Efficiency and Longevity of Two Commercial Sex Pheromone Lures for Indianmeal Moth and Almond Moth (Lepidoptera: Pyralidae)[1]

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ABSTRACT Two commercially available sex pheromone lures, a rubber septum and a controlled release membrane, that were impregnated with (Z,E)-9-12-tetradecadien-1-yl-acetate, were tested for efficiency and longevity in capturing released Indianmeal moths, *Plodia interpunctella* (Hübner), and almond moths, *Cadra cautella* (Walker), in a large warehouse. When both species were released simultaneously, traps baited with both types of lures captured 19-20% of the Indiandmeal moths but captured less than 1% of the almond moths. The lures remained attractive for over 40 wks.

KEY WORDS Indianmeal moth, *Plodia interpunctella*, almond moth, *Cadra cautella*, wing traps, insect behavior, sex pheromone.

Monitoring stored product insect populations with pheromone traps is an integral part of many pest management programs (Brady et al. 1975, Read and Haines 1976, Ahmad 1987, and Vick et al. 1986). The Indianmeal moth, *Plodia interpunctella* (Hübner), and the almond moth, *Cadra cautella* (Walker), are serious pests of stored food in warehouses in the United States and thoughout much of the world. The major component of the sex pheromone of these two moths, as well as other phycitine moths, is (Z,E)-9,12-tetradecadien-1-yl-acetate (ZETA) (Brady and Nordlund 1971, Brady et al. 1971, and Kuwahara et al. 1971a,b). Attempts have been made to utilize this pheromone to control or monitor moth populations in stored products (Ahmad 1987, Vick et al. 1985, 1986). In this study, we compared the efficiency and longevity of two types of lures containing ZETA for monitoring Indianmeal and almond moth populations in a large warehouse. This is an initial step in developing an effective pest monitoring system for use in warehouses containing processed foods.

Methods and Materials

Test Facility. All lures were tested in a 22,225 m^3 (61 × 51 m) warehouse at the U. S. Naval Supply Center in Jacksonville, FL. The roof had three arches with skylights extending along the entire 51 m length. Ceiling height varied from 4.6 m to a maximum of 7.3 m at the center of each skylight. Six small windows and 3 overhead doors were evenly spaced along each 51 m length. The windows were never opened and only one door was used during the experiment. At each end

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there were large doors in the center, one of which led to other warehouse space. All doors were closed at night. The warehouse contained furniture and office items. Low level traffic in and out of the warehouse varied from week to week.

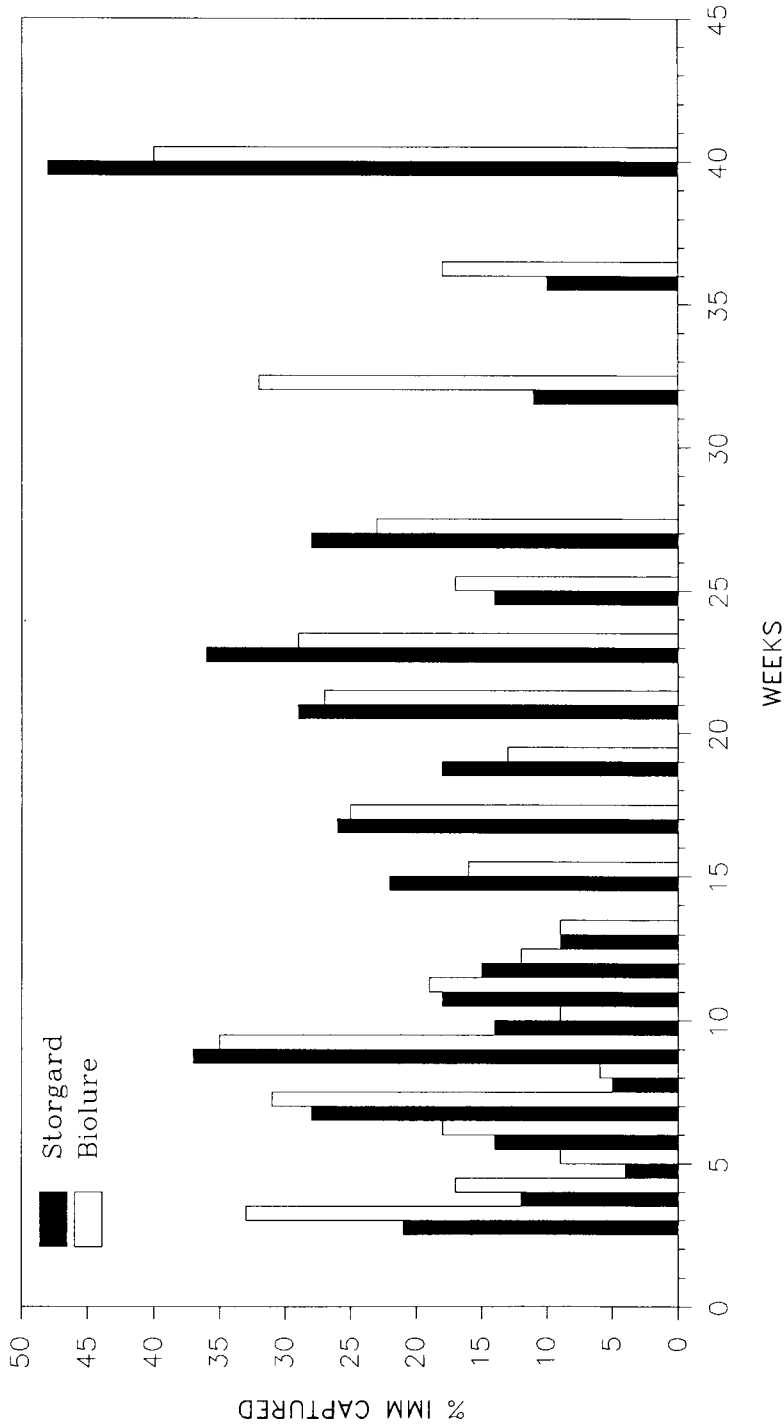
Traps and lures. Storgard® lures marketed by Tre'ce' Inc., Salinas, CA, and Biolure® lures marketed by Concep Membranes Inc., Bend, OR were used in this test. The trap used was the standard wing trap Pherocone 1C® marketed by both companies. The Storgard® lure is an impregnated rubber septum and the Biolure® lure is a controlled release membrane. Lures contained 1.0 and 5.3 mg ZETA, respectively, and were designed to attract the Indianmeal moth and almond moth as well as several related species. The traps had sticky inside bottoms to capture the lured insects and tops spaced about 25 mm from the bottoms. The manufacturers recommend that the Storegard® lures be replaced every 6 wks and Biolure® lures every 16 wks. In this study, the same lures were used for the duration of the test (40 wks).

Trap arrangements. Traps were hung at a height of 4 m and arranged in the warehouse so that a density of about one trap per 880 m^3 was obtained. A total of 24 traps (12 with each lure) were spaced so that each lure would be represented in all areas of the warehouse. Traps were placed 15.2 m apart, and after each sampling period they were moved one position and returned to the original position at the next sampling period to minimize the effect of position. The traps were placed in the warehouse on May 4, 1988. Two wks later they were examined for wild moth populations and none were found. Before test insects were released, the lures were replaced.

Insects. The insects used were reared on artificial moth medium (Boles and Marzke 1966) at 27 ± 2° C and 60 ± 10% Rh with a 12h photoperiod. Pupae were collected in corrugated paper rolls, about 25 pupae per roll, which were placed in each of 36 locations in the warehouse. Adult emergence from pupae ranged from 96 - 100% throughout these tests. About nine hundred pupae of each species were placed in the warehouse each week for the first six weeks, biweekly until week 28, and every 3 wks until week 40. Pheromone lures were not changed during the test period and all trap bottoms were replaced as they became dusty. The test was concluded on February 22, 1989, and the insects in 25% of the traps were examined to determine sex ratios. Temperature and relative humidity were monitored throughout the test. Data were analyzed by using the t-test of the Statistical Analysis System (SAS Institute 1987).

Results and Discussion

Efficiency of lure types. No significant differences in trap catches were found between the two lures ($F = 0.13$; $DF = 40$; $P = 0.72$) (Fig. 1). Based on number of males released each week (assuming a 1:1 sex rtio among pupae), the average total recapture rate for male Indianmeal moths released was 39% for both lures. Mean capture rates were 19% for Storgard® and 20% for Biolure®. When both species were released simultaneously, neither commercially produced lure was effective for the almond moth with less than 1% recovery. There was no position effect for traps containing either the Storgard® lure ($F = 1.69$; $DF = 9,9$: $P = 0.44$) or Biolure® lure ($F = 1.01$; $DF = 9,9$; $P = 0.99$) in the warehouse.



Since ZETA has been used successfully to capture almond moths in the absence of Indianmeal moths (Ahmad 1987), the low capture rates of almond moths when both species are released together provides evidence that the Indianmeal moth somehow suppresses the response of the almond moth to the pheromone. This suppression or inhibition is similar to that reported by Ganyard and Brady (1971) who found that female Indianmeal moths produce a volatile substance, later identified at (Z,E)-9, 12-tetradecadien-1-01 (Sower et al. 1974, Krasnoff et al. 1984), that inhibits the sex pheromone response of the male almond moth. The Indianmeal moths present may have produced enough of this inhibitor to reduce the capture of the male almond moths.

Sex ratio and density. Nearly all trapped insects were male Indianmeal moths and less than 3% were females, probably trapped in random flight. There was some indication that the number of Indianmeal moths released influenced the percentage of males captured. At 9 wks 1600 Indianmeal moths were inadvertently released instead of the normal 900. Capture following this release was the lowest (11%) for any sampling period. The following week 250 Indianmeal moths were released and the second highest capture (72%) was recorded. It is known that at high population densities, males of the Indianmeal and almond moths do not respond to synthetic ZETA as readily as to the natural pheromone produced by the calling females (Brady et al. 1975).

Temperature averaged 29°C for the 40 wks of the test and ranged from 15°C to 39°C. Because the insects are active throughout this range, temperature was not considered an important factor in these tests.

Longevity of lures. Both lures were attractive for 40 wks. This is beyond the manufacturers' recommendation of 16 wks for the Biolure® and 6 wks for the Storegard® lure. Because of this longevity, trap catch can be enhanced by periodically changing the sticky liners (Riedl 1980).

Conclusion. When both species are released simultaneously, the rubber septa and the controlled release membrane lures were effective for attracting male Indianmeal moths, but not the almond moths. Very few females were trapped, indicating that at the trap density described, sex pheromome baited traps are useful only to monitor populations. There is some indication that at high population densities, efficiency of the traps is reduced. In spite of limitations, pheromone traps can be useful in an integrated pest management system for insect detection and surveillance, as well as for the timing and evaluation of control procedures.

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