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Influence of lure (food/sex pheromone) on young mated cigarette beetle (*Lasioderma serricorne* (F.)) (Coleoptera: Anobiidae) flight initiation

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ABSTRACT

Pheromone traps have been used successfully for monitoring of stored-product insects in the facilities but factors that could influence accuracy have not been fully examined. In this study, we examined the influence of lure (food for females and sex pheromone for males) on minimum flight initiation temperature (MFIT[1]) and percentage of 6–9 d-old mated cigarette beetles, *Lasioderma serricorne* (F.) that initiate flight. Temperature had a greater influence on minimum flight initiation temperature compared to food lure for young mated females or sex pheromone lure for young mated males. There was no significant effect of sex pheromone lure on the MFIT of 6–9 d-old mated male cigarette beetles nor was there a significant effect of food lure on the MFIT of 6–9 d-old mated females.

1. Introduction

Pheromone traps have been widely used for monitoring insect populations in grain storages, warehouses, food processing facilities and retail stores. They can be a reliable and cost effective method to detect the presence of insects within a facility. However, they are not without problems. Most pheromone traps capture only adults, not larvae, and few pheromones attract females (Witzgall et al., 2010). Advantages of using pheromone traps in a food facility to monitor pest populations may include the ability to detect incoming contaminated materials; low maintenance, requiring only periodic examination, but providing 24 h surveillance; and the ability to evaluate the effectiveness of control strategies such as fumigation. In addition, they can reveal hidden infestations early (Burkholder and Ma, 1985).

Factors that influence insect movement, may negatively impact the reliability of pheromone trap data. One such factor is temperature (Fargo et al., 1989). For example, an insects' ability to move is predicated upon environmental temperature, and if they can't fly, they can't move to a trap, thus the reliability of pheromone traps is compromised. If the microclimate where the insect is residing is below the temperature necessary for flight, insects may be present, and even growing, but not able to move to traps. As a result, monitoring traps may indicate no pest infestation; while in reality, the pest infestation is undetected. This can lead to costly, and at time litigious assumptions about pest infestation levels.

The purpose of this research was 1) to determine whether presence of food lures will increase the number of mated young females flying at a particular temperature and decrease the minimum flight initiation temperature (MFIT) and 2) to determine if sex pheromone lures will increase the number of mated young males initiating flight at the particular temperature and decrease the MFIT.

2. Materials and methods

2.1. Insects

Cigarette beetle colonies were reared on a diet of 50% flour/yeast and 50% wheat in series I-36 controlled environmental chambers at 27 °C (±0.5), 60% (±10%) R.H., a light regime of 14:10 (L:D), at the Department of Entomology, Purdue University, West Lafayette, IN USA.

2.2. Test insect preparation

Cigarette beetle pupae were obtained from the colony, were sexed after removal of the pupal cocoon (Halstead, 1963; Shukla and Palli, 2012), and kept in separate Petri dishes. Newly emerged adults were collected from the dishes and individual adults were transferred to 163 ml cups (Solo® Cup Company, Urbana, IL, USA) filled with a medium of 10 g of 90% flour and 10% yeast where they

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[1] MFIT: Minimum flight initiation temperature at which 2% flight initiation occurred.

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would remain isolated from the opposite sex until mated. Sexual maturation initiates when the adults emerge from the pupal case and is fully achieved three days after emergence from the cocoon (Howe, 1957). Since adults remain within the cocoon after the pupal emergence for three days then mature for three days after cocoon emergence a total maturation of 6–7 days post pupal emergence was used prior to allowing individuals to mate. At this time (6–7 d-old) they were examined to confirm that they were free of any defects.

To obtain mated cigarette beetles, an individual of each sex was removed from the single-sexed Solo cups and placed as pairs in each cell of a 16-well plate, a day before using in the experiment. Cells in the 16-well plates did not contain medium. The 16-well plate was covered by plastic sheet to prevent insect escape. In order to distinguish the sexes, males were marked with a small spot of luminous yellow powder (BioQuip Products, Inc., Gardena, CA USA) on their thorax. Cells were marked if the beetles were seen copulating. Pairs were kept together for 24 h, and once mating was confirmed, adults were separated and placed in a single-sex 4 oz cups with diet (90% flour/10% yeast) and held until used in the experiment. Mated adults were placed in a Petri dish release chamber that contained no food medium (Fig. 1, See flight chamber design below). The Petri dish release chamber was placed in the flight chamber and the whole device was then placed in an environmental chamber for temperature and light control under experimental conditions for a 2 h acclimation period. During this acclimation period, the 3.8 cm diameter hole in the Petri dish lid was covered with a 1 oz plastic cup (Fabri Kal®) (4 cm dia.). The cup was replaced with a fluon coated plastic ring when the experiment started (Fardisi and Mason, 2013).

2.3. Flight chamber design

A flight chamber developed by Cox and Dolder (1995) was used with slight modifications to original design. Our flight chamber consisted of a plastic cylinder (23 cm h by 12 cm dia.), closed on the top, placed on a Buchner funnel (5.5 cm h by 12 cm dia.) that was lined with white filter paper (Fig. 1). Insects were placed in a Petri dish release chamber (1.2 cm h; 8 cm dia.) with sides coated with fluon® (BioQuip Products, Inc., CA 90220). A plastic cone/funnel (2.8–3 cm h by 0.75 cm dia.) was placed in the middle of the Petri dish release chamber, protruding through a circular opening (3.8 cm dia.) in the Petri dish lid. The cone was used as a launching pad (Fig. 1) by the beetles confined in the Petri dish. Climbing the cone/funnel up through the Petri dish lid opening was the only way beetles could leave the dish and demonstrate flight. The Petri dish release chamber containing the test insects was placed in the bottom of the Buchner funnel on the filter paper.

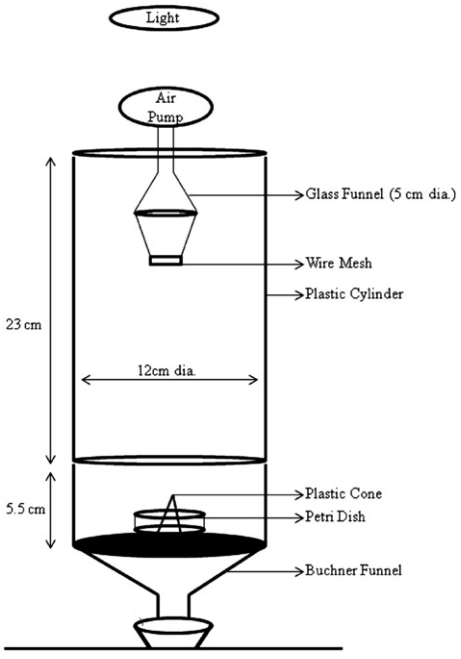

Fig. 1. Flight chamber used to examine flight initiation.

To prevent beetles from re-entering the Petri dish release chamber, the outer sides of the Petri dish and a plastic ring (1.8 cm h) placed around the opening in the lid were coated with fluon. To trap those insects that initiated flight, the insides of the plastic cylinder and Buchner funnel were coated with Tanglefoot® (The TangleFoot Company® Grand Rapids, MI 49504 USA). The exterior sides of the plastic cylinder were covered with aluminum foil so light could only enter from the cylinder's top. A 60 W fluorescent soft white light was suspended above the cylinder (L:D 14:10).

Flight chamber parts (Buchner funnel, plastic cylinder, etc) were cleaned with cooking oil and alcohol then recovered with Tanglefoot® after each test. Flight traps used for females and males were kept separate from each other and not tested at the same time. In order to prevent bias in flight behavior, only adults that had never flown before were used in the experiments.

Each temperature regimen and the presence or absence of a lure was replicated three times, each time with 15 insects. A total of 45 insects were tested for each temperature–lure combination. Temperatures tested ranged from 20 to 27.5 °C at 2.5 °C increments based on a previous study (Fardisi and Mason, 2013). Published literature indicates that cigarette beetles fly in bright sunlight, at dusk and early evening (Howe, 1957). To sure that we would encompass the entire activity period, the number of beetles that flew out of the Petri dish for 24 h (one day) was recorded and thus included both photo and scotophase.

2.4. Baits/lures

To determine if beetles could be stimulated to initiate flight at lower temperatures with a lure; a bait/lure unit consisting of a funnel (5 cm dia.) with a wire mesh base was placed 14.5 cm above the Petri dish insect release chamber. The bait/lure unit was connected to the top of the plastic cylinder through a small hole in the center. An air pump (Aquarium Air Pump MK-1504, China) (1180 cc/min) was connected to the tube portion of the glass funnel in order to have a slight air current move over the bait/lure unit and toward the Petri dish insect release chamber.

The food lure used for females consisted of an absorbent pad (3 cm dia.) soaked with water, coated with chili powder (Kroger® Co. Cincinnati, OH) and dried. Chili powder was chosen based on previous work describing chili powder odor, attractiveness to cigarette beetles (Mahroof and Phillips, 2007). Cigarette beetle sex pheromone lure® (TRÉCÉ Inc., OK USA) was used in the bait/lure unit for males. Since commercial pheromone lures are effective for 60 d and fresh lures have a higher release rate compared to older lures we used aged lures (3 wks-old), to decrease any bias in attractiveness or repellence of high pheromone concentration.

2.5. Data analysis

Insects were divided into two experimental treatment groups: 6–9 d-old mated females, and 6–9 d-old mated males. Multiple logistic regression was used to determine the significance of independent variables (temperature and lure) between two designated groups (for example: 6–9 d-old mated females tested with a