# Forest Pest Management Cooperative

## 2008 Research Project Proposals

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# Forest Pest Management Cooperative

## 2008 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 leaf-cutting ant control) in 2008. 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 2008 are presented below. Arborjet/Syngenta and BASF have developed new formulations of emamectin benzoate and fipronil, respectively, for injection use. Four studies to test the efficacy of the new formulations of emamectin benzoate and fipronil 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 bug in pine seed orchards, will be continued. .In addition, two new studies are proposed, one to evaluate abamectin for protection of trees against bark beetles and the second to evaluate the same chemical for control of seed bug in pine seed orchards.

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 2008. The first, a cooperative study with Andy Burrow, Potlatch Forest Holdings, 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 – 2005), technique and rate (2003 - 2005), operational planting (2003 - 2005), technique and rate refinement studies (2004 - 2006), and soil injection (2005 - 2007), evaluation of operational treatments will be expanded in 2008 to test the newly registered PTM™ Insecticide. The Bayer trials (2003 – 2006) showed that imidacloprid / fertilizer spikes and tablets have some potential for protection of pine seedlings against tip moth. A new trial will be established to test the newly registered SilvaShield™ formulation.

Several new formulations of bait were evaluated in 2007 for attractiveness to and efficacy against leaf-cutting ants. Refinement of a promising formulation was completed late in the year. One or more efficacy trials will be established in 2008 to test this new formulation.

Continuation of these or initiation of other projects will be dependent upon approval by the FPMC Executive Committee. Extension of each project into 2009 will depend on the degree of success achieved in 2008 and remaining gaps in knowledge.

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## LEAF-CUTTING ANT

### Leaf-cutting Ant Bait Development and Evaluation - East Texas (Continued from 2007)

**Cooperators:**

Forest Pest Management Cooperative members

| | |
|---|---|
| Mr. Phil Brown | Dupont Crop Protection, Wilmington, DE |
| Mr. Ray Prewett | Texas Citrus Mutual |

**Objective:** Evaluate the preference for and efficacies of different indoxacarb/citrus pulp bait formulations to Texas leaf-cutting ants.

**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 was 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 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.

The use of baits have several advantages over fumigants and contact poisons, including being far safer to use, being more effective particularly during the summer months, and less costly and labor intensive to apply. Research trials conducted by R.S. Cameron (unpublished data) and Grosman (et al. 2002) have shown that leaf-cutting ants prefer citrus pulp to other carriers, such as, defatted corn grit. A citrus pulp bait containing sulfluramid (Volcano® leafcutter ant bait, Griffin L.L.C., Mexico, 0.5% ai) was registered as an alternative to methyl bromide in Texas and Louisiana in 1999 and 2000, respectively. The registered application rates were 4.0 g/m$^2$ for winter treatments and 10.0 g/m$^2$ for summer treatments. This sulfluramid bait was nearly 100% effective in halting ant activity year around with a single application (D. M. Grosman, unpublished data; Darwin Foster, Temple-Inland Forest Products, and Ken Addy, Louisiana Pacific, personal communications). In addition, Grosman (et al. 2002) determined preference to orange peel compared to a mixture of different citrus pulps (lemon, lime, and grapefruit).

Bait formulations have been very effective for control of imported fire ants, *Solenopsis invicta* Buren. Active ingredients currently used in fire ant baits include several toxicants (indoxacarb, fipronil, hydramethylnon, and spinosad) and insect growth regulators (IGR) (fenoxycarb, s-methoprene and pyriproxyfen). Indoxacarb is a relatively new active ingredient being released by DuPont as Advion fire ant bait. This AI blocks the insect's sodium channels in the nervous system. The Advion fire ant bait is reported to halt fire ant activity within 3 – 7 days after application. A similar response when applied to TLCA colonies would be desirable as ant colonies are often found and treated as pine seedlings are planted in the winter.

We conducted several trials in 2007 to develop one or more formulations that combine indoxacarb with citrus pulp (orange and grapefruit) or corn and tested them for attractiveness and efficacy for the Texas leaf-cutting ant. Ultimately, a corn bait containing 0.15% indoxacarb was found to be most attractive to leaf-cutting ants. In 2008, we plan to evaluate the efficacy of this new bait and determine the optimal concentration of active ingredient.

**Study Sites:** Active Texas leaf-cutting ant colonies (60) will be selected in East Texas on lands owned by forest industries, investment organizations and private individuals.

**Insecticide:**

Indoxacarb – undectable, slow-acting poison

Corn bait - concentration (0.25 – 0.15% a.i.); corn carrier with soybean oil; packing (tight); color (yellow); size (3 mm dia. & 3-12 mm long.).

**Research Approach:**

Corn bait formulations were developed based on instructions provided by DuPont. Upon mixing the corn and active ingredient, bait pellets were formed using a laboratory pellet mill equipment provided by DuPont.

Efficacy Trial

Experiments will be conducted in east Texas; within 75 miles of Lufkin. In this area, 60 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 10 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 will not be included in the central nest area. Application rates will be based on the area (length X width) of the central nest. Depending on the results of the above preference trial, the treatments may include:

1) indoxacarb, 0.15% ai - during the winter only, bait will be spread uniformly over CNA at 4.0 g/m$^2$.
2) indoxacarb, 0.1% ai - during the summer and winter, bait will be spread uniformly over CNA at 10.0 g/m$^2$.
3) indoxacarb, 0.5% ai - during the winter only, bait will be spread uniformly over CNA at 4.0 g/m$^2$.
4) indoxacarb, 0.25% ai - during the summer and winter, bait will be spread uniformly over CNA at 10.0 g/m$^2$.
6) Check - untreated colonies

Bait application rates will be based on the Volcano/Blitz® label recommendation of 4 or 10 g / m$^2$. A cyclone spreader will be used to evenly spread measured amounts of indoxacarb bait over the CNA.

It is of interest to determine the rate at which leaf-cutting ants retrieve the applied bait formulation. To do this, five petri dishes containing four bait particles (= 10g/m$^2$) will be distributed evenly within the CNA just after each colony is treated. The dishes will be checked at 3 hour intervals during the first 24 - 36 hours after treatment. At each interval, the number of particles removed will be recorded. In addition, observations will be made to determine if animals (birds), other than leaf-cutting ants, are feeding on the applied bait.

**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, 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:**

Late-Winter 2007/2008: Treatments applied to 10 colonies in February.
Early-Summer 2008: Treatments applied to 10 colonies in June.
Fall 2008: Treatments applied to 10 colonies in October.

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

**Research Time Line:**

<u>January - February 2008</u>

- Produce corn/indoxacarb bait.
- Locate 60 leaf-cutting ant colonies.
- Randomly assign and treat colonies.
- Reevaluate ant activity 2 weeks post treatment.

<u>March - May, 2008</u>

- Reevaluate ant activity 4 and 8 weeks post treatment.

<u>June - July 2008</u>

- Reevaluate ant activity 16 weeks post treatment.
- Conduct statistical analyses of data.
- Produce corn/indoxacarb bait.
- Locate 60 leaf-cutting ant colonies.
- Randomly assign and treat colonies.
- Reevaluate ant activity 2 weeks post treatment.

<u>August - September, 2008</u>

- Reevaluate ant activity 4 and 8 weeks post treatment.

October - November, 2008

- Reevaluate ant activity 16 weeks post treatment.
- Conduct statistical analyses of data.
- Produce corn/indoxacarb bait.
- Locate 60 leaf-cutting ant colonies.
- Randomly assign and treat colonies.
- Reevaluate ant activity 2 and 4 weeks post treatment.

December, 2008 – February, 2009

- Reevaluate ant activity 8 an 16 weeks post treatment.
- Conduct statistical analyses of data.
- Prepare and submit reports to FPMC and DuPont.

## SYSTEMIC INSECTICIDE INJECTION TRIALS

### Potential Insecticides for Seed Bug Control in Pine Seed Orchards (Continued from 2007 and Initiated in 2008)

**Cooperators:**

| | |
|---|---|
| Dr. Tom Byram | Western Gulf Tree Improvement Program |
| Mr. Steve Smith | Weyerhaeuser Company, Magnolia, AR |
| Mr. Todd Leeson | Rayonier, Glenville, GA |
| 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, dinotephuran and abamectin in reducing seed crop losses due seed bugs 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 regeneration programs. One of the most important insect pest groups is the seed bugs, *Leptoglossus corculus* (Say) and *Tetyra bipunctata* (Herrich-Schaffer) in the South and *L. occidentalis* Foote in the West, that suck the contents from developing seeds in conelets and cones (Ebel et al. 1980). Without a comprehensive insect-control program, this insect group commonly destroys 30% of the potential seed crop; 50% losses are not uncommon (Fatzinger et al. 1980).

The FPMC Systemic Insecticide Duration and Rate Studies have demonstrated that trunk injection of emamectin benzoate (Arise® 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.

Fipronil (BASF), a new pheny pyrazole insecticide, has been shown to have systemic activity in pine and is highly effective in reducing pine tip moth damage on young seedlings (Grosman, unpublished data). An experimental EC formulation of fipronil was found to reduce coneworm damage by 80% in the second year after injection, but it had no significant effect against seed bugs (Grosman, unpublished data).

The FPMC tested imidacloprid, another neonictinoid insecticide, in our seed orchard trials at low (2ml, Pointer® w/ Wedgle Tip injector in 1997) and high (30 ml, Admire® w/ STIT injector in 1999-2000) volumes. Generally, low volume injections were ineffective against coneworms and seed bugs. High volume injections of imidacloprid did significantly reduce coneworm damage (45%), but were not nearly as effective as emamectin benzoate (94%) in the first year after injection. In contrast, imidacloprid was more effective against seed bugs (82% reduction) than was emamectin benzoate (34% reduction). However, there was considerable variability in the efficacy against both groups of pests and efficacy against both coneworms and seed bugs declined markedly in the second year. One problem with imidacloprid is that it has a low solubility in water (0.4g/L). Thus, mixing currently-registered products (Merit® and

Admire®) in water to create an injectable solution at an effective concentration that is easily injected is difficult. For these reasons, we elected to discontinue our evaluation of imidacloprid after 2000. However, recently Arborjet has developed a new formulation of 5% injectable imidacloprid (Ima-jet™). This formulation may be more effective against seed bugs.

Dinotefuran (Valent) is a "3rd generation" neonicotinoid insecticide with primary activity against sucking insects as well as Coleoptera (beetles). Arborjet has found that injections of dinotefuran at 0.4g/DBH" was as effective as imidacloprid against emerald ash borer (Joe Doccola, personal communication). One advantage dinotefuran has over imidacloprid is that it is 100X more water soluble (40g/L vs 0.4g/L). Thus, higher concentrations can be developed that translocate more quickly compared to imidacloprid. Arborjet is currently developing a formulation of dinotefuran that may be injected alone or combined with other chemicals, e.g., emamectin benzoate or fipronil, for seed orchard use.

Abamectin (1.9%; Mauget) is 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.

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

**Research Approach:** The first phase of the study was initiated in 2007 in a slash black (TFS's Magnolia Springs Seed Orchard, TX) and loblolly pine block (Weyerhaeuser's Magnolia Seed Orchard, AR). The second phase of the study will be initiated in fall 2008 in a loblolly pine block (Rayonier's Glenville Orchard, GA). 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 2007, 7-11 ramets from each of 6-10 loblolly/slash clones was/will be selected. 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:**

**TX Orchard (Slash pine)**

1) Imidacloprid (Ima-jet®) (0.2 – 0.4 g AI per inch DBH of tree)
2) Dinotefuran (0.2 – 0.4 g AI per inch DBH of tree)
3) Imidacloprid + Emamectin benzoate (each at 0.2 – 0.4 g AI per inch DBH of tree)
4) Dinotefuran + Emamectin benzoate (each at 0.2 – 0.4 g AI per inch DBH of tree)
5) Emamectin benzoate (0.2 – 0.4 g AI per inch DBH of tree)

6) Asana®XL (standard) applied by hydraulic sprayer to foliage at labeled rate 2 times per year (May and July).
7) Check - untreated

**AR Orchard (Loblolly pine)**

**1)** Imidacloprid (Ima-jet®) (0.2 g AI per inch DBH of tree)
2) Imidacloprid (Ima-jet®) (0.4 g AI per inch DBH of tree)
3) Imidacloprid + emamectin benzoate (each at 0.2 g AI per inch DBH of tree)
4) Imidacloprid + emamectin benzoate (each at 0.4 g AI per inch DBH of tree)
5) Imidacloprid + fipronil (each at 0.2 g AI per inch DBH of tree)
6) Imidacloprid + fipronil (each at 0.4 g AI per inch DBH of tree)
7) Emamectin benzoate (0.2 g AI per inch DBH of tree)
8) Emamectin benzoate (0.4 g AI per inch DBH of tree)
9) Fipronil (each at 0.2 g AI per inch DBH of tree)
10) Fipronil (each at 0.4 g AI per inch DBH of tree)
11) Check - untreated

**GA Orchard (Loblolly pine)**

**1)** Abamectin (1.9%)(0.4 g AI per inch DBH of tree)
2) Abamectin (1.9%)(0.8 g AI per inch DBH of tree)
3) Abamectin + emamectin benzoate (each at 0.4 g AI per inch DBH of tree)
4) Abamectin + emamectin benzoate (0.4 g and 0.8g AI per inch DBH of tree)
5) Abamectin + fipronil (each at 0.4 g AI per inch DBH of tree)
6) Abamectin + fipronil (0.4 g and 0.8g AI per inch DBH of tree)
7) Emamectin benzoate (0.4 g AI per inch DBH of tree)
8) Fipronil (0.4 g AI per inch DBH of tree)
9) Asana®XL (standard) applied by hydraulic sprayer to foliage at labeled rate 5 times per year (April, May, June, July & August).
10) Check - untreated

Injection treatments will be applied in March (slash), April (loblolly) 2007 or October (loblolly) 2008 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.

Treatment 9 (Capture®, Asana® XL, Guthion®, or Imidan® standard) will be applied to foliage beginning in April 2007 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 2007, 2008 and possibly 2009 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 (slash) or September (loblolly) 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 from each tree in August (slash) or September (loblolly) of 2007, 2008 & 2009. 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:**

January - April 2008

- 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, 2008

- 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 2008

- 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 2009

- 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, 2009

- 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 2008

- Evaluate conelet and cone survival on flagged branches (early September).
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- Prepare and submit report to FPMC, Syngenta, BASF, Arborjet, and Valent

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## SYSTEMIC INSECTICIDE INJECTION TRIALS

### Systemic Insecticide Treatment Timing, Rate and Duration for Protection of Loblolly Pine from Bark Beetles. (Continued from 2006)

**Cooperators**

| | |
|---|---|
| Mr. Jason Ellis | Texas Forest Service, Jacksonville, TX |
| Dr. Harold Quicke | BASF, Auburn, AL |
| Dr. David Cox | Syngenta, Modesta, CA |
| Doug Rugg | Fort Dodge Animal Health |
| Mr. Joseph Doccola | Arborjet, Inc., Worchester, MA |

**Objectives:** 1) Determine the efficacy of systemic injections of emamectin benzoate 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, 4) determine the duration of treatment efficacy, and 5) determine chemical concentrations in plant tissues that affect attacking adult beetles and brood development.

**Justification:** In 2005, a trial was conducted to evaluate the efficacy of a new formulations of emamectin benzoate and fipronil for protection of loblolly pine against *Ips* engraver beetles. The results showed that both emamectin benzoate (Ava-jet) and 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 and timing of emamectin benzoate, fipronil and nemadectin on efficacy against Ips engraver beetles. Generally, efficacy of emamectin benzoate treatments was not influenced by timing (season) of treatment application. However, efficacy of treatments did improve with increasing chemical rate. The study should be continued to evaluate the duration of treatment efficacy at different rates.

**Treatments:**

1) Emamectin benzoate injection at 0.4 g AI per inch DBH,
2) Emamectin benzoate injection at 0.08 g AI per inch DBH,
3) Emamectin benzoate injection at 0.016 g AI per inch DBH,
4) Fipronil injection at 0.4 g AI per inch DBH,
5) Fipronil injection at 0.08 g AI per inch DBH
6) Fipronil injection at 0.016 g AI per inch DBH,
7) Nemadectin injection at 0.4 g AI per inch DBH,
8) Nemadectin injection at 0.08 g AI per inch DBH
9) Nemadectin injection at 0.016 g AI per inch DBH,
10) Untreated (control) - used to assess beetle pressure during each summer (2007 - 2008)

**Treatment Methods and Evaluation:**

This study was established in loblolly pine plantation (about 20 years old) that was recently thinned in the Fairchild State Forest, Rusk Co., Texas. Test trees (390), ranging from 15 to

23cm dbh, were selected. Each of the above emamectin benzoate and fipronil treatments was applied to 30 trees in October 2005 and 30 more trees were treated with emamectin benzoate and nemadectin treatments in April 2006. 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 June 2008, 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.).

At the time of annual tree felling (July), plant tissue samples will be collected from several points (bole phloem and xylem, crown foliage and cones) of five randomly-selected emamectin benzoate-treated trees.

1) Phloem tissue – strips of bark plates (1-2 " wide) will be excised using a hammer and chisel around the circumference of the bole at 5 m (= 16 ft; both EB and FIP trees) and 11 m (= 36 ft; EB trees only) heights. The phloem tissue layer (50 g) will be peeled from each bark plate, placed in properly labeled plastic cups and stored temporarily in a freezer prior to analysis. Chisels will be cleaned with acetone after collecting each sample.

2) Xylem tissue – a drill (1/2” dia.) will be used to collect xylem wood chips from numerous points around the circumference of the bole at 5 m (= 16 ft; both EB and FIP trees) height. Samples will be collected from the cambial layer to a depth of 1”. The samples from around the bole will be combined (50 g), placed in a labeled plastic cups and stored temporarily in a freezer prior to analysis. Drill bits will be cleaned with acetone after collecting each sample.
3) Foliage tissue – Approximately 100 new 1$^{st}$ year needles will be collected from each of the lower, middle, and upper portions of the crown of each EB and FIP tree. The needles will be combined, placed in a labeled zip-loc bag and stored temporarily in a freezer prior to analysis.

All emamectin benzoate samples will be analyzed in-house by Syngenta via HPLC analysis (Takai et al. 2003b) to determine chemical concentrations present in individual tissue samples. Samples from fipronil trees will be analyzed in-house by BASF.

**Project Support:** BASF, Syngenta and Fort Dodge have provided funding toward the project and agreed to donate chemical product and analyze the tissue samples from injected trees in house. Arborjet, Inc. has agreed to loan the FPMC injection equipment for the project.

**Research Time Line:**

**CY 2008**

June - August, 2008

- Fell second and third series of trees, collect tissue samples, transport bolts to thinned stand, lay out bolts and install lures; send off tissue sample for analysis (July)
- Remove bolts and record attacks and gallery lengths (August)

September - December, 2008

- 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.

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## 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, BC (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. Leo Rankin | British Columbia Ministry of Forests, Williams Lake, BC |
| 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* spp. bark beetles found in the southeastern and western regions of the United States and 2) to determine the duration of treatment efficacy.

**Justification:** The 2004 FPMC injection trial in East Texas showed 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 (MS and AL) and WPB (CA) indicate that again emamectin benzoate and fipronil are effective in preventing mortality by bark beetles (see 2006 Accomplishment Report). In contrast, data from the MPB (ID) and SB (UT) indicate that the treatments were largely ineffective in the first year after treatment; treatments were effective in protecting trees in ID during the second year. The trials need to be continued to determine the duration of treatment efficacy (AL and CO) and confirm the level of efficacy (BC). Other trials (AL) are needed to further validate treatment efficacy.

**Research Approach:** This study is being continued or established at 7 sites: 2) private timberland owned by Sierra Pacific Industries (SPI) in Calaveras Co. California, with western pine beetle (WPB) attacking ponderosa pine; 5) provincial timberland near 100 Mile House, British Columbia with mountain pine beetle (MPB) attacking lodgepole pine, 6 & 10) Talladega National Forest, Oakmulgee Ranger District in Bibbs and Perry Co., Alabama with southern pine beetle attacking loblolly pine; 7 & 8) private land owned by Gary Severson in Summit Co., CO and State Forest State Park in Jackson Co., CO with MPB attacking lodgepole pine; 9) Bankhead National Forest, Bankhead Ranger District in Green Co., Alabama with southern pine beetle attacking loblolly pine;. There were 2-4 treatments at each site:

Sites 1 – 9:

1) emamectin benzoate injection at 0.2 –0.4 g AI per inch DBH,
2) fipronil injection at 0.2 –0.4 g AI per inch DBH,

3) bifenthrin or carbaryl spray (standard) at 0.06% AI or 2% AI, respectively (optional)
4) Untreated (control) - used to assess beetle pressure during each summer (2006 - 2008)

Site 10:

1) fipronil injection at 0.4 g AI per inch DBH,
2) fipronil injection at 0.8 g AI per inch DBH,
3) Untreated (control) - used to assess beetle pressure during each summer (2008 - 2009)

Test trees were located in areas with recent beetle activity and isolated from other sample trees. Trees selected will be 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 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 May (CA & ID), August (UT) and September (BC) 2005, and April (AL), May (BC) and September (CO) 2006, and October (AL) 2007, preferably after a heavy rain event or snow melt. The injected trees are generally allowed one to two months (depending on water availability) to translocate chemicals prior to being challenged by the application of synthetic pheromone baits. Due to the short season because elevation, the trees in Utah will not be baited until April 2006 (Table 11).

The standard (bifenthrin or carbaryl) spray was applied at the same time as the injections in CA. Insecticides were applied with a trailer-mounted hydraulic sprayer (300 psi, #8 oriface), which allowed treatment of the entire bole of each tree, until saturation, to a height of >10m. Approximately 8 to 15 liters of formulated material was required per tree. All treatments were applied between 0600 and 1100 when wind speeds average <10 mph.

All test trees and the first set of untreated check trees were/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 2009 (AL). Similarly, the treated trees and third set of check trees will be baited in 2010.

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 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 pending mortality. Presence of species-specific 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 $\geq$ 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 trials are being funded by a grant from the Southern Pine Beetle Initiative. The WPB, MPB (ID) and SB trials are being funded by grant from the Western Bark Beetle Initiative. BASF, Syngenta and Arborjet, Inc. are providing chemicals or injection equipment for the project.

**Research Time Line:**

**CY 2008**

<u>April, 2008</u>

- Bait trees in Alabama (April)

<u>May - September, 2008 and 2009 (where appropriate)</u>

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

<u>November - December, 200 and 2009</u>

- 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.

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## 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 |

**Objectives:** 1) Evaluate systems ability inject EB formulation based on time to prepare/load, install and treat each tree and safety; 2) Evaluate speed of uptake based on control 30-60 days after injection, and then yearly for 2 more years.

**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 (Ava-jet) that will be submitted for registration by EPA in the near future. Applications of Ava-jet have been made almost exclusively through the use of Arborjet's Tree IV system. Syngenta, the AI manufacturer, is interested in knowing if the Ava-jet (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)

Quick-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 will be conducted in a loblolly pine plantation (about 20 years old) that has been recently thinned in Texas. Test trees (135), ranging from 15 to 23cm dbh, will be selected. Fifteen (15) trees will be 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 EB (Arborjet, Inc.) using each system in late March 2007 (Table 1). Fifteen trees will serve as untreated controls. The application procedure used to inject the EB formulation will be based on the recommendations of each system manufacturer. The injected trees will be allowed at least 1 month to translocate chemicals prior to being challenged by bark beetles.

**Table 1. Volume (ml) of Emamectin benzoate formulation injected per tree diameter class**

| | | Low Volume | | | | High Volume | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 EB (0.2 g/" dia) undilute | | | | 1 EB (0.2 g/" dia): 1 Water | | | |
| Tree Diameter | | EB | Water | Total | mls/ Inj | EB | Water | Total | mls/ Inj |
| Inches | cm | ml | ml | ml | Pt | ml | ml | ml | Pt |
| 1 | 2.5 | 5 | 0 | 5 | 1 | 5 | 5 | 10 | 3 |
| 2 | 5.1 | 10 | 0 | 10 | 3 | 10 | 10 | 20 | 5 |
| 3 | 7.6 | 15 | 0 | 15 | 4 | 15 | 15 | 30 | 8 |
| 4 | 10.2 | 20 | 0 | 20 | 5 | 20 | 20 | 40 | 10 |
| 5 | 12.7 | 25 | 0 | 25 | 6 | 25 | 25 | 50 | 13 |
| 6 | 15.2 | 30 | 0 | 30 | 8 | 30 | 30 | 60 | 15 |
| 7 | 17.8 | 35 | 0 | 35 | 9 | 35 | 35 | 70 | 18 |
| 8 | 20.3 | 40 | 0 | 40 | 10 | 40 | 40 | 80 | 20 |
| 9 | 22.9 | 45 | 0 | 45 | 11 | 45 | 45 | 90 | 23 |
| 10 | 25.4 | 50 | 0 | 50 | 13 | 50 | 50 | 100 | 25 |
| 11 | 27.9 | 55 | 0 | 55 | 14 | 55 | 55 | 110 | 28 |
| 12 | 30.5 | 60 | 0 | 60 | 15 | 60 | 60 | 120 | 30 |

Groups of five (5) trees for each treatment will be felled at 1 month, 1 year and 2 years 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.

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.).

**Research Time Line:**

**CY 2008 and CY 2009**

April - July

- Fell second and 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.

## PINE TIP MOTH

### Impact Study
### (Continued from 2001 -2007)

**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.

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**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).

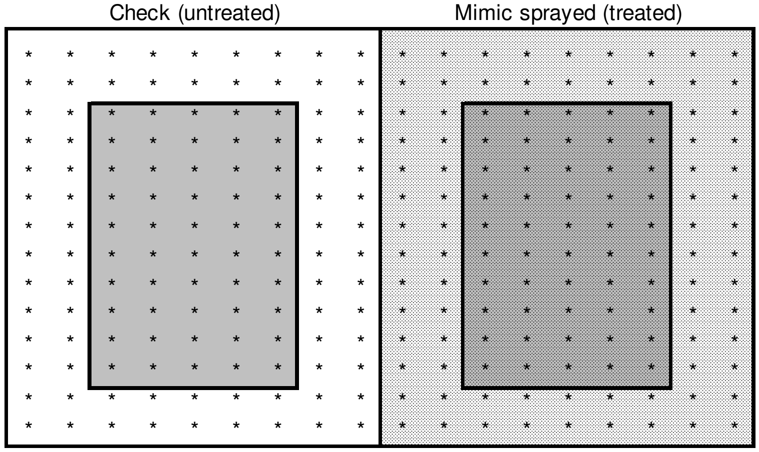
The impact of tip moth attack on tree growth has not been clearly established. Beal (1967) showed that pine trees protected from tip moth attack grew significantly faster than unprotected trees during the first 6 years after planting on some sites, but not on others. At age 16, differences in height 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 2008, the prediction is for a slightly warmer and wetter weather at least through June. Based on experience over the past 8 years, if this prediction holds true, we should see generally similar lower tip moth populations and damage levels compared to 2006 and 2007. Therefore, it is proposed that we continue the establishment of five new sites (per member) in 2008 and continue the analysis of data already obtained to determine the effects of tip moth attacks on tree growth.

**Research Approach:** Most participating company/organization has established one or more impact sites from 2001 to 2007. We are asking that each member establish five new sites during each of the next two years 2007 & 2008). 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) were established in each block. Each plot contains 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 applied at recommended times before each tip moth generation for the first **2 years** after planting.




Insecticides (Mimic® and/or Pounce®) will be applied on first- and second-year sites by backpack sprayer at label rates (0.6 ml / liter of water = 2.4 ml / gal) during the optimal spray period for each tip moth generation based on Fettig's (et al. 2003) recommendation for the location closest to each study site.

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 2008 and 2007, respectively); tree height, diameter (at breast height (DBH)), and form will be measured after year 3 (2006), and 5 (2004).

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$^2$).

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

**Research Time Line:**

January - February 2008

- Locate and establish new plots.

March - September 2008

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

October - November 2008

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

December 2008 - January 2009

- 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 - 2007)

**Objectives:** 1) Establish new plots to validate the tip moth hazard-rating model, 2) complete data collections on sites established in 2007, 3) continue development of regression models using stand characteristics and other abiotic factors to predict future levels of tip moth damage, and 4) identify factors which may facilitate hazard rating of stands for tip moth damage.

**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 seven years (2001 – 2007), we have established and monitored 116 hazard-rating plots across the Western Gulf Region. A hazard-rating model, developed by Andy Burrow, 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. We propose that five additional plots be established by each member during the last year (2008) to validate the new hazard-rating model.

**Research Approach:**

From 2001 to 2007, 116 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 1$^{st}$ and 2$^{nd}$ year after establishment, so the 11 plots established in 2007 need to be monitored in 2008. Members are asked to select five sites that generally represents the company's land base. The 50-tree plot should be situated in an area that is generally representative of the stand. A single plot can be established in a plantation block if the soil, topography and site index are similar across the block. Do not locate plots too near swamps, cypress domes, rocky outcrops, drainage ditches, etc. However, if these characteristics are variable across the block, then two or more plots can be established in a block. For example: 1) one plot can be on a flat area and another on a "steep" slope or 2) one plot can be on a well-drained area and another on a poorly-drained area, etc.

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

One or more plots of 50 trees (5 X 10) each will be established at each site. **Note:** As mentioned above, the Impact study check plots can serve as Hazard Rating plots. The 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) each year 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:**

January - February 2008

- Work with participating FPMC members to identify and receive all missing data from previously established hazard rating plots (2001 – 2007) (Grosman).
- Select and establish new sites based on target characteristics.

March - July 2008

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

August – October 2008

- 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 2008

- 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.

January 2009

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

**Literature Cited:**

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## PINE TIP MOTH

### Fipronil Control Evaluation Studies (DISCONTINUE)

**Objectives:** The objectives had been to evaluate the efficacy of fipronil for reducing tip moth damage on loblolly pine seedlings; and determine the duration of treatment efficacy.

**Justification:** Several field trials were initiated in 2002 - 2006 to evaluate the efficacy of fipronil, applied by various techniques and rates, for reducing tip moth damage on loblolly pine seedlings. The results from all trials indicate that fipronil is highly effective in reducing tip moth damage through the first year, in many cases, well into the second year, and a few cases, through most or all of the third year. Several trials also show that plant hole and soil injection treatments at or post planting are effective techniques of application. Further efforts to monitor small recently established trials are not warranted. Given that PTM™ SC Insecticide was registration by EPA in June 2007, future efforts should focus on 1) fine tuning operational techniques of fipronil application by hand or machine planter, and 2) evaluating the efficacy of fipronil when applied to containerized seedlings, 3) evaluating the efficacy of fipronil when applied to second year trees, and also 4) there is a need to confirm efficacy of the recently-registered SilvaShield Forestry tablet (imidacloprid + fertilizer).

## PINE TIP MOTH

### Fipronil Operational Soil Injection Study
### (Continued from 2006)

**Cooperators**

| | |
|---|---|
| Ms. 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. The efficacy of fipronil applied via soil injection by machine planter or hand in reducing pine tip moth infestation levels on loblolly pine seedlings needs to be determined.

**Research Approach:**

One first-year plantation was selected near Crossroads, Arkansas in February 2006, two 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 AR near Mineral Springs in March 2008.

A single family of loblolly pine bare-root seedlings was selected at Weyerhaeuser Nursery in Magnolia, AR for Sites 1, 4, 5 & 6. 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 2 & 3, International Paper's containerized loblolly pine seedlings from Bullard, TX 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 the AR, LA or TX based on uniformity of soil, drainage and topography in each pair of stands. All tracts were intensively site prepared, i.e., subsoil, bedding, and/or herbicide.

Initially, to evaluate the effects of treatment on large area tip moth damage levels, a randomized complete block design, with sites as blocks, was used. Site 1 plantations was initially divided in half (Figure 1). One half was operationally hand planted (1.8 X 3.6 m (= 6 X 12 ft) spacing) by a contracted crew. Immediately after planting, this half of the plantation was divided in half again and each seedling in one quarter of the plantation was treated with fipronil (0.3% ai in 3 ml volume) using the Kioritz soil injector or modified drench applicator. Using the injector, the chemical solution was injected 4-5 inches below the soil surface near the seedling root ball. The number of trees treated and the time required to treat these trees was recorded at each site.

The other section of the plantation also was to be divided in half and machine planted. Unfortunately, development of the soil injection system was delayed and could not be operationally tested until the following fall.

To further evaluate the effects of treatment on tip moth damage levels, an internal randomized block design, with quarter plots as blocks, was used. At each site, 4 – 0.5 acre plots were established. Each treatment was randomly assigned to one of the four internal plots in each main treatment plot quarter (Figure 1).

For sites 2, 3, & 4 the study design was modified to focus on fipronil treatments applied by machine planting. 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). At each site, 4 replicates of 4 – 0.5 acre plots (16 plots total) were established (Figure 2). 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 with a foliar spray (5x). Additional sites may be established later in the fall (October – December 2008).

For sites 5 & 6, 80-acre plantation areas were divided in half (Figure 1). Both halves were machine-planted (1.5 X 6.1 m (= 5 X 20 ft) spacing), but one-half was treated with PTM SC Insecticide with the system describe above. At each site, 5 – 0.5 acre plots were established. Each treatment was randomly assigned to one of the four internal plots in each main treatment plot quarter (Figure 1).

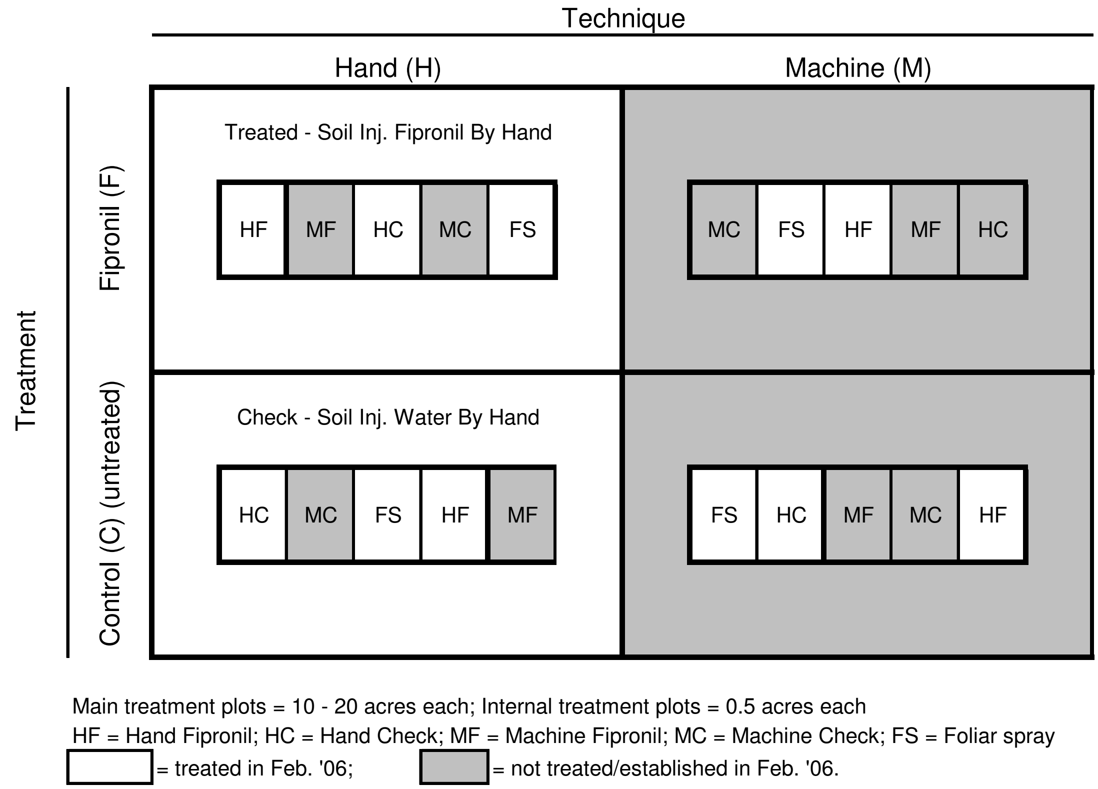



Figure 1. Generalized Plot Design for Arkansas site established in February 2006.

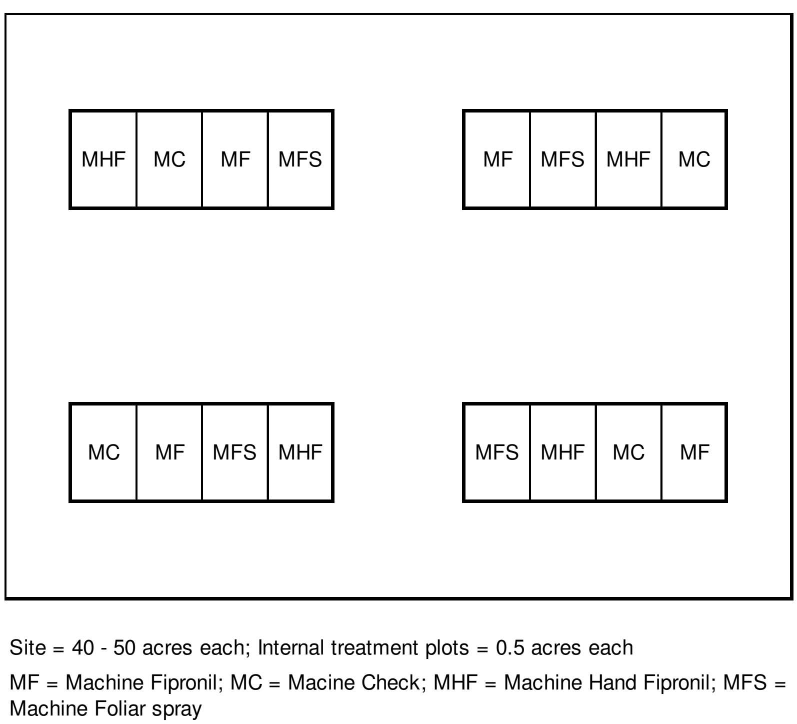
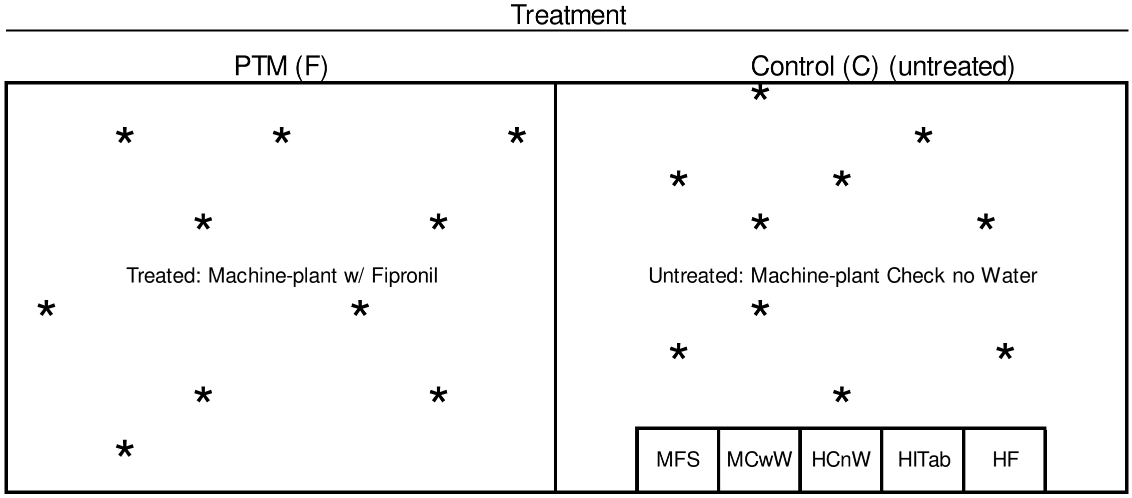



Figure 2. Generalized Plot Design for two Texas sites established in December 2006.




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

Treatments:

Site 1:

1) HF = Seedling hand planted; afterwards fipronil applied at 0.1g ai (in 3 ml water) per seedling by Kioritz soil injector.
2) HFS = seedlings hand planted; foliar spray (Pounce® or Mimic®2LV (0.6 ml / liter of water)) applied (5X)
3) HC = seedlings hand planted; no additional treatment (Check).

Site 2, 3 & 4

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 5&6

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

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).

<u>Sub-plots (0.5 acres each)</u>

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

Sites 1, 5 & 6: Ten 10-tree plots will be spaced equally within each plantation quarter or half (but outside the internal treatment plots) to evaluate tip moth damage levels in this area. Sites 1 – 6: A 50-tree plot will be positioned within each internal treatment plot to evaluate tip moth damage levels in this area. All stands will be treated with herbicide after planting to minimize herbaceous and/or woody competition.

Tip moth damage will be evaluated for all three trials 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 and height and ranked as to form in the fall (November) 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). Data will be analyzed by GLM and the Fisher's Protected LSD test using Statview or SAS statistical programs.

**Project Support:** Weyerhaeuser and BASF will provide extra funds toward the rental and fitting of a machine planter with application equipment. BASF is donating 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:**

**CY2008**

<u>January - February 2008</u>

- Select research sites.
- Fit machine planter with injection equipment
- Lift, plant and treat seedlings in plantation sites
- Begin trap monitoring of tip moth populations near each site
- Apply foliar spray to appropriate plots prior to 1$^{st}$ generation

<u>March - October, 2008</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.

November - December 2008

- 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 2008 data.
- Prepare and submit report to FSPIAP sponsor, FPMC Executive Committee, BASF.
- Present results at annual Entomological Society of America meeting.

**CY2009**

January - February 2009

- Select research sites.
- Fit machine planter with injection equipment
- Lift, plant and treat seedlings in plantation sites
- Begin trap monitoring of tip moth populations near each site
- Apply foliar spray to appropriate plots prior to 1st generation

March - October, 2009

- Apply foliar spray to appropriate plots prior to each of generations 2 - 5.
- 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 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.

**Literature Cited:**

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

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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 will be established to determine the efficacy of fipronil applied at different rates to containerized seedling.

**Research Approach:**

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

Treatments**:**

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

Containerized seedlings were individually treated using a small syringe in July 2006. The seedlings were treated at 1X and 5X the rate designated for transplanted bare root seedlings (1X = 0.13 lbs AI/acre/year = 0.118 g AI/seedling at 500 seedlings/acre). All bare root seedlings were operationally lifted by machine in March 2007, culled of small and large caliper seedlings, treated with Terrasorb™ root coating, bagged and stored briefly in cold storage. Each family was planted on each of two plantation sites. At each site, treatments was randomly assigned to 1 of 7 plot areas. One hundred seedlings were planted per plot at 9’ X 10’ (?) spacing (500 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 diameter and height (at 6”) in the fall (November) following planting. Data will be analyzed by GLM and the Tukey’s Compromise test using Statview or SAS statistical programs.

**Research Time Line:**

**CY 2008 & 2009**

<u>January - February 2008 & 2009</u>

- Begin trap monitoring of tip moth populations near each site

<u>March - October, 2008 & 2009</u>

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

<u>November - December 2008 & 2009</u>

- Evaluate tip moth damage after 5th generations; measure seedling and height of seedlings.
- Conduct statistical analysis of 2008 (and 2009) data.
- Prepare and submit report to FPMC Executive Committee, BASF.

**PINE TIP MOTH**

**Evaluation of PTM Treatments Applied by Hand to Second-Year Pine Trees (To be Initiated in 2008)**

**Cooperators**

| | |
|---|---|
| Mrs. Peavy | Private landowner, Hudson, TX |
| Dr. Harold Quicke | BASF, Auburn, AL |

**Objectives:** 1) Evaluate the efficacy of PTM (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 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 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) loblolly pine will be selected in the east Texas area.

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

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

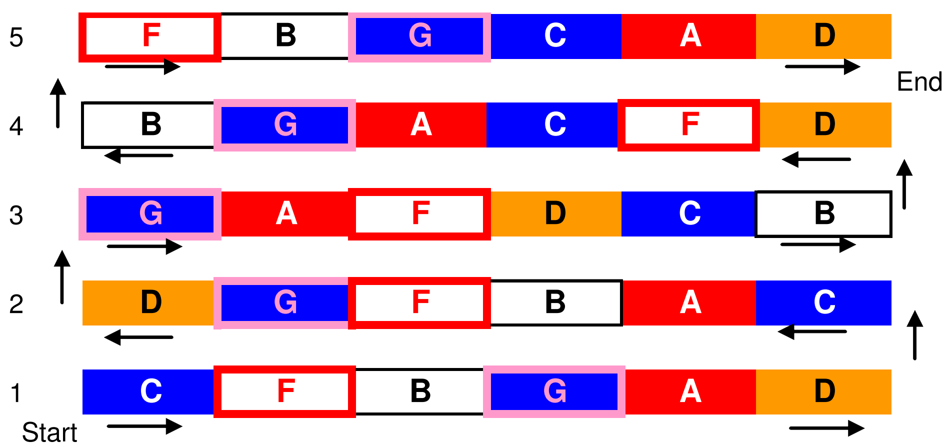
A 1 acre (approximate) area within each site will be selected. A randomized complete block design will be established with beds (or rows of trees) serving as blocks, i.e., each treatment will be randomly selected for placement along a bed. Fifty trees for each treatment will be selected on each site.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

**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 2008**

January – February 2008

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

March - October, 2008

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

November - December 2008

- Evaluate tip moth damage after 5th generations; measure seedling and height of seedlings.
- Conduct statistical analysis of 2008 data.
- Prepare and submit report to FPMC Executive Committee, BASF.

**CY 2009**

<u>January - February 2009</u>

- 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

### SilvaShield™ Forestry Tablet Trial
### (Continued from 2007)

**Cooperators**

| | |
|---|---|
| Ms. Peter Burk, | Weyerhaeuser Co., Columbus, MS |
| Mr. Bob Cassell | 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**

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

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

Bayer Cropscience has been developed tablets contain 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 2$^{nd}$ through the 5$^{th}$ generation. The absence of control in the first generation indicates that the tablets were slow to release the insecticide. On the other hand, a slower than expected release of chemical from the tablets may have prolonged the treatment effects into the second year. Bayer 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.

**Research Approach:**

In 2007, a single family (Advanced Generation) of loblolly pine bare-root seedlings will be selected at the TFS Indian Mounds Nursery, Alto, TX (or member nursery if available). All seedlings will be 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.

Fifty seedlings for each treatment (A – D, see below) will be 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 E & F will be added at two of the six sites. At each site, resident trees will be removed and replaced with treatment trees. A randomized complete block design will be 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 will be planted on each of five beds. Treatments A, E & F will be applied as the seedling is planted. Just after seedling transplant, one tablet (Treatment B) will be pushed into the soil 6 cm deep and 4 cm from each assigned seedling or poured onto the surface of the ground around each seedling. For treatment C, a Mimic foliar spray will be applied by backpack sprayer to each seedling 4 – 5 times per season based on location and recommendations of Fettig et al. (2003).

**Treatments and Layout on 4 sites**

| Code | Treatment | Color |
|---|---|---|
| A | 20% FXT Ball tablet in plant hole at planting | pink |
| B | 20% FXT Ball tablet in soil next to seedling after planting | green |
| C | Foliar application (5X) of pine seedlings with Mimic 2LV (0.6ml / 1 water) | orange |
| D | Check (lift and plant bare root seedlings) | red |

| Bed 1 | Bed 2 | Bed 3 | Bed 4 | Bed 5 |
|---|---|---|---|---|
| C | D | A | B | B |
| B | B | D | A | C |
| A | A | C | C | D |
| D | C | B | D | A |

**Treatments and Layout on 2 site**

| Code | Treatment | Color |
|---|---|---|
| A | 20% FXT Ball tablet in plant hole at planting | pink |
| B | 20% FXT Ball tablet in soil next to seedling after planting | green |
| C | Foliar application (5X) of pine seedlings with Mimic 2LV (0.6ml / 1 water) | orange |
| D | Check (lift and plant bare root seedlings) | red |
| E | 15% FXT Ball tablet in plant hole at planting | yellow |
| F | 10% FXT Ball tablet in plant hole at planting | blue |

| Bed 1 | Bed 2 | Bed 3 | Bed 4 | Bed 5 |
|---|---|---|---|---|
| F | D | E | A | B |
| C | B | A | D | E |
| E | A | D | B | F |
| B | C | C | F | C |
| A | F | B | C | D |
| D | E | F | E | A |

**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 2008**

<u>January - February 2008</u>

- Begin trap monitoring of tip moth populations near each site

<u>March - October, 2008</u>

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

<u>November - December 2008</u>

- Evaluate tip moth damage after 5th generations; measure seedling and height of seedlings.
- Conduct statistical analysis of 2008 data.
- Prepare and submit report to Bayer Environmental Science, FPMC Executive Committee.

**CY 2009**

<u>November - December 2008</u>

- Measure tree height and DBH.
- 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.

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.

## Evaluation of SilvaShield™ Tablet Depth and Dose Response for Control of Pine Tip Moth (To be Initiated in 2008)

**Cooperators**

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

**Objectives:** 1) Evaluate the efficacy of SilvaShield™ tablets for reducing pine tip moth infestation levels, 2) evaluate SilvaShield™ efficacy applied at different rates and depths into soil; and 3) determine the duration of SilvaShield activity.

**Justification**

Several recent trials (2004 - 2007) have shown that SilvaShield™ tablets (20% imidacloprid + fertilizer) applied to bare root and seedlings at or after planting is highly effective in reducing tip moth damage for 18 - 24 months. EPA recently approved the registration and use of SilvaShield™ insecticide for tip moth control. A trial will be established to determine the dose response of tip moth to different numbers of SilvaShield™ tablets.

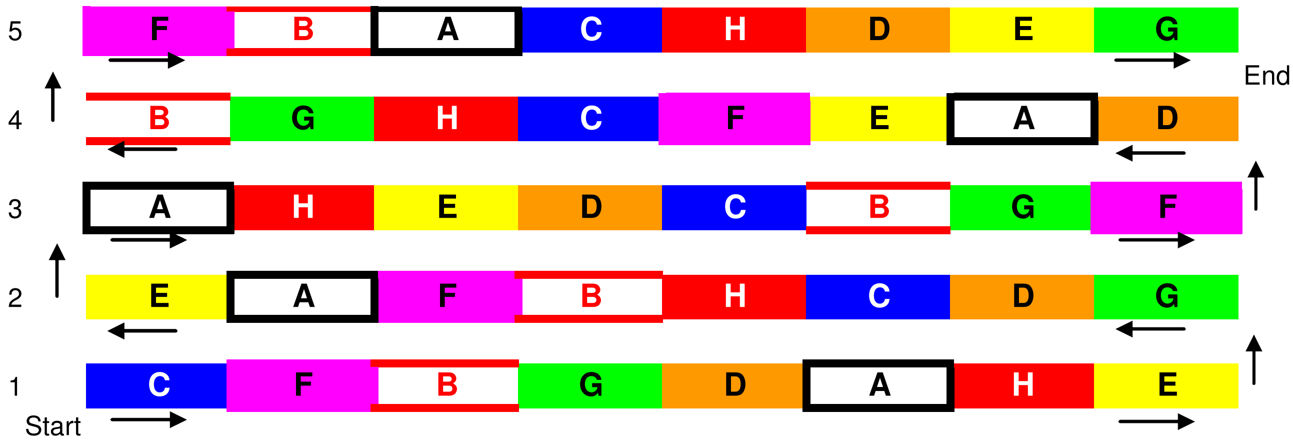
**Research Approach:**

Four plantations containing one-year old (trees beginning their second year in January 2008) loblolly pine will be selected in the east Texas area. The use of on year old site will ensure a high level of tip moth pressure on the treatment trees.

Treatments:

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

**Figure 2. 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")

A single family (Advanced Generation) of loblolly pine bare-root seedlings will be selected. All seedlings are to be operationally lifted by machine, culled of small and large caliper seedlings, treated with Territory™ root coating, bagged and stored briefly in cold storage.

A 1 acre (approximate) area within each site will be selected. Resident trees will be removed and replaced with treatment trees. Fifty seedlings for each treatment will be planted (spacing dependent on landowner). 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. (see Plot Design Example). Ten seedlings from each treatment were planted on each of five beds. Treatments 1, 3, 4 and 5 will be applied as seedlings were planted. Just after seedling transplant, one tablet (Treatment 2) will be pushed into the soil 6 cm deep and as close to each assigned seedling as possible without disturbing the seedling.

The plot corners should 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.

**Research Time Line:**

**CY 2008**

January – February 2008

- Select research sites
- Treat one year old seedling with tablets or fipronil via soil injection
- Begin trap monitoring of tip moth populations near each site

March - October, 2008

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

November - December 2008

- Evaluate tip moth damage after 5th generations; measure seedling and height of seedlings.
- Conduct statistical analysis of 2008 data.
- Prepare and submit report to FPMC Executive Committee, BASF.

**CY 2009**

January - February 2009

- Begin trap monitoring of tip moth populations near each site

March - October, 2009

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

November - December 2009

- 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)**

January - February 2010

- Begin trap monitoring of tip moth populations near each site

March - October, 2010

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

November - December 2010

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

**SilvaShield™ Operational Treatment of Loblolly Pine Seedlings After Planting for Control of Pine Tip Moth**
(To be Initiated in 2008)

**Cooperators**
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 unwedded 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, and one one-year old tract, each 80 acres in size, will be selected in Texas or Louisiana based on uniformity of soil, drainage, topography and susceptibility to tip moth infestation (based on FPMC Tip Moth Hazard-Rating Model, Andy Burrow, Temple-Inland Forest Products.

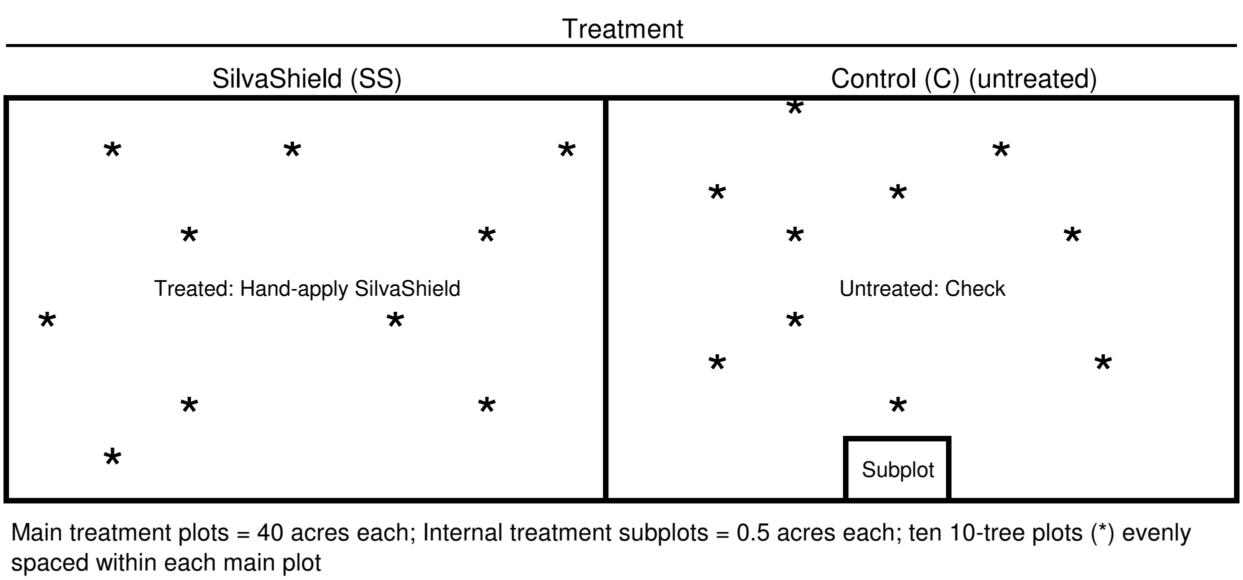



Figure 1. Generalized Plot Design

**Treatments:**

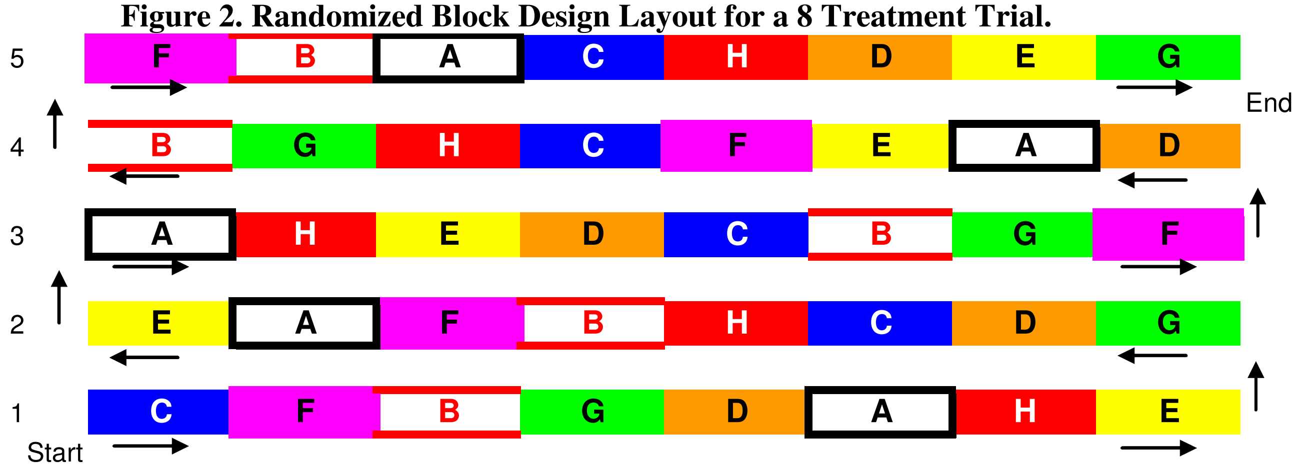
Main Plot (40 acres each)

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

Sub-plot (0.5 acres)

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

**Figure 2. Randomized Block Design Layout for a 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")

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 to each seedling after planting (Figure 1.). A lance will be used to create a 4 inch deep hole in the soil, angled toward the seedling. The tablet is then dropped into the hole and covered up. In the other half of the plantation, seedlings will be hand or machine planted at the same spacing.

Additionally, 0.75 acre subplot will be installed within check main treatment plot. Each treatment will be randomly assigned to ten trees on each of five rows (Fig 2).

Ten 10-tree plots 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 4$^{th}$ generation in 2009, the "best" treatment(s) will be followed into 2010 to continue evaluating duration of treatments.

**Research Time Line:**

**CY2008**

January - February 2008

- Select research sites.
- Lift, plant and treat seedlings in plantation sites
- Begin trap monitoring of tip moth populations near each site

March - October, 2008

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

**CY2008**

November - December 2008

- Evaluate tip moth damage after 5th generations; measure diameter and height of seedlings.
- Conduct statistical analysis of 2008 data.
- Prepare and submit report to FPMC Executive Committee and Bayer Crop Science.

**CY2009**

January – February 2009

- Begin trap monitoring of tip moth populations near each site

March - 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 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.

**Forest Pest Management Cooperative**
**Activity Time Line - CY2008**

January
- Contact and meet with FPMC members to identify suitable tip moth sites; gather information on management plans for each site.
- Deploy pheromone traps for tip moth impact, hazard rating, and control (fipronil) studies.
- Monitor tip moth populations and rainfall for tip moth studies.
- Begin development of leaf-cutting ant bait.

February
- Machine plant for Operational Soil Injection Trial.
- Establish new tip moth research plots.
- Monitor tip moth populations and rainfall for tip moth studies.
- Test preference of leaf-cutting ants to 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.
- Test efficacy of leaf-cutting ants to bait formulations.

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 foliar treatment for Seed Orchard Injection Studies.
- 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.

May
- Evaluate tip moth damage after 1$^{st}$ 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.
- Continue monitoring leaf-cutting ant colonies for efficacy of bait formulations.

June
- 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 *Ips* Bark Beetle Injection Trial.
- Evaluate tip moth damage after 2$^{nd}$ 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.
- Test efficacy of leaf-cutting ants to bait formulations.

## Forest Pest Management Cooperative
## Activity Time Line - CY2008

July
- Treat study trees with standard foliar treatment for Seed Orchard Injection Studies.
- Retrieve and evaluate bolts for *Ips* Bark Beetle Injection Study.
- Treat selected tip moth impact plots with insecticides.
- Monitor tip moth populations and rainfall for tip moth studies.
- Monitor leaf-cutting ant colonies for efficacy of bait formulations.

August
- Evaluate tip moth damage after 3rd generation for all tip moth studies; photograph damage.
- Treat study trees with standard 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.
- Evaluate slash pine conelet and cone survival on flagged branches (late August).
- Continue monitoring leaf-cutting ant colonies for efficacy of bait formulations.

September
- Evaluate loblolly pine conelet and cone survival on flagged branches (early September).
- Evaluate tip moth damage after 4th generation for all tip moth studies; photograph damage.
- Monitor tip moth populations and rainfall for tip moth studies.
- Collect all cones from sample trees for Seed Bug Injection trial.

October
- Treat selected tip moth impact plots with insecticides.
- Evaluate coneworm damage for Pine Seed Orchard studies.
- Monitor tip moth populations and rainfall for tip moth studies.
- Treat study trees with injection treatments for new Seed Bug Injection Study.
- Test efficacy of leaf-cutting ants to 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.
- 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.

December
- Extract, radiograph and evaluate seed samples for Seed Orchard studies.
- Conduct statistical analyses of 2008 data.
- Prepare and submit reports to FPMC Executive Committee, Syngenta Crop Protection, Inc, and Bayer Cropscience, and BASF Co.
- Present results at annual Entomological Society of America meeting.
- 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.

## 2007 Expenditures vs. Budget

Expenditures to operate the FPMC for CY 2007 totaled $239,180 (Table 1). This was $27,377 more than the projected $211,803 budget (Table 2) due to a 3% raise in salaries, and additional costs for fuel, travel and rentals. Sources of funding to cover expenses were derived from membership dues (25%), the SPBI and FSPIAP federal grants and industry grants from BASF, Syngenta, Bayer and Fort Dodge (39%), and the Texas Forest Service (36%). Of this total, 81% was devoted to professional salaries, fringe benefits, and seasonal wages, and the remainder (19%) to equipment, operating expenses, and indirect costs. Overall, FPMC account funds exceeded expenditures by $5,917. Due to the 2007 federal and corporate grants ($74,755), we currently have a surplus of $70,897 in these accounts at the end of CY 2007.

Emergency funds totaling $9,393 (recovered FPMC funds from FY2006 and 2007) were being held in a separate account awaiting the need to spend them.

## 2008 Proposed Budget

The proposed budget for CY 2008 totals $234,569 (Table 3). The proposed budget includes an increase of $7,913 for system-mandated raises for salary that took effect in 2007 and the addition of a third seasonal employee. Monies budgeted for operating expenses increased $13,083 primarily in response to rising fuel costs. One full member was lost at the end of CY2007 but two were gained so far in 2008. Therefore, current membership dues ($78,000) plus $1,000 for seed analysis work for WGTIP will provide $79,000 (34%). An additional $70,897 (30%) is available from BASF, Syngenta, Bayer and Fort Dodge gifts ($20,214), and funds available from SPBI (injection) and FSPIAP (tip moth) grants ($50,682). The remaining (36%) 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.

## 2009 Proposed Budget

A proposed budget for CY 2009 is given in Table 5 by source of funding. A total of $239,665 is proposed for CY 2009. To provide more stable support for the Research Specialist position, it is recommended that dues be increased to $10,000 / full member / year and $3,500 / associate member / year. Assuming that membership stays at 8 full members and two associate member in 2008, $88,000 (37%) would be provided by the increased membership dues and anticipated funds from WGTIP for seed analysis. Even with this proposed dues increase, 63% of the budget 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 2009 is given in Table 6. We anticipate that one or more small projects will terminate at the end of CY 2008, allowing the funding of one new applied research or technology transfer project in CY 2009.

**Table 1.** WGFPMC Expenditures by Source of Funding - CY 2007

| | Source | | | | % of |
|---|---|---|---|---|---|
| | WGFPMC | TFS | Fed./Ind. Grants * | Total | Total |
| **A. Salaries and Wages** | | | | | |
| Principal Investigator (Grosman) (100%) | $ 15,728 (26%) | $ 44,717 (74%) | $ 0 | $ 60,445 | |
| Research Specialist (Helvey) (100%) | 3,245 (10%) | 0 | 30,316 (90%) | 33,561 | |
| Staff Forester (Upton) (75%) | 12,811 (30%) | 20,833 (45%) | 0 | 33,644 | |
| SPB Specialist (Murphrey) (9%) | 3,652 (9%) | 0 | 0 | 3,652 | |
| 4 Seasonal Technicians (1 - 4 mos. ea.) | 2,187 | 0 | 16,282 | 18,469 | |
| Total Salaries and Wages | $ 37,624 | $ 65,550 | $ 46,598 | $ 149,771 | |
| **B. Fringe Benefits / TFS Matching** | $ 11,474 | $ 19,606 | $ 9,794 | $ 40,874 | |
| | 49,098 | 85,156 | 56,392 | 190,645 | 81% |
| **C. Operating Expenses** | | | | | |
| Supplies | $ 5,632 | $ 0 | $ 18,395 | $ 24,027 | |
| Vehicle Use and Maintainance | 2,407 | 0 | 5,324 | 7,731 | |
| Travel | 1,123 | 0 | 7,672 | 8,795 | |
| Telecommunications (15% of PCS) | 1,428 | 0 | 0 | 1,428 | |
| Utilities (15% of PCS) | 0 | 1,356 | 0 | 1,356 | |
| Other Services (rentals, publications, postage, etc.) | 394 | 0 | 2,180 | 2,574 | |
| Total Operating Expenses | $ 10,985 | $ 1,356 | $ 33,571 | $ 45,912 | 19% |
| Indirect Costs (26%) | | | 2,623 | 2,623 | |
| Grand Total | $ 60,083 | $ 86,512 | $ 92,586 | $ 239,180 | |
| % of Total | 25% | 36% | 39% | 100% | 100% |

* Grant funds remaining from 2006; grants awarded to TFS from the Southern Pine Beetle Initiative and FSPIAP (Tip Moth); and gift donations from BASF, Syngenta, Bayer and Fort Dodge.

| | WGFPMC | TFS | Fed./Ind. Grants * |
|---|---|---|---|
| Funding Available from January 1 - December 31, 2007 | $ 66,000 | | $ 74,755 |

**Table 2.** WGFPMC Proposed Budget by Source of Funding - CY 2007

| | Source: WGFPMC | Source: TFS and Others* | Total | % of Total |
|---|---|---|---|---|
| **A. Salaries and Wages** | | | | |
| Principal Investigator (Grosman) (100%) | $ 17,974 (30%) | $ 41,939 (70%) | $ 59,913 ** | |
| Research Specialist (Helvey) (100%) | 9,962 (30%) | 23,245 (70%) | 33,207 ** | |
| Staff Forester (Upton) (75%) | 12,853 (30%) | 19,280 (45%) | 32,133 ** | |
| SPB Specialist (Murphrey) (9%) | 3,616 (9%) | | 3,616 ** | |
| 2 Seasonal Technician (4.5 mo.) | | 19,980 | 19,980 | |
| Total Salaries and Wages | $ 44,405 | $ 104,444 | $ 148,849 | |
| **B. Fringe Benefits (26% of Salaries & 8% of Wages)** | $ 11,545 | $ 23,559 | $ 35,104 | |
| | 55,950 | 128,003 | 183,953 | 87% |
| **C. Operating Expenses** | | | | |
| Supplies | $ 3,861 | $ 3,000 | $ 6,861 | |
| Vehicle Use and Maintainance | 4,000 | 4,000 | 8,000 | |
| Travel | 3,200 | 3,300 | 6,500 | |
| Telecommunications (15% of PCS) | 500 | 100 | 600 | |
| Utilities (15% of PCS) | 0 | 1,200 | 1,200 | |
| Other Services (rentals, publications, postage, etc.) | 2,489 | 2,200 | 4,689 | |
| Total Operating Expenses | $ 14,050 | $ 13,800 | $ 27,850 | 13% |
| Grand Total | $ 70,000 *** | $ 141,803 | $ 211,803 | |
| % of Total | 33% | 67% | 100% | 100% |

* includes $86,100 remaining from 2005 and 2006 grants and gifts and any new members or federal grants.

** includes 3% salary increase

*** member dues at $9,000/yr for seven members; $3,000/yr for two members, and $1,000 for WGTIP seed analysis. = $70,000

**Table 3.** FPMC Proposed Budget by Source of Funding - CY 2008

| | | Source | | | % of |
|---|---|---|---|---|---|
| | | FPMC | TFS and Others* | Total | 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 4.** FPMC Proposed Budget by Source of Project - CY 2008

| | 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%) | $ 24,604 (40%) | $ 9,226 (15%) | $ 9,226 (15%) | $ 9,226 (15%) | $ 9,226 (15%) | $ 61,509 |
| Research Specialist (100%) | 0 | 12,800 (40%) | 12,800 (40%) | 3,200 (10%) | 3,200 (10%) | 32,000 |
| Staff Forester (75%) | 0 | 4,410 (10%) | 4,410 (10%) | 13,231 (30%) | 11,026 (25%) | 33,077 |
| Staff Assistant (10%) | 0 | | | | 1,335 (10%) | 1,335 |
| 3 Seasonal Technician (4.5 mos.) | 0 | 7,493 (25%) | 10,489 (35%) | 8,991 (30%) | 2,997 (10%) | 29,970 |
| **B. Fringe Benefits (26% of Salaries & 8% of Wages)** | $ 6,397 | $ 7,473 | $ 7,713 | $ 7,390 | $ 6,684 | $ 35,657 |
| **C. Operating Expenses** | | | | | | |
| Travel and Vehicle Use | $ 3,800 | $ 2,700 | $ 3,000 | $ 3,500 | $ 3,000 | $ 16,000 |
| Supplies & Postage | 7,416 | 2,896 | 2,896 | 2,896 | 3,230 | 19,334 |
| Other Operating Expenses | 999 | 899 | 1,991 | 899 | 899 | 5,687 |
| **Grand Total** | $ 43,216 | $ 47,897 | $ 52,525 | $ 49,334 | $ 40,263 | $ 234,569 |

**Table 5.** 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%) | $ 16,324 (26%) | $ 46,414 (74%) | $ 62,738 ** | |
| | Research Specialist (Kavanagh) (100%) | 24,480 (75%) | 8,160 (25%) | 32,640 ** | |
| | Staff Forester (Upton) (75%) | 13,320 (30%) | 20,418 (45%) | 33,738 ** | |
| | Staff Assistant (10%) | 2,288 (10%) | | 2,288 | |
| | 3 Seasonal Technician (4.5 mo.) | | 29,970 | 29,970 | |
| | Total Salaries and Wages | $ 56,412 | $ 104,962 | $ 161,374 | |
| **B.** | **Fringe Benefits (26% of Salaries &** | $ 14,667 | $ 21,896 | $ 36,563 | |
| | **8% of Wages)** | 71,079 | 126,858 | 197,937 | 83% |
| **C.** | **Operating Expenses** | | | | |
| | Supplies | $ 6,644 | $ 10,773 | $ 17,417 | |
| | Vehicle Use and Maintainance | 4,000 | 5,000 | 9,000 | |
| | Travel | 3,200 | 4,400 | 7,600 | |
| | Telecommunications (15% of PCS) | 1,500 | 0 | 1,500 | |
| | Utilities (15% of PCS) | 0 | 1,500 | 1,500 | |
| | Other Services | 1,577 | 3,134 | 4,711 | |
| | (rentals, publications, postage, etc.) | | | | |
| | Total Operating Expenses | $ 16,921 | $ 24,807 | $ 41,728 | 17% |
| | Grand Total | $ 88,000 *** | $ 151,665 | $ 239,665 | |
| | % of Total | 37% | 63% | 100% | 100% |

* includes $14,750 SPB grant and any new members or federal grants.

** includes 2% salary increase

** member dues at $10,000/yr for eight members; $3,500/yr for two members, and $1,000 for WGTIP seed analysis. = $88,000

**Table 6.** 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%) | $ 25,095 (40%) | $ 9,411 (15%) | $ 9,410 (15%) | $ 9,411 (15%) | $ 9,411 (15%) | $ 62,738 |
| Research Specialist (100%) | 0 | 13,056 (40%) | 13,056 (40%) | 3,264 (10%) | 3,264 (10%) | 32,640 |
| Staff Forester (75%) | 0 | 4,498 (10%) | 4,498 (10%) | 13,496 (30%) | 11,246 (25%) | 33,738 |
| Staff Assistant (10%) | | | | | 2,288 (10%) | 2,288 |
| 3 Seasonal Technician (4.5 mos.) | 0 | 7,493 (25%) | 10,489 (35%) | 8,991 (30%) | 2,997 (10%) | 29,970 |
| **B. Fringe Benefits (26% of Salaries & 8.4% of Wages)** | $ 6,525 | $ 7,610 | $ 7,850 | $ 7,524 | $ 7,054 | $ 36,563 |
| **C. Operating Expenses** | | | | | | |
| Travel and Vehicle Use | $ 3,800 | $ 2,700 | $ 3,300 | $ 3,500 | $ 3,300 | $ 16,600 |
| Supplies & Postage | 7,417 | 2,990 | 2,990 | 2,990 | 2,990 | 19,377 |
| Other Operating Expenses | 1,000 | 917 | 2,000 | 917 | 917 | 5,751 |
| **Grand Total** | $ 43,837 | $ 48,675 | $ 53,593 | $ 50,093 | $ 43,467 | $ 239,665 |

**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 | $79,000 | $67,000 | $86,553 | $232,553 | 34% | 37% | |
| 2009 * | 9 / 2 * | $10K / $3.5K | $97,000 | $66,000 | $75,000 | $238,000 | 41% | 32% | *** |
| Mean | | | $52,500 | $48,352 | $65,609 | $163,007 | 33% | 43% | |

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

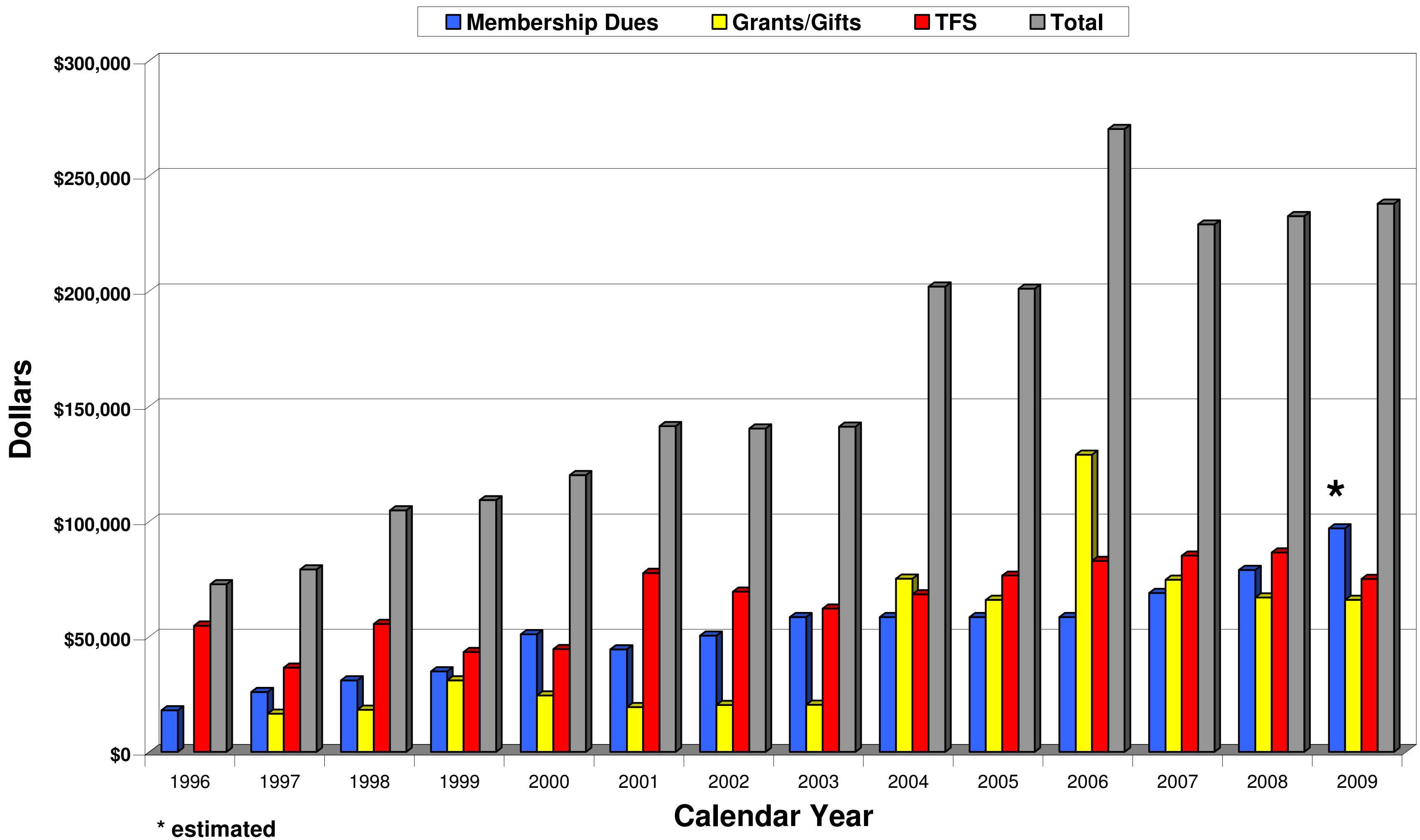



**Figure 1**: Forest Pest Management Cooperative budget by source.

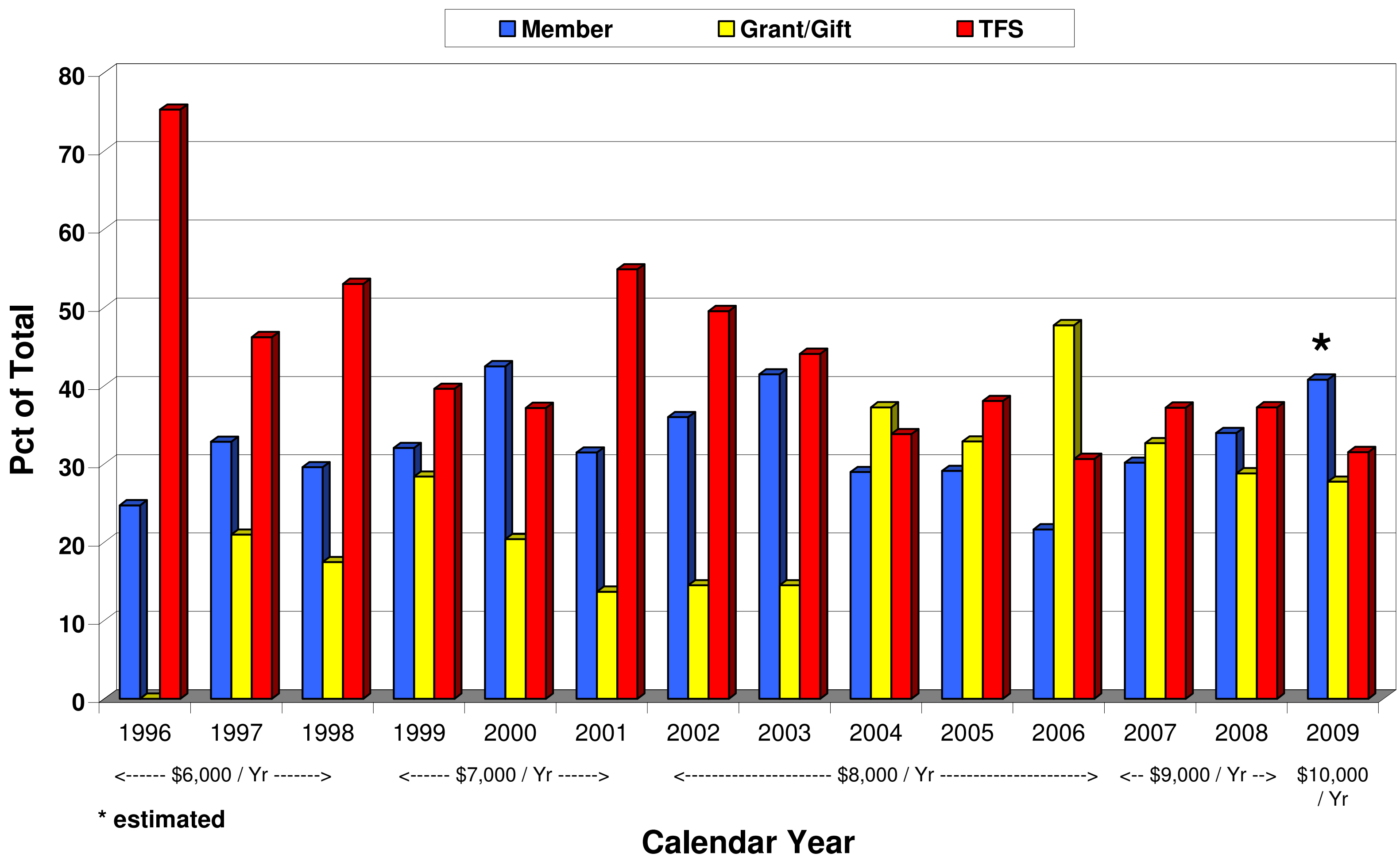



**Figure 2.** Forest Pest Management Cooperative membership dues, grants/gifts and TFS as percentage of total expenditures.

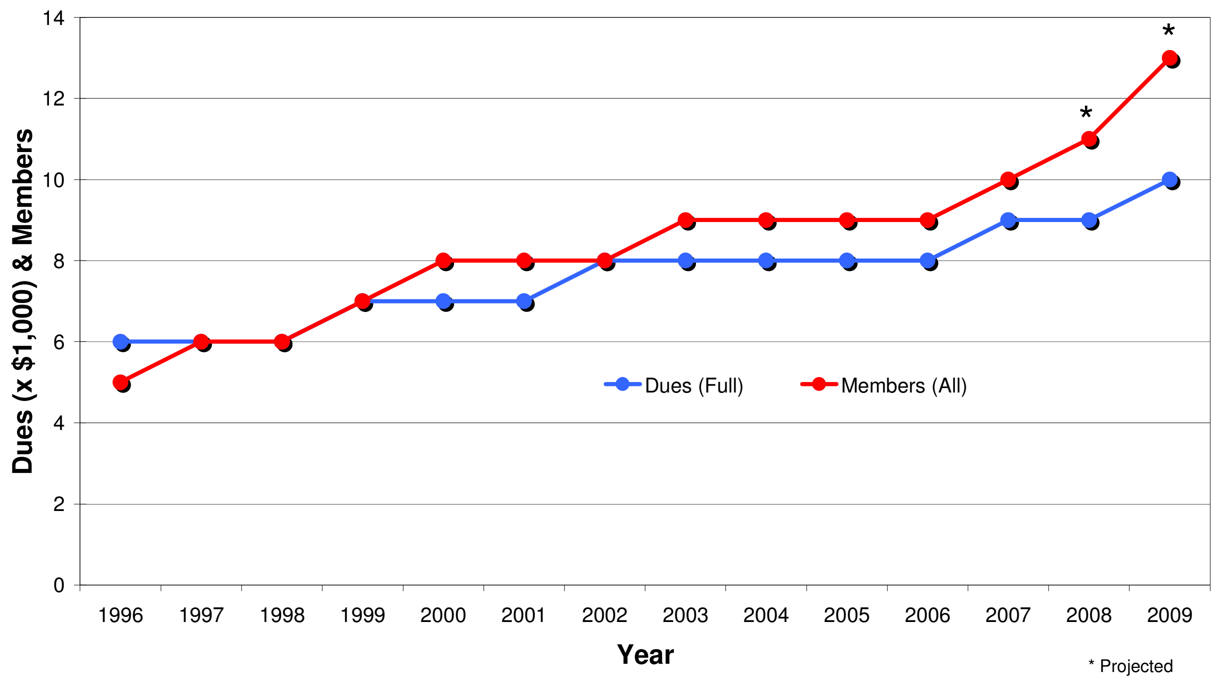



**Figure 3.** Forest Pest Management Cooperative membership levels and dues from 1996 to 2009 (projected).

# FPMC Executive and Contact Member Representatives In 2008

## FULL MEMBERS

**The Campbell Group** (since 2007)

| | | |
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| | |
|---|---|
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**Hancock Forest Management, Inc.** (since 2006)

| | | |
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