Turning Ultraviolet Light Traps On and Off Increases Their Attraction to House Flies (Diptera: Muscidae)

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Abstract

Pairs of electrocutor-grid ultraviolet light traps were assigned to three treatments to evaluate the effects of illumination events, e.g., light traps turned on, on house fly, Musca domestica L., attraction as indicated by numbers of flies captured by the traps. Both traps in treatment 1 were illuminated constantly (no illumination event). Both traps in treatment 2 were turned on, illuminated for 1 h, then turned off for 1 h, then repeated (1 illumination event every 2 h). Traps in treatment 3 were operated singularly. One trap was turned on for 1 h, then turned off. As it turned off, the other trap turned on for 1 h, then turned off, then repeated (1 illumination event every hour). The mean number of flies attracted per trap pair was significantly greater in treatment 1 than in treatments 2 or 3. However, in treatment 3, with one trap illuminated at a time and hourly illumination events, the mean fly catch was just 27% less, numerically, than the mean number of flies attracted to treatment 1 with both traps illuminated constantly. The effects of intermittent lighting and its potential use are discussed.

Key words: fly trap, urban entomology, fly behavior, fly management, intermittent lighting

It has been well documented in the literature that light in the ultraviolet (UV) range is attractive to flies and other insects (e.g., Hollingsworth et al. 1968), but it was Thimijan and Pickens (1973) who found that wavelengths between 310 and 370 nm are the most attractive to house flies, Musca domestica L. They also found a positive correlation between the intensity of UV light radiating directly into a room and the number of flies attracted to the light (Thimijan and Pickens 1973). This suggests that the best trap design for maximum efficacy is one with an open front allowing for maximum radiation of UV light (Pickens and Thimijan 1986, Hogsette 2008). However, even the open front traps in operation do not immediately attract all of the flies in a room (Lillie and Goddard 1987).

Although most UV light trap evaluations are conducted only under laboratory conditions, studies have also been performed in facilities with high fly densities, such as poultry houses (Miller et al. 1993a, b). Although studies in these facilities more closely simulate real-life conditions, the fly behavior in relation to the traps has not been fully described in the literature. In preliminary studies in Florida, a commercial model electrocutor-grid UV light trap was mounted in the manure pit ca. 2 m above the floor at one end of a 152 × 14 m caged-layer house, facing the long axis of the house. When the trap was turned on at night in the completely darkened house, there was an immediate rush of house flies toward and into the trap, particularly by flies within 10 m of the front of the trap (J.A.H., unpublished data). Flies from more distant parts of the house moved forward to fill the unoccupied space in 1–2 min, then all activity ceased. Movement was verified by dusting flies resting on vertical support poles 4–15 m from the trap with colored fluorescent dust (Day-Glo Color Corp., Cleveland, OH) applied with a hand-pump duster (Hudson Manufacturing, Chicago, IL). Flies captured in the trap were viewed under long-wave UV light to determine the presence of marked flies (Hogsette 1983). When the light trap was turned off and then turned on again after about 5 min, the process was repeated. Each time there was a frenzy of fly activity caused by the illumination of the trap, followed soon thereafter by a state of acclimation and inactivity.

Because of the observed fly activity caused by these illumination events, i.e., the sudden activation of the light trap, we hypothesized that a system for turning light traps on and off and creating illumination events at desired intervals might increase the fly catch when compared with traps in a constant state of illumination. Herein we describe an experiment where pairs of UV light traps fitted with automatic timers to produce selected illumination events were evaluated in a commercial poultry house with a high-density house fly population.

Materials and Methods

Test Site

To be completely free from artificial laboratory conditions, tests were conducted in one house on a commercial caged-pullet farm near La Crosse (Alachua County), Florida, where house fly populations were...
extremely large. Chicks, which were housed at 1 d of age and grown for 18–20 wk, were one floor (4 m) above the ground and manure dropped into the ground-level manure pit directly below the chicks. Houses were 91 m long by 15 m wide with forced-air ventilation fans at the chick level. Because of management techniques, manure was usually wet (>80% moisture) and there was essentially a house fly monoculture in the house.

Traps and Trapping
Pairs of electrocutor-grid UV light traps (Model 661-30, Gardner Manufacturing Co., Horicon, WI) were mounted inside of the pullet house in the manure pit in three locations along one 91-m wall. One trap pair was mounted at the longitudinal mid-point of the wall and the other two trap pairs were 35 m distant in either direction. Traps in each pair were 30 cm apart. Aluminum trays were attached to the bottoms of the traps to catch and retain the large numbers of flies killed daily by the electrocutor grids. Distance from the ground to the bottom of the traps was 1 m (Hogsette 2008). Each trap was fitted with two black light (40-w Sylvania, #F40BL) fluorescent tubes that had been illuminated for 200 h prior to use. As recommended by Sylvania (OSRAM Sylvania, Wilmington, MA), this allowed phosphors in the tubes to stabilize and ensured that the maximum emission of wavelengths in the desired range (310–390 nm) was maintained throughout the test.

Each light trap was connected to a household timer (numerous brands available, e.g., Timex Corp., Middlebury, CT) that could be programmed to turn traps on or off hourly during a 24-h period. Timers were synchronized and checked for uniform operation in the laboratory before being used in the field tests. Lighting schedules (treatments) for the three trap pairs were as follows:

- **Treatment 1:** Both traps were turned on when the tests began and were illuminated continuously for the duration of the test (no illumination event).
- **Treatment 2:** Both traps were turned on, illuminated for 1 h then both traps were turned off for 1 h. Repeat for the duration of test (1 illumination event every 2 h).
- **Treatment 3:** One trap was turned on and remained illuminated for 1 h. Then as it was turned off, the second trap was turned on. The second trap was illuminated for 1 h. Then as it was turned off, the first trap was again turned on. Repeat for the duration of test (1 illumination event every hour).

Treatments were assigned to each pair of traps according to a pre-determined systematic rotation schedule. Flies were collected for a 24-h period, after which dead flies were removed from collection trays and the treatments were reassigned to different trap pairs. The process continued until each treatment had been replicated 3 times in each trap pair location (n = 9 test days/treatment). It was assumed that numbers of flies killed by the traps was an indication of trap attraction. Dead flies were measured volumetrically in a 1,000-ml plastic graduated cylinder. After counting 10 measured numbers of dead flies from the test site in the graduated cylinder, it was determined that 1 ml was equivalent to 20 flies. Captured flies were not sexed because previous studies indicated no preferential attraction due to sex (Hogsette 2008).

Statistical Analysis
Log-transformed data from trap pairs were subjected to ANOVA and means between trap pairs were separated with Fisher's Least Significant Difference Test at the P = 0.05 level (SAS Institute 2003). Logs were back-transformed to actual values for presentation in text.

Results and Discussion
Treatment effects based on daily mean numbers of flies killed by the three trap pairs were significant (F = 22.51, df = 10, 25, P < 0.0001). Daily treatment means are summarized in Table 1.

The mean daily mortality produced by the light trap pair in continuous illumination (treatment 1) was significantly greater than those of treatments 2 and 3. Daily mean mortality differences between treatments 2 and 3 were not significant. When both traps in a pair were turned on and off hourly and produced an illumination event every 2 h (treatment 2), daily mean mortality was slightly more than half of that produced by the continuously illuminated trap pair (treatment 1). However, when one trap in a pair was always illuminated and an illumination event occurred hourly (treatment 3), daily mean mortality was 27% more, numerically, than that of the treatment 2 trap pair; and just 27% less, numerically, than that of the treatment 1 trap pair with 2 traps in continuous operation.

Treatment 1 was essentially a control treatment because it simulated the continuous operation of light traps in a commercial setting. Although the daily mean mortality produced by trap pairs with programmed illumination events (treatments 2 and 3) did not exceed that produced by trap pairs in constant operation (treatment 1), expected mortality was exceeded, especially in treatment 3.

Pickens and Thimijan (1986) indicated that traps closer together than 3.6 m appear as one trap to house flies. Therefore, each trap pair in this study should have appeared as a single unit to the flies, and the distance between the trap pairs (35 m) ensured that each treatment attracted flies independently. Pickens and Thimijan (1986) also stated that the total brightness, measured in Watts, produced by fluorescent tubes between 320 and 420 nm was most important for fly attraction. Thus, the trap pair in treatment 1 with four 40-W fluorescent tubes in continuous operation produced twice the brightness in the 320–420 nm range as the single trap in operation in treatment 3 with only two 40-W fluorescent tubes. Except for the hourly treatment 3 illumination events, treatments 1 and 3 were similar in that they always had two or one traps, respectively, in operation. However, the hourly illumination events in treatment 3 appeared to supplement the effect of the brightness level produced by one trap and greatly increase the fly attraction above the level expected from one trap.

This appears to be the first report of the effects of illumination events on house fly attraction. No similar papers could be found in the literature. Although the effects of the flicker factor have been well documented (Miall 1978), the effects of turning lights on and off at selected intervals have not. In the preliminary studies (J.A.H., unpublished data), house flies became highly activated when a fluorescent light trap was illuminated in a completely dark poultry house. This activity subsided in a minute or two and flies seemed to become

| Table 1. Fisher’s least significant difference test (SAS Institute 2003) |
|-------------------------|-----------------------------|
| Treatment (n = 3)       | Daily house fly trap pair mean ± SE |
| 1 (both traps illuminated continuously) | 25,456 ± 2,546a |
| 2 (both traps illuminated 12 h of the 24-h test period) | 13,536 ± 1,459b |
| 3 (one trap and then the other illuminated hourly during the 24-h test period) | 18,466 ± 2,105b |

Means followed by the same letter are not significantly different (P = 0.05).
acclimated to the light. We can assume that this phenomenon also occurred in the study reported herein.

Results indicate that mean numbers of flies attracted and killed, i.e., trap efficiency, could be improved if UV light traps are turned on and off intermittently. Unfortunately, the limits of the household timers used in this study did not permit traps to be turned on and off more frequently than once an hour. A greater number of illumination events per hour might be even more beneficial, but additional testing is required to make this determination. Creating illumination events would be detrimental to the fluorescent tubes and the ballasts if used for long periods, thus necessitating the development of electrical circuitry to mitigate these effects. Substituting light-emitting diodes (LEDs) for fluorescent tubes might be an alternative approach. Turning traps on and off might be most important in indoor areas, e.g., restaurants and large stores, where the trap lighting is competing with overhead lights, all of which are flickering together at a frequency twice that of the alternating current used to power them (Miall 1978). Light traps that are turning on and off intermittently would not be popular where traps are in plain view. However, this might not be of concern in places like warehouses, storage areas, and agricultural facilities.

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