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# A pheromone-baited trap for monitoring the Indian meal moth, *Plodia interpunctella* (Hübner) (Lepidoptera: Pyralidae)

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## Abstract

A pheromone-baited trap was developed to monitor the Indian meal moth in grocery stores and similar areas where visible traps are not desirable. The trap can be used under shelves and against walls. As a shelf mount, the trap is in close proximity to the food packages and may capture emerging insects before they mate. The trap can also be used as a hanging trap similar to the Pherocon II. When used as a shelf or wall mount, it was as effective as the Pherocon II, but when used as a hanging trap significantly fewer insects were captured. © 2001 Elsevier Science Ltd. All rights reserved.

*Keywords:* Insect detection; Stored-product insects; Insect monitoring

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## 1. Introduction

Monitoring of pest populations is essential for a successful integrated pest management program (IPM). The development of synthetic insect pheromones and food attractants has given the food industry a highly effective tool for early detection of insect infestation. The use of pheromone-baited traps to monitor insect populations offers several advantages over visual inspections. Traps work 24 h a day and 7 days a week. Maintenance of traps is simple and requires regular inspections to record the numbers and species of insects caught, to clean traps and replace lures. Tolerances for insects established by the US Food and Drug Administration (FDA) for processed foods are low and the FDA now encourages the use of insect traps in pest management programs (Mueller, 1998). To achieve low pest densities, it is important that pest populations be detected while in the early stage of infestation and before serious problems develop. To do this, the proper combination of traps and pheromone baits must be used. Most stored-product pest monitoring has been conducted in warehouses, processing plants, and grain storage facilities. In

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these situations, traps can be hung or placed without regard to any negative impressions that the public may have when they see the traps. However, when monitoring for pests in retail grocery stores, the presence of traps containing insects might lead to the perception by the shoppers that the store is dirty or insect-infested. A trap that is hidden from view should appeal to retailers and increase the acceptance and use of traps.

Often insect problems in grocery stores are localized (Cuperus and Platt, 1996) and a trap that draws insects from a relatively small area would be beneficial when looking for points of infestation. In this study we designed a trap for the Indian meal moth, *Plodia interpunctella* (Hübner), with the specific objectives of developing a versatile trap that could be used in confined areas, remain out of view, and be as effective as other commercially available traps.

## 2. Materials and methods

Traps were made from strips of 0.28-mm thick paperboard that were  $10 \times 27$  cm. The last 2.5 cm of each of the long ends was folded towards the center of the strip and  $\frac{1}{2}$  of the strip was folded away from the center and towards the edge (Fig. 1a). When viewed in cross section it had an appearance similar to the cross section of a dinner plate. The total trapping surface was  $10 \times 22$  cm ( $220 \text{ cm}^2$ ) and was coated with a layer of Tanglefoot™ (The Tanglefoot Co., Grand Rapids, MI). Each of the folded ends of the trap was fitted with a magnetic clip or magnetic tape to hold the trap in place on a metal surface. The trap was designed so that it could be used under a shelf, as a wall mount (Fig. 1a), or with the ends folded together as a hanging trap similar to the Pherocon II trap (Trécé Inc., Salinas, CA) (Fig. 1b).

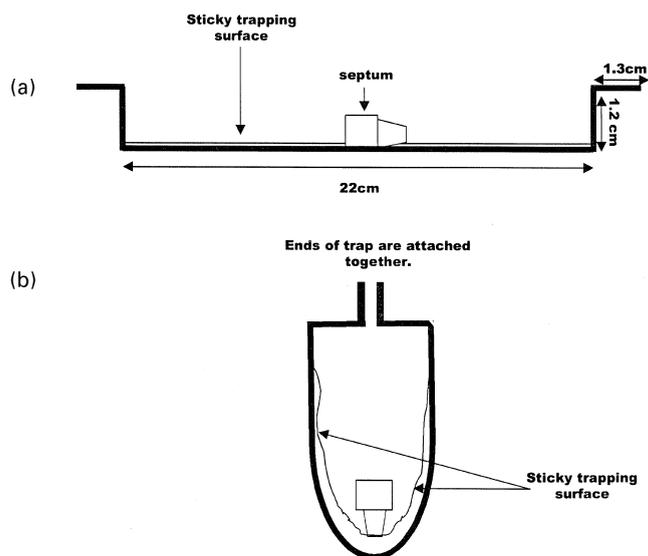


Fig. 1. Experimental trap for the Indian meal moth shown as a shelf/wall mount (a) or as a hanging trap (b). The trap can be held with magnetic clips, tape, Velcro or pins. Ends of the hanging trap can be held together with clips.

The traps were tested in a warehouse 11.8 m × 11.8 m. The ceiling followed the roof line with a height of 4.3 m at the walls and 6.2 m at the highest point. The building was 610 m<sup>3</sup>. The Pherocon II trap was used as a comparison. The Pherocon II trap is also a small trap (15 × 19 cm) with a trapping surface of 10 × 28 cm (280 cm<sup>2</sup>). The trap comes assembled and is designed to be pulled apart to reveal the sticky interior. The trap, when in use, is roughly diamond shaped. Three Pherocon II, three hanging experimental traps, and three shelf-mounted experimental traps were used in each test. The hanging traps were hung at 1.8 m and the shelf-mounted traps 0.9 m above the floor. Unbaited traps were not included in this study because very few insects are trapped in unbaited traps (Mullen, 1994; Mullen et al., 1998). The building had no temperature or light controls. The temperature varied from a low of 24°C at night to a high of 39°C in the afternoon. Light entered the building from four skylights and six windows. Traps were baited with Trécé, Indian meal moth (IMM + 4) rubber septa lures loaded with 1 mg of (Z,E)-9,12-tetradecadien-1-ol-acetate (Brady and Nordland, 1971; Brady et al., 1971, Kuwarahara et al., 1971a, b; Mullen, 1994). The septa were placed in the center of the trapping surface. Tests were replicated six times and lures were replaced after each test. The replications were spaced 2 weeks apart to allow the adult insects not trapped to die.

The Indian meal moths used in this study were reared on a standard laboratory diet (McGaughey and Beeman, 1988) at 27 ± 2°C. For each replication 400 unsexed 3–4 day-old Indian meal moth pupae were placed in groups of 100 at four points approximately 3 m from each corner of the warehouse. The number of adults that failed to emerge in each replication was recorded. Trap counts were made at 2 and 4 days. The trap catch was expressed in terms of percent of total capture. Data were analyzed using a general linear model procedure (SAS Institute, 1997) and means were separated using the least significant difference test.

### 3. Results and discussion

The total number of insects in the study was 2400 and 86% (2064) emerged. Assuming a 1:1 ratio of males to females (Mullen et al., 1998) 1032 adult male Indian meal moths were available. The mean percentage of total insects trapped in the experimental wall/shelf configuration was 42.5 ± 17.4% (285 ♂) compared to 38.9 ± 15.5% (263 ♂) for the Pherocon II trap. However, when the experimental trap was configured for use as a hanging trap, it caught only 18.9 ± 1.8% (127 ♂) of the total insects trapped. The differences in the number of insects collected in the traps were significant ( $F = 38.17$ ; d.f. = 2, 10;  $P \leq 0.0001$ ; least significant difference = 6.4) and there was no significant difference between replications ( $F = 0.02$ ; d.f. = 5, 10;  $P = 0.99$ ).

One of the main advantages of the Pherocon II trap is its small size. Although not as large as the Pherocon 1c wing trap also sold by Trécé, Inc., it has the advantage of being usable in areas where it might not be desirable to use the larger wing trap. The total trapping surface of the Pherocon 1c wing trap is 414 cm<sup>2</sup> as compared to 280 cm<sup>2</sup> for the Pherocon II. Previous research found that trap catch was 0.61 and 0.63 insects/cm<sup>2</sup>, respectively (Mullen et al., 1998). In the present study the Pherocon II trapped 0.92 insects/cm<sup>2</sup> and the shelf trap 1.4 insects/cm<sup>2</sup>. However, when the trap was reconfigured to make it a hanging trap, the capture rate was reduced to 0.55 insects/cm<sup>2</sup>. The lower number of insects per cm<sup>2</sup> may be influenced by the smaller openings resulting from the trap being folded. These data also suggest that the area of the trapping surface

may have an influence on trap efficiency. One of the most significant factors that may affect insect catch is the design of the trap (Valles et al., 1991).

Although there was some indication that the area of the trapping surface may influence trap efficiency, greater size such as in the Pherocon 1c was not the sole factor. AliNiazee (1983) suggested that pheromone plume characteristics could affect trapping efficiency. In our study, the hanging trap design lacked the raised edge of the Pherocon II, which may have altered the configuration of the plume influencing trapping effectiveness. Vick et al. (1979) found that the Pherocon 1c was more effective than traps with larger surface areas due to the presence of two horizontal surfaces. Our under-the-shelf or wall-mounted trap also has two surfaces, the sticky board and the surface formed by the underside of the shelf or the wall.

The shelf trap may be particularly useful in situations where it is desirable to hide the trap from view. It can be mounted under shelves in retail markets. In a parallel study, the trap was mounted under grocery shelves between the stiffening ribs that are generally found on the bottom of the shelves (Dowdy and Mullen, unpublished data). In this case, the traps were held in place with magnetic clips. Velcro, pins, or tape could also hold the traps in place depending on the mounting surface. The trap was effective as a wall or shelf mount.

The benefits of this trap are that it can be hidden from view and it can be placed in close proximity to the food products being monitored. With the trap placed under the shelf air movement is restricted which can enhance trap catch (Burkholder, 1985). This may result in a possible reduction in re-infestation by capturing insects as they emerge and before they can mate (Platt et al., 1998). When placed between the ribs of the shelf the trap was also protected from accidental damage. In addition, the trap could be used in a home pantry situation to monitor pantry pests. Because our trap does not have to be hung in place, it is easy to install and maintain. Despite the fact that some trap efficiency is lost, the trap can be reconfigured and used as a hanging trap.

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