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Research Article

Field Evaluation of Locally Designed Ultraviolet Light Trap for Collection of *Culicoides* spp. (Diptera: Ceratopogonidae)

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Abstract

The efficacy of the locally designed insect light traps (down draft) which were fitted with UV fluorescent light and with Ultraviolet (UV) light emitting diode (LED)was field evaluated. The trial was conducted for fifteen consecutive nights at two sites during October 2015. Analysis of catch data based on adults showed equivalency between UV LED and UV fluorescent light. Despite the fact, that LED light traps possessed limited light exposing surface compared to UV fluorescent tube yet it showed similar effectiveness in collection of *Culicoides* species.

Keywords: *Culicoides spp.; Down Draft Light trap; Ultraviolet Fluorescent light; Ultraviolet Light Emitting Diode; Vectors; West Bengal*

Abbreviations

UV: Ultraviolet; LED: Light Emitting Diode; BTV: Bluetongue Virus; BU UV LED LT: Burdwan University Ultraviolet Light Emitting Diode Light Trap; BU UV LT: Burdwan University Ultra Violet Light Trap

Introduction

The hematophagous midges belonging to genus *Culicoides* latreille have assumed worldwide significance due to its capacity to transmit protozoans, filarial nematodes and several arboviruses [1] particularly bluetongue virus (BTV), African horse sickness virus, and the newly emerged Schmallenberg virus [2]. Despite incidences of BTV outbreak, field based data is severely lacking throughout the Indian subcontinent on abundance and distribution of adult *Culicoides* spp. Sapre [3] first reported outbreak of BTV from Maharashtra. Thereafter, Southern India witnessed 285 outbreaks between 1986 and 1995 [4]. Near about 60 goats died in the outbreak from Dehradun [5]. Serological screening across India reported the presence of BTV to be ubiquitous, ranging across several states including West Bengal [5]. Although *Culicoides* spp. are known to vector BTV, but their association with host under Indian context needs to be assessed [6]. The bottleneck lies in choosing an effective surveillance tool for regular sampling and monitoring the *Culicoides* spp. population across the country [6]. In Europe, Africa and Australia, surveillance programme are primarily centered on deployment of light suction traps as it proved to be effective in collection of *Culicoides imicola*, a well-known vector of BTV [6].

Usage of suction Light traps as efficient instrument for collection and surveillance of nocturnal insects is well established [7]. Similarly, most convenient and exclusively used tool for the monitoring of *Culicoides* species is suction light traps [8,9]. The studies concerned with the seasonality, dispersal and response of *Culicoides* midges to light of varying wavelength is heavily reliant on the overnight catches of the hematophagous insects by suction light trap [10]. However, the major shortcoming of suction light trap is that diurnal species vectoring the viruses have a little chance of being collected by light trap [9]. Some studies have shown that the number of *Culicoides* spp. collected with light traps is not necessarily comparable to species diversity and host bite rate [11,12]. Black light and LED based traps were widely used by several working groups. Venter., *et al.* [8] used various traps viz., Onderstepoort trap, BG sentinel traps (UV fluorescent light), Rieb trap and CDC trap (LED based). Later Del Rio., *et al.* [13] used Pirbright trap in addition to above mentioned traps for collection of the midges. In relation to field sampling the UV fluorescent light trap has various disadvantages i.e. higher power consumption and bulkiness [14]. Alternatively, light emitting diodes (LED) to capture the nocturnally active dipterans of medical importance was stated by Burkett., *et al* [15]. The LEDs are efficient in converting electrical energy to light energy in contrast to the fluorescent light which wasted much of the energy (approximately 94%) in the form of heat or infrared radiation [16]. The brightness of LED depends on the amount of current passing through it; however, the longevity of the LED is reduced in higher currents. The high durability of LED is due to its solid state, which makes it suitable for field sampling [14].

The *Culicoides* caught by the locally designed battery operated suction UV traps were evaluated in the field using two different light sources i.e. (i) UV fluorescent light and (ii) UV Light Emitting Diode. The traps were fabricated locally for easy maintenance, reduction in the cost with extended hours of operation without recharging the battery in the field.

Materials and Methods

Specification of the light traps

	Trap 1 BU UV LT	**Trap 2 BU UV LED LT**
Designed and fabricated	Entomology Research Unit, Dept. of Zoology and University Science Instrumentation Centre (USIC), The University of Burdwan, India	
Weight	0.9 kg	0.7 kg
Photo switch	Disabled	Enabled
Light source specifications; Power consumption	30 cm, 8W UV light, black light; 0.9 Ah	8 mm, 4.8W UV LED, (20 LED) black light; 0.06 Ah
Trap hour duration	4 - 5 hr	45 - 48 hr
Fan size (diameter); Power Consumption	7.5 cm; 0.13Ah	
Power pack	12 V, 7 Ah lead acid battery power supply with the photo sensors.	
Collecting container	Wide mouth (20 mm), 125 mL polypropylene (PP) bottles and replaceable with a muslin net cage for collection of live insects	
Wavelength	350-400 nm	
Materials used	Acrylic plate, iron stand with PVC coating, Aluminum funnel, PVC socket, CPU fan, PVC funnel, connecting wire with Jone's plug, lead acetate battery	

Table 1: *Specifications of Burdwan University Ultraviolet Suction Light Trap.*

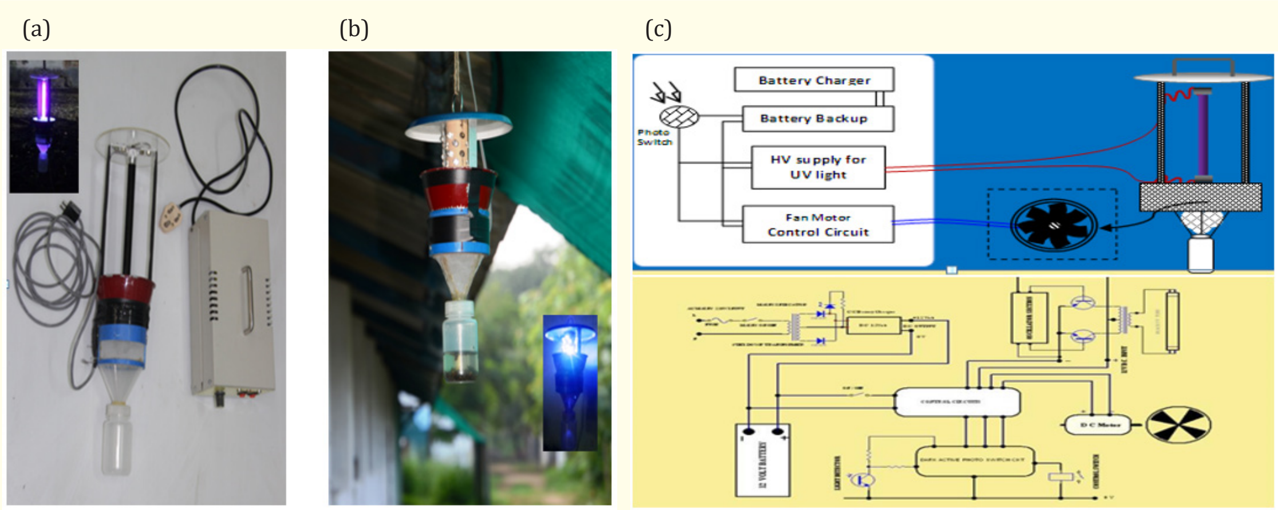

Figure 1: *Light Trap (a) UV fluorescent light (b) UV LED (c) line diagram of light trap with the circuit.*

The light traps were designed and fabricated from easily available and cheap materials to minimize cost of traps as compared to other light traps.

1. Burdwan University fluorescent Light Trap (BU UV LT)
2. Burdwan University LED Light Trap (BU UV LED LT)

Study site

The study was under taken during October, 2015 in cattle shed located at Adisaptagram, West Bengal (22°56′50″N; 88°23′08.3″E). The sheds (A and B) were located within a typical rural Bengal village with small cattle sheds adjacent to the households. Distance between the sheds was 500m (approximately) apart housing 3 - 4 adult cattle. The surrounding habitat contained banana plantations, sewage pond, dung heaps strewn with rotten straw with mud lined drainage system. Nearby run off channels and drains containing cattle excreta and fecal matter which was conducive breeding sites of the biting midges.

Collection methods

The traps were designated as 1 and 2 respectively and were hung at a height of 2m inside the animal shed. Adults trapped were collected in 70% ethanol. The samples were sorted, transferred to absolute alcohol and then stored at 4°C. Both the traps were operated throughout fifteen consecutive nights which was set from dusk to dawn. The on/off cycle of Trap 1 was controlled manually, whereas Trap 2 was done with an automatic photo switch. During the study location of trap were interchanged between Site A and B to minimize the bias effect of the location on the sampling.

Identification of species and age grading of the females

The trapped *Culicoides* spp. was identified on the basis of morphological characters and thereafter age graded on the basis of pigmentation of abdomen. Initially the adults so collected were sorted under stereo binocular microscope (Magnus MS13/MS24) and then mounted on glass slides following Wirth and Marston [17]. The mounted specimens were identified following the taxonomic key of Wirth and Hubert [18]. The total number of males and females were also recorded. Age grading of the female were carried out following Dyce [19]. Generally, the nulliparous individuals usually lacked pigmentation, while the parous possessed pigmented abdomen; whereas the blood fed or freshly engorged had distended dark abdomen. The swelled abdomen of gravid females contained developing eggs.

Statistical analysis

The species composition and abundance obtained from two trap collections were subjected to paired t-test using MS EXCEL and graphical representation was made using STATISTICA.

Results and Discussion

Culicoides peregrinus was the most dominant which was followed by *C. fulvus* Sen and Das Gupta, 1959; *C. oxystoma* Kieffer, 1910; *C. innoxius* Sen and Das Gupta, 1959 and species of belonging to *Trithecoides* (sub genera). In trap 1collections the following species were recorded viz., *C. peregrinus* (86%), *C. oxystoma* (4%), *C. fulvus* (6%), *C. innoxius* (1%), and species (*C. anophelis* Edwards, 1922 and *C. palpifer* Sen & Das Gupta, 1956). belonging to *Trithecoides* (3%). Likewise, in trap 2 the following: *C. peregrinus* (79%), *C. oxystoma* (3%), *C. fulvus* (10%), *C. innoxius* (3%) and species (*C. anophelis* and *C. palpifer*) belonging to Trithecoides sub genera (3%) was recorded. The catch data showed non-significant statistical differences when paired t- Test was performed when two different light sources were used; however, catches in LED light source were more in numbers (Figure 2). During the study period biting midges in UV fluorescent light were 44% whereas LED contributed 56% of the total collections. Although there was difference in number of engorged, nulliparous, and gravid females, however none of the variations were statistically significant. Unlike the other age groups, the parous individuals attracted towards LED light outnumbered the numbers in fluorescent light which showed significant differences (significant $p < 0.01$ and 0.05).

Besides 68% parous females were collected using LED source, whereas only 32% individuals were trapped using fluorescent light. The number of males in either trap was similar. Similar species composition and prevalence of the midges occurred between the sites with species abundance of site A and B being 14852 and 14240 respectively.

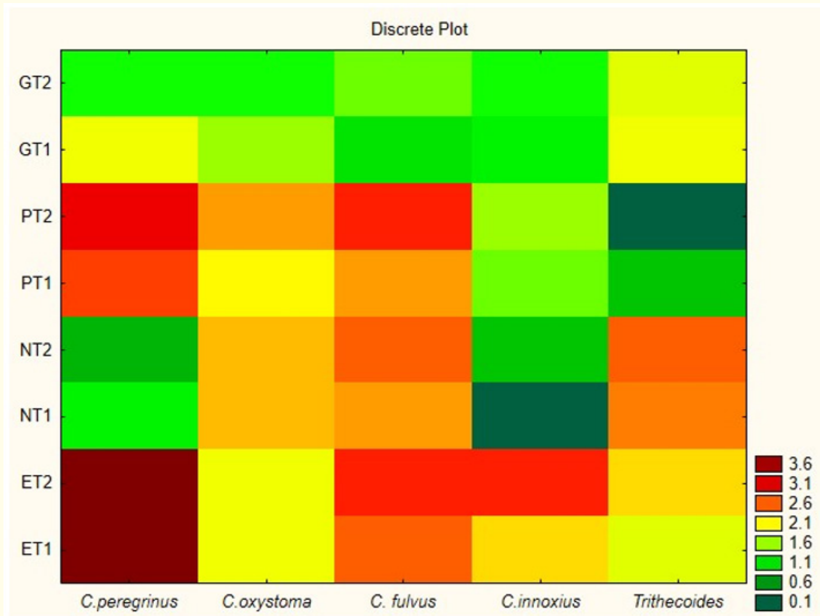

Figure 2: *Age graded females of Culicoides spp. trapped under two light sources. T1= UV fluorescent light; T2= UV LED; E= Engorged; N= Nulliparous; P= Parous; G= Gravid.*

Culicoides peregrinus is a dominant species in West Bengal [20], as expected it also reflected in our collections too. Next in abundance was *C. fulvus*, which has been reported as potent vector in India [6]. Besides, *Culicoides oxystoma* was trapped in significant numbers with *Culicoides innoxius* and species belonging to sub genus *Trithecoides* were also trapped. Several comparative studies on the efficacy between UV light and LED have been made. Effectiveness of Onderstepoort light trap (UV black light) over LED was claimed by Venter., *et al* [8]. Similarly, Venter and Hermanides [21] observed 2 - 3 folds increase in catch numbers when UV fluorescent lights were used. Likewise, González., *et al.* [22] did a similar work by integrating UV fluorescent light and LEDs into CDC light trap and agreed with Venter., *et al* [8]. Probst., *et al.* [23] reported that the two traps, Rieb trap and CDC trap were relatively less powerful compared to Onderstepoort and BG Sentinel trap since the collection of midges were significantly less with the former traps. But our results demonstrated the congruence in number of *Culicoides* spp. collected by both the traps. It may be proposed that there might be attraction equivalence between UV lights and LED. Further, Probst., *et al.* [23] remarked that ineffectiveness of Rieb and CDC trap was due to their limited light exposing area, however, this investigation suggested otherwise. Efficiency of BU UV LT has been previously tested as it was used as primary tool to obtain large number of live *Culicoides* species. for laboratory rearing [24] and for seasonality studies [25]. The light trap got mentioned in CIE Newsletter (http://campus.belmont.edu/cienews/CIE%20no%2096%20Dec%202015.pdf). During the trial the LED lights was integrated into BU UV LT in a flexible mode. The other provisions of the trap were as follows: flexible light attachment fixtures, varying numbers of LED, to make variations in wavelength, intensity and angle of view as per the requirement of the experiment. As animal husbandry is one of the major economic activities in rural areas of India therefore significant animal population resides in the villages. Not only these animals are exposed to *Culicoides* bite but become susceptible to arboviruses including Bluetongue.

Conclusion

In this context, the LED Light Trap seems the most suitable tool for monitoring adult populations in rural areas where the option of recharging is lacking; besides, this trap minimizes the power consumption [14] with longer hours of operation. Results obtained through the use of LED baited traps are also effective for capturing adult *Culicoides* spp. in remote and forested areas for epidemiological surveillance. Despite several limitations throughout our experiment viz., trap bias, host influence, short period of study; the BU UV LED LT and BU UV LT traps seemed quite effective, though LED gave reduced exposure area compared to fluorescent light. Still it may replace UV light due to its low cost and longer catch period, therefore, we propose BU UV LED LT to adopted for surveillance and monitoring the BT vectors throughout the subcontinent.

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