

Evaluation of New Formulation for Mating Disruption of the Western Pine Shoot Borer

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Introduction: The western pine shoot borer (WPSB), *Eucosma sonomana*, is a pest that causes severe height reduction in several pine species in western North America. Forest industry has invested considerable resources in planting sites subjected to wildfire, but the incidence of WPSB is on the increase, probably as a result of the increased acreage devoted to large, even-aged pine plantations. Many plantations are experiencing infestation levels of 30-40% of stems and in some cases, such as parts of the Pondsosa plantation, infestation levels are in the 80-90% range. Attacks occur when tree heights are between 1 – 15 m tall. Female moths prefer terminal shoots and can reduce height growth more than 20% per year (Sower et al. 1984). This reduction in height growth results in considerable volume loss. Past studies showed that WPSB selectively attacks the fastest growing trees in the stands, and that elimination of WPSB can increase volume growth over a five-year period by 17-24%, depending on the background level of infestation (based on actual tree measurements) (Williams et al. 1989). Several different types of dispensers are effective for mating disruption with synthetic semiochemicals (Sower et al. 1982, Sower et al. 1984, Williams et al. 1989). However, the older pheromone release systems are limited because of their physical characteristics: Hercon® lure tapes must be applied from the ground, when sites are often inaccessible, and Hercon® flakes require specialized aircraft that are no longer

available. A new, microencapsulated (MEC) pheromone release system has been developed that shows promise for other forest pests (Rappaport et al. 2001). The MEC is a water suspension of microscopic beads containing the pheromone, and it is fully compatible with existing pesticide aerial application equipment. Thus, no specially equipped aircraft are needed to spray the MECs, and application can be made regardless of season, snow-pack, or road conditions. A MEC pheromone registered for eastern pine shoot borer (*Eucosma gloriola*) (Grant et al. 1994) is essentially the same as the pheromone for the WPSB, and thus is likely to also be effective against WPSB. We propose to test the MEC formulation of the eastern pine shoot borer pheromone as an aerial application for mating disruption of the WPSB.

Objectives:

- Evaluate a microencapsulated blend of Z-9 and E-9-dodecenyl acetate for mating disruption of WPSB.
- Determine reduction in host damage levels.
- Establish guidelines for operational use.

Justification: Cost-benefit analyses clearly demonstrate the value of prophylactic treatments for the control of WPSB damage in pine plantations; for young stands, the return on the investment was seven-fold (Williams et al. 1987, Daterman, unpublished).

Estimates of infestation rates in the Ponderosa plantation average 70-80% of the standing trees, with a concomitant potential height loss of 20% per year (i.e. a 5% loss in volume at harvest). There currently exist hundreds of thousands of acres of pine plantations in the Pacific Northwest that are susceptible to WPSB or that will soon become susceptible. These plantations resulted from catastrophic wildfires such as the Ponderosa, Scarface, Day and Fountain Fires, and are of necessity pine monocultures. As such, they are particularly susceptible to plantation pests, and steps must be taken to prevent further losses before these younger plantations reach the vulnerable stage. The new pheromone product is already registered with the US EPA, so very little expense or regulatory work will be required to implement this product for use in forest stands once efficacy is demonstrated.

Methods: The test sites will be located in pine plantations in northern California or southern Oregon that are heavily infested with WPSB, such as the Ponderosa, Day, or Scarface plantations. Sites will be selected with trees that are 10-20 years old and range up to 7m tall. Two treatments (untreated controls, pheromone at 12g ai/A) will be replicated as five 50 acre plots (larger plots are better than smaller plots because of the risk of immigrating mated females from outside the treated area; however, 50 acres is the maximum we can treat without triggering an EUP requirement). Application will be made using standard procedures using helicopters or fixed-wing aircraft (as required by the terrain) equipped with booms for pesticide spray application. Plots will be separated by 1 kilometer

for maximum isolation from treatment influence. A monitoring subplot of nine acres will be located in the center of each of the ten plots (5 treated and 5 control plots). Within each subplot, efficacy of mating disruption will be measured using 5 randomly placed male response traps ("sentinel" traps baited with the equivalent of one female moth's pheromone), monitored at biweekly intervals. Damage reduction will be assessed by measuring height and diameter growth of 50 randomly selected trees per nine-acre subplot. Post treatment impact evaluation will occur during the month of August 2002. Subsequent measurements will be made at two 5-year intervals if funding or in-kind services are available to cover the labor costs for the measurements. If results warrant, more 5-year or 10-year measurements could be taken until the end of the rotation. FHTET, in concert with the MEC manufacturer, will assess release rates of the formulation over the winter to ensure that release rates match those of Hercon® lures and flakes, which have demonstrated efficacy for western pine shoot borer. The treatments will be considered successful if the rate of damage reduction equals or exceeds that of the Hercon® flake release system (i.e. a 70% reduction in infested terminals).

Principal

Investigators/Cooperators: Nancy Rappaport – Pacific SW Research Station; Jeff Webster – Roseburg Resources Co.; Ed Frederickson – Sierra-Cascade Forest Intensive Management Research Cooperative; Gary Daterman – Pacific NW Research Station; Gary G. Grant – Canadian Forest Service; John Stein and Richard Reardon – Forest Health Technology

Enterprise Team; Grant Oliver – 3M Canada.

Duration: October 2001 – December 2003. We will conduct just a single application of the microencapsulated pheromone (March 2002). Post-treatment measurements will be done for

References cited:

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- Rappaport, N.G., D.R. Owen and J.D.Stein. 2001. Interruption of semiochemical-mediated attraction of *Dendroctonus valens* (Coleoptera: Scolytidae) and selected nontarget insects by verbenone. *Environmental Entomology* one year post-treatment, but may continue for 5 years or more if treatment is sufficiently successful to warrant extra follow-up costs. Efficacy of mating disruption will be summarized and reported by November, 2002; impact on height and volume growth in 2002 will be reported by December 2002.
- Sower, L.L., D.L. Overhulser, G.E. Daterman, C. Sartwell, D.E. Laws, and T.W. Koerber. 1982. Control of *Eucosma sonomana* by mating disruption with synthetic sex attractant. *Journal of Economic Entomology* 75: 315-318.
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- Williams, C.B., E.L. Smith and T.W. Koerber. 1989. Damage appraisal and management of the western pine shoot borer, *Eucosma sonomana*, in pine plantations in California: a case study. Pp. 110-123 in: R.I. Alfaro and S.G. Glover, *Insects affecting reforestation: Biology and Damage*. Forestry Canada, Pacific Forestry Centre, Victoria, British Columbia, Canada.

***Proposed Budget - FY 2002 (only):**

<u>Source</u>	<u>Contributed Resources</u>
FHTET	\$14,000
3M Canada	\$10,000
PSW	\$8,000
PNW	\$5,000
Cooperative (Sierra- Cascade)	\$7,500
Roseburg Resources	\$2,000
Total	\$46,500

* Alternative budget, below, assumes that Coop will do post-treatment measurements.

Alternative Proposed Budget - FY 2002 (only):

<u>Source</u>	<u>Contributed Resources</u>
FHTET	\$14,000
3M Canada	\$10,000
PSW	\$8,000
PNW	\$5,000
Cooperati ve (Sierra- Cascade)	\$5,000
Roseburg Resources	\$2,000
Total	\$44,000

2002: A new study was initiated this year (2002) in northern California to test mating disruption of the western pine shoot borer (*Eucosma sonomana*). This moth is a serious pest, known to reduce height growth of pines up to 20% per year in western North America. A synthetic pheromone registered for the eastern pine shoot borer (*E. gloriola*) is also effective against the western pine shoot borer. This year, FHTET sponsored a new microencapsulated formulation of the pheromone for aerial application, and tested it for an area-wide effect on five 50-acre plots.

Preliminary results indicate that 12g/acre, applied aerially as a microencapsulated formulation of the active pheromone ingredient, significantly reduced early season trap catch (we report only results for the first month post-treatment, since moth flight was nearly over by that point).

The effect on infestation level was variable, with the best results seen in the two Pondosa plots and the worst results seen in the two Scarface plots (Table 2):

The reduction on infestation level varied between 21.1% and 77.4%, with the best results seen in the two Pondosa plots and the worst results at Scarface 2.

We have not yet determined the reason for the differences in efficacy at the different plots, but there are several possible explanations. First, differences in temperature and humidity may have caused the active ingredient to release at a more rapid rate on the Scarface and Crank plots than at Pondosa. Second, differences in weather may have caused differential degradation of the active

ingredient (this possibility is not likely considering the nature of the pheromone). Third, there were different WPSB population pressures at the different sites (Scarface 2, in particular, started out with a very low pre-treatment infestation rate (2%), but infested leaders at the control site increased astronomically (to 38%), between 2001 and 2002) (Table 3).

Fourth, and probably most likely, differences in temperature and/or snow cover may have resulted in later emergence at some sites, thus missing the window of pheromone elution from the microcapsules. Results from the monitoring traps (Table 1), support this conclusion. For example, if the higher levels of infestation in treated plots resulted simply from increased population pressure, then we would expect Pondosa 1 to have had a high infestation level, because by one month following treatment the Pondosa 1 control plot had one of the highest trap catches. But in fact, Pondosa 1 had the second-lowest level of infestation in the treated plot. We conclude, therefore, that the greater levels of control seen at the Pondosa plots resulted from better synchrony of local phenology with spray timing. This conclusion suggests a need for a longer-releasing microcapsule, perhaps on the order of just 7-14 days longer.

The striking increase in background populations at Scarface 2 suggests that those plots constituted a stronger challenge to the treatments than did the Pondosa plots, where background populations were either flat or only increased moderately. A second year of testing and statistical analyses is

necessary to determine stand growth benefits. We will clearly need to assess treatment effects using the annual increase in infestation as a covariate, since it appears that rapid increases in background populations can affect efficacy.

technology still has promise for use in western plantations, because it remains the only formulation that can be aerially applied using conventional spray equipment. We are currently trying to recruit funding for a second application, which we hope would further suppress moth populations.

These results, while somewhat disappointing, compare favorable in terms of efficacy with results from the luretape technology. We feel that the

Table 1. Numbers of moths responding to pheromone-baited traps, by week

	2 Weeks	2 Weeks	4 Weeks	4 Weeks
Location	Treatment	Control	Treatment	Control
Pondosa 1	0	15	2	127
Pondosa 2	0	82	0	41
Scarface 1	0	182	1	141
Scarface 2	0	24	19	168
Crank	0	96	7	44

Table 2. Percent infestation of leaders by WPSB, treatment vs. control plots

Location	Treatment	Control	% Reduction
Pondosa 1	14	62	77.4
Pondosa 2	6	48	75.0
Scarface 1	32	70	54.3
Scarface 2	30	38	21.1
Crank	20	56	64.3

Table 3: Percent infestation of leaders by WPSB, 2001 vs. 2002 (control plots only):

Location	2001	2002
Pondosa 1	54	62
Pondosa 2	48	48
Scarface 1	64	70
Scarface 2	2	38
Crank	50	56

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Crank	50	56

2003: The Principal Investigators reported on the results of the 2002 application at the January 2003 business meeting of the Co-op. If 3M could develop a better/longer lasting formulation, the Investigators were proposing a second treatment in the spring of 2003. In March, the Co-op membership was notified that the new formulation had been developed and the Investigators were requesting funding amounting to \$1850 from the Co-op for this 2003 application. Funding for the second application was approved by the membership on March 24, 2003.

The pheromone got held up in customs (it was coming from Canada) and by the time it cleared customs and reached the researchers, the weather on the test site had deteriorated and prevented the application. By the time the weather improved, the insects were already flying and it was too late to apply the treatment in 2003. The plan is to store the pheromone and apply for Co-op funding for a spring 2004 application. This request will be made at the January 2004 business meeting in order to distribute the funds to the researchers in time to apply the treatment in early spring.

2004: The second of two applications of a microencapsulated formulation of western pine shoot borer (*Eucosma sonomana* Kearfott) pheromone, 80:20 Z:E-9-dodecenyl acetate, was conducted in 2004 to disrupt moth mating in a northern California ponderosa pine plantation. The first application was conducted in 2002 (see above). The pheromone proved to be behaviorally active for another pest species, (*Rhyacionia bushnelli* Busck), so its effect on that species was measured as

well. Five 20.25-ha plots were treated with the pheromone, and five 20.25-ha untreated plots served as controls. The 2002 application was made at the rate of 20.5 g AI/ha, and the 2004 application was made at twice that rate, or 59.0 g AI/ha. Sentinel traps baited with western pine shoot borer lures were placed in treated and control stands in both 2002 and 2004 to assess efficacy of mating disruption of both moth species. *E. sonomana* infestation levels were tallied at the end of the season. Both applications effectively shut down mating by both moth species for several weeks, with the 2002 application lasting about 45 days and the 2004 application for fully 75 days. Both applications significantly reduced infestation levels by western pine shoot borer, but the lower application rate provided greater absolute reductions in infestation level, perhaps because infestation levels were far higher before the 2002 treatments than before the 2004 treatments. In any case, the infestations were reduced to similar levels in both years, suggesting that while increasing the application rate may prolong mating disruption, it may not provide greater efficacy in terms of tree protection from moth attack. The incidence of moth infestations even in plots with complete mating disruption suggest either that the treatments missed a few early emerging females or that mated female moths immigrated into treated plots; thus operational testing should be timed earlier in the season and should comprise much larger plots to decrease the edge effect. In both 2002 and 2004, moth emergence began considerably earlier than reported in previous studies, indicating that mating disruption programs should account for potentially warmer climates in timing applications. The active ingredients in

this pheromone blend have also shown behavioral activity for 13 other species of *Rhyacionia* and six other species of *Eucosma*, so the approach may have broad application for control of many damaging pest species.

Total Funded: \$12,500; Total Spent as of 12/31/04: \$11,938.40.