Proceedings of the Seventh International Conference on Urban Pests
William H Robinson and Ana Eugênia de Carvalho Campos (editors) 2011
Printed by Instituto Biológico, São Paulo, SP. Brazil.

CATCH RATE OF *MUSCA DOMESTICA* IN LABORATORY TESTS: CONTRASTING ULTRAVIOLET LIGHT TRAPS WITH THEIR SURROUNDING

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Abstract Commercial ultra violet light traps for flying insect control are commonplace and provide an effective means of monitoring and providing reduction in populations of house flies (*Musca domestica* L) in cases where exclusion is difficult or impossible. Catch rate investigations were undertaken in laboratory rooms using a single type of fly trap with interchangeable trap covers, glue boards, and wall colours. Catch rates were found to be higher for contrasting combinations of cover/glue board/wall than for matching combinations over a seven hour period after release of 3, 4 and 5 day old house flies. The implications for the design and positioning of UV fly traps are discussed.
Key Words Contrast, house fly, fly monitoring, fly management

INTRODUCTION

There are a diverse range of ultra violet light traps marketed for the monitoring and control of flying urban insect pests. There are an equally diverse number of methods employed to qualify their efficacy. Whilst the design of commercial light traps differs, all incorporate a UV-A light source and a lethal surface, be it an electrified metal grid or an adhesive board. Quantifiable measurements from these traps that purport to effect catch rate are often quoted as de facto figures for their efficacy, including total bulb power, UV-A output and lethal surface area. Whilst there is certainly some evidence to support the maximisation of these measurements (Pickens and Thimijan, 1986; Cottee, 2004), previous studies and preliminary laboratory testing suggest various design factors that may negate any advantages gained through such efforts (Hanley et al., 2009).

There is no agreed methodology for insect trap testing, either in academic literature or within the pest management industry. Previous studies have taken different approaches to testing ultra violet fly traps with differing degrees of success at reducing the large number of variables (Sargent, 2010; Gilbert, 2009; Hogsette, 2008; Pickens and Thimijan, 1986). Cottee (2004) gives a preliminary list of design and testing variations that affect the catch rate of house flies that includes the colour of the trap; colour, and shape of the lethal surface; and the incorporation of pheromones in the unit.

In addition to a lack of uniform testing procedure there is also no unified method of data presentation. Relative trap 'efficacy' is often displayed in sales literature as line graph curve of insect catch plotted over an arbitrary timeframe that show a qualitative measure of effectiveness. Another oft-quote statistic for fly killers is 'coverage area'. The coverage area of a trap is a function of the power output of the lamps used in the traps. The greater the light output from the trap, the greater the coverage area. In an ideal situation, the coverage area defines the limit of the trap's range of effectiveness, beyond which flying insects are no longer attracted to the unit. In field situations, complicating factors (e.g.: solid barriers, alternative light sources) render the direct application of these values difficult if not completely meaningless.

The aim of this work was to derive a relative efficacy rank from a consistent series of tests that enables direct comparison between traps. Removing flies from the environment as fast as possible is seen as the most important factor for the end user (Sargent, 2010), therefore the catch rate was quantified by estimating the best possible time to catch 50% of flies within a room.

Typically, a given number of flies are released into a test room. At the start of such a trial a large number of flies are caught, but the rate of catch logically slows down as there are fewer flies available, i.e. there is a finite limit on the rate of fly catch. Some manufacturers quote a time to catch all the flies in such a trial at which point

(usually many hours into the trial) there are so few flies left in the room that the rate of catch of inferior units tends to equalise with superior units. This bears little relation to a field situation where new flies may enter the area at any time. Thus, measuring the catch rate performance of a unit as described here captures the moment when it is performing optimally, when this is not limited by the number of flies left in the room, and is much more relevant to likely performance in the field.

A significant amount of prior investigation into catch rates for *Mucsa domestica* has centred on UV light wavelength attraction (Smallegange, 2003; Roberts et al, 1992; Syms, 1988). The black light bulbs sold for the fly killer market radiate light in the 330-385 nm ultraviolet range, within which there does not seem to be a consensus for the wavelength that is most attractive *M. domestica* in practice, despite electrophysiological studies (Smallegange, 2003). The colour of the catch surface has also been the subject of previous investigation in quantifying fly trap catch. Whilst yellow catch surfaces have been found to catch more flies in a laboratory setting, the results are less clear in the field and there is some consumer resistance to using glue boards that display the catch, resulting in a preference for black boards (Hanley et al., 2009).

MATERIALS AND METHODS

A single type of ultraviolet light trap chassis (Figure 1) was tested with a variety of different configurations in two identical controlled environment rooms (4 m^2 with a volume of 9 m^3), maintained at 25°C ± 2°C and 50% ± 10% RH, illuminated daily on a 12 hr cycle. The rooms were subject to 10 air changes per hour and sealed to prevent flies escaping.

All UV lamps used in the traps were burned in for a minimum of 100 hours prior to testing and all traps used were electrically tested for safe use. Plastic-sleeved shatter-proof lamps were used in all tests. All traps tested were mounted securely to the wall at height of 1.8 m from the floor.

Unsexed adult *Musca domestica* from laboratory cultures, selected for the ability to fly, were captured, anesthetised with carbon dioxide and counted into cups. One hundred flies were used in each replicate test; any remaining flies were discarded. Flies were released at floor level from the centre of the room, marked with a plumb line suspended from the ceiling.

Figure 1. Ultra violet fly trap chassis and glue board.

Atmospheric pressure was recorded using a manometer (Digitron Instrumentation P200) and ultraviolet light was monitored using a MACAM 101 UV radiometer to ensure consistent output throughout the test. All readings were taken from the centre of the room; UV output was measured from the vertical mid-point directly in front of the trap.

The number of flies captured in the unit was counted eight times in seven hours at intervals of: 15, 30, 60, 90, 120, 240 minutes, 5 hours, 7 hours and again at 24 hrs. After 24 hours all live flies still in the room, dead flies on the floor or within the unit (not on the glue) and observed escapees were accounted for. Six replicates of each test (three in each room) were conducted with fresh glue surfaces for each test and tubes emitting the same level of UV-A light.

RESULTS

An average time for half the flies to be caught (C_{50}) was calculated by averaging the counts from six days of testing. The C_{50} score is the minimum possible time that it would take each unit to catch 50% of the available flies (given maximal performance of the unit based on the average recorded catch for each of the eight time intervals), using the following equation:

$$C_{50} = \frac{t}{\log_2 (N_0/N_t)}$$

where C_{50} is the fastest average catch time, t is the time elapsed, N_0 is the initial percentage of flies (100) and Nt is the percentage remaining after t.

The results (Figure 3) indicate a trend for a faster catch rate with increasing amounts of contrast that is more pronounced in traps with a white cover despite a recorded preference to blue light wavelengths (Geden, 2006).

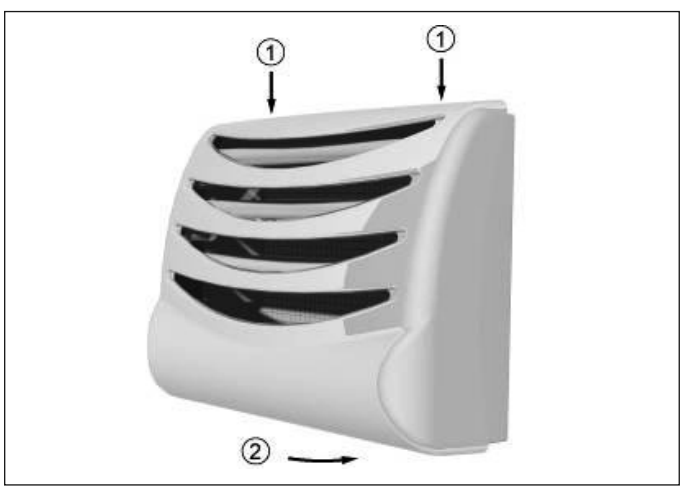

Figure 2.

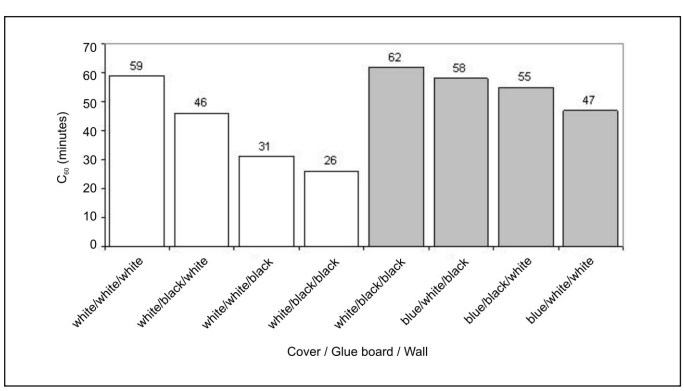

Figure 3. Catch rate variation with changes in contrast.

DISCUSSION

The use of this particular fly trap allowed us to investigate the effects of contrasting components of the trap with themselves and the surroundings in a previously unexplored way. Presenting catch rate data in this way gives a clear indication of the potential benefits of contrasting a fly trap with its surroundings rather than trying to blend into the background wall cover, which maybe more ascetically pleasing for some end users of fly traps, but increases the risk of product contamination.

Previous work by Conlon and Bell (1991) found that *M. domestica* responded to high contrast substrates only when there was a food source available there. Coupling attraction to UV-A light and high contrast appears to have a cumulative effect and increases fly catch in the absence of a food source.

Further work will examine the relationship between the power output and glue board surface area on catch rate under the same experimental conditions.

REFERENCES CITED

Conlon, D. and Bell, W.J. 1991. The use of visual information by house flies, *Musca domestica* (Diptera: Muscidae), foraging in resource patches. J. Comp. Physiol. A 168: 365-371

Cottee, P. 2004. Green Light: A Holistic View. A review of the literature and research on the attraction of insects to lights of different wavelengths. http://www.uki.net/php/files/insectocutorpages.uki.net/green_light.pdf (15/03/2011)

Geden, C.J. 2005. Visual targets for capture and management of house flies, *Musca domestica* L. J. Vector Ecol. 31 (1): 152-157

Gilbert, D. 2009. The Professional Flytrap Challenge. http://www.gilbertinc.com/research.htm (16/03/2011)

Hanley, M.E., Cruickshank, K.L. Dunn, D., Stewart-Jones, A., and Goulson, D. 2009. Luring houseflies (*Musca domestica*) to traps: do cuticular hydrocarbons and visual cues increase catch? Medical and Veterinary Entomology. 23: 26–33.

Hogsette, J.A. 2008. Ultraviolet light traps: design affects attraction and capture *In*: Proceedings of the Sixth International Conference on Urban Pest. Eds: W. H. Robinson and D. Bajomi. Budapest, Hungary.

Pickens, L.G. and Thimijan, R.W. 1986. Design parameters that affect the performance of UV-emitting traps in attracting house flies (Diptera: Muscidae). J. Econ. Entomol. 79: 1003-1009.

Roberts, A.E. 1990. The response of *Musca domestica* to ultraviolet electrocutor traps under field and laboratory conditions. Ph.D. Thesis. University of London.

Roberts, A.E., Syms, P.R., and Goodman, L.J. 1992. Intensity and spectral emission as factors affecting the efficacy of an insect electrocutor trap towards the house-fly. Entomologia Experimentalis et Applicata 64: 259-268.

Sargant, J. 2010. Which ILT is Best? Prescription Treatment® Quarterly, BASF Pest Control Solutions. In: Pest Control Technology Magazine (June 2010 issue), GIE Media, Richfield, Ohio. USA

Smallgange, R.C. 2003. Attractiveness of different light wavelengths, flicker frequencies and odours to the housefly (*Musca domestica* L.) Ph.D. Thesis. University of Groningen, The Netherlands.

Syms, P.R 1988. A laboratory study of factors influencing the effectiveness of an electrocutor fly trap against the house-fly*, Musca domestica*. Ph.D thesis, Queen Mary College, University of London, United Kingdom.