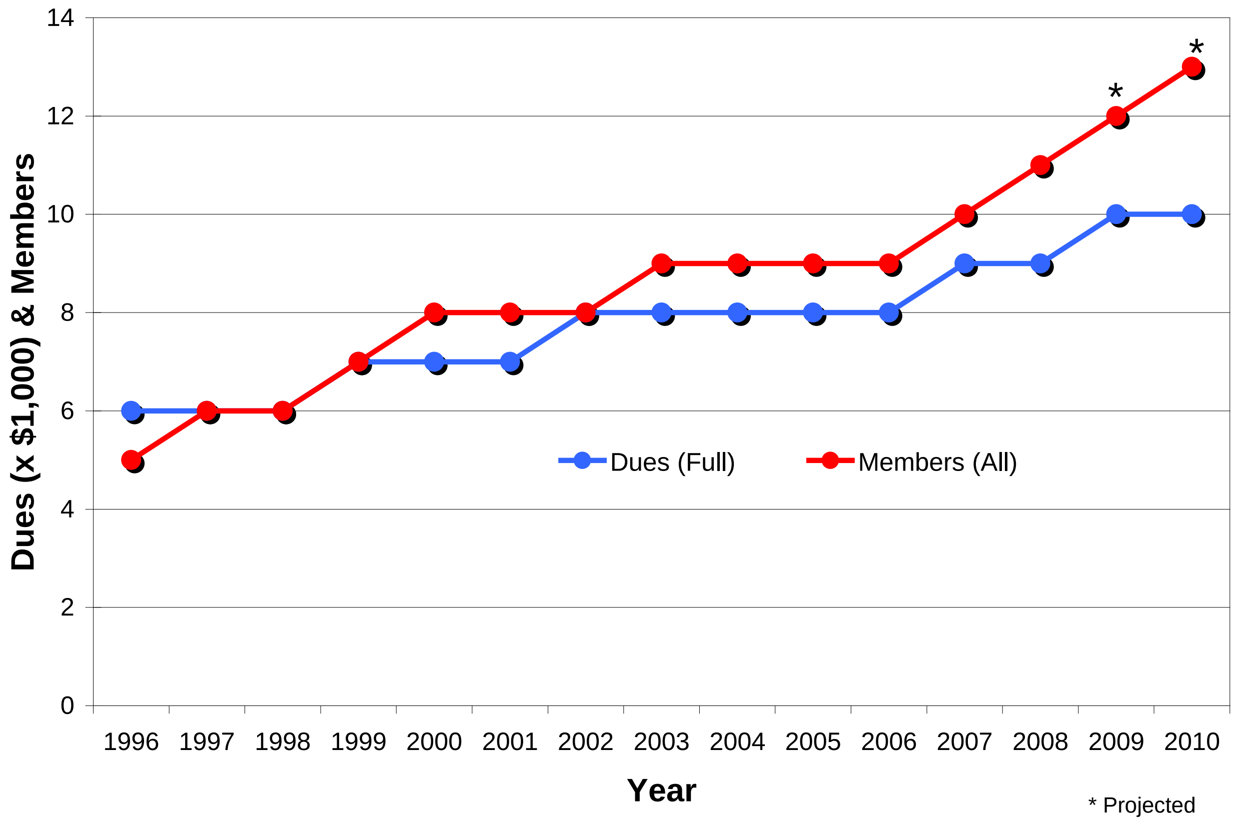


Figure 10. Forest Pest Management Cooperative membership levels and dues from 1996 to 2010 (projected).

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