Mass Aerosol Drift Component Sampling Device for Evaluating Mosquito Adulticide Applications

Jonathan Hornby, Ph.D., Milton Sterling and Wayne Gale
Lee County Mosquito Control District, Ft. Myers, FL

ABSTRACT

A truck mounted ULV truck aerosol generator was used to demonstrate the effectiveness of an air sampling device, Air-O-Cell (Zefon International, St. Petersburg, FL, USA) in collecting and determining the maximum mass of adulticide available at the sampling point of the treatment block for effecting adult mosquito control or impacting nontarget organisms. This wind speed and direction independent device adds a critical component to the development of a mortality model when combined with sample site aerosol plume drop spectra characterization, wind speed and adult mortality data. The aerosol drift component mass of adulticide applications were sampled at 15.2, 30.5, 61 and 91.4 meters downwind along with the afore mentioned variables. The insecticide mass collected by the Air-O-Cell was correlated with the other parameters measured.

INTRODUCTION

Efficacy evaluation of mosquito adulticide applications is most complete when variables of droplet spectra, ambient wind speed, air temperature, humidity and the mass of adulticide exposure are known and correlated with adult mortality. Ambient wind speed, air temperature and humidity variables are accurately measured by weather stations with wind speed sensitivity below 0.5 mph. The standard for measuring droplet spectra has been the 1 inch slide rotary impinger (500 rpm). More recently, higher speed impingers (625 rpm) sample a broadened drop range by collecting smaller drops. Higher rotational speed combined with narrower slides shift the collection range to even smaller drops.

Recently the collection and quantifying of the mass of adulticide available to impact the mosquito has been performed with 'Fuzzy Yarn'. The fine fibers of the yarn mimic the fine structures of the mosquito by providing artificial impingement surfaces for the small drops expected to impinge on the mosquitoes. The adulticide collected is extracted and analyzed by HPLC or GC. The 'Fuzzy Yarn' collection device is primarily wind-direction-independent; however, its collection efficiency is wind-speed-dependent. The higher the wind speed, the more inertia is imparted on small drops resulting in an increase in the collection efficiency of small drops.

This paper describes the evaluation of a mass aerosol sampling device which is both wind speed and direction independent, 100% efficient in collecting drops greater than 3 microns in diameter and is uncomplicated in placement and retrieval. Because of its independences it can measure the amount of adulticide passing a particular point available for adult mosquito control. Combined with the other measured variables a predictive mortality model can be developed. The data provided by this device is also a measure of the quantity of adulticide available to a nontarget organism at the point of sampling.

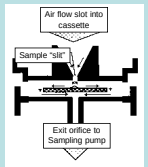
MATERIALS

Meteorological measurements **of wind direction and speed were made with a 2 dimensional sonic wind sensor (WindSonic4-L, Campbell Scientific, Logan, Utah) while a temperature/humidity probe (HMP45C-L, Campbell Scientific, Logan, Utah) was used for the other measurements. The sensors were coupled with a Model CR510 datalogger (Campbell Scientific, Logan, Utah).**

Droplet spectra **was determined with high speed rotary impingers (625 rpm) fitted with 1 inch Teflon coated slides.**

Mass Aerosol Collector **is an industry standard indoor particulate air quality sampler: the *Air-O-Cell*® (Figure 1.). The *Air-O-Cell*® operates upon the principle of inertial impaction. Particulate laden air is accelerated as it is drawn through the cassette's tapered inlet slit and directed towards a small slide containing the collection media, where the particles become impacted, and the air flow continues out the exit orifice**

Figure 1. Air-O-Cell



MATERIALS cont.

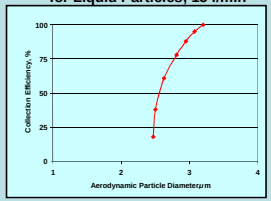
The Air-O-Cell is wind direction independent because of its horizontal orientation and has a collection efficiency of 100% for drops greater then 3.2 microns (Fig. 2). The use of the vacuum pump to provide a constant wind speed through the device eliminates bias related to droplet spectra collection efficiency making it also wind speed independent. Vacuum flow through the mass aerosol sampler of 15 l/min. was achieved with a DC vacuum pump (Gardner Denver Thomas, Sheboygan, WI) in conjunction with a flowmeter (Key Instruments, Model 907CDC18).

The aerosol cloud **was composed of Orchex 796 or Biomist and was produced by a truck mounted Leco ULV sprayer. Uvitex OB was dissolved in the spray material at 0.25% w/vol. to facilitate quantification of the material collected.**

Quantification of material collected **was by fluorimetry analysis using a Turner Designs (Sunnyvale, CA) TD700 fluorometer.**

Efficacy bioassay evaluation **used lab reared 3 or 7 day-old adult Oc. taeniorhynchus**

Figure 2. Collection Efficiency of Zefon Air-O-Cell for Liquid Particles; 15 l/min



Willeke, K. 1998. *Final Report, Cut-Size Evaluation of Air-O-Cell Sampler*. Zefon International-Analytical Accessories, St. Petersburg, FL.

PROCEDURES

Application. **The aerosol cloud was applied with a ULV truck driving in a line perpendicular to the wind direction and the collection stations. The mass aerosol drift component, droplet spectra and adult mortality, when incorporated, data were collected at 50, 100, 200 and 300 ft. down wind from the ULV truck application line. Six application passes of the truck were used for the aerosol drift component and droplet spectra data collection. Exposure of adult mosquitoes was for one application pass with a no-treat control cage incorporated.**

Mass Aerosol Collection. **A baseline fluorescence of the application material was established by sampling and analyzing the tank material the day of the test and ambient fluorescence was evaluated by running a ten minute blank with the mass aerosol samplers prior to treatment. Spiked samples were generated by placing 5 µl of tank sample on the target substrate of the Air-O-Cell cartridge. An air flow rate of 15 l/min was maintained through the samplers for a minimum of two minutes following the final pass of the aerosol cloud. The Air-O-Cell cartridges were kept in the dark following retrieval until the internal target was removed for extraction. Extracted samples and extracted spikes were refrigerated at – 4°C until analysis. Triplicate samples were taken at each collection station.**

RESULTS & DISCUSSION

Adult Bioassay. **The adult response for the test performed at 15 mph was less than 40% mortality and corresponded with mass aerosol collections of less than 1500 ng/station. At the slower wind speed of 6 mph mortality was 77% or better for all distances from spray line with aerosol collections of greater than 100,000 ng/station (Fig. 4).**

RESULTS & DISCUSSION cont.

Mass Aerosol Collections. **Collections of the aerosol were made at various ambient wind speeds using Orchex 796 and Biomist. Aerosol collection averages were multiplied by the wind speed to standardize for the time duration that the spray cloud spent over the sampling station. The mass of aerosol collected decreased with distance from the spray line at all wind speeds accept for the highest wind of 15 mph (Figure 3.) Wind speeds above 7 mph showed a fairly linear slope across the sampling stations indicating a linear relationship between distance and density of aerosol cloud. This relationship is expected since the diffusion of smoke clouds from their point of origin is linear and it is expected that small particle aerosols would behave in the same manner. For aerosol collections during winds below 7 mph a steep downward slope was seen between 50 and 100 ft with a shallower slope between 100 and 200 ft. with little slope between 200 and 300 ft. from the truck.**

Aerosol Plume Spectra. **For wind speed 2 – 5 mph there was a precipitous decrease from 50 to 200 feet in drop diameters and no change from 200 to 300 ft down wind. Above 5 mph the spectra of the aerosol plume was nearly the same at 50 ft as 300 ft. (Fig 5).**

Figure 3. Mass Aerosol Collected Standardized on Wind Speed

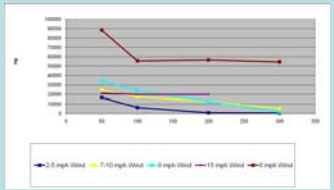
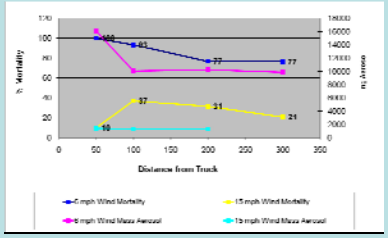


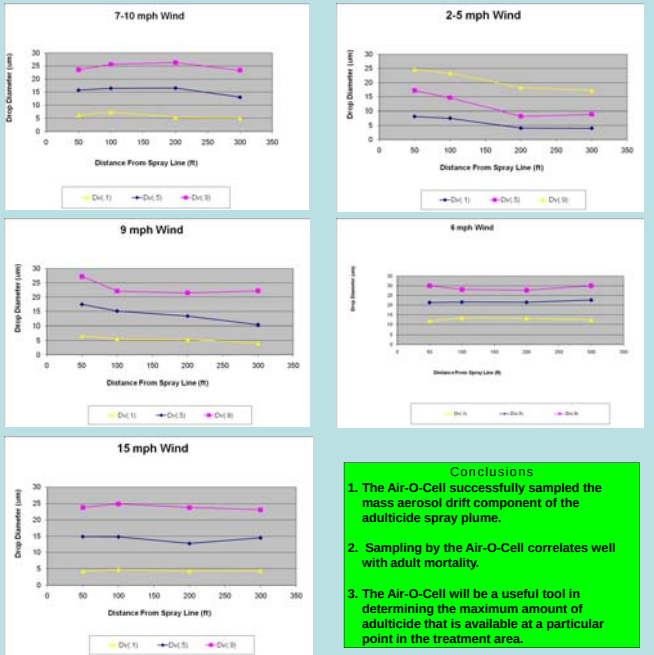
Figure 4. Response of Oc. taeniorynchus Adults to Biomist



The mass aerosol plume collections by the Air-O-Cell provided results which are reasonable and expected. A decrease in quantity with an increase in the distance from the spray line was expected and agreed with observations of the application. Low wind conditions revealed a non-linear relationship between mass and distance and is explained by similar pattern in the change in plume spectra for low winds (Fig. 3). The spectra indicate the large drops fell out of the cloud between 50 and 100 ft and at a lesser extent between 100 and 200 ft. A stable spectra was reached by 200 ft and retained to 300 ft. (Fig. 5. "2-5 mph Wind"). This pattern of large drop loss was reflected in the aerosol mass collections (Fig. 3).

The adult bioassay indicated a direct correlation between mortality and mass aerosol level (Fig. 4) with greater mass corresponding with increased mortality demonstrating the Air-O-Cell provides satisfactory results.

Figure 5. ULV Truck Drift Component Spectra



Conclusions

1. **The Air-O-Cell successfully sampled the mass aerosol drift component of the adulticide spray plume.**
2. **Sampling by the Air-O-Cell correlates well with adult mortality.**
3. **The Air-O-Cell will be a useful tool in determining the maximum amount of adulticide that is available at a particular point in the treatment area.**