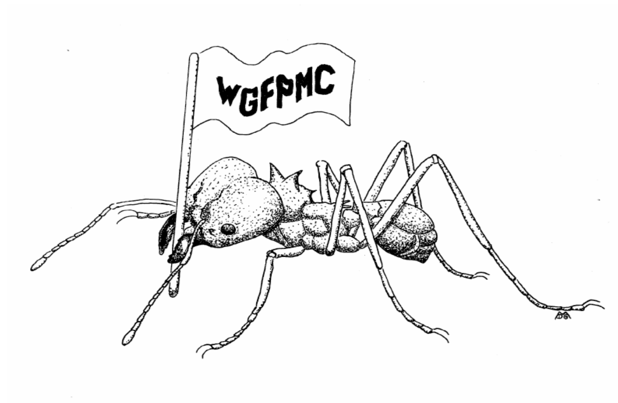
Western Gulf
Forest Pest Management
Cooperative



2004 Research Project Proposals

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February 2004

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Western Gulf Forest Pest Management Cooperative

2004 Research Project Proposals

With the approval of the Executive Committee representatives, the Western Gulf Forest Pest Management Cooperative (WGFPMC) will continue to address two primary research areas (trunk injection of systemic insecticides and tip moth impact/hazard-rating/control) in 2004. Results obtained this past year warrant further evaluations in these areas. As we still await the registration of BES-100 leaf-cutting ant bait, a small leaf-cutting ant control study also will be undertaken in the spring 2004 to test another bait, Grant's Total Ant Killer Bait.

Proposed objectives and methods for the systemic injection and tip moth studies in 2004 are presented below. The Forest Service Pesticide Impact Assessment Program grant entitled "Systemic Insecticide Injection Rate Study for Control of Cone and Seed Insects in Loblolly Pine Seed Orchards" was initiated in 2001 and is scheduled to end in 2003. The original emamectin benzoate formulation, Arise®, out of Japan and used in the Duration Study (1999 – 2003) and Rate Study (2001 – 2003), will not be registered in the United States. Therefore, the Duration and Rate studies will be discontinued and more important that we continue evaluation of the efficacy and duration of Denim® formulation (already registered in the United States) in reducing cone and seed insect damage. Two fipronil formulations also had been injected as part of the Denim study in 2003. Evaluation of these treatments should be continued as well. A new study is proposed to also test the effects of emamectin benzoate and as well as two new chemicals for protection of trees against pine bark beetles, e.g., southern pine beetle and *Ips* engravers.

As a result of the outbreak of Nantucket pine tip moth in the Western Gulf region (1998 – 2001) and the perceived damage being caused by this insect, the WGFPMC initiated two new projects in 2001 and will extend/expand them into 2004. The first, a cooperative study with Drs. Wayne Berisford, University of Georgia, and Andy Burrow, Temple - Inland, is evaluating the impact of pine tip moth and developing hazard-rating models to assess the susceptibility of sites to this pest across the South. The second study is evaluating the potential of different systemic insecticides, applied to pine seedlings prior to planting, in reducing pine tip moth damage. As a result of the promising results shown by fipronil in the seedling treatment (2002 – 2003), technique and rate (2003) and operational planting (2003) studies, the technique and rate study will be expanded in 2004. A small study will also evaluate the effects of Bayer's insecticide/ fertilizer tablets for protection against tip moth.

Continuation of these or initiation of other projects will be dependent on approval by the WGFPMC Executive Committee. Extension of each project into 2005 will depend on the degree of success achieved in 2003 and remaining gaps in knowledge.

Denim® and Fipronil Efficacy and Duration Study for Control of Cone and Seed Insects in Loblolly Pine Seed Orchards (Continued from 2003)

Objectives: The objectives of this research proposal are to: 1) evaluate the efficacy of systemic injections of Denim® (emamectin benzoate) and fipronil in reducing seed crop losses in loblolly pine seed orchards; 2) evaluate the treatments applied using the STIT, Arborjet™, and Sidewinder™ pressurized injection system; and 3) 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. Two of the most important insect pest groups include the coneworms (*Dioryctria* spp.) that attack flowers, cones and stems of pines; and the seed bugs, *Leptoglossus corculus* (Say) and *Tetyra bipunctata* (Herrich-Schaffer), that suck the contents from developing seeds in conelets and cones (Ebel et al. 1980). Without a comprehensive insect-control program, these insect groups commonly destroy 50% of the potential seed crop; 90% losses are not uncommon (Fatzinger et al. 1980).

The WGFPMC Systemic Insecticide Duration and Rate Studies have demonstrated that trunk injection of emamectin benzoate (Arise®), alone or in combination with thiamethoxam, is effective at protecting cones against coneworms and seed bug (Grosman et al. 2002, see also 2001 and 2002 WGFPMC Systemic Injection Reports). Regression curves indicate that 20ml of the emamectin benzoate and thiamethoxam is necessary to maintain highest levels of reduction of coneworm and seed bug damage and provides the greatest gain in cone survival and filled seed per cone. Unfortunately, the Arise® formulation from Japan will not be registered for use in the United States due to the flammability of the carrier (Dave Cox, Syngenta Crop Protection, personal communication).

Syngenta recently (1999) registered emamectin benzoate (Denim®) with EPA in the United States for use against lepidopteran pests on cole crops. The Denim® study initiated in 2003, showed that this formulation of emamectin benzoate, applied at 16ml and 8ml per inch diameter of tree, was effective in reducing coneworm damage by 73% and 64%, respectively (see Denim® Efficacy Study). Drought conditions prevalent at and one month post-injection likely delayed movement of the chemical into the canopy of the tree, thus preventing it from providing full protection against coneworm.

Fipronil, 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 (see Seedling Treatment, Technique and Rate and Operational Planting Studies). Injections of two formulations of fipronil (experimental EC and Termidor®) as part of the Denim® Efficacy Study in 2003 were not effective in reducing early season coneworm damage, but did reduce late season damage by 73% and 44%, respectively. Drought condition prevalent at the time of injection likely delayed movement of this chemical in the trees as well.

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 to individual trees can significantly reduce both coneworm-caused damage. The trees injected as part of the Denim/Fipronil Study in 2003 needed to further evaluate the extent and longevity of protection resulting from injections of alternative formulations using a manufactured injector system. The goal of the proposed research is to continue evaluations the efficacy of the Denim® (emamectin benzoate) and two fipronil formulations applied via three pressurized injection systems, for control of cone and seed insects in southern pine seed orchards.

Research Approach: The study was established in 2003 at the Texas Forest Service Magnolia Springs Seed Orchard in a block containing 10-year old drought-hardy loblolly pine. This orchard section has not been protected since it was established. In 2003, 8 ramets from each of 6 - 8 loblolly clones were selected. The treatments are being evaluated using the experimental design protocol described by Gary DeBarr (1978) (i.e., randomized complete block with clones as blocks). The treatments include:

1) 16 ml of 1.92% emamectin benzoate (Denim®) per inch tree diameter at breast height (DBH) by STIT injector
2) 8 ml of 2% emamectin benzoate (Denim®) per inch tree DBH by STIT injector
3) 16 ml of 2% emamectin benzoate (Denim®) per inch tree DBH by Arborjet™ injector
4) 16 ml of 2% emamectin benzoate (Denim®) per inch tree DBH by Sidewinder™ injector
5) 10 ml of 4% fipronil (experimental EC) per inch tree DBH by Arborjet™ or Sidewinder™ injectors
6) 4 ml of 4% fipronil (Termidor®) per inch tree DBH by Arborjet™ or Sidewinder™ injectors
7) Asana XL (standard) applied by hydraulic sprayer to foliage 5 times per year at 9.6 oz/100 gal at 5-week intervals beginning in April.
8) Check

Injection treatments were applied in April 2003 using the STIT, Arborjet™ or Sidewinder™ injection systems to selected ramets under drought conditions that extended into the beginning of June. Each tree had at least four injection points (at cardinal directions). The Arborjet™ and Sidewinder™ injections often required more to get the full amount of product into each tree.

Treatment 7 (Asana XL standard) will be applied to foliage beginning in April 2004 using a hydraulic sprayer from a bucket truck at 10 gal/tree. The distance between test trees is ~20 m to minimize the effects of drift.

Conelet and cone survival will be evaluated in 2004 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 September of each year. Conelet and cone survival reflects protection from seed bugs and coneworms. Reduction of coneworm attacks will be evaluated by collecting all cones present from each tree in September of 2004. From the samples, counts will be made of healthy and coneworm-attacked cones.

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 Tukey's Compromise test using Statview statistical program.

Research Time Line:

<u>January - April, 2004</u>

- Flag 6-10 branches/tree and record number of conelets and cones on all treatment and check trees (April).

<u>May - August, 2004</u>

- Treat study trees with standard (Asana® XL) foliar treatment (April, May, June, July, August)

<u>September - December, 2004</u>

- Evaluate conelet and cone survival on flagged branches (late September).
- Collect all cones from sample trees for evaluation of coneworm and seed bug damage levels (early October).
- Conduct statistical analyses of data.
- Prepare and submit report to WGFPMC Executive Committee, and Syngenta Crop Protection, Inc.
- Present results at annual Entomological Society of America meeting.

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Systemic Insecticide Injection Study for Single Tree Protection Against Southern Pine Bark Beetles (Initiated in 2004)

Objectives: 1) Evaluate the efficacy of systemic injections of emamectin benzoate, imidacloprid, thiacloprid, dinotefuran and fipronil in reducing attack success of pine bark beetles on loblolly pine; 2) evaluate the treatments applied using the Arborjet's Tree IV™ pressurized injection system; and 3) determine the duration of treatment efficacy.

Justification: The southern pine beetle (SPB), *Dendroctonus frontalis* Zimmermann, is the most important pest of pine forests in the southern United States. Local and regional outbreaks of SPB cause severe economic losses on a nearly annual basis. Recently, an unprecedented outbreak extended across much of the southeast United States. During the period from 1999 to 2002, losses due to SPB-caused tree damage and mortality were estimated at over $1 billion (Report on losses caused by forest insects, Southern Forest Insect Work Conference, 2000, 2001, 2002 and 2003). The SPB does not just impact timber industry, it also has a significant impact on recreation, water, and wildlife resources as well as residential property. The urban / wildland interface is continuing to expand thus placing more high-valued residential trees at risk to SPB attack. The current abundance of susceptible trees and forests underlines the importance of the development of new protective methods for individual trees against SPB.

Protection of individual trees has historically involved chemical spray applications to the entire bole of the tree using hydraulic sprayers. Several products had been registered with the Environmental Protection Agency (EPA) for this use, including benzene hexachloride (BHC), Lindane®, fenitrothion (Pestroy®) and chlorpyrifos (Durban®), but recently the use of the last of these, Dursban®, was withdrawn. In 2003, bifenthrin (Onyx®) was registered by EPA for use against southern pine beetle, but so far this product is not been made widely available to consumers. Even when available, insecticide spray applications have limitations. They are expensive, time-consuming, are a high risk for worker exposure and drift, and are detrimental to natural enemies (Billings 1980).

Systemic insecticides have been suggested as a potentially useful tool for protection of individual trees or forested areas. One of the first to be tested, acephate (Orthene®), was applied to foliage at two different rates (Crisp, Richmond, and Shea 1979 unpublished data, in Billings 1980). The treatments were reported to reduce SPB larvae survival, but had no effect on eggs, pupae, callow or parent adults. A more recent study evaluated fenitrothion (Pestroy®) and a combination treatment of sodium N-methyldithiocarbamate (SMDC, Vapam®) plus dimethyl sulfoxide (DMSO) applied to bark hacks and dicrotophos (Bidrin®) applied by Mauget injectors™ (Inject-a-icide - B®) to trees at the head of SPB infestations (Dalusky et al. 1990). Although tree mortality was not prevented by any of the treatments, dicrotophos was found to significantly reduce both egg gallery length and subsequent brood production. Because dicrotophos has a relatively high mammalian toxicity, it has not been registered for use by the general public. Oxydementon methyl (Metasystox-R) applied by Mauget injectors (Inject-a-cide®) is registered for use against several Dendroctonus and Ips species of bark beetles, but it not registered for southern pine beetle. In addition, it is reported that Mauget injectors do not function well because the pressure produced when the injector is primed after installation is often insufficient to overcome the resin pressure produced by pine trees (R. Billings, personal communication).

In recent years, several new active ingredients have been registered by EPA and are known to or recently discovered to have systemic activity. They include:

Emamectin benzoate – an avermectin derivative, has shown systemic activity in pine and is highly effective against pine wood nematode, *Bursaphelenchus xylophilis* (Takai et al. 2000, 2001, 2003a, 2003b), and coneworm, *Dioryctria* spp. (Grosman et al. 2002), with protection lasting more than three years. Preliminary trials also suggest activity against coleopteran pests including pales weevil, *Hylobius pales* (Jeff Fidgeon, unpublished data) and Asian longhorned beetle, *Anoplophora glabripennis* (Therese Poland, unpublished data).

Imidacloprid – a neonicotinoid insecticide with known systemic activity after trunk injections against several coleopteran pests including Japanese beetles, *Popillia japonica* Newman, and bronze birch borer, *Agrilus anxius*.

Thiacloprid – a new neonicotinoid, was conditionally registered by EPA in 2003 for targeted use against sucking insects (aphids and whiteflies) on cotton and chewing insects (codling moth and plum curculio) on plum fruits. It may also be registered eventually for use on ornamentals.

Dinotefuran - another new neonicotinoid with reported activity against chewing and sucking insects. EPA recently designated this active a reduced risk and OP alternative for ornamentals.

Fipronil - a new pheny pyrazole insecticide, has been shown to have systemic activity in pine and is highly effective in reducing Nantucket pine tip moth, *Rhyacionia frustrana*, damage on young seedlings for greater than 12 months (Grosman, unpublished data).

Research Approach: The treatments will be evaluated using the experimental design protocol described by Berisford et al. (1980). Loblolly pine trees, *Pinus taeda* L.**,** 15 – 20 cm (= 6 – 8 inch) diameter at breast height (DBH), will be selected in March 2004 in a pine stand in east Texas. Each treatment will be injected into four cardinal points on each of 24 trees using the new Arborjet Tree IV™ microinfusion system.

The treatments* include:

1) 4% emamectin benzoate (technical) applied at 8 ml per inch tree DBH
2) 5% imidacloprid (technical) applied at 2 ml** per inch tree DBH
3) 5% thiacloprid (technical) applied at 2 ml** per inch tree DBH
4) 10% dinotefuran (technical) applied at 4 ml** per inch tree DBH
5) 4% fipronil (experimental EC) applied at 8 ml per inch tree DBH
6) Check (untreated)

* Arborjet, Inc. will be providing the emamectin benzoate, imidacloprid, thiacloprid and dinotefuran formulations. Bayer CropScience will provide the fipronil formulation.

** Volumes injected are dependent on tree diameter:

- 2 ml / inch DBH for trees 2 – 11 inches DBH
- 4 ml / inch DBH for trees 12 – 23 inches DBH
- 8 ml / inch DBH for trees 24 – 35 inches DBH
- 12 ml / inch DBH for trees 36 + inches DBH

After 1, 3, 5, 13, 15 & 17 months post-injection, 4 trees of treatment will be randomly selected, felled and a 1.5 m long bolt will be removed from the center portion of the bole.

The bolts will be transported to active SPB infestations. Eye hooks will be inserted into one end of each bolt and they will be hung 3 m high from hook placed on uninfested trees in front of the SPB infestation. Bolts will be hung in pairs on trees in a randomized block pattern. Each bolt and the support tree will be baited with frontalin and turpentine. A metal screen trap (50 cm X 20 cm = 1000 cm^2) will be attached to the middle of each bolt and coated with Stickem Special™ to monitor beetle visitations.

After 30 days, the number of SPB on each screen trap and the number of successful attacks (construction of nuptial chambers) will be counted. Egg galleries constructed by attacking SPB will be measured in each of two 10 X 50 cm strips (total = 1000 cm^2) of bark removed from each bolt. Treatment efficacy will be determined by comparing attacks and egg gallery length on treated and untreated bolts. Data will be analyzed by GLM and the Tukey's Compromise test using Statview statistical program.

If one or more treatments continue to reduce attack success and/or egg gallery length by 75% or more after the October 2004 evaluation, the evaluations will be continued into 2005 and additional trials will be established to refine individual treatment rates and evaluate the potential for improving efficacy through combination treatments.

Research Time Line:

CY 2004

<u>January - April, 2004</u>

- Select study trees (March).
- Inject trees with assigned treatment (early April)

<u>May - October, 2004</u>

- Fell trees, transport to SPB infestations, hang bolts and install traps and lures (May, July, September)
- Remove bolts and record trap catch, attacks and gallery lengths (June, August, October)

<u>November - December, 2004</u>

- Conduct statistical analyses of data.
- Prepare and submit report to WGFPMC Executive Committee, Arborjet and Chemical Companies.

CY 2005

<u>January - April, 2004</u>

- Select study trees (March).
- Inject trees with assigned treatment (early April)

<u>May - October, 2004</u>

- Fell trees, transport to SPB infestations, hang bolts and install traps and lures (May, July, September)
- Remove bolts and record trap catch, attacks and gallery lengths (June, August, October)

November - December, 2004

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

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Impact of Nantucket Pine Tip Moth Attack on Loblolly Pine Growth - A Western Gulf Study (Continued from 2001, 2002 & 2003)

Objectives: The objectives of the study is to 1) determine the impact of Nantucket pine tip moth infestation on height and diameter growth and form of loblolly pine in the Western Gulf Region and 2) identify a treatment threshold for pine tip moth infestation.

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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).

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).

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 WGFPMC 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 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 was 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 see 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 was improved by 10%, 17%, and 38%, respectively, compared to check trees.

We propose to continue the study in 2004 on various sites in different areas of the Western Gulf Region to evaluate the effects of tip moth attacks on tree growth.

Research Approach: Each participating company/organization is asked to establish at least one new site in 2004. All sites are to be planted with improved 1-0 bare root loblolly pine seedlings. The study uses a randomized block design with 2 replications (blocks) per site. Two treatments (plots) will be established in each block. Each plot will contain 126 trees (9 rows X 14 columns at approximately 6 ft X 9 ft spacing). The treatments will include:

1) a check (standard company practices, i.e., site prep., herbicide, and fertilizer)
2) standard practices plus tip moth control applied at recommended time before each generation for the first **2 years** after planting.

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

Tip moth damage will be evaluated for 2 years after the 1st, 2nd, 3rd and 4th (for sites north of the LA/AR border) and 5th (on sites south of the border) 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 for the first 2 years; tree height, diameter (at breast height), and form after year 3, 5, 8 and at 4-year intervals thereafter.

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).

Training: If assistance will likely be needed in the application of insecticides and collection of insect damage and tree measurement data, participants are asked to contact Don Grosman at 936/639-8170. Training sessions can be held for personnel on spray techniques, chemical mixing, establishing study plots, identification and measurement of tip moth damage, standardized measurement of tree height, diameter, form, and estimation of competing vegetation.

Research Time Line:

January - February 2004

- Contact and meet with WGFPMC members to identify suitable sites for impact and gather information on management plans for each site (Grosman).
- Establish new research plots

March - September 2004

- Treat selected plots with insecticides based on optimal spray timing recommended 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; photograph damage.
- Send out announcements regarding the occurrence of any pest outbreaks (Grosman).

October - November 2004

- Evaluate tip moth damage after 4th and 5th (if necessary) generation; take tree measurements; evaluate tree form on three year old sites; photograph damage.
- Send out announcements regarding the occurrence of any pest outbreaks (Grosman).

December 2004 - January 2005

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

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Hazard Rating Sites for Nantucket Pine Tip Moth Attack on Loblolly Pine - A Southwide Study (Continued from 2001, 2002 & 2003)

Objectives: The objective of the study is to 1) develop regression models using stand characteristics and other abiotic factors to predict future levels of tip moth damage and 2) 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). We propose to continue a study in 2003 on various sites in different regions of the South to determine what factors influence the development high tip moth populations on certain sites, but not others.

Research Approach:

In 2001, 2002 and 2003, all check plots used in the Impact Study were used in the Hazard Rating Study. Similarly, Impact Study plots established in 2004 can be used as new Hazard Rating Study plots. We ask that each member have at least **two new** Hazard Rating sites established by 2003 and that each member establish two new sites as well in 2005. Each hazard-rating plot will be evaluated in the 1st and 2nd year after establishment. At the end of year 2, two-year old stands drop out and are replaced by newly established sites. Members should select sites that represent the majority of their land base, i.e., soil texture and drainage, topography, and site index. 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) <u>each year</u> at each of the 5 random points within the 50 tree plot. At each point, an estimate is 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%.

Training: If assistance is needed in the collection of insect damage and tree measurement data, contact Don Grosman at (936) 639-8170. Training sessions can be held for personnel on establishing study plots, identification and measurement of tip moth damage, standardized measurement of tree height, height, and form, and estimation of competing vegetation.

Research Time Line:

January - February 2004

- Contact and meet with WGFPMC members to identify suitable sites for hazard rating and gather information on management plans for each site (Grosman).
- Establish research plots

March - July 2004

- Evaluate tip moth damage after 1st and 2nd generations; conduct competing vegetation assessment; photograph damage.
- Send out announcements regarding the occurrence of any pest outbreaks (Grosman).

August – October 2004

- 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 2004

- 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); on second year sites, evaluate for occurrence of fusiform rust; photograph damage.

January 2005

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

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Systemic Insecticide Treatment of Loblolly Pine Seedlings for Control of Pine Tip Moth (Continued from 2002 & 2003)

Objectives: The objectives of this research are to: 1) continue to evaluate the efficacy of several systemic insecticides (emamectin benzoate, imidacloprid, thiamethoxam and fipronil) in reducing tip moth damage on loblolly pine seedlings; and 2) determine the duration of treatment efficacy.

Justification: Forest industry has steadily increased the intensity of management in southern pine plantations to increase growth. Tip moth populations typically increase with intensive management (Grosman, unpublished data), thus resulting in increased damage and economic losses. Tip moths also cause serious problems in Virginia pine Christmas tree plantations in the South pine Christmas tree plantations in southern California. Numerous insecticides (applied as foliar sprays) are registered to control tip moths, i.e., Azatin®, Orthene®, Talstar®, Carbaryl®, Cyren®, Warrior T®, Dimilin®, Dimethoate®, Asana XL®, Merit®, Pounce®, SpinTor®, and Mimic®. However, control is difficult due to the need for life stage monitoring and precise timing, especially when a manager is dealing with several, large plantations. Also, multiple aerial sprays during the first 2 to 3 years to control tip moths in pine plantations may be marginally economical over 20-30 year rotations.

Pine plantations in the South are regenerated by planting "bare-root" seedlings at a density of about 550-600 trees per acre. In the past, some forest industries used Furadan® 15G in new pine plantations to effectively control tip moths for about one year by applying granules in the seedling planting hole, or in covered depressions adjacent to recently planted seedlings. A systemic insecticide that is applied to seedlings as a drench in the nursery, as a dip after lifting, or to recently planted seedlings in plantations, and effectively controls pine tip moths for one or more years, is likely to be used widely in the South.

A field trial was initiated in 2002 to determine if any of five systemic insecticides (azadirachtin, emamectin benzoate, fipronil, imidacloprid or thiamethoxam) show promise for controlling pine tip moths. The result in 2002 indicate that fipronil was able to reduce tip moth damage by 90% on all 3 study plots and significantly improved tree growth on 2 of 3 plots compared to check trees. Fipronil continued to show activity in 2003, reducing damage by an average of 48% on the 3 study plots. We propose to continue monitoring the study plots in 2004 to evaluate the duration of treatment efficacy.

Research Approach:

A single family (Advanced Generation) of bare root loblolly pine seedlings was used from the Texas Forest Service Indian Mounds Nursery at Alto, TX. Seedlings were lifted after receiving at least 400 chilling hours (hours where temperature is below 40^{o}F). The seedlings were culled of small caliper (< 3 mm) seedlings, placed in bundles of 50 seedlings, and the roots were soaked in insecticide solution for 2 hours. After immersion, the seedlings were rebagged and placed in cold storage until the following day. Fifty seedlings from each treatment were planted (6 X 10 ft spacing) on each of 2 sites in the Fairchild State Forest, Cherokee Co. TX. A third plot was established near Plot 1 and planted with a 3 X 10 foot spacing. A randomized complete block design was used at each site with beds 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.

The treatments include:

Plot 1 & 2:
1) Emamectin benzoate (Proclaim®) solution (0.12%) root soak
2) Fipronil (Termidor® SC) solution (0.157%) root soak
3) Imidacloprid (technical) solution (0.53%) root soak
4) Thiamethoxam (25 WP) solution (0.17%) root soak
** 5) ~~Azadirachtin (Neemix® 4.5) solution (0.0000045%) root soak~~
6) Tebufenozide (Mimic®)
7) Check bare root seedling (lift and plant)

Plot 3:
1) Emamectin benzoate (Proclaim®) solution (0.12%) root soak
2) Emamectin benzoate (Proclaim®) solution (0.24%) root soak
3) Fipronil (Termidor® SC) solution (0.146%) root soak
4) Fipronil (Termidor® SC) solution (0.287%) root soak
5) Imidacloprid (technical) solution (0.53%) root soak
6) Imidacloprid (technical) solution (1.064 %) root soak
7) Thiamethoxam (25 WP) solution (0.17%) root soak
8) Thiamethoxam (25 WP) solution (0.34%) root soak
** 9) ~~Azadirachtin (Neemix® 4.5) solution (0.0000045%) root soak~~
** 10) ~~Azadirachtin (Neemix® 4.5) solution (0.0000045%) root soak~~
11) Check bare root seedling (from nearby Plot 1)

** Evaluation of azadirachtin treatments were discontinued after 2002 due to high seedling mortality.

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. Each tree will be measured for height, diameter (at breast height) and ranked as to form in the fall (November). Form ranking of seedling or tree will be ranked 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).

Research Time Line:

<u>January – October 2004.</u>

- Evaluate tip moth damage on treated and untreated seedlings 3-4 weeks after generations 1 - 4.

<u>November - December 2003</u>

- Evaluate tip moth damage on treated and untreated seedlings 3-4 weeks after the 5th generation.
- Measure height, diameter (at breast height) and form of trees (November).
- Conduct statistical analyses of 2004 data.
- Prepare and submit report to WGFPMC Executive Committee, Syngenta, Aventis Crop Protection, and Bayer.

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.

Fipronil Treatment Technique and Rate Study for Control of Pine Tip Moth (Continued from 2003)

Objectives:

The objectives of this research are to 1) determine the efficacy of fipronil in reducing pine tip moth infestation levels on loblolly pine seedlings; 2) evaluate this product applied at different rates to nursery beds, lifted bare root seedlings, and plant holes; and 3) determine the duration of chemical activity.

Justification:

Chemical control of tip moth infestations has not traditionally been performed except in high value plantings such as Christmas tree plantations, seed orchards and progeny tests. However, recently there has been increased interest in developing methods for reducing volume losses associated with tip moth damage in production forests. Numerous insecticides (applied as foliar sprays) are registered to control tip moths, but only tebufenozide (Mimic®), spinosad (SpinTor® 2SC), carbaryl (Sevin®), diflubenzuron (Dimilin®) and dimethoate (Dimethoate® 4EC & 400) can be applied in forested areas. However, control is difficult due to the need for life stage monitoring and precise timing, especially when a manager is dealing with several, large plantations. Also, multiple aerial sprays during the first 2 to 3 years to control tip moths in pine plantations may not be cost effective over 20-30 year rotations. To make control of tip moth economical in large forest plantations, one option is to use a systemic chemical that can be applied when seedlings are in the nursery bed or after lifting and can protect seedlings for one or more years. Several new systemic insecticides have been developed in recent years. One in particular, fipronil, has shown promise in meeting the criteria mentioned above.

Fipronil is a fairly new pheny pyrazole insecticide introduced commercially in 1983 and is now marketed by BASF as Regent® and Icon® (crop pests), and Termidor® (termites) and by Bayer CropScience as Frontline® (fleas and ticks), Combat® and Maxforce® (roaches) and Chipco® (turf pests) products. Fipronil is reported to disrupt normal nerve function by blocking the GABA-gated chloride channels of neurons in the central nervous system and has some activity against lepidopteran insects. This chemical can be applied in-furrow, is moderately systemic in plants, and is somewhat persistent. In a preliminary trial conducted in 2002, loblolly pine seedlings (bare root) were soaked for 2 hours in one of two fipronil solutions (0.146% and 0.287%) and out planted on 3 sites. Both treatments were found to significantly reduce tip moth damage during the first year by 90% and 27 – 91% in the second year compared to check trees (see 2002 & 2003 Seedling Treatment Trial).

In 2003, three study plots were established in TX to evaluate the efficacy of fipronil applied to pine seedlings by different techniques at different rates. Pine seedlings treated with fipronil (Termidor®) using plant hole, root dip with Terrasorb™, root soak (0.3%) and single in-furrow techniques, reduced tip moth damage by 86%, 79%, 67% and 23%, respectively, compared to untreated check trees. Seedlings treated by root soak (0.3% Regent®) and root dip (0.3% Termidor® + Terrasorb™) consistently had the greatest improvement in height, diameter and volume parameters compared to check trees. Those seedlings soaked with Regent® consistently had less tip moth damage than seedlings soaked with Termidor® at the same rate (0.3%), but there was no difference in tree growth between these treatments. Increasing rate from 0.0003% to 0.3% significantly improve protection provided by fipronil (Termidor®) root soaks. The effect of chemical rate on growth was inconsistent. Seedlings treated with the highest fipronil concentration (6.5% in plant holes) experienced significantly higher seedling mortality than check trees. In contrast, seedlings treated with moderate fipronil rates had significantly higher survival. Based on the above results, We propose to continue evaluations in the three study plots in 2004 to determine the duration of fipronil treatments.

Research Approach:

A single family of loblolly pine bare root seedlings was selected at the TFS Indian Mounds Nursery, Alto, TX. Lateral root pruning equipment was used to apply Treatment 1 and 2 (described below) to a nursery bed section in October and December 2002. For all treatments, seedlings were lifted in January 2003 in a manner to cause the least breakage of roots, culled of small and large caliper seedlings, bagged and stored briefly in cold storage.

The treatments included:

1) In furrow treatment of nursery bed with fipronil (0.0246% Termidor® SC) solution applied at 23 ml per linear meter (= 7 ml per ft) in October only.
2) In furrow treatment of nursery bed with fipronil (0.0123% Termidor® SC) solution applied at 23 ml per linear meter (= 7 ml per ft) in October and December.
3) Root soak of bare root seedling in fipronil (0.003% Termidor® SC) solution
4) Root soak of bare root seedling in fipronil (0.03% Termidor® SC) solution
5) Root soak of bare root seedling in fipronil (0.3% Termidor® SC) solution.
6) Root soak of bare root seedling in fipronil (0.3% Regent® SC) solution.
7) Root dip of bare root seedling in fipronil (0.3% Termidor® SC) and TerraSorb® solution.
8) Plant hole treatment (liquid) – 30 ml of fipronil (6.5% Termidor® SC) solution per plant hole.
9) Bare root seedling - Check (lift and plant)

When ready, the cold-stored seedlings to be used for Treatment 3 - 7 were warmed at room temperature (~70^{o}F) for 3 hours. For each of Treatments 3 - 6, 150 seedlings were soaked in 9.5 liters (2.5 gal) of insecticide solution for 2 hours. For Treatment 7, the same number of seedlings were dipped in the fipronil/TerraSorb® solution. After treatment, all seedlings were dipped in TerraSorb® solution, rebagged and placed in cold storage until the following day. Fifty seedlings from each treatment were planted (1.8 X 3 m (= 6 X 10 ft) spacing) on each of 3 second-year plantation sites – to ensure a high level of tip moth pressure on the treatment trees. At each site, resident trees were removed and replaced with treatment trees. A randomized complete block design was used at each site with beds or site areas serving as blocks, i.e., each treatment was randomly selected for placement along a bed. Ten seedlings from each treatment were planted on each of five beds.

Note: Five study plots also were established on the East Coast by Scott Cameron, International Paper Co. (3), and Wilson Edwards, Weyerhaeuser Co. (2).

In 2004, Tip moth populations will be monitored weekly at each site using at least three Phericon® 1C traps with Trece® septa lures. 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., aphids, weevils, coneworm, etc. Each tree will be measured for diameter (at 6") 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 Tukey's Compromise test using Statview or SAS statistical programs.

Research Time Line:

January - February 2004

- Begin trap monitoring of tip moth populations near each site

March - October, 2004

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

November - December 2004

- Evaluate tip moth damage and tree form after 5th generation; measure seedling diameter and height.
- Conduct statistical analysis of 2004 data.
- Prepare and submit report to FSPIAP sponsor, WGFPMC Executive Committee and 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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Fipronil Operational Planting Study for Control of Pine Tip Moth
(Continued from 2003)

Objectives:

The objectives of this research proposal are to 1) determine the efficacy of fipronil in reducing pine tip moth infestation levels on loblolly pine plantations and 2) determine the duration of chemical activity.

Justification:

Chemical control of tip moth infestations has not traditionally been performed except in high value plantings such as Christmas tree plantations, seed orchards and progeny tests. However, recently there has been increased interest in developing methods for reducing volume losses associated with tip moth damage in production forests. Numerous insecticides (applied as foliar sprays) are registered to control tip moths, but only tebufenozide (Mimic®), spinosad (SpinTor® 2SC), carbaryl (Sevin®), diflubenzuron (Dimilin®) and dimethoate (Dimethoate® 4EC & 400) can be applied in forested areas. However, control is difficult due to the need for life stage monitoring and precise timing, especially when a manager is dealing with several, large plantations. Also, multiple aerial sprays during the first 2 to 3 years to control tip moths in pine plantations may not be cost effective over 20-30 year rotations. To make control of tip moth economical in large forest plantations, one option is to use a systemic chemical that can be applied when seedlings are in the nursery bed or after lifting and can protect seedlings for one or more years. Several new systemic insecticides have been developed in recent years. One in particular, fipronil, has shown promise in meeting the criteria mentioned above.

Fipronil is a fairly new pheny pyrazole insecticide introduced commercially in 1983 and is now marketed by BASF as Regent® and Icon® (crop pests), Termidor® (termites), and by Bayer CropScience as Frontline® (fleas and ticks), Combat® and Maxforce® (roaches) and Chipco® (turf pests) products. Fipronil is reported to disrupt normal nerve function by blocking the GABA-gated chloride channels of neurons in the central nervous system and has some activity against lepidopteran insects. This chemical can be applied in-furrow, is moderately systemic in plants, and is somewhat persistent. In a preliminary trial conducted in 2002, loblolly pine seedlings (bare root) were soaked for 2 hours in one of two fipronil solutions (0.146% and 0.287%) and out planted on 3 sites. Both treatments were found to significantly reduce tip moth damage during the first year by 90% and 27 – 91% in the second year compared to check trees (see 2002 & 2003 Seedling Treatment Trial).

Relatively little is known about pine tip moth population dynamics. However it know that pine tip moth typically invade stands shortly after establishment with most rapid colonization occurring in smaller stands with relatively little competing vegetation. Establishment and population expansion are often rapid and possibly aided by generally low rates of parasitism (Lashomb et al. 1980). Tree resistance to tip moth attack is apparently lower in newly established seedlings but increases rapidly with age. Based on the preliminary data presented above, it may be possible to use a systemic insecticide to substantially reduce or eliminate tip moth colonization in a stand for a long period of time after stand establishment, particularly in larger stands. It is not yet known how long such a treatment may curtail colonization. It is assumed that over time increases in tree volume will result in dilution of chemical concentrations in individual plants and become too low to prevent attack. However, it is hypothesized that here may be a residual effect of the treatment in large stand areas thereby preventing colonization for an extended period of time.

In 2003, fipronil-treated seedlings planted in portions of four plantations consistently had lower tip moth damage levels (shoot and terminal) compared to check areas throughout the growing season. Overall, fipronil reduced damage by 83% - 87%. Treated seedlings also had significantly less damage from regeneration weevils and reduced infestation by aphids. Overall height, diameter and volume were improved by fipronil in treated areas. Based on the above results, we propose to continue evaluations in the four plantations in 2004 to determine the duration of fipronil treatments.

We propose to continue a study in 2003 on various sites in different regions of the South to determine what factors influence the development high tip moth populations on certain sites, but not others.

Research Approach:

A single family of loblolly pine bare root seedlings was selected at the TFS Indian Mounds Nursery, Alto, TX. Seedlings were lifted in January in a manner to cause the least breakage of roots, culled of small and large caliper seedlings, bagged and stored briefly in cold storage.

When ready, the cold-stored seedlings were warmed at room temperature (~70^{o}F) for 3 hours. Seedlings were soaked in 190 liter (50 gal) tanks of fipronil (0.3% ai) solution for 2 hours. All seedlings (treated and untreated) were then dipped in TerraSorb® (or Drywater) solution, rebagged and placed in cold storage until the following day. Seedlings from each treatment were hand- or machine-planted (spacing was dependent practices of participating member) in each of 4 plantations - preferably near a young (< 4 years old) plantation.

Four tracts (19 – 38 acres in size) were selected in the Western Gulf region 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. One half of each of each tract was planted with fipronil-treated seedlings. The other half was planted with untreated seedlings at the same spacing. A small 100 tree plot was established in each half tract as a contrast to the treatment of the other half tract. The plot in treated half contained untreated seedlings, while the plot in untreated half contained treated seedlings. Ten 10 tree plots were spaced equally within each of the half tract (20 – 10 tree plots / whole tract) to evaluate tip moth damage levels in this area. Some tracts were treated with herbicide after planting to minimize herbaceous and/or woody competition.

In 2004, tip moth populations will be monitored weekly at each site using at least three Phericon® 1C traps with Trece® septa lures. Tip moth damage will be evaluated in the two 100 tree plots and 20-10 tree plots 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 6") 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 Tukey's Compromise test using Statview or SAS statistical programs.

If seedlings in the treated plots, at one or more sites, continue to show reduced tip moth damage (> 50% reduction) into the 5th generation in 2004, the stands will be monitored into 2005 to continue evaluating duration of treatments. In addition, the study will be expanded in 2005 to evaluate operational planting of seedling treated with refined fipronil application rates and techniques.

Research Time Line:

CY2004

<u>January - February 2004</u>

- Begin trap monitoring of tip moth populations near each site

<u>March - October, 2004</u>

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

<u>November - December 2004</u>

- Evaluate tip moth damage after 5th generations; measure seedling and height of seedlings.
- Conduct statistical analysis of 2003 data.
- Prepare and submit report to FSPIAP sponsor, WGFPMC Executive Committee, Bayer/BASF.
- Present results at annual Entomological Society of America meeting.

CY2005

<u>January - April 2005</u>

- Continue evaluation of duration of 2003 tip moth treatments if warranted.
- Establish research plots
- Lift and plant treated seedlings
- Evaluate tip moth damage after 1st generation; photograph damage.

<u>April - October 2005</u>

- Evaluate tip moth damage after 2nd through 4th generations; photograph damage.

Literature Cited:

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

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

Fipronil Treatment Technique and Rate Refinement Study
(Initiated in 2004)

Objectives:

The objectives of this research are to 1) determine the efficacy of fipronil in reducing pine tip moth infestation levels on loblolly pine seedlings; 2) evaluate two formulations of this chemical applied at different rates to nursery beds, lifted bare root and containerized seedlings, and/or plant holes; and 3) determine the duration of chemical activity.

Justification:

Chemical control of tip moth infestations has not traditionally been performed except in high value plantings such as Christmas tree plantations, seed orchards and progeny tests. However, recently there has been increased interest in developing methods for reducing volume losses associated with tip moth damage in production forests. To make control of tip moth economical in large forest plantations, one option is to use a systemic chemical that can be applied when seedlings are in the nursery bed or after lifting and can protect seedlings for one or more years. Several new systemic insecticides have been developed in recent years.

An initial field trial was conducted in 2002 to determine if any of five systemic insecticides (azadirachtin, emamectin benzoate, fipronil, imidacloprid or thiamethoxam) show promise for controlling pine tip moths. The results in 2002 indicate that fipronil was able to reduce tip moth damage by 90% on all 3 study plots and significantly improved tree growth on 2 of 3 plots compared to check trees. Fipronil continued to show activity in 2003, reducing damage by an average of 48% on the 3 study plots (see 2002 & 2003 Seedling Treatment Trial).

In 2003, the evaluation of fipronil was expanded to determine the efficacy of this chemical applied to pine seedlings by different techniques at different rates. Fipronil (Termidor®), applied to pine seedlings using plant hole, root dip with Terrasorb™, root soak (0.3%) and single in-furrow techniques, reduced tip moth damage by 86%, 79%, 67% and 23%, respectively, compared to untreated check trees. Seedlings treated by root soak (0.3% Regent®) and root dip (0.3% Termidor® + Terrasorb™) consistently had the greatest improvement in height, diameter and volume parameters compared to check trees. Those seedlings soaked with Regent® consistently had less tip moth damage than seedlings soaked with Termidor® at the same rate (0.3%), but there was no difference in tree growth between these treatments. Increasing rate from 0.0003% to 0.3% significantly improve protection provided by fipronil (Termidor®) root soaks. The effect of chemical rate on growth was inconsistent. Seedlings treated with the highest fipronil concentration (6.5% in plant holes) experienced significantly higher seedling mortality than check trees. In contrast, seedlings treated with moderate fipronil rates had significantly higher survival.

Based on the above results, further evaluation of treatment techniques (individually or combined), rates and formulations is warranted. Because trials in 2003 suggest that fipronil requires several months to move through the plant to the upper shoots, better protection may be obtained with this treatment technique if higher rates (4X and 8X) were applied in the fall or if seedlings in nursery beds were treated earlier in the year (perhaps June or July).

Bare root seedlings soaked in fipronil (Termidor®) in 2003 at concentrations ranging from 0.0003% to 0.3%, showed a defined rate response for the second through the fifth generations. Unfortunately, the highest rate (0.3%) did not hold up as long as it did in 2002 (see 2X rate in the Seedling Systemic Treatment Study). It is possible that the seedlings were saturated at treatment so the plants did not take up as much fipronil. Waiting to treat seedlings until the soil is moderately dry and treating early in the morning when the stomates are open may improve chemical uptake by seedlings. Treatment efficacy also may be improved by increasing the concentration of fipronil for root soaks up to 3%. There is no restriction on rate when treating lifted seedlings prior to transplant (Harry Quicke, BASF, personal communication).

Seedlings treated with Regent® in 2003 consistently had less tip moth damage and better volume growth compared to seedlings treated with Termidor® at the same rate. Because Regent® already has an in-furrow use on its label, it has a much larger market than Termidor® and it provide better protection against tip moth, Regent® should be used in all future trials. Another formulation of fipronil, Icon®, is registered for use on rice seed for protection against water weevil. The Icon® formulation contains a sticker to improve adhesion of fipronil molecules to seeds and could also improve adhesion of the chemical to seedling roots.

Somewhat surprisingly, the root dip treatment provided very good protection of seedlings through most of the growing season in 2003, but the degree of protection began to fade late in the year. An increase in fipronil concentration in the Terrasorb™ mixture could extend protection well into the second year. As there are several types of root coatings available (Terrasorb™, Driwater™, clay slurry), it is of interest to determine if the performance of fipronil in a root dip treatment could be improved with the use of Driwater™ or clay slurry compared to the Terrasorb™ coating.

The concentration used in the plant hole treatment in 2003 was exceptionally high (6.5%). It was hoped that a single application could be made per rotation of the stand (~25 years X 0.13 lb ai / ac / yr). However, Harry Quicke's, BASF, opinion is that EPA would not approve this rate applied to the soil. Regardless, the high concentration proved to be somewhat toxic to the young seedlings; reducing survival by 15%. Combining lower rate plant hole treatments with in-furrow and/or root soak or dips treatments may provide long duration protection against tip moth.

The trials conducted in 2003 evaluated treatments applied to bare root seedlings only. However, the containerized seedling market is expanding at a fast rate. It is important that the effects of fipronil treatment on containerized seedlings be determined as well.

We propose to initiate a new study containing 3 separate trials in 2004 on various sites across the South to evaluate refined fipronil treatment techniques and rates for protection of bare root and containerized pine seedlings against pine tip moth.

Research Approach:

For all trials, a single family of loblolly pine bare root seedlings was/will be selected at the TFS Indian Mounds Nursery, Alto, TX. For Trial 1, lateral root pruning equipment was used create 8" deep furrows between drills in a nursery bed section in early December 2003. Immediately afterwards, treatment solutions (as described below for Treatments 1 - 4) were applied to furrows within one of four 10 foot sections of bed. The seedlings in these sections and from the remaining portion of bed (for other treatments and trials) were lifted in mid-January 2004 in a manner to cause the least breakage of roots, culled of small and large caliper seedlings, grouped in bundles of 60, and temporarily in seedling bags until treatment. Those seedlings receiving no treatment or treatment at or post-planting were stored temporarily in coolers. Containerized seedlings for the same family of loblolly pine were used in Trial 2. Bare root seedlings used for Trial 4 will be treated in July in the same fashion as described for Trial 1.

The trials and treatments included:

<u>Trial 1: In-furrow (December) alone or combined with plant hole treatment (January)</u>

A = 1) In-furrow (2X - 0.026%, 0.62 ml Regent®/liter of water)
B = 2) In-furrow (4X - 0.051%, 1.24 ml Regent®/liter)
C = 3) In-furrow (4X - 0.051%, 1.24 ml Regent®/liter + methanol)
D = 4) In-furrow (8X - 0.102%, 2.48 ml Regent®/liter)
E = 5) In-furrow (2X - 0.0256%, 0.62 ml Regent®/liter) + Plant hole, 30 ml (0.267%, 6.8 ml/liter)
F = 6) In-furrow (4X - 0.0512%, 1.24 ml Regent®/liter) + Plant hole, 30 ml (0.267%, 6.8 ml/liter)
G = 7) In-furrow (4X - 0.0512%, 1.24 ml Regent®/liter + methanol) + Plant hole, 30 ml (0.267%, 6.8 ml/liter + methanol)
H = 8) In-furrow (8X - 0.1%, 2.48 ml Regent®/liter) + Plant hole, 30 ml (0.267%, 6.8 ml/liter)
I = 9) Plant hole only - 30 ml (0.267%, 6.8 ml Regent®/liter) applied to plant hole
J = 10) Foliar application (5X) of pine seedlings with Mimic® 2LV (0.6 ml / liter of water)
K = 11) Check (lift and plant)

<u>Extra Treatment for TFS Site</u>
L = 12) In-furrow (4X - 0.0512%, 1.24 ml Regent®/liter) + Root dip (1.0% Regent® (243 ml Regent® + 9.26 liters of water + 60.8g Terrasorb™) + Plant hole, 30 ml (0.267%, 6.8 ml Regent®/liter)

<u>Trial 2: Root soak of containerized and bare root seedlings</u>

A = 1) Root soak (0.3% = 73 ml Regent® in 9.43 liters of water) of containerized seedling.
B = 2) Root soak (0.3% = 73 ml Regent® + 950 ml methanol + 8.48 liters of water) of containerized seedling.
C = 3) Root soak (1.0% = 243 ml Regent® in 9.26 liters of water) of containerized seedling.
D = 4) Root soak (3.0% = 730 ml Regent® in 8.77 liters of water) of containerized seedling
E = 5) Root soak (0.3% = 73 ml Regent® in 9.43 liters of water) of bare root seedling
F = 6) Root soak (0.3% = 73 ml Regent® + 950 ml methanol + 8.48 liters of water) of bare root seedling.
G = 7) Root soak (1.0% = 243 ml Regent® in 9.26 liters of water) of bare root seedling
H = 8) Root soak (3.0% = 730 ml Regent® in 8.77 liters of water) of bare root seedling
I = 9) Foliar application (5X) of pine seedlings with Mimic® 2LV (0.6 ml per l water)
J = 10) Check (lift and plant bare root seedling)
K = 11) Check (plant containerized seedling)

<u>Extra Treatments for TFS Site</u>
L = 12) Root soak (1.0% = 157 ml Icon® in 9.26 liters of water) of bare root seedling
M = 13) Root soak (2.0% = 340 ml Icon® in 9.16 liters of water) of bare root seedling

Trial 3: Root dip of bare root seedlings

A = 1) Root dip (1.0% = 243 ml Regent® in 9.26 liters of water) + Terrasorb™ (60.8 g)
B = 2) Root dip (1.0% = 243 ml Regent® + 950 ml methanol + 8.31 liters of water) + Terrasorb™ (60.8 g)
C = 3) Root dip (3.0% = 730 ml Regent® in 8.77 l water) + Terrasorb™ (60.8 g)
D = 4) Root dip (1.0% = 243 ml Regent® in 9.26 l water) + Driwater™ (85.5 g)
E = 5) Root dip (3.0% = 730 ml Regent® in 8.77 l water) + Driwater™ (85.5 g)
F = 6) Root dip (1.0% = 243 ml Regent® in 9.26 l water) + clay slurry (2470 g)
G = 7) Root dip (3.0% = 730 ml Regent® in 8.77 l water) + clay slurry (2470 g)
H = 8) Foliar application (5X) of pine seedlings with Mimic® 2LV (0.6 ml per l water)
I = 9) Terrasorb® Check (60.8 g Terrasorb™ in 9.5 l water)
J = 10) Driwater® Check (85.5 g Driwater™ in 9.5 l water)
K = 11) Clay Check (2470 g clay in 9.5 l water)

Trial 4: In-furrow alone (July or September)

A = 1) In-furrow (2X - 0.026%, 0.62 ml Regent®/liter of water) applied in July
B = 2) In-furrow (2X - 0.026%, 0.62 ml Regent®/liter of water) applied in September
C = 3) In-furrow (4X - 0.051%, 1.24 ml Regent®/liter) applied in July
D = 4) In-furrow (4X - 0.051%, 1.24 ml Regent®/liter) applied in September
E = 5) In-furrow (4X - 0.051%, 1.24 ml Regent®/liter + methanol) applied in July
F = 6) In-furrow (4X - 0.051%, 1.24 ml Regent®/liter + methanol) applied in September
G = 7) In-furrow (8X - 0.102%, 2.48 ml Regent®/liter) applied in July
H = 8) In-furrow (8X - 0.102%, 2.48 ml Regent®/liter) applied in September
I = 9) Foliar application (5X) of pine seedlings with Mimic® 2LV (0.6 ml / liter of water)
J = 10) Check (lift and plant)

When ready, the bundles of bare roots seedlings to be used for Trial 2, Treatment 5 – 8, 12 & 13 were soaked in 9.5 liters (2.5 gal) of insecticide solution for 2 hours. For Trial1, Treatment 12 and Trial 3, Treatments 1 - 7 & 9 - 11, bundles of seedlings were dipped in the fipronil plus one of three root coatings solution. After treatment, all seedlings not already dipped in a root coating were dipped in TerraSorb™ solution, rebagged and placed in cold storage for 2 - 14 days. Trays of 45 containerized seedlings used for Trial 2, Treatments 1 – 4 were soaked in 7.6 liters (2 gal) of insecticide solution for 30 minutes. These seedlings were similarly placed in cold storage for 2 – 14 days. Fifty seedlings from each treatment and were planted (spacing variable) on each of 3 - 4 second-year plantation sites for each trial. Planting on second-year sites ensure a high level of tip moth pressure on the treatment trees. At each site, resident trees were removed and replaced with treatment trees. A randomized complete block design was used at each site with beds or site areas serving as blocks, i.e., each treatment was randomly selected for placement along a bed. Ten seedlings from each treatment were planted on each of five beds.

The trials and cooperators for Western Gulf sites include:
Trial 1: Four sites (Anthony For. Prod., International Paper, Texas Forest Service & Weyerhaeuser)
Trial 2: Four sites (For. Invest. Assoc., Plum Creek, Temple-Inland & Texas Forest Service)
Trial 3: Three sites (Potlatch, Temple-Inland & Texas Forest Service)
Trial 4: Two + sites (TFS, ?)

Note: Four additional study plots were established on the East Coast by Scott Cameron, International Paper Co. (Trials 2 & 3), and Wilson Edwards, Weyerhaeuser Co. (Trials 2 & 3).

In 2004, tip moth populations will be monitored weekly at each of the TFS sites using at least three Phericon™ 1C traps with Trece™ septa lures. 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., aphids, weevils, coneworm, etc. Each tree will be measured for diameter (at 6") 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 Tukey's Compromise test using Statview or SAS statistical programs.

Research Time Line:

CY2003

<u>December 2003</u>

- Apply in-furrow treatments to nursery beds

CY2004

<u>January - February 2004</u>

- Establish research plots
- Lift and plant treated seedlings
- Begin trap monitoring of tip moth populations near each site

<u>March - October, 2004</u>

- Evaluate tip moth damage after 1st through 4th generations; photograph damage.
- Apply in-furrow treatments to nursery beds (July & September).

<u>November - December 2004</u>

- Evaluate tip moth damage and tree form after 5th generation; measure seedling diameter and height.
- Conduct statistical analysis of 2004 data.
- Prepare and submit report to FSPIAP sponsor, WGFPMC Executive Committee and BASF.
- Present results at annual Entomological Society of America meeting.

CY2005

<u>January - February 2005</u>

- Establish research plots
- Lift and plant treated seedlings
- Begin trap monitoring of tip moth populations near each site

<u>March - October, 2005</u>

- Evaluate tip moth damage after 1st through 4th generations; photograph damage.
- Apply in-furrow treatments to nursery beds (July).

November - December 2005

- Evaluate tip moth damage and tree form after 5th generation; measure seedling diameter and height.
- Conduct statistical analysis of 2005 data.
- Prepare and submit report to FSPIAP sponsor, WGFPMC Executive Committee and 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.

Carey, W.A. and W.D. Kelley. 1993. Seedling production trends and fusiform rust control practices at southern nurseries, 1981-1991. So. J. Appl. For. 17: 207-211.

Imidacloprid Tablet Study for Control of Pine Tip Moth
(Initiated in 2004)

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

Justification

Imidacloprid, a neonicotinoid insecticide, is highly systemic in plants and know to have activity against several Lepidopteran pests including pine tip moth. In 2002. root soaks of bare root seedlings with imidacloprid significantly reduced tip moth damage for 2 generations and overall damage for the year was 40% lower compared to check trees. Although, imidacloprid treatment effects did not last nearly as long as that for fipronil (2 versus 10 generations), both treatments had essentially the same significant improvement in height, diameter and volume index compared to check trees for two years in a row.

In 2003, imidacloprid plus fertilizer spikes (Bayer 2 – N – 1 Plant Spikes) reduced tip moth damage for three generations. The treatments also resulted in a significant improvements in height, diameter and volume index compared to check trees.

Recently, Bayer CropScience has developed tablets contain imidacloprid. They have been used operationally in Australia to control _____. The WGFPMC has been asked by Mr. Nate Royalty (Bayer CropScience) to evaluate the efficacy of tablets containing several different concentrations of imidacloprid alone or combined with fertilizer. We propose to evaluate these tablets at two sites for protection of bare root pine seedlings against pine tip moth.

Research Approach:

A single family of loblolly pine bare root seedlings was selected at the TFS Indian Mounds Nursery, Alto, TX. All seedlings were operationally lifted by machine in January 2004, culled of small and large caliper seedlings, treated with Terrasorb™ root coating, bagged and stored briefly in cold storage.

The treatments included:

A =	5% Imidacloprid tablet -	1 tablet in soil next to transplant
B =	5% Imidacloprid tablet + Fertilizer-	1 tablet in soil next to transplant
C =	10% Imidacloprid tablet -	1 tablet in soil next to transplant
D =	10% Imidacloprid tablet + Fertilizer-	1 tablet in soil next to transplant
E =	15% Imidacloprid tablet -	1 tablet in soil next to transplant
F =	15% Imidacloprid tablet + Fertilizer-	1 tablet in soil next to transplant
G =	20% Imidacloprid tablet -	1 tablet in soil next to transplant
H =	20% Imidacloprid tablet + Fertilizer-	1 tablet in soil next to transplant
I =	Fertilizer only-	1 tablet in soil next to transplant
J =	Mimic® Foliar -	Apply Mimic® (0.6 ml/L water) 5X / season
K =	Bare root Check -	Treat w/ Terrasorb™ and plant bare root

Fifty seedlings for each treatment were planted (1.8 X 3 m (= 6 X 10 ft) spacing) on each of 2 second-year plantation sites – to ensure a high level of tip moth pressure on the treatment trees. At each site, resident trees were removed and replaced with treatment trees. A randomized complete block design was used at each site with beds or site areas serving as blocks, i.e., each treatment was randomly selected for placement along a bed. Ten seedlings from each treatment were planted on each of five beds. Just after seedling transplant, one treatment tablet will be pushed into the soil 6 cm deep and 4 cm from each assigned seedling.

Note: Study plots also will be/were established on the East Coast by Scott Cameron, International Paper Co.

In 2004, tip moth populations will be monitored weekly at each site using at least three Phericon™ 1C traps with Trece™ septa lures. 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., aphids, weevils, coneworm, etc. Each tree will be measured for diameter (at 6") and height 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:

<u>January - February 2004</u>

- Begin trap monitoring of tip moth populations near each site

<u>March - October, 2004</u>

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

<u>November - December 2004</u>

- Evaluate tip moth damage and tree form after 5th generation; measure seedling diameter and height.
- Conduct statistical analysis of 2004 data.
- Prepare and submit report to Bayer CropScience and WGFPMC Executive Committee.
- Present results at annual Entomological Society of America meeting.

Western Gulf Forest Pest Management Cooperative
Activity Time Line - CY2004

<u>January</u>
- Establish new tip moth control research plots.
- Deploy pheromone traps for tip moth impact, hazard rating, and control (fipronil) studies.
- Monitor tip moth populations and rainfall for tip moth studies.

<u>February</u>
- Contact and meet with WGFPMC members to identify suitable tip moth impact and hazard rating sites; gather information on management plans for each site.
- Establish new tip moth impact and hazard rating research plots.
- Monitor tip moth populations and rainfall for tip moth studies.

<u>March</u>
- Treat selected tip moth impact plots with insecticides.
- Monitor tip moth populations and rainfall for tip moth studies.
- Make selection of study trees for Bark Beetle Injection study.

<u>April</u>
- Flag 6-10 branches/tree and record number of conelets and cones on all treatment and check trees for Denim® study at Magnolia Springs SO.
- Treat study trees with injection treatments for SPB Injection Study.
- Treat study trees with standard (Asana® XL) foliar treatment for Denim® study at Magnolia Springs SO.
- Collect site information and soil samples and conduct vegetation evaluation for hazard rating study.
- Monitor tip moth populations and rainfall for tip moth studies.

<u>May</u>
- Evaluate tip moth damage after 1st generation for all tip moth studies; photograph damage.
- Treat study trees with standard (Asana® XL) foliar treatment at Magnolia Springs SO.
- Fell trees, deploy bolts, traps and bark beetle pheromones for SPB Injection Study.
- Treat selected tip moth impact plots with insecticides.
- Monitor tip moth populations and rainfall for tip moth studies.

<u>June</u>
- Treat study trees with standard (Asana® XL) foliar treatment at Magnolia Springs SO.
- Collect and evaluate bolts and traps SPB Injection Study.
- Evaluate tip moth damage after 2nd generation for all tip moth studies; conduct competing vegetation assessment for hazard rating study; photograph damage.
- Monitor tip moth populations and rainfall for tip moth studies.

<u>July</u>
- Treat study trees with standard (Asana® XL) foliar treatment at Magnolia Springs SO.
- Fell trees, deploy bolts, traps and bark beetle pheromones for SPB Injection Study.
- Treat nursery seedlings with in-furrow treatments.
- Treat selected tip moth impact plots with insecticides.
- Monitor tip moth populations and rainfall for tip moth studies.

Western Gulf Forest Pest Management Cooperative
Activity Time Line - CY2004

August
- Evaluate tip moth damage after 3rd generation for all tip moth studies; photograph damage.
- Treat study trees with standard (Asana® XL) foliar treatment at Magnolia Springs SO.
- Collect and evaluate bolts and traps SPB Injection Study.
- Treat selected tip moth impact plots with insecticides.
- Monitor tip moth populations and rainfall for tip moth studies.

September
- Evaluate conelet and cone survival on flagged branches (late September).
- Fell trees, deploy bolts, traps and bark beetle pheromones for SPB Injection Study.
- Evaluate tip moth damage after 4th generation for all tip moth studies; photograph damage.
- Treat nursery seedlings with in-furrow treatments.
- Monitor tip moth populations and rainfall for tip moth studies.

October
- Treat selected tip moth impact plots with insecticides.
- Collect and evaluate bolts and traps SPB Injection Study.
- Collect all cones from sample trees for systemic injection rate and Denim® studies.
- Evaluate coneworm damage for systemic injection rate and Denim® studies.
- Monitor tip moth populations and rainfall for tip moth studies.

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.

December
- Extract, radiograph and evaluate seed samples for systemic injection Denim® studies.
- Conduct statistical analyses of 2004 data.
- Prepare and submit report to FSPIAP sponsor, WGFPMC Executive Committee, Syngenta Crop Protection, Inc, and Bayer/BASF Co.
- Present results at annual Entomological Society of America meeting.
- Monitor tip moth populations and rainfall for tip moth studies.

2004 Proposed Budget

The proposed budget for CY 2004 totals $145,734 (Table 1). The proposed budget includes a slight increase of $1,296 for salaries and fringe benefits due to shifting time share of the staff forester and research specialist and the need for 3 seasonal technicians (4 months each). Monies budgeted for operating expenses increased by about 45% to a total of $20,559 compared to actual CY2003 operating expenses. The increase is in anticipation of additional travel and vehicle use and maintenance expenses. One new member joined the WGFPMC, so current membership dues plus a CY2003 surplus of $4,119 in the WGFPMC account plus $2,000 for seed analysis work for WGTIP will provide $56,619 (39%). An additional $26,679 (18%) is anticipated for the first year of a two year FSPIAP (fipronil) grant and the remainder of the second year FSIAP grant (systemic injection and Griffin LLC grant). The remainder (43%) will be borne by the Texas Forest Service and any new members that join during the year. The addition of a new member(s) to the WGFPMC will serve to reduce the TFS contribution to the WGFPMC. A summary by project or activity for CY 2004 is given in Table 2.

2005 Proposed Budget

A proposed budget for CY 2004 is given in Table 3 by source of funding. A total of $140,988 is proposed for CY 2005. Membership dues will remain stable at $8,000 per full member in CY 2005 (3 years after the last increase), and will represent $52,500 (37%) from the 8 current industry and federal members and the remainder (63%) from other sources (new member dues, federal grants and/or membership, and Texas Forest Service contributions).

The proposed budget summary by project or activity for CY 2005 is given in Table 4. We anticipate that one or more small projects will terminate at the end of CY 2004, allowing the funding of one new applied research or technology transfer project in CY 2005.

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