United States
Department of
Agriculture

Forest Service

**Northeastern Forest
Experiment Station**

Research Note NE-339

Field Comparison of Spruce Budworm Pheromone Lures

David G. Grimble

Abstract

Four types of spruce budworm pheromone lures were tested to compare field longevity and efficiency. Biolures with three different pheromone release rates and Silk-PVC lures all caught male budworm moths throughout the moth flight period in proportion to the different release rates. Fumigant strips in traps to kill trapped moths were necessary.

The goal of most managers who deal with forests infested by spruce budworm (*Choristoneura fumiferana* (Clem.)) is to implement integrated pest management (IPM), insofar as possible, to reduce reliance on insecticidal sprays. IPM requires reliable and affordable insect population detection and monitoring techniques. Pheromone traps offer greater efficiency for these purposes, especially at low-population levels, than current techniques (Allen et al. 1984).

Spruce budworm pheromone has been identified and characterized (Weatherston et al. 1971, Sanders and Weatherston 1976, Silk et al. 1980): various trap designs have been evaluated; and a standardized, commercially available trap recommended for monitoring purposes (Sanders 1978, Allen et al. 1986). Some of the more important variables associated with budworm pheromone trapping have been investigated (Houseweart et al. 1981; Sanders 1986).

Budworm pheromone lures used in most recent field studies were produced on contract for specific purposes. Before users can fully implement this technique to detect or monitor budworm populations, the lures as well as the traps must be off-the-shelf commercially available items. Recently, spruce budworm lures became available from commercial sources. This research note reports results of field tests to compare the longevity and efficiency of three commercial lures to a "standard" lure that was used in recent field experiments.

The author is research entomologist, USDA Forest Service, Northeastern Forest Experiment Station, Orono, ME 04469

Methods

Pheromone traps used in this study were Multipher-1® plastic canister, non-saturating traps[1] that were thoroughly tested and recommended for monitoring spruce budworm (Allen et al. 1986). Insecticide strips (Vaportape II®) impregnated with a 9.95 percent concentration of 2, 2-dichlorovinyl dimethyl phosphate[2] were placed in most of the traps as a fumigant to prevent escape of trapped moths.

Pheromone lures were from two sources:

1. Biolure® lures are commercially available chips impregnated with budworm pheromone and covered with a permeable membrane.[3] The pheromone release rate through the membrane was reported to be essentially constant for the life of these lures.

2. Standard lures, hereafter called Silk-PVC lures, were used for comparison to Biolures. These lures were small pellets of polyvinyl chloride impregnated with budworm pheromone (0.03 percent by weight of 95:5, E:Z-11-tetradecenal). These were manufactured under contract.[4] The pheromone release rate for Silk-PVC lures was expected to approximate an exponential decay curve, beginning with a large burst of pheromone emission that declines as the lures aged in the field.

1. Extermination Sevigny, Service Antiparsitaire, 2949 Chemin Ste. Foy; Ste.-Foy, PQ; Canada G1X 1P3. The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

2. Health-Chem Corporation; Hercon Division; 1107 Broadway; New York, NY 10010

3. Consep Membranes Inc.; 213 Southwest Columbia: P.O. Box 6059; Bend, Oregon 97708

4. Dr. Peter J. Silk; New Brunswick Research and Productivity Council; P.O. Box 6000; Fredericton, New Brunswick, Canada E3B 5H1

Table 1.—Composition, release rates, and estimated duration of spruce budworm pheromone lures used at Costigan, Maine, 1986

Lure[a]	Ratio[b]	Release rate[c]	Duration[c]
		ng/hr	*Days*
Biolure A	95:5	1208	93
Biolure B	95:5	404	278
Biolure C	97:3	2083	108
Silk-PVC	95:5	100-20	28-35

[a] Biolures produced by Consep Membranes, Inc., Bend, Oregon: Silk-PVC lures supplied by Dr. Peter Silk, New Brunswick Research and Productivity Council, Fredericton.

[b] Ratios are for E:Z — 11 tetradecenal.

[c] Determined by supplier: release rates were measured after lures were aged for 10 days at 21°C (Silk-PVC) and 25°C (Biolures); release rate for Biolures was constant for life of the lure; release rate for Silk-PVC lure approximates exponential decay curve. Duration is theoretical period during which approximately 95 percent of pheromone is expended from lure.

All pheromone lures were stored frozen and were protected from sunlight and heat until deployed in the field. Release rates and expected field life of all four lures used in this study are shown in Table 1.

Plots

In May 1986, 10 study plots were located along Stud Mill Road east of Costigan, Maine. Five plots were grouped at about 0.5-km intervals in T 32 MD: five were grouped in an area approximately 25 km further east (T 34 MD and T 35 MD). Plots were similar spruce-fir stands (5 to 10 m in height) that had been thinned by Champion International Paper Company field crews. All were infested by budworm and had received spray protection 2 to 5 years previously. The plots represented a range of budworm population densities, with higher populations in the easterly plot grouping.

Pheromone traps were deployed in field plots on June 17 and 18, when approximately 10 percent of the budworm population had pupated, and at least a week before male moth flight began. All traps were removed on August 13 and 14 after moth flight had ceased.

Pheromone traps were hung on the shady side of individual spruce or fir trees about 2 m from the ground. Branches that grew close to the trap openings, and so might impede moth flight or air flow over the trap, were removed. Traps were spaced about 40 to 60 m apart along a random transect across each plot area.

Fifteen traps were placed along each transect, three each with the following lure-fumigant combinations:

1. Silk-PVC lure without fumigant strip.
2. Silk-PVC lure with fumigant strip.
3. Biolure A lure with fumigant strip.
4. Biolure B lure with fumigant strip.
5. Biolure C lure with fumigant strip.

Order of trap placement with specific lure-fumigant combinations on each transect was determined by random numbers.

From July 2, when budworm moth flight had begun, until August 5, when moth flight had ceased, most of the traps were inspected and emptied 2 times per week. However, traps with lure-fumigant combination 1 and two-thirds of those with lure-fumigant combination 2 were left undisturbed throughout the flight period. The intent was to determine the effect, if any, of a fumigant on total seasonal moth catch.

Results

In all plots, mean trap catches of male budworm moths were quite variable (Table 2). As expected, budworm moth populations were higher in easterly plots 6 to 10 than in westerly plots 1 to 5, generally by a factor of 2 or more.

Among the four lure types, there seemed to be a relationship between pheromone emission rate (ng/hr) and mean trap catch. Lures with the lowest release rates (Silk-PVC) caught the fewest moths, in either plot group, while the highest release rate lures (Biolure C) consistently caught the most. However, the results for Biolures A and B were reversed, in that B with a lower release rate caught more moths than A.

In both plot groups, the lack of a fumigant killing agent in traps baited with Silk-PVC lures resulted in much lower mean moth catches than when the fumigant was present, probably indicating that some captured moths had escaped. Sanders (1986) found that about half of the trapped moths escape if traps are not coated inside with adhesive. However, he also concluded that dichlorvos-impregnated fumigant strips and accumulations of dead moths in traps had a repelling effect, resulting in lowered trap catches. This was not confirmed by our results. Presence of a fumigant increased mean trap catches, but only in plots 1 to 5 did removal of trapped moths twice a week result in higher seasonal catches (Table 3). Removal of moths from traps in the much higher populations (plots 6 to 10) apparently did not result in higher seasonal trap catches. Perhaps greater trapping intensity or less variability in trap catches would have demonstrated this repellency effect on high-density plots.

Table 2.—Mean cumulative number of male spruce budworm moths caught in pheromone traps baited with different lure-fumigant combinations; Costigan, Maine, 1986

Lure	Fumigant	Plots 1-5			Plots 6-10		
		$\bar{X}^a$	SD	CV%	$\bar{X}^a$	SD	CV%
Silk-PVC	Absent	15.53a	24.08	155	70.00a	49.60	70
Silk-PVC	Present	41.00ab	36.01	87	112.07ab	69.93	62
Biolure A	Present	49.86abc	31.07	62	125.86b	54.27	43
Biolure B	Present	60.46bc	31.97	52	133.46bc	36.92	27
Biolure C	Present	81.40c	41.86	51	180.60c	70.50	39

[a] Means represent 15 traps each. Within a column, means followed by the same letter are not significantly different (p=0.05), by Duncan's Multiple Range Test.

Table 3.—Mean male spruce budworm moths caught in pheromone traps, with and without fumigant strips; Costigan, Maine, 1986

Lure	Fumigant	Plots 1-5		Plots 6-10	
		No. traps	$\bar{X} \pm$ SD	No. traps	$\bar{X} \pm$ SD
Silk-PVC	absent	15	15.5 ± 24.08	15	70.0 ± 49.60
Silk-PVC	present	10	33.6 ± 30.82	10	120.0 ± 81.47
Silk-PVC	present	5[a]	55.8 ± 44.62	5[a]	96.2 ± 41.38

[a] Trapped moths were removed twice weekly from these traps.

One field observation which caused immediate concern was the delamination of Biolure baits. By the first examination date (July 2), about the time of initial budworm moth flight, many of the permeable membranes covering the pheromone-impregnated chips of Biolure types A and B had visibly separated from the main lure disc and curled upward to expose the chip, perhaps in response to high field humidity. Because the membrane was designed to regulate and extend the period of pheromone release, we were advised that failure of the lure adhesive and resultant delamination of Biolures would result in complete "bleeding" of pheromone and, thus, inactivation of affected lures within 12 to 24 hours (Personal communication, M.G. Banfield, Consep Membranes, Inc.). That apparently did not happen. By July 8, virtually all Biolures A and B and most of the Biolure C lures had separated. A plot of periodic mean trap catch by lure type over time for plots 6 to 10 (Fig. 1) showed that all four lure types continued to catch male budworm moths over the entire flight period, again in proportion to the different lure release rates. Lures in plots 1 to 5 performed similarly. There was no sudden drop in moth catch that would have signaled a deactivation of lures following membrane separation under field conditions. Furthermore, we were assured (Personal,.communication, M. G. Banfield, Consep Membranes, Inc.) that the lure adhesive problem has been resolved and lure delamination should not reoccur.

Conclusions

Although all pheromone baits performed satisfactorily in this field study, we believe that release rates for all four types of lures were too high. For monitoring purposes, total trap catch is less important than is the variability of the catch. Larger trap catches increase the time needed to count moths and perhaps increase the repellent effect caused by accumulations of dead moths. We believe that a commercially available lure with a release rate equal to or slightly less than Silk lures, but with a more constant release rate, like Biolures, would be preferable to lures with rapidly declining emissions. Use of fumigant strips in traps is worthwhile to prevent moth escape, in spite of the possibility of fumigant repellency. Moth accumulations in traps with fumigant strips were cleaner, less damaged, and much

easier to count than those without insecticide strips. Without fumigants, trapped moths flutter about for longer periods before dying.

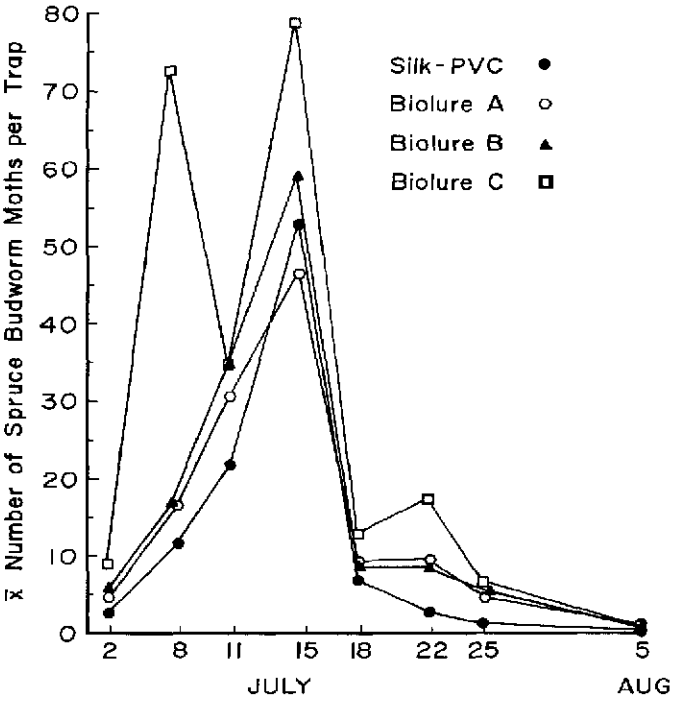

Figure 1.—Periodic mean male spruce budworm moth catch in pheromone traps with four different lures, each with a fumigant strip: Costigan, Maine, 1986. (Data from eastern plots 6 to 10.)

Literature Cited

Allen, D.C.: Abrahamson, L.P.: Jobin L.: Souto, D.J.: Sanders, C.J. 1986. **Use of pheromone traps to monitor spruce budworm populations.** Ottawa, ON: Canadian Forestry Service. 16 p.

Allen. D.C.: Dorais, L.; Kettela, E.G. 1984. **Survey and detection.** In: Schmitt, D.M.; Grimble, D.G.; Searcy, J.L. Tech. coords. Managing the spruce budworm in eastern North America. Agric. Handb. 620. Washington, DC: U.S. Department of Agriculture, Forest Service: 22-36.

Houseweart, M.W.: Jennings, D.T.; Sanders, C.J. 1981. **Variables associated with pheromone traps for monitoring spruce budworm populations (Lepidoptera: Tortricidae).** Canadian Entomologist. 113:527-537.

Sanders, C.J. 1978. **Evaluation of sex attractant traps for monitoring spruce budworm populations (Lepidoptera: Tortricidae).** Canadian Entomologist. 110:43-50.

Sanders, C.J. 1986. **Accumulated dead insects and killing agents reduce catches of spruce budworm (Lepidoptera:-Tortricidae) male moths in sex pheromone traps.** Journal of Economic Entomology. 79(5):1351-1353.

Sanders, C.J.: Weatherston, J. 1976. **Sex pheromone of the eastern spruce budworm (Lepidoptera:Tortricidae): optimum blend of *trans* — and *cis* -11- tetradecenal.** Canadian Entomologist. 108:1285-1290.

Silk, P. J.: Tan, S.H.: Wiesner, C.J.: Ross, R.J.: Lonergan, G.C. 1980. **Sex pheromone chemistry of the eastern spruce budworm, *Choristoneura fumiferana.*** Environmental Entomology. 9: 640-644.

Weatherston, J.: Roelofs, W.: Comeau, A. 1971. **Studies of physiologically active arthropod secretions. X. Sex pheromone of the eastern spruce budworm *Choristoneura fumiferana* (Lepidoptera: Tortricidae).** Canadian Entomologist. 103:1741-1747.

Acknowledgments

We are indebted to Champion International Paper Co. for use of their timberland. Biolures were donated by Consep Membranes Inc., while Silk-PVC lures were provided by the Canadian Forestry Service.

Northeastern Forest Experiment Station
370 Reed Rd., Broomall, PA 19008

December 1987

☆U. S. GOVERNMENT PRINTING OFFICE: 1987/548-006/60008