A MODEL TRAP FOR MONITORING *EPHESTIA CAUTELLA* (WALKER)

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ABSTRACT

Three commercially available pheromone traps used for monitoring *Ephestia cautella* (Walker) were compared in a wind tunnel in moving (0.65 m/s) and still air. The shape and dimensions of the pheromone plume emitted from the traps determined the behavioural responses of the moths and the numbers captured. To improve trap design, the visual responses of the moths to brown paper rectangles and brown and white stripes showed that more moths were attracted to a 6 x 50 cm vertical rectangle on a white background and to 7.5 mm wide brown and white stripes. A striped cylindrical trap constructed to incorporate these features captured 90% and 80% of the moths released in the wind tunnel in moving and still air, respectively, compared with 70% and 35% by the best commercial traps.

INTRODUCTION

Pheromone-baited traps are used for monitoring insect species and are often integral parts of pest management programmes (Cammel and Way, 1987). Such traps are most useful if they are consistent in their catches and reflect the relative abundance of the insect being monitored. Various types of traps have been tested for warehouse moths including; sticky traps (Read and Haines, 1976; Reichmuth *et al.*, 1976), water traps (Snifer *et al.*, 1983), and "funnel" traps in which the captured moths are killed by insecticide (Cogan, 1983; Cogan & Hartley, 1984). Although sticky traps (Fly strip & Delta) are usually superior to other trap types, the trapping surface can become covered with debris or dust and prevents their use in storage environments.

Studies have shown that male *Ephestia cautella* are visually attracted to certain shapes (Levinson and Hoppe, 1983) and colours with preference for brown, red and black vertical rectangles (Quartey and Coaker, unpublished data). To improve trap design, the various parameters which influence the attraction and capture of moths in moving and still air conditions were studied and incorporated into a model trap.

MATERIALS AND METHODS

E. cautella was cultured on an artificial medium consisting of wheatmeal, dried yeast, glycerol and glucose (10:1:2:2) in a 12 h light : 12 h dark regime at 27±2°C and 65±5% r.h. Non-mated adult males unexposed to female sex pheromone were used in the experiments.

Traps and moth behaviour were assessed in a large wind tunnel (6.0 m x 2.3 m x 1.8 m high) with laminated airflow at 0.65 m/s maintained at 27°C and 65% r.h (Hawkes and Coaker, 1979). Illumination was provided by one red 60 watt tungsten bulb. About 40, 2-3 days old caged male moths were pre-conditioned in the tunnel for 1 h before release. Tests were carried out between the first four hours of the scotophase, the period of maximum diurnal moth activity (Quartey, 1988).

Comparison of Commercial Traps.

The Delta, Covered Funnel and Uni-traps (Agrisence-Biological Control Systems Ltd.) were compared. The Delta trap was constructed from translucent corrugated plastic sheet folded into a rectangular prism (28 cm x 14 cm) open at each end. A pheromone polythylene vial was placed on the floor of the trap which was coated with a polybutene-based adhesive to entrap moths that entered the trap. The Covered Funnel trap consisted of an 11 cm diameter funnel above which was suspended a pheromone vial and a cover. Moths attracted to the lure fell through the funnel into a detachable container where they were killed by a dichlorvous strip. The Uni-trap was a modified version of the Covered Funnel trap but with a 16 cm diameter funnel.

The traps were baited with 1 mg of a 2:1 mixture of the synthetic sex attractants; (Z,E)9,12-tetradecenyl acetate [(Z,E)9,12-14:Ac] and Z,9-tetradecenyl acetate [Z,9-14:Ac] (Agrisense-Biological Control Systems Ltd.). The patterns of the pheromone plumes emitted from the traps were visualized using titanium tetra-chloride smoke. Each trap was tested separately in moving (0.65 m/s) and still air. Moths were released 4 m downwind of the traps and those that approached within 1 m of the traps, alighted on them, and were caught were recorded.

Visual attraction

A comparism was made of the visual attractiveness of six brown paper rectangles of different dimensions (Table II) but with the same area (300 cm^2) based on the findings by Levinson and Hoppe (1983). The brown paper rectangles were mounted on a white background and covered with transparent polythene sheet coated with adhesive. Three rectangles were displayed 50 cm apart at either end of the wind tunnel in still air. Forty moths were released in the centre of the tunnel on each occasion and the number of moths trapped and their positions on the rectangle recorded.

In another experiment, 12 cm x 50 cm white cards were covered in brown paper stripes ranging from 60 mm to 3.8 mm wide (Table III). The moths trapped were recorded as before. Both experiments were repeated 4 times with the rectangles and striped cards randomized in different positions.

Assesment of a model trap

Based on the optimal rectangular and stripe dimensions for attracting male *E. cautella*, a cylindrical trap (50 cm x 6 cm diameter), patterned on the outside with 7.5 mm brown and white vertical stripes, was constructed. A detachable funnel with a 1.5 cm orifice was fitted internally and a dichlorvos strip was placed in the enclosed section of the cylinder beneath the funnel. A flat 6 cm diameter cover was attached 2 cm above the cylinder and from it was suspended a pheromone lure (Fig 1). Similar traps 25 cm long were also constructed and tested as one and two units, one suspended beneath the other, with one or two pheromone lures. The traps were assessed using the same procedure as the commercial traps.

An analysis of variance was performed on the data and means separated by the Student-Newman-Keul's test (Sokal and Rohlf, 1969).

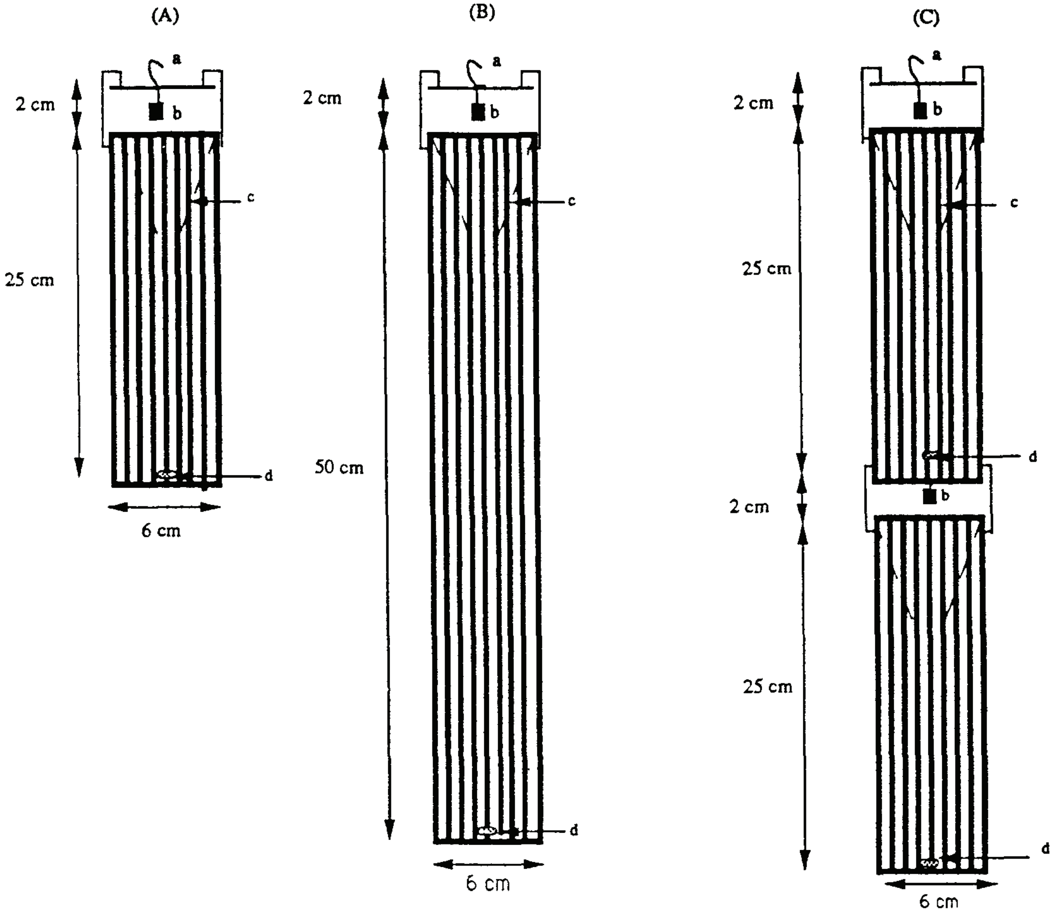

Figure 1. Cylindrical pheromone traps with 7.5 mm wide brown and white stripes: A-25 cm model, B-50 cm model and C-2x25 cm model. a, hanger; b, lure; c, funnel; d, DDVP.

RESULTS

Commercial traps

The shape and design of the traps determined the plume shape and form, and hence the moths' response to them. In moving air, the Delta trap produced a 1.5 m discrete plume downwind from the trap before becoming diffuse, but due to turbulence around the Covered Funnel and Uni-traps, the smoke first flowed around the outside of the traps before forming a discrete plume that persisted for less than 1 m downwind. In still air, the plume flowed around all the traps before forming a non-directional diffuse cloud.

In moving air, more moths approached, alighted on and were caught (72%) by the Delta trap than the other traps (40%), mainly because more moths entered the Delta trap directly whereas many of the moths that alighted on the other traps flew off without entering the traps. In still air, the performance of all the traps was reduced, with the Delta trap capturing fewest moths (Table I).

TABLE I. Percentage (± s.e.) of male *E. cautella* approaching, alighting on and captured by pheromone traps in (a) moving air (0.65 m/s) and (b) still air.

Trap design	% moths		
	Approaching within 1-m of trap	Alighting on the trap	Captured
(a)			
UNI-TRAP	77.2 ± 4.9a	65.4 ± 3.0a	41.4 ± 3.1a
COVERED FUNNEL	73.1 ± 6.1a	60.8 ± 4.2a	39.9 ± 2.2a
DELTA	95.0 ± 4.1b	22.1 ± 3.2b	72.0 ± 3.6b
(b)			
UNI-TRAP	62.1 ± 3.0a	59.1 ± 2.3a	34.3 ± 3.9a
COVERED FUNNEL	59.3 ± 2.9a	52.9 ± 3.2a	31.0 ± 3.7a
DELTA	29.9 ± 1.8b	25.2 ± 3.9b	22.1 ± 2.2b

Means followed by the same letter in columns are not significantly different (P > 0.05)

The variable performance of the traps in both attracting and capturing male *E. cautella* moths indicated limitations in their design. In moving air, a trap should provide minimum disturbance to the plume to enable moths to orientate towards the pheromone source, and in still air, when a diffuse plume is formed, provide a visual stimulus to attract moths over at least a distance equal to a discrete plume.

Visual attraction

The three rectangles with the highest length : breadth ratio caught the largest number of moths as more moths were attracted to the margins of the brown and white vertical interfaces than to the centre of the rectangles (Table II). Similar results were obtained from the brown and white stripes with more moths caught on the 7.5 mm wide stripes and fewest on the 3.8 mm strips, indicating the inability of the moths to recognize the interfaces between the narrowest stripes (Table III). The reason for the greater attraction of the moths to the narrower stripes was shown by comparing the frequency of moths caught on different parts of the cards (Fig. 2). More moths were caught on the interfaces between the stripes as their widths narrowed to 15 mm and 7.5 mm compared with those caught on the outer margins. The lowest numbers of moths were caught in the centre of the stripes.

TABLE II. Response of male *E. cautella* moths to brown paper rectangles of different dimensions

Rectangles (cm)	% captured	% of moths on rectangle	
		edge	center
2 x 150	27.0a	89.4	10.6
4 x 75	25.9a	83.5	16.5
6 x 50	23.6a	77.2	22.8
8 x 38	8.4b	81.4	18.6
10 x 30	6.2b	79.2	20.8
12 x 25	2.9b	56.9	43.1

Means followed by the same letter in colomns are not significantly different (P > 0.05).

TABLE III. Percentage of male *E. cautella* moths caught on brown and white striped cards

Card pattern	Stripe width (mm)	% caught ($\pm$ S.E)
	control	0.1 ± 0.2a
	60.0	1.9 ± 0.1b
	30.0	2.4 ± 0.6b
	15.0	17.2 ± 3.2c
	7.5	36.0 ± 3.9d
	3.8	0.5 ± 0.4a

Means follwed by the same letter in columns are not significantly different ($P > 0.05$).

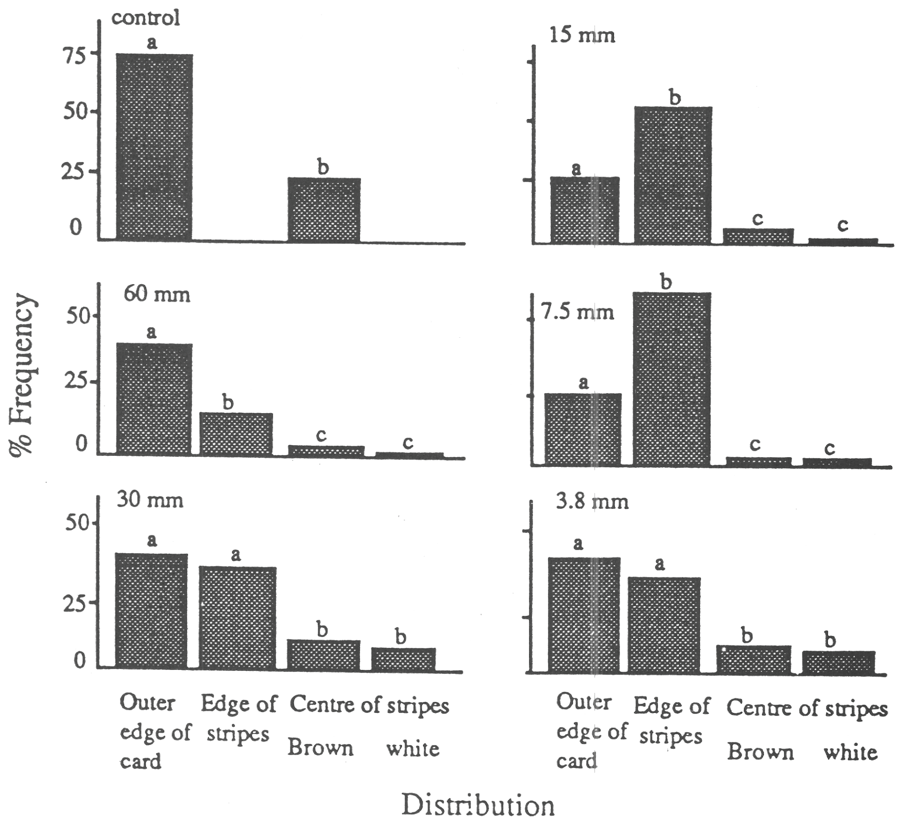

Figure 2. Percentage frequency of male *E. cautella* moths caught on different parts of the brown and white strip for each stripe width. Histograms with the same letter are not significantly different ($P > 0.05$).

Model traps

No moths were caught in the model traps without a lure. With a lure included more than 30% of the moths that alighted on the 25 and 50 cm traps left before entering them. This loss was reduced to about 10% in the paired 25 cm traps, when with a single lure in the upper trap 70% snd 57% of the moths were captured in moving and still air respectively, and with two lures, one in each trap, 96% and 85% (Table IV).

TABLE IV. Percentage of male *E. cautella* moths alighting on and caught by model trapswith and without a lure in moving and still air

Traps length (cm) ± lure (l)	% alighting		% caught	
	moving air	still air	moving air	still air
25-l	4.1 ± 0.1a	11.1 ± 2.7a	nil	nil
25+l	53.4 ± 2.7c	39.0 ± 4.2b	33.0 ± 1.9a	19.3 ± 1.5a
50-l	11.9 ± 0.6b	29.0 ± 3.1b	nil	nil
50+l	69.2 ± 3.0d	63.5 ± 4.9c	47.0 ± 2.0b	40.0 ± 2.9b
2x25+l	77.1 ± 4.1d	64.0 ± 2.1c	70.0 ± 3.1c	57.0 ± 4.0c
2x25+2l	96.9 ± 2.9e	84.6 ± 6.2d	90.2 ± 4.6d	79.0 ± 4.3d

Means followed by the same letter in columns are not significantly different (P > 0.05).

DISCUSSION AND CONCLUSIONS

The commercial traps used for monitoring male *E. cautella* moths in warehouses when asessed under controlled conditions, showed limitations in their effectiveness in moving air, mainly due to the turbulent plumes generated around the traps which interfered with the moths orientation to the lure and from entering the trap, and to their lack of visual cues valuable in still air conditions.

The model traps were designed to incorporate visually attractive features and to encourage moths to enter them, either directly or after having alighted on the trap. These features provided an improvement over the commercial traps, by combining optimal dimensions of the brown and white stripes and the size of the trap to provide a visually attractive image to the moths. To encourage more of the moths that alighted on the trap to enter and be captured, two 25 cm long traps suspended one beneath the other trapped more moths than a single 50 cm long trap. With one lure placed on the upper trap the same number of moths were caught as in the Delta trap in moving air, and almost three times the number in still air. With an additional lure placed in the lower trap, 90% and 80% of the moths were caught in moving and still air respectively.

In conclusion, pheromone baited traps used for monitoring warehouse moths should be designed to incorporate visual cues and to cause the least disturbance of the plume to provide maximum effectiveness across a range of conditions and moth abundance.

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UN NOUVEAU MODELE DE PIEGE POUR LA SURVEILLANCE D'*EPHESTIA CAUTELLA*

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Résumé

Trois pièges à phéromone disponibles dans le commerce (fournis par AgriSense-BCS S.A.), et employés pour la surveillance de la mite *Ephestia cautella* ont été comparés en soufflerie, avec et sans courant d'air. La forme des pièges et la taille de la "plume" de diffusion de la phéromone ont conditionné le comportement des mites et le nombre d'individus capturés par les pièges.

Afin d'améliorer la conception des pièges, les réactions visuelles des mites à différentes couleurs ont montré que la plupart d'entre elles étaient attirées par un rectangle vertical noir ou brun sur fond blanc, éclairé à l'interface entre les couleurs. Le nombre des mites attirées a augmenté par la suite lorsque le rectangle a été divisé en bande brunes et blanches de 7,5 mm pour allonger la longueur totale de l'interface.

Les pièges à phéromones cylindriques à rayures, construits pour intégrer un maximum de ces caractéristiques, avaient, après cinq heures, capturé 80 à 90 % des mites lâchées dans le tunnel de vol, respectivement en atmosphère immobile et en air pulsé, par rapport aux 30 et 50 % de prises capturées dans les pièges conventionnels du commerce.