Western Gulf
Forest Pest Management
Cooperative

2003 Research Project Proposals

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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 2003. Results obtained this past year warrant further evaluations in these areas. The leaf-cutting ant control study will be discontinued for the time being with the assumption that the BES-100 leaf-cutting ant bait will by registered by Bayer/BASF in the United States in the near future.

Proposed objectives and methods for the systemic injection and tip moth studies in 2003 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 will not be registered in the United States. It is important that we evaluate the efficacy of Denim® formulation (already registered in the United States) in reducing cone and seed insect damage.

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 2003. The first, a cooperative study with Drs. Wayne Berisford, University of Georgia, and Roy Hedden, Clemson University, is evaluating 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 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 study, two additional trials will be established in 2003. The first will evaluate different fipronil treatment techniques and rates that can be applied before or after pine seedlings are lifted from the nursery bed. The second trial will evaluate the area-wide effects of operationally planting fipronil-treated seedlings.

Members of the Seed Orchard Pest Management Subcommittee are requesting assistance from the WGFPMC to conduct the x-ray analysis of seed lots obtained when evaluating the efficacy of Capture® (bifenthrin) and Imidan® (phosmet) applied in southern pine seed orchards. A proposal, entitled "Imidan® and Capture® efficacy study for cone and seed insect control in southern pine seed orchards: a regional cooperative study," is attached.

Continuation of these or initiation of other projects will be dependent on approval by the WGFPMC Executive Committee. Extension of each project into 2004 will depend on the degree of success achieved in 2003 and remaining gaps in knowledge.

Systemic Insecticide Injection Rate Study

Objectives: The objectives of the research in 2003 are to: 1) evaluate the efficacy of systemic injections of emamectin benzoate and thiamethoxam, alone or combined, in reducing seed crop losses in loblolly pine seed orchards two year after treatment; 2) evaluate the efficacy of a combination treatment (emamectin benzoate plus thiamethoxam, applied at three rates) two year after treatment; 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).

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.

Both Systemic Insecticide Duration and Rate Studies have demonstrated that trunk injection of emamectin benzoate, 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). Surprisingly, thiamethoxam alone has been nearly as effective as emamectin benzoate at reducing coneworm damage during the first two seasons after injection in the Rate Study. 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, all injection treatments in the Rate Study showed a marked reduction in efficacy in 2002 compared to results observed in 2001. This is in contrast to the increased efficacy observed in the second year of the Duration Study. The reason may be due to a combination of factors. One factor may include the fact that due to the smaller size of trees in the Rate Study orchard (8.9 in. DBH) compared to the Duration Study orchard (16.8 in DBH), lower volumes of insecticides were required and subsequently fewer injection points (2.2 versus 2.8) were used per tree. The reduced number of injection points on the Rate Study trees may have limited the distribution of the insecticide into the canopy of the trees. Another factor may be the amount of insect pressure on trees in a given year. Check trees in Duration Study had relatively low levels of coneworm damage during the first two years (21%) and less than half the amount of seed bug damage (24%) in the second year of the study (2000) compared to the first year (53%). In contrast, check trees in the Rate Study orchard had high levels of coneworm damage (46% in 2001 and 31% in 2002) and the same level of seed bug damage in 2002 (33%) compared to 2001 (33%). The results obtained in 2001 and 2002 warrant continuing the study through 2003.

Research Approach:

The study is being conducted 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 with insecticides since it was established. In 2001, 7 ramets from each of 10 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) 20 ml rate each for 4% emamectin benzoate (Arise SL®) and 5% thiamethoxam (25WG) by injector
2) 10 ml rate each for 4% emamectin benzoate (Arise SL®) 5% thiamethoxam (25WG) by injector
3) 3 ml rate each for 4% emamectin benzoate (Arise SL®) 5% thiamethoxam (25WG) by injector
4) 20 ml rate for 4% emamectin benzoate (Arise SL®) alone by injector
5) 20 ml rate for 5% thiamethoxam (25WG) alone by injector
6) Check

* Note* The Asana XL foliar treatment, initially applied in 2001 and 2002, will be discontinued in 2003 in order to reduce the work load.

Injection treatments were applied using the STIT (Systemic Tree Injection Tube) system to selected ramets in April 2001 (just after a heavy rain). The injector system is made up of 3 parts: a maple syrup stile, a 60 cm section of tubing, and a tire valve (Helson et al. 2001). Seven centimeter deep holes (1 cm dia.) were drilled into each treatment tree approximately 30 cm above the ground. The number of holes was based on the diameter of the treatment tree: approximately 1 hole per 10 cm of diameter. Upon assembly of the system, one injector stile was hammered into each drill hole. Each injector was filled and pressurized to approximately 50 psi. The volume of insecticide solution applied was based on the diameter of each treatment tree, as follows:

Tree	Treatments		
Diameter	1, 4 & 5	2	3
11 - 15 cm	20 ml	10 ml	3 ml
16 - 20 cm	20 - 40 ml	10 - 20 ml	3 - 6 ml
21 - 25 cm	40 - 60 ml	20 - 30 ml	6 - 9 ml
26 - 30 cm	60 - 80 ml	30 - 40 ml	9 - 12 ml
>30 cm	+20 ml/5 cm dia. increment	+10 ml/5 cm dia. increment	+3 ml/5 cm dia. increment

After each injector had drained, the stile was removed and the hole was plugged with a cork to reduce the chance of fungal invasion.

Reduction of coneworm attacks will be evaluated again by collecting all cones present from each tree in early October of 2003. 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 or SAS statistical programs.

Research Time Line:

September - December 2003

- Collect all cones from sample trees for evaluation of coneworm and seed bug damage levels (early October).
- Conduct statistical analyses of 2003 data.
- Prepare and submit report to WGFPMC Executive Committee, and Syngenta Crop Protection, Inc.
- Present results at annual Southern Forest Insect Work Conference.

Literature Cited:

DeBarr, G.L. 1978. Southwide test of carbofuran for seed bug control in pine seed orchards. USDA For. Serv. Res. Pap. SE-185. 24 p.

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Denim® Efficacy Study for Control of Cone and Seed Insects in Loblolly Pine Seed Orchards

Objectives: The objectives of this research proposal are to: 1) evaluate the efficacy of systemic injections of Denim® (emamectin benzoate) alone or combined with thiamethoxam, in reducing seed crop losses in loblolly pine seed orchards; 2) evaluate the treatments applied using the Arborjet™ 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. This formulation has not been tested for its efficacy against cone and seed insects in pine seed orchards.

The injection or implant of systemic insecticides into drill holes on individual pine trees have been evaluated as an alternative to foliar applications, but with limited success. In loblolly and slash pines, the drilled holes necessary for insecticide application quickly fill with oleoresin released by the tree in response to the wounding (Don Grosman, personal observation). To bypass or overcome the resin response of pines, a pressurized systemic tree injection tube (STIT) was developed by Dr. Blair Helson, Canadian Forest Service. Trials conducted on loblolly pine showed that 50 ml of the Arise® formulation can be completely injected or pushed into a tree using the STIT injector in as little as 4 minutes (Don Grosman, unpublished data). A more recent test showed that 50 ml of undiluted Denim® can be injected using the STIT injector in 15 minutes.

The STIT injector has been successfully used to injecting high volumes of insecticide into loblolly pine. However, the system has several limitations. The STIT injector is not manufactured, so considerable effort is required to make and maintain functional injectors. The effort and time required to load and clean each injector is considerable. Two manufactured injection systems are/will be available in 2003 – the Arborjet™ and Sidewinder™ systems. We are in the process of testing a new model of the Arborjet system that may allow faster injections into pine. Unfortunately, the Arborjet™ system, the newest one on the market, currently costs $4,200. The Sidewinder system (base price $1,800) has not yet been tested on loblolly pine.

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. Additional trials are 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 evaluate the efficacy of the Denim® (emamectin benzoate) formulation and thiamethoxam applied at different rates via a pressurized injection system, for control of cone and seed insects in southern pine seed orchards.

Research Approach:

The study will be conducted 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, 4 ramets from each of 10 loblolly clones will be selected. The treatments will be evaluated using the experimental design protocol described by Gary DeBarr (1978) (i.e., randomized complete block with clones as blocks). The treatments include:

1) 1.9 % emamectin benzoate (undiluted Denim®) by Arborjet injector at 20 ml per inch diameter at breast height (DBH)
2) 1.9 % emamectin benzoate (undiluted Denim®) by Arborjet injector at 10 ml per inch diameter at breast height (DBH)
3) 0.95% emamectin benzoate (1:1 Denim®:water) by Arborjet injector at 40 ml per inch diameter at breast height (DBH)
4) 0.95% emamectin benzoate (1:1 Denim®:water) by Arborjet injector at 20 ml per inch diameter at breast height (DBH)
5) 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.
6) Check

Injection treatments will be applied using the Arborjet injection system to selected ramets in April 2003 (just after a heavy rain, if possible). Seven centimeter deep holes (1 cm dia.) will be drilled into each treatment tree approximately 30 cm above the ground. Each tree will have at least four injection points (at cardinal directions).

Treatment 5 (Asana XL standard) will be applied to foliage beginning in April 2003 using a hydraulic sprayer from a bucket truck at 10 gal/tree. The distance between test trees will be ~20 m to minimize the effects of drift.

Conelet and cone survival will be evaluated in 2003 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 early October of 2003. 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.

If one or more treatments continue to be successful in reducing coneworm and/or seed bug damage by >75% in 2003, the condition of 2003 conelets may be followed into the year 2004 to continue evaluating the residual effects of treatments.

Research Time Line:

<u>January - April, 2003</u>

- Select study trees (March).
- Treat study trees with assigned injection treatments (early April).
- Flag 6-10 branches/tree and record number of conelets and cones on all treatment and check trees (April).

<u>May - August, 2003</u>

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

<u>September - December, 2003</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.

Literature Cited:

DeBarr, G.L. 1978. Southwide test of carbofuran for seedbug control in pine seed orchards. USDA For. Serv. Res. Pap. SE-185. 24 p.

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

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Grosman, D.M., W.W. Upton, F.A. McCook, and R.F. Billings. 2002. Systemic Insecticide Injections for Control of Cone and Seed Insects in Loblolly Pine Seed Orchards – 2 Year Results. So. J. Appl. For. 26: 146-152.

Impact of Nantucket Pine Tip Moth Attack on Loblolly Pine Growth - A Western Gulf Study

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 25%, 23% and 87%, 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 first-year (planted in 2002) and second-year (planted in 2001) seedlings averaging 7% and 21%, respectively. Tip moth pressure was insufficient to impact first year seedling growth in 2002. However, the high 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.

We propose to continue the study in 2003 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 established one to three research sites in 2001. We ask that each member have at least **three** established sites by the end of 2003. 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 121 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 once per month for the first **3 years** after planting.

Insecticides (Mimic® and/or Pounce®) will be applied by backpack sprayer at label rates during the optimal spray period for each generation (Fettig et al. 2003).

Tip moth infestation levels will be determined by percent of infested shoots in the top whorl (terminal + shoots of the uppermost whorl of lateral branches) in the first, second and last tip moth generation for 3 years. Tree height, diameter (at 6 inches), and form will be measured at the end of the growing season for the first 3 years and at 4-year intervals thereafter (should include measurements at year 8 to fit into company growth and yield models). 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: 1) no forks, 2) one fork, 3) two to four forks, and 4) 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 2003

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

March - September 2003

- Treat selected plots with insecticides once per month (March 1 – October 1 or April 1 to September 1).
- Evaluate tip moth damage after 1st, 2nd, 3rd and 4th generations in treated and check plots; photograph damage.
- Send out announcements regarding the occurrence of any pest outbreaks (Grosman).

October - November 2003

- Evaluate tip moth damage after last 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 2003 - January 2004

- 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

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 and 2002, all check plots used in the Impact Study were used in the Hazard Rating Study. Similarly, Impact Study plots established in 2003 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 each year over the next two years (2004 – 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 top 1" & 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, and last
- Height and diameter (at 6 inches)
- Form
- Fusiform rust

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, are as follows: 1) no forks, 2) one fork, 3) two to four forks, and 4) 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.

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 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.

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 2003

- 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 2003

- 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 2003

- Conduct statistical analysis of spring data and distribute preliminary report to members (Grosman).
- Collect site information for hazard rating study.

November - December 2003

- Evaluate tip moth damage, conduct competing vegetation assessment after last generation; on send year sites evaluate for form and occurrence of fusiform rust; photograph damage.

January 2004

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

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Evaluation of Systemic Insecticide Treatments of Loblolly Pine Seedlings for Control of Pine Tip Moth

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 sites and significantly improved tree growth on 2 of 3 plots compared to check trees. The study plots will be monitored in 2003 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®) foliar application (5X) prior to each generation at 0.8 oz/gal
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 (0.145%) root soak
10) Azadirachtin (Neemix® 4.5) solution (0.290%) root soak
11) Check bare root seedling (lift and plant)

Tip moth populations will be monitored weekly at each site in 2003 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., coneworm, aphids, sawfly, etc. Each tree will be measured for diameter (at 6 inch) and 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 – February 2003.</u>

- Begin weekly monitoring of tip moth populations at each planting site.

<u>March – October 2003</u>

- Evaluate tip moth damage on treated and untreated seedlings 3-4 weeks after each generation.

November - December 2003

- Evaluate tip moth damage on treated and untreated seedlings 3-4 weeks after the last generation.
- Measure diameter (at 6 inches), height and form of trees (November).
- Conduct statistical analyses of 2003 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

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 Bayer CropScience as Regent® and Icon® (crop pests), Termidor® (termites), 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 four generations by an average of 90% compared to check trees (see 2002 Seedling Treatment Trial).

Over one billion pine seedlings are produced annually from genetically improved seed in southeastern nurseries (Carey and Kelley 1993). At the Texas Forest Service's Indian Mound Nursery, seedlings beds are about 480 feet long, 4 feet wide and contain 8 drills (rows). Nursery beds are managed on a four-year cycle. The beds are fumigated with methyl bromide prior to growing two consecutive years of pine seedling. Subsequently, the beds are sown with a cover crop for the remaining two years of the cycle. During the first two years, pine seed are sown in April and the result is about 100 seedlings per linear foot of bed or 600,000 seedlings per acre. Seedlings roots are undercut and laterally pruned to promote robust but compact root systems. Root pruning is usually performed once in early fall (October) and once a few weeks prior to lifting (December – February). The lateral root pruning equipment can be fitted to dispense pesticide in furrows (Harry Vanderveer, IMN, personal communication). Between December and March, seedlings are lifted by hand or machine, culled of small and large caliper seedlings, bagged and stored briefly (1 – 7 days?)

in cold storage. Some nurseries are known to apply superabsorbant polymer (TerraSorb®, HortaSorb® or Drywater®) to seedling roots to reduced desiccation prior to planting. Seedlings are planted by hand (dibble bar) or machine at different spacing with a normal range from 988 (2.8 X 3.7 m) to 1,978 (1.8 X 2.8 m) trees per ha (= 400 – 800 trees per acre).

A study will be initiated in 2003 to further evaluate the potential of treating pine seedlings with fipronil for protection against pine tip moth. The study will also evaluate the efficacy of fipronil applied by different techniques at different rates.

Research Approach:

A single family of loblolly pine bare root seedlings will be selected at the TFS Indian Mounds Nursery, Alto, TX. Lateral root pruning equipment will be used to apply Treatment 1 and 2 (described below) to a nursery bed section in October 2002. For all treatments, seedlings will be 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.

The treatments will include:

1) In furrow treatment of nursery bed with fipronil (0.0246% = 2.7 ml Termidor® SC per liter of water) 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% = 1.4 ml Termidor® SC per liter of water) 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% = 3 ml Termidor® SC in 9.5 l water) solution
4) Root soak of bare root seedling in fipronil (0.03% = 32 ml Termidor® SC in 9.5 l water) solution
5) Root soak of bare root seedling in fipronil (0.3% = 324 ml Termidor® SC in 9.5 l water) solution.
6) Root soak of bare root seedling in fipronil (0.3% = 73 ml Regent® SC in 9.5 l water) solution.
7) Root dip of bare root seedling in fipronil (0.3% = 324 ml Termidor® SC in 9.5 l water) and TerraSorb® (37.8g in 9.5 l water) solution.
8) Plant hole treatment (liquid) – 30 ml of fipronil (6.5% = 1210 ml Termidor® SC + 490 ml water) 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 will be warmed at room temperature (~70^{o}F) for 3 hours. For each of Treatments 3 - 6, 150 seedlings will be soaked in 9.5 liters (2.5 gal) of insecticide solution for 2 hours. For Treatment 7, the same number of seedlings will be dipped in the fipronil/TerraSorb® solution. After treatment, all seedlings will be dipped in TerraSorb® solution, rebagged and placed in cold storage until the following day. Fifty seedlings from each treatment will be planted (1.8 X 3 m (= 6 X 10 ft) spacing) on each of 3 second-year plantation sites – this will ensure a high level of tip moth pressure on the treatment trees. At each site, resident trees are 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.

(Note: Four to six study plots also may be established on the East Coast by Scott Cameron, International Paper Co, and Wilson Edwards, Weyerhaeuser Co.)

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., 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 Tukey's Compromise test using Statview or SAS statistical programs.

If one or more treatments continue to be successful in reducing tip moth damage by > 75% in the 4th generation in 2003, the "best" treatment(s) will be followed into 2004 to continue evaluating duration of treatments. In addition, the study may be expanded in 2004 to refine application rates, timing, and techniques for the promising treatment(s).

Research Time Line:

CY2002

<u>October – December 2002</u>

- Treat seedlings at TFS Indian Mounds Nursery (IMN) with assigned treatment (October).
- Select research sites.

CY2003

<u>January - February 2003</u>

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

<u>March - October, 2003</u>

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

<u>November - December 2002</u>

- Evaluate tip moth damage and tree form after 5th generation; measure seedling diameter and height.
- 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.
- Treat seedlings at IMN with best treatment (October & December).

CY2004

<u>January - April 2004</u>

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

<u>April - October 2004</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.

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.

Fipronil Operational Planting Study for Control of Pine Tip Moth

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 Bayer CropScience as Regent® and Icon® (crop pests), Termidor® (termites), 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 five generations by an average of 90% compared to check trees (see 2002 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.

A study will be initiated in 2003 to evaluate the efficacy and duration of fipronil in reducing damage on treated seedlings planted over large areas.

Research Approach:

A single family of loblolly pine bare root seedlings will be selected at the TFS Indian Mounds Nursery, Alto, TX. Seedlings will be 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 will be warmed at room temperature (~70^{o}F) for 3 hours. Seedlings will be soaked in 190 liter (50 gal) tanks of fipronil (0.3% ai) solution for 2 hours. All seedlings (treated and untreated) will be dipped in TerraSorb® (or Drywater) solution, rebagged and placed in cold storage until the following day. Seedlings from each treatment will be hand- or machine-planted (spacing is dependent practices of participating member) in each of 4 plantations - preferably near a young (< 4 years old) plantation.

Four tracts (divided in half by an SMZ or flagging) will be selected in the Western Gulf region based on uniformity of soil, drainage and topography in each pair of stands. All tracts will have been intensively site prepared, i.e., subsoil, bedding, and/or herbicide. On half of each of the four tracts will be planted with fipronil-treated seedlings. The other half will be planted with untreated seedlings at the same spacing. A small 100 tree plot will be established in each half tract as a contrast to the treatment of the other half tract. The plot in treated half will contain untreated seedlings, while the plot in untreated half will contain treated seedlings. Ten 10 tree plots will be spaced equally within each of the half tract (20 – 10 tree plots / whole tract) to evaluate tip moth damage levels in this area. All tracts will be treated with herbicide after planting to minimize herbaceous and/or woody competition.

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 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 2003, the stands will be monitored into 2004 to continue evaluating duration of treatments. In addition, the study will be expanded in 2004 to evaluate operational planting of seedling treated with refined fipronil application rates and techniques.

Research Time Line:

CY2003

January - February 2003

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

March - October, 2003

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

November - December 2002

- 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.

CY2004

January - April 2004

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

April - October 2004

- 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.

Imidan® and Capture® Efficacy Study for Cone and Seed Insect Control in Southern Pine Seed Orchards: A Regional Cooperative Study Plan

(prepared by Dr. Tom Byram, WGTIP)

Objective

This cooperative test will evaluate the efficacy of Imidan® and Capture® for control of coneworms and seed bugs in loblolly and slash pine seed orchards across the South. The current labeled rates will be compared to a check (no insecticide application).

Justification

As many as five monthly foliar sprays may be required each year to protect southern pine seed orchards from coneworms (*Dioryctria* spp.) and seed bugs (*Leptoglossus corculus* and *Tetyra bipunctata*). Damage to seed crops by these insects can exceed 50 percent and losses as high as 90 percent have been documented (Fatzinger et al. 1980). Imidan® (common name: phosmet) is an organophosphate insecticide which has been shown to be effective in single-tree hydraulic spray applications for both coneworms and seed bugs. Imidan® is being promoted by the Environmental Protection Agency as a substitute for Guthion®, which has served as the industrial standard for many years. However, Imidan® has never been tested for efficacy in conifer seed orchards under operational conditions. Orchard-wide treatments with aerial applications use much less pesticide per tree than employed in ground applications with hydraulic spray rigs. In addition, it has been shown that at a high pH, 50 percent of the material may hydrolyze in less than two hours. This information was not available when the original studies were done. Therefore, it is critical to verify that efficacy observed in single-tree treatments also is observed when Imidan® is applied under operational conditions. Capture® (common name: bifenthrin) has been evaluated in one previous South-wide study (Lowe et al. 1994), but has not been widely adopted for both economic and historical reasons. Coneworms were at very low levels in 1991 and the efficacy of Capture® for the control of these pests may have been poorly evaluated.

Treatments:

Two treatments, one with Imidan® 70W and one with Capture® 2EC, will be compared to an untreated check. The timing of the applications will be identical for both treatments. For loblolly pine seed orchards, the first application will be within 7 days of peak pollen flight (April). The first application in slash pine seed orchards should be made about April 1. In orchards of either species, the initial application should be followed by four subsequent applications made at monthly intervals (May, June, July, and August). Both treatments should consist of a total of five applications at the following rates:

1) Imidan 70W ® will be applied at a rate of 1.5 pounds of product per acre (1.07 pounds active ingredient/acre) at each of five monthly treatments. Because Imidan® hydrolyzes quickly at high pHs, the tank water should be adjusted to a pH of 6 or lower before mixing.
2) Capture 2EC ® will be applied at a rate of 0.20 pounds ai/acre at the first spray date and at the rate of 0.10 pounds ai/acre at each of the four remaining monthly treatments. Applications for the season will total 0.60 pounds ai/ac.

Aerial Application Methods:

Aircraft: Either a fixed-wing or rotary-wing aircraft may be used. Studies have shown little difference between aircraft types in application effectiveness with proper calibration.

Aircraft speed: This will be determined by the kind and type of aircraft used. For rotary wing aircraft, a speed of 50 mph is recommended. Fixed wing aircraft often fly at speeds of 100-130 mph.

Swath width: The aircraft should be set up to deliver an effective swath width of 60 ft.

Aircraft calibration: The aircraft should be calibrated to deliver 5 gallons of solution per acre. The aircraft should make two passes over each row or aisle to deliver a total spray volume of 10 gallons of solution per acre. This assumes a 30 ft. row spacing in the orchard. A droplet size of 350 VMD is desired. Each applicator should provide proof that his application rate has been calibrated and his swath width and droplet size have been characterized or arrangements to do this should be made prior to making the first application.

Release height: The aircraft should release the insecticide 10-20 ft. above the tops of the trees.

Five applications will be made during the growing season. Spraying will begin on April 1 in slash pine orchards. Initial applications in loblolly orchards will be made within 7 days following peak pollen flight.

Field Layout:

In each orchard, three treatment plots will be laid out in the test area. Each plot should be at least 5 rows wide and comprise at least 5 acres in area. There should be 4 rows of buffers between treatments. A complete block design will be used. An experimental unit will consist of one treatment plot. Each orchard will serve as a replicate. Two sample ramets will be selected from each of six clones in each plot for a total of 36 sample trees from each orchard. These same six clones will be sampled in each plot within an orchard, but clones will differ among orchards. Treatments will be randomly assigned to plots within each orchard. The experiment will be replicated in six to seven pine seed orchards that are located throughout the South. The orchards will be selected on the basis of geographic location, reliability of the cooperator, and a past history of *Dioryctria* problems.

Data Collection:

Efficacy data will include crop survival, yields of healthy and damaged cones, and seed yields for each sample tree. Each orchard/treatment block will be surveyed in the year after treatment for the presence of secondary insects.

Crop Survival. Crop survival will be determined for both conelets (2002 flower crop) and cones (2001 flower crop). A sample of at least 50 healthy conelets and 50 healthy cones will be counted and tagged on each sample ramet by orchard personnel. Standardized data collection sheets will be provided. A minimum of ten female flower or cone clusters should be selected on the south side of each ramet. These counts should be made within one month of peak pollen flight in loblolly pine seed orchards and during the month of April in slash pine orchards. All counts should be completed within a one-week period. These conelets and cones (survivors) will be recounted at the end of the growing season, as close to cone harvest as possible, in order to determine crop survival.

Cone Yields and Damage. Yields of healthy and damaged cones will be determined by making 100% cone counts on each sample ramet at harvest. Orchard personnel will harvest all cones (both sound and damaged) from each sample ramet. These cones will be sorted into two groups: "healthy-undamaged" and "damaged". Each cone will be examined carefully, by turning it several times to look for holes, "insect frass", brown or discolored patches of scales, dead tips, and distorted cones. Cones counted as healthy should be damage-free. Questionable cones should be placed with the damaged cones. The number of healthy and damaged cones will be recorded for each sample ramet in the field. Damaged cones from each ramet will be placed in an individual cloth bag. Bags of damaged cones should be placed in cold storage (at least 45° F or below) until they can be examined by entomologists and sorted into several specific damage classes. Arrangements for examining the cones will be made by the entomologist assigned to each orchard.

Seed analysis. Ten sample cones will be picked at random from the "healthy" cones collected from each ramet. These clones will be used for seed analysis. It is very important that these cones be examined carefully and are free of coneworm attacks. Ten sample cones will be placed in small cloth bags (rice bags turned inside out) and labeled by orchard, block, clone, ramet, and treatment. The bags should be tied as close to the end as possible to allow maximum room for cone expansion. Bags will be provided. Once the 10-cone sample has been collected, all remaining "healthy" cones can be bulked with operational orchard collections. The bags of 10-cone samples will be subjected to the standard after-ripening procedures to insure proper cone opening. Bags of 10-cone samples will be shipped to the orchard manager's Cooperative for extraction. Cooperative personnel will extract the seed but NOT CLEAN IT . Second-year aborted ovules (i.e. flattened seeds) will not be removed until counted by the WGFPMC staff. After second-year aborted ovules are counted, the seed will be dewinged, cleaned and radiographed by ramet by the WGFPMC staff. Total, filled, empty, second-year aborts and seed bug damaged seed will be counted.

Secondary Pests. Test trees will be visually inspected for the occurrence of homopteran insect (scale or mealybug) populations about once a month. Key symptoms include grey or black foliage caused by honeydew, mildew, and sooty mold; the presence of white "snow-like" material on needles or branches; small pitch blisters at the base of the tips of the branches or scale insects on the needles and branches. If the orchard manager observes any of these symptoms, the entomologist working with his orchard should be contacted and provided with samples. If it is determined that secondary pests are present, the relative population levels of the following insects will be determined: pine tortoise scale, *Toumeyella parvicornis* (Cockerell); striped pine scale, *T. pini* (King); wooly pine scale, *Pseudophillippia quaintancii* (Cockerell); mealybug, *Oracella acuta* (Lobdell); and the pine needle scale, *Chionaspis heterophyllae* (Colley). This will be done following the infestation scoring system of Cameron (1989): 0 = none, 1 = few insects on scattered branches, 2 = many branches with few insects, or few branches with moderate to large numbers of insects, and 3 = many branches with many insects. Test trees should be reviewed for homopteran insect populations again in June 2003. If the orchard manger observes any symptoms of an outbreak, the procedure outlined above should be followed.

Data Analysis:

Efficacy will be evaluated by comparing treatment differences for both direct and indirect measures of insect-caused losses. Direct treatment effects include reductions in coneworm attacks and seed damage. Indirect treatment effects include increases in conelet and cone survival and yields of total and filled seed. Data will be subjected to analyses of variance. Percentage data will be transformed by the arcsine % transformation prior to analysis. The analyses of variance are shown in Table 1 will be performed using Statistical Analysis System (SAS) software.

WGFPMC Involvement:

The WGFPMC has been asked to provide assistance, primarily with radiograph analysis of seed for seed bug damage. Also, the WGFPMC entomologist may be assigned to one or more orchards involved in the study. The entomologist will evaluate collected cones for coneworm damage and may be asked to identify and rate the population levels of secondary pests.

Research Time Line:

Month	**Activity**
March	Orchard layout: select and flag sample ramets (Cooperative staffs).
April	Apply first application. Tag 50 conelets and 50 cones / ramet (Orchard personnel).
May	Apply second application. Evaluate for secondary pest outbreaks (Orchard personnel; **Entomologist if required**).
June	Apply third application. Evaluate for secondary pest outbreaks (Orchard personnel; **Entomologist if required**).
July	Apply fourth application. Evaluate for secondary pest outbreaks (Orchard personnel; **Entomologist if required**).
August	Apply fifth application. Evaluate for secondary pest outbreaks (Orchard personnel; **Entomologist if required**).
Harvest	Count sample cones and conelets. Harvest **ALL** cones on sample ramets. Separate and count damaged and undamaged cones. Collect 10 cone sample from each ramet to send to the Cooperatives (Orchard Personnel).
Post-Harvest	**Examine and categorize damaged cones (Entomologist).** Extract seed from 10 cone samples (Cooperative Staffs). **Radiograph and evaluate seed samples (WGFPMC).**
Summer 2003	Evaluate for secondary pest outbreaks (Orchard personnel; **Entomologist if required**).
Final Report	Summarize and analyze data. Prepare final report (SOPM Committee)

Tank Mix Table

Treatment (lb/ai/ac)	Amount of product to mix with 10 gallons of water for each acre to be sprayed.
Capture 2EC ® 0.20	0.1 gallons or 25.6 fl oz
Capture 2EC ® 0.10	0.05 gallons or 12.8 fl oz
Imidan 70W ® 1[1]	1.5 lb
[1]The pH of the tank water should be adjusted to a pH of 6 or lower prior to mixing.	

Responsibilities

Task	Assignment
Study Plan	SOPM Committee
Orchard Selection and Layout	Tree Improvement Cooperatives
Pesticide Acquisition and Application	Orchard Personnel
Experimental Design	SOPM Committee
Data collection	Orchard Personnel with any needed oversight from **Entomologist**
Cone Harvest	Orchard Personnel
Coneworm Damage Assessment	**Entomologist**
Seed Extraction	Tree Improvement Cooperatives
Seed Radiography	**WGFPMC (Upton, Grosman)**
Seed Analysis	**WGFPMC (Upton, Grosman)**
Data Analysis	SOPM Committee
Secondary Pest Assessment	Seed Orchard Personnel; **Entomologist if needed**
Final Report	SOPM Committee

Literature Cited:

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Lowe, W.J., L.R. Barber, R.S. Cameron, G.L. Debarr, G.R. Hodge, J.B. Jett, J.L. McConnell, A. Mangini, J. Nord, and J.W. Taylor. 1994. A Southwide test of bifenthrin (Capture®) for cone and seed insect control in seed orchards. S Jour. Appl. For. 18(2): 72-75.

Western Gulf Forest Pest Management Cooperative
Activity Time Line - CY2003

January
- 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.

February
- Radiograph and evaluate seed samples for Imidan®/Capture® study.
- 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, hazard rating, and control research plots.
- Monitor tip moth populations and rainfall for tip moth studies.

March
- Treat selected tip moth impact plots with insecticides.
- Monitor tip moth populations, rainfall and temperature for tip moth studies.
- Make selection of study trees for Denim® study at Magnolia Spring SO.

April
- 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 Denim® treatments at Magnolia Springs SO.
- 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.

May
- 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.
- Treat selected tip moth impact plots with insecticides.
- Monitor tip moth populations and rainfall for tip moth studies.

June
- Treat study trees with standard (Asana® XL) foliar treatment at Magnolia Springs SO.
- 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.

July
- Treat study trees with standard (Asana® XL) foliar treatment at Magnolia Springs SO.
- 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 - CY2003

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.
- 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).
- Evaluate tip moth damage after 4th generation for all tip moth studies; photograph damage.
- Monitor tip moth populations and rainfall for tip moth studies.

October
- Treat selected tip moth impact plots with insecticides.
- 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 rate and Denim® studies.
- Conduct statistical analyses of 2003 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.

2003 Proposed Budget

The proposed budget for CY 2003 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 CY2002 operating expenses. The increase is in anticipation of additional travel and vehicle use and maintenance expenses. Two WGFPMC members were lost but two new members joined the WGFPMC, so current membership dues plus a CY2002 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 2003 is given in Table 2.

2004 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 2004. Membership dues will remain stable at $8,000 per full member in CY 2004 (2 years after the last increase), and will represent $52,500 (37%) from the 7 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 2004 is given in Table 4. We anticipate that one or more small projects will terminate at the end of CY 2003, allowing the funding of one new applied research or technology transfer project in CY 2004.

Table 1. WGFPMC Proposed Budget by Source of Funding - CY 2003

	Source: WGFPMC	Source: TFS and Others*	Total	% of Total
A. Salaries and Wages				
Principal Investigator (Grosman) (100%)	$ 15,865 (30%)	$ 37,021 (70%)	$ 52,886	
Staff Forester (Upton) (75%)	12,558 (35%)	14,352 (43%)	26,910	
Research Specialist (Smith) (10%)	3,200 (10%)	0	3,200	
3 Seasonal Technician (4 mo. ea)		17,280	17,280	
Total Salaries and Wages	$ 31,623	$ 68,653	$ 100,276	
B. Fringe Benefits (30% of Salaries)	$ 9,487	$ 15,412	$ 24,899	
	41,110	84,065	125,175	86%
C. Operating Expenses				
Supplies	$ 4,000	$ 1,000	$ 5,000	
Vehicle Use and Maintainance	3,724	1,000	4,724	
Travel	4,250	750	5,000	
Telecommunications (15% of PCS)	335	0	335	
Utilities (15% of PCS)	0	1,300	1,300	
Other Services (rentals, publications, postage, etc.)	3,200	1,000	4,200	
Total Operating Expenses	$ 15,509	$ 5,050	$ 20,559	14%
Grand Total	$ 56,619 **	$ 89,115	$ 145,734	
% of Total	39%	61%	100%	100%

* includes any new members or federal grants.

** member dues at $8,000/yr for six members; $2,500/yr for one member, $4,119 CY02 surplus,and $2,000 for WGTIP seed analysis.

Table 2. WGFPMC Proposed Budget by Source of Project - CY 2003

	Activity				
	Administration	Tip Moth Studies		Systemic	
	Site Visits/Service	(Impact & HR)	(Systemic Trt)	Injection Studies	Total
A. Salaries and Wages					
Entomologist II (100%)	$ 21,155 (40%)	$ 10,577 (20%)	$ 10,577 (20%)	$ 10,577 (20%)	$ 52,886
Staff Forester (75%)	0	8,970 (25%)	8,970 (25%)	8,970 (25%)	26,910
Research Specialis (10%)	0	1,600 (5%)	0	1,600 (0%)	3,200
3 Seasonal Technicians (4 mos. ea.)	0	5,876 (34%)	5,702 (33%)	5,702 (33%)	17,280
Total Salaries and Wages	$ 21,155 (21%)	$ 27,023 (27%)	$ 25,249 (25%)	$ 26,849 (27%)	$ 100,276
B. Fringe Benefits (30% of Salaries)	$ 6,347	$ 6,344	$ 5,864	$ 6,344	$ 24,899
C. Operating Expenses					
Travel and Vehicle Use	$ 4,750	$ 2,340	$ 1,740	$ 894	$ 9,724
Supplies & Postage	2,700	1,600	1,200	1,200	6,700
Other Operating Expenses	1,335	930	930	940	4,135
Total Operating Expenses	$ 8,785	$ 4,870	$ 3,870	$ 3,034	$ 20,559
Grand Total	$ 36,287	$ 38,237	$ 34,983	$ 36,227	$ 145,734
% of Total	25%	26%	24%	25%	100%

Table 3. WGFPMC Proposed Budget by Source of Funding - CY 2004

	Source					
	WGFPMC		TFS and Others*		Total	% of Total
A. Salaries and Wages						
Principal Investigator (Grosman) (100%)	$ 16,659	(30%)	$ 38,871	(70%)	$ 55,530 **	
Research Technician (100%)	10,000	(50%)	10,000	(50%)	20,000	
Staff Forester (Upton) (30%)	3,767	(10%)	7,535	(20%)	11,302 **	
Seasonal Technician (4 mo.)			5,760		5,760	
Total Salaries and Wages	$ 30,426		$ 62,166		$ 92,592	
B. Fringe Benefits (30% of Salaries)	$ 9,128		$ 16,922		$ 26,050	
	39,554		79,088		118,642	84%
C. Operating Expenses						
Supplies	$ 3,500		$ 3,000		$ 6,500	
Vehicle Use and Maintainance	3,500		1,500		5,000	
Travel	3,746		1,250		4,996	
Telecommunications (15% of PCS)	0		350		350	
Utilities (15% of PCS)	0		1,300		1,300	
Other Services (rentals, publications, postage, etc.)	2,200		2,000		4,200	
Total Operating Expenses	$ 12,946		$ 9,400		$ 22,346	16%
Grand Total	$ 52,500 ***		$ 88,488		$ 140,988	
% of Total	37%		63%		100%	100%

* includes any new members or federal grants.

** includes 5% salary increase

*** member dues at $8,000/year for six members, $2,500/yr for one member, and $2,000 for WGTIP seed analysis.

Table 4. WGFPMC Proposed Budget by Source of Project - CY 2004

	Activity					
	Administration	Tip Moth Studies		Systemic		
	Site Visits/Service	(Impact & HR)	(Systemic Trt)	Injection Study	Other Study	Total
A. Salaries and Wages						
Entomologist II (100%)	$ 22,212 (40%)	$ 8,330 (15%)	$ 8,329 (15%)	$ 8,330 (15%)	$ 8,329 (15%)	$ 55,530
Research Specialist (100%)	0	6,000 (30%)	4,000 (20%)	4,000 (20%)	6,000 (30%)	20,000
Staff Forester (30%)	0	3,767 (10%)	1,884 (5%)	3,767 (10%)	1,884 (5%)	11,302
Seasonal Technician (4 mos.)	0	1,728 (30%)	1,152 (20%)	1,728 (30%)	1,152 (20%)	5,760
Total Salaries and Wages	$ 22,212	$ 19,825	$ 15,365	$ 17,825	$ 17,365	$ 92,592
B. Fringe Benefits (30% of Salaries)	$ 6,664	$ 5,429	$ 4,264	$ 4,829	$ 4,864	$ 26,050
C. Operating Expenses						
Travel and Vehicle Use	$ 4,991	$ 1,900	$ 1,300	$ 400	$ 1,500	$ 10,091
Supplies & Postage	2,900	1,400	900	900	1,400	7,500
Other Operating Expenses	1,540	810	800	800	805	4,755
Total Operating Expenses	$ 9,431	$ 4,110	$ 3,000	$ 2,100	$ 3,705	$ 22,346
Grand Total	$ 38,307	$ 29,364	$ 22,629	$ 24,754	$ 25,934	$ 140,988
% of Total	27%	21%	17%	18%	18%	100%

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