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Pheromone Lures to Monitor Sparse Populations of Spruce Budworm, *Choristoneura Fumiferana* (Lepidoptera: Tortricidae)

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PHEROMONE LURES TO MONITOR SPARSE POPULATIONS OF SPRUCE BUDWORM, *CHORISTONEURA FUMIFERANA* (LEPIDOPTERA: TORTRICIDAE)

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ABSTRACT

Four types of spruce budworm pheromone lures were field-tested in sparse spruce budworm populations in Maine. BioLures® with constant pheromone emission rates less than 1.0, ca. 1.0-1.5, and ca. 15.0 micrograms of pheromone per day were compared to polyvinyl chloride (PVC) lures with rapidly decreasing pheromone emission rates. Mean trap catch was roughly proportional to lure emission rates. All lures continued to catch moths over the entire flight period but moth catches with the three lowest emission-rate lures were judged to be too low. BioLures with the highest emission rate (15.0 micrograms of pheromone per day) showed the lowest variability in trap catch and the fewest zero trap catches.

Traps baited with pheromone lures to catch male moths are probably the most efficient tools currently available to monitor sparse populations of spruce budworms, *Choristoneura fumiferana* (Clem.). Large capacity traps are placed in the field immediately prior to the onset of moth flight and retrieved 3 to 4 weeks later after all moth flight has ceased (Allen et al. 1986). Mean trap catch can then be used to evaluate relative population density and, with serial data, make useful predictions of population trends over time. To use this new technology, however, pest control personnel need reliable sources of effective traps and pheromone baits.

Various trap designs have been tested and a commercially available trap has been accepted as adequate for monitoring purposes by most users (Sanders 1978, Allen et al. 1984). Previous field testing has generally employed baits produced on contract for specific purposes but commercial pheromone baits are now available. In preliminary testing of commercial baits, trap catch was often too high, largely because of high pheromone emission rates (Grimble 1987, Sanders and Meighen 1987) and high budworm population levels.

For monitoring purposes, a large trap catch is less important than is uniformity in catch. Large trap catches increase the time needed to count moths and may even result in a repellent effect from dead moths already in the trap (Sanders 1986). This paper reports the results of a field test to compare trap catch from four pheromone baits with low emission rates in sparse budworm populations.

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METHODS

Pheromone traps used in this field study were Multipher - 1[2] plastic canisters (Extermination Savigny, Service Antiparsitaire, Canada), tested and recommended for monitoring spruce budworm populations (Allen et al. 1986). An insecticide strip (Vaportape II®) impregnated with a 9.95 percent concentration of 2, 2- dichlorovinyl dimethyl phosphate (Health-Chem. Corporation, Hercon Division) was placed in each trap as a fumigant to kill trapped moths and prevent their escape.

Pheromone baits used in this study were from two sources. BioLures (Consep Membranes Inc.) with 3 different emission rates, labeled A, B, and C, were pheromone-impregnated fiber chips sandwiched between a permeable membrane and an impermeable backing. The complete baits were flat and circular, approximately 3.2 cm in diameter, and were mounted directly on the inner surface of the trap lids by means of adhesive strips on the back of the lures. For these baits, the pheromone release rate through the membrane was reported to be essentially constant for the expected life of the lures (pers. comm. M. Banfield, Consep Membranes Inc.).

BioLure A baits were loaded with 0.42 milligrams of pheromone and had a calculated release rate of less than 1.0 micrograms per day; BioLure B baits contained 1.10 milligrams pheromone and released 1.0-1.5 microgram per day; BioLure C baits had a 2.54 milligram loading and released about 15.0 micrograms of pheromone per day. All of these lures were expected to remain functional for much longer than the 2 to 3 week moth flight period.

In addition, "PVC" lures were small (4 mm diam. × 10 mm long) pellets of polyvinyl chloride impregnated with budworm pheromone (0.03 percent by weight) and were manufactured under specific contract (New Brunswick Research and Productivity Council). The pheromone release rate from these lures was expected to approximate an exponential decay curve, beginning with a large burst of pheromone emission (approximately 2.4 micrograms/day) that declined with age to about 0.5 micrograms per day. Thus, soon after the initial burst of pheromone these lures were expected to have lower emission rates than BioLure A baits. Nearly all the pheromone should be expended in approximately 28 to 35 days. This type of lure had been used in most of the recent budworm pheromone trap field testing and was considered a standard in this test, to which others could be compared (Grimble 1987, Sanders and Meighen 1987). PVC lures were held in place on the inner surface of the trap lid by means of a small pin stuck through the lure.

All pheromone lure formulations were a 95:5 blend of E:Z-11-tetradecenal. Release rates were determined by suppliers after lures were aged for 10 days at 21°C (PVC) and 25°C (BioLures). Lures were stored frozen until field deployment and were protected from excessive heat and direct sunlight at all times.

PLOTS

Three groups of four plots each were established along Stud Mill Road east of Costigan, Maine: near Great Pond (T33 MD), 8 km further east near Deer Lake (T34 MD), and about 5 km south of that near Bracey Pond (T34 MD and T35 MD). Within a grouping, individual plots were spaced 0.5 km apart.

All plots were selected in similar mixed stands of red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*). Individual trees were 8 to 10 m tall and had been mechanically

[2]The use of trade, firm, or corporation names is for the information and convenience of the reader, and 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.

Table 1. Mean spruce budworm catch in traps baited with four different spruce budworm pheromone lures, 1987 flight season.

	Great Pond		Deer Lake		Bracey Pond	
Lure[a]	$\bar{X}^b$	S.D.	$\bar{X}^b$	S.D.	$\bar{X}^b$	S.D.
PVC	1.0a	1.2	2.1a	2.1	2.8a	2.8
BioLureA	3.4ab	2.5	2.7ab	2.4	7.3ab	8.6
BioLureB	2.8ab	2.1	4.3ab	5.4	5.3ab	3.8
BioLureC	12.1b	9.8	6.7b	5.2	12.6b	7.7

[a]pheromone emission rates were determined by the lure manufacturer: PVC, 2.4-0.5 micrograms per day; BioLure A, less than 1.0 microgram per day; BioLure B, 1.0-1.5 microgram per day; BioLure C, 15.0 micrograms per day. Emission rates were measured after lures were aged for 10 days at 21°C (PVC) and 25°C (BioLures).
[b]means represent 16 traps each. Means within a column followed by the same letter are not significantly different ($p = 0.05$) by Duncan's Multiple Range Test. Separation of means test was done on logarithms of trap catches.

thinned by Champion International Company field crews. Sixteen pheromone trap trees were marked at 40 to 50 m intervals along a transect across each plot area. Selected trap trees were either spruce or fir, with large, healthy crowns and sufficient clearing around them to allow air movement on all sides. Although all of these plot areas had high population levels during the recent budworm outbreak (1976 to 1984), budworm populations were currently very sparse and budworm feeding was negligible on trap trees.

During the week of 15 June 1987 a pheromone trap was placed in each trap tree. At that time, budworm present were in the sixth instar or early stages of pupation. Traps were hung about 2 m from the ground level on the shady side of the tree, after all branches within a 1 m distance which might impede moth flight or air movement were removed.

Successive traps on a transect were systematically baited with different lures (i.e. PVC, BioLure A, BioLure B, BioLure C) and the order of lure use was repeated four times, so that of the 16 traps in each plot, four were baited with each lure. Traps were inspected, and trapped moths counted and removed, three times; on 6–7 July, about 7–10 days after moth flight began, one week later on 13–14 July, and finally on 29–30 July after all moth flight had ceased. At each inspection except the last, traps were rotated one space forward on the transect, to minimize the effect of trap location on total catch.

RESULTS AND DISCUSSION

By visual examinations, spruce budworm population levels on our study plots were judged to be uniformly low and, by pupation time, live budworms were difficult to find. It would be generally impractical to attempt sampling of such sparse populations by conventional means, e.g. egg mass or larval/branch sampling. Mean trap catch in all plots was quite low regardless of lure type, and highly variable, but still measurable with pheromone traps (Table 1). However, the high variability in trap catch indicates that pheromone traps in sparse populations can only be useful for gross population monitoring purposes, not as precise measurements of sparse population levels.

There was no significant difference between catches in traps baited with the three lowest emission rate lures (PVC, BioLure A, BioLure B) (Table 1), although PVC lures consistently caught the fewest moths (Fig. 1). The strongest lure (BioLure C) consistently caught more moths than the other types. For BioLure C, mean trap catch over the entire flight period (6.56 to 12.63) was still sufficiently low that field counts of trapped moths were not overly time consuming and the repellent effects of trapped dead moths should have been negligible. Repellancy of dead moths noted by Sanders (1986) resulted from

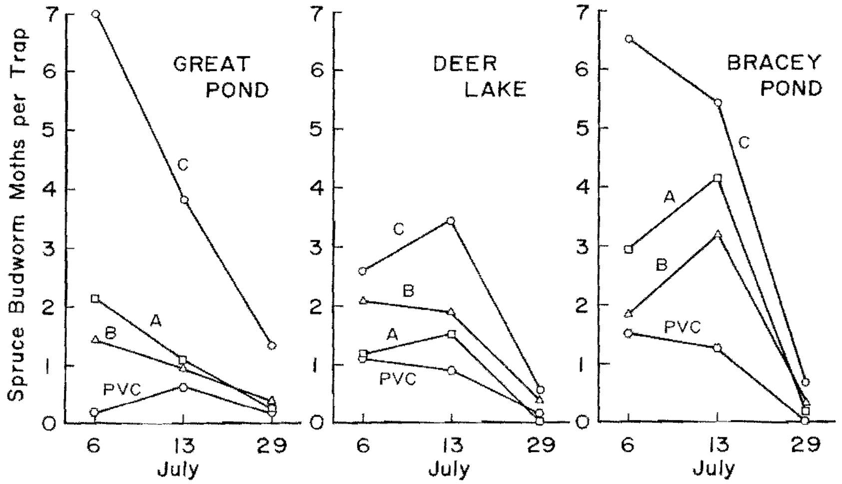

Fig. 1. Average catch of male spruce budworm moths in pheromone traps at three locations in Maine, 1987. Trap lures were BioLures A, B, and C, and PVC.

cumulative trap catches of 190 to 380 moths per trap. Fumigant strips in our traps killed moths quickly and kept the trapped moth collections clean and easy to count. Thus, I believe the use of insecticide strips in traps is justified in spite of the slight risk of repellancy from this agent.

Figure 1 illustrates periodic mean trap catch by lure type for the three plot groups. Most moths were caught by the second inspection (13 July) but the lures still continued to catch some moths for the next week as well (Fig. 1). Also, a relationship apparently exists between lure strength and trap catch, with the lowest emission rate lure (PVC) catching fewest and the strongest lure (BioLure C) always catching the most moths. Catches for BioLures A and B were very similar even though the emission rate for B was expected to be somewhat higher than that of A. Overlap in average moth catch was found only in the last week, when catches for all lures were minimal.

Even though all lures seemed to perform adequately in this field test, I believe that for monitoring endemic populations of budworm, the use of a lure with a constant emission rate and a potency similar to BioLure C (15.0 micrograms/day) is the best choice. An average trap catch of 12 to 15 moths is easy to count in the field, yet high enough to lessen the chances of numerous zero counts in trap catches. With many zero trap catches, the reliability of the lure comes into question, even in sparse populations. With a rapidly-declining emission rate lure (PVC), total catch can be easily influenced by poor timing of field deployment or bad weather early in the flight period.

The usefulness of trap catch data from sparse populations will increase with the number of years over which cumulative data is acquired. We need experience with these traps and lures at endemic population levels in order to be able to identify important changes in population trends.

ACKNOWLEDGMENTS

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