BOTTLE BIOASSAYS OF FIELD COLLECTED MOSQUITOES FOR LEVEL OF ETOFENPROX RESISTANCE IN CENTRAL MASSACHUSETTS 2018 UPDATE

FRANK H. CORNINE III
Central Mass. Mosquito Control Project
111 Otis Street Northborough, MA 01532
(508) 393-3055 • www.cmmcp.org • cmmcp@cmmcp.org

ABSTRACT

During the 2018 season, the Central Massachusetts Mosquito Control Project conducted bottles bioassays to help monitor etofenprox resistance in the local mosquito population. The process is outlined by the Center for Disease Control and Prevention, with CMMCP using field collected adult mosquitoes against the standardized baseline etofenprox concentration. Resistance to etofenprox was examined because the primary adulticide product of CMMCP is Zenivex® E4, of which etofenprox is the sole active ingredient. Results from these ongoing bottle bioassays are given to the CDC in an effort to help expand the understanding of resistance in the United States.

BACKGROUND

Pesticide resistance in this age of vector-borne disease can hamper the ability of public health officials to successfully control threats. Potential resistance may also lead to the reemergence of several diseases that would have been otherwise contained through control measures (Brogdon 1998). Current resistance in select mosquito populations may be the result of historical insecticide use in the agricultural and pest control industries (Rodriguez 2005). The bygone use of DDT for example, could have contributed to current resistance to synthetic pyrethroids, due to the mechanism for resistance being similar for both (Brogdon 1998; McAbee 2003). Another associated and contributing factor may be the contracting classes and options for public health insecticides as well as growing regulatory restrictions (Brogdon 1998).

Although examples of pesticide resistance has been well documented, the scope of the issue and its real world impact on public health control activities is not known. This is partially due to varying levels of resistance surveillance programs that currently exist. This factor is shown in Massachusetts where some organized mosquito control agencies conduct zero resistance surveillance, while others have limited to well-developed programs collecting data on pesticide resistance in mosquitoes. In addition to the variety of resistance surveillance programs, resistance also appears to be quite localized which further clouds the impact. One noted example involved two separate mosquito populations that not only differed in resistance levels, but also resistance mechanism, all despite being only a few miles apart (Brogdon 1998). These continuing uncertainties surrounding insecticide resistance have supported CMMCP efforts to monitor for detection of early resistance. In the case of observed resistance, adulticide protocols could be modified to ensure continued efficacy.

The primary adulticide product used by CMMCP during the 2018 season was Zenivex® E4 (Wellmark International, Schaumburg, IL) (EPA Reg No. 2724-807), a synthetic pyrethroid that utilizes the active ingredient etofenprox. Prior to this season CMMCP had used another synthetic pyrethroid, ANVIL® 10+10 (Clarke Mosquito Control Products, Inc., Roselle, IL) (EPA Reg. No. 1021-1688-8329). Unlike Zenivex® E4, ANVIL® 10+10 uses the active ingredient sumithrin along with the synergist piperonyl butoxide (PBO). The absence of PBO in Zenivex® E4 is one of its advantages over ANVIL® 10+10. Etofenprox also presents a low toxicity to birds and dried foliar residues are not harmful to honeybees. The EPA has classified Etofenprox as a reduced risk pesticide.

MATERIALS & METHODS

The procedure used for these bottle bioassays comes from the Centers for Disease Control and Prevention (CDC 2010). Using the CDC diagnostic concentration established from naïve specimens against mosquito populations from the CMMCP service area, potential resistance can observed. In these bottle bioassays, clean 250ml Wheaton bottles (Wheaton Science Products, Millville, NJ) were lined with the baseline etofenprox concentration of 12.5µg/ml. The solutions used in this project were created using pesticide grade acetone (Thermo Fisher Scientific, Inc., Fair Lawn, NJ) and technical grade etofenprox supplied by the CDC. In addition to the bottles coated with etofenprox, untreated bottles were created using only the pesticide grade acetone to establish a control for the bioassays.

Field collected mosquitoes were obtained by using CDC light traps (John W. Hock Co., Gainesville, FL) deployed in areas with a history of CMMCP adulticide applications. The CDC light traps used compressed carbon dioxide gas as an attractant at a release rate of 500cc/min. Once the labeled bottles were coated and sufficiently dried, approximately 10-15 adult mosquitoes were aspirated into each bottle mechanically. ABC standard collection nets (Clarke Mosquito Control Products, Inc., Roselle, IL) were used in conjunction with the CDC light traps and held the mosquitoes until introduction into the bioassay bottles.

With these local exposed mosquitoes aspirated into the bottles, specimen knockdown percentage was recorded at various intervals, up to 100% knockdown or ending at 120 minutes elapsed time. For the untreated control bottles lined with only acetone (zero etofenprox), knockdown percentage was observed at similar intervals. Potential differences between the plotted knockdown curves of the treatment mosquito populations and the established baseline group could be used to determine if resistance was forming in local mosquitoes. If test specimens survived longer than those of the baseline group, it could be an indication of resistance developing.

DISCUSSION

Utilizing the CDC established baseline concentration for etofenprox (12.5µg/ml), the Central Massachusetts Mosquito Control Project was able to contribute resistance surveillance data to the CDC and mosquito control community. It should be noted that CMMCP uses field collected mosquitoes as opposed to lab

reared, which can have influence on the bottle bioassays observations. Adult mosquitoes collected from the field may be at various metabolic stages and process exposure to synthetic pyrethroids at different rates. If lab reared mosquitoes are used instead, their food source intake can be more readily regulated and uniform for bottle bioassay testing. With Zenivex® E4 remaining the primary adulticide product of CMMCP, resistance surveillance will continue using this CDC baseline etofenprox concentration against local mosquito populations. When CMMCP changes products, the resistance surveillance program will make the appropriate shift to that particular active ingredient. CMMCP staff will continue monitoring for etofenprox resistance to ensure that this aspect of control practices is functioning properly. Expansion of mosquito sampling sites is anticipated in 2019, increasing the range of resistance surveillance in central Massachusetts.

REFERENCES

Brogdon WG, McAllister JC. 1998. Insecticide Resistance and Vector Control. *Emerg Infect Dis* 4:605-613.

CDC. 2010. Guideline for evaluating insecticide resistance in arthropod vectors using the CDC bottle bioassays. Atlanta, GA: Center for Disease Control and Prevention [accessed January 10, 2019]. Available from: http://www.cdc.gov/malaria/resources/pdf/fsp/ir_manual/ir_cdc_bioassay_en.pdf

McAbee RD, Kang KD, Stanich MA, Christiansen JA, Wheelock CE, Inman AD, Hammock BD, Cornel AJ. 2003. Pyrethroid tolerance in *Culex pipiens pipiens* var *molestus* from Marin County, California. *Pest Manag Sci* 60:359-368.

Rodriguez MM, Bisset JA, DeArmas Y, Ramos F. 2005. Pyrethroid Insecticide-Resistant Strain of *Aedes Aegypti* From Cuba Induced by Deltamethrin Selection. *J Am Mosq Control Assoc* 21(4):437-445.