Efficacy Trials of the Central Massachusetts Mosquito Control Project Residential Adulticide Program (Update 2015)

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ABSTRACT

To gauge the efficacy of current adulticide practices, the Central Mass. Mosquito Control Project (CMMCP) conducted field trials in the summer of 2015 for both Anvil® 10+10 and Zenivex® E20. Surveillance on the local mosquito populations before and after the residential adulticide applications, indicated the level of control from current treatment procedures can vary based on several dynamics. These forces include but are not limited to, the particular residual properties of the adulticide product used, immigration from mosquitoes beyond the treatment zone, the physical barrier interference, and new local mosquito emergence. An increase in flow rate and/or application area would elevate the level of control of the program. At the particular application rates used during this trial, Anvil® 10+10 and Zenivex® E20 produced comparable levels of control.

BACKGROUND

To help protect the public from mosquitoes and the diseases they may carry, many control projects utilize ultra-low volume (ULV) applications. These machines allow the product to be applied at micron-level droplet size, enabling drift over a target area. CMMCP uses this technology as one component of their integrated mosquito management (IMM) plan (Mount 1998). Since 2007 CMMCP has used Anvil® 10+10 (Clarke Mosquito Control Products, Inc., Roselle, IL) (EPA Reg. No. 1021-1688-8329), a synthetic pyrethroid composed of 10% SUMITHRIN® (Sumitomo Chemical Company, Ltd., Osaka, Japan)(d-phenothrin) and 10% piperonyl butoxide (PBO) (Center for Disease Control and Prevention 2002; Petersen 2004). In 2015 CMMCP also added Zenivex® E20 (Wellmark International, Schaumburg, IL) (EPA Reg. No. 2724-791), with the active ingredient etofenprox, as an adulticide option. In addition to a different active ingredient than Anvil® 10+10, Zenivex® E20 also does not contain any PBO synergist.

During the 2015 season, CMMCP applied Anvil® 10+10 at a flow rate of approximately 1.3oz/min at 10mph, which results in the application of .0012lbs of active ingredient per acre. This is the lowest active ingredient rate available on the product label (CMMCP 2015). Zenivex® E20 was also applied at a flow rate of approximately 1.3oz/min at 10mph. This lower spectrum rate results in approximately .0025lbs of active ingredient per acre (CMMCP 2016). As described in its Standard Operating Procedures Manual, CMMCP conducts a ULV Sprayer Maintenance and Calibration Program to ensure all application equipment is operating correctly. Essentially, spray droplet size and flow rates are monitored and recalibrated if needed. Additional maintenance for the ULV machines such as spray head flushing and ultrasonic cleaning is also conducted through this program.

Although many efficacy trials use caged mosquitoes over free populations because of their quick, standardized results, studies have shown that the reduction of caged mosquitoes is also relative to the reduction of the natural populations (Mount 1998). Despite ULV applications being in common use, several regular issues can be associated with a decreased level of control. These factors can include ineffective insecticide dosage, along with mosquito resistance to that insecticide. Additionally, unfavorable weather conditions, reduced target coverage due to dense vegetation, and quick repopulation of the area can decrease the effectiveness of a ULV application (Curtis 1996; Efird 1991; Mount 1998).

One issue that can directly impact the level of control from a ULV application is mosquito insecticide resistance. Where local mosquito populations are routinely exposed to a single class of insecticide, resistance has been documented, both domestically and internationally. Fortunately, routine resistance surveillance can help indentify the issue so procedural changes can take place to preserve the efficacy of local ULV applications (Brogdon 1998). CMMCP has been conducting resistance surveillance for several years and the results continue to indicate that resistance is not an issue with the local mosquito population (Cornine 2015).

Along with insecticide resistance, weather conditions can also have a significant impact on the level of control from a ULV application. At the time of an application the wind direction and velocity, as well as temperature and temperature gradients can play an important role (Mount 1998). Drift, made possible by the small droplet size, is influenced by the wind direction and velocity. Ideally, wind speeds of 1-7mph are sought with high speeds no greater than 11mph. The temperature present at the time of an application is also important to the efficacy of ULV applications because it will influence mosquito activity in the area.

Temperature gradients in the atmosphere can also impact the delivery of chemical from a ULV machine. Differences in temperature within the air column can help facilitate the inversion of the application product into tree canopies (Mount 1998). This movement of chemical into elevated areas will have a greater impact on species such as *Culiseta melanura* and *Culex pipiens*, which studies have shown favor such heights. These two species are also potential vectors of Eastern Equine Encephalitis (EEE) and West Nile virus (WNV), making them important target species for control projects (Anderson 2004). Considering all these meteorological factors, evenings are typically better suited for applications than early mornings (Mount 1998). This concept plays a role in why CMMCP begins ULV treatments immediately following sunset.

Physical barriers such as structures and vegetation can significantly impact the efficacy of a ULV application (Mount 1998). In such situations, a higher application rate may be needed compensate for the lowered penetration of the droplets. Open spaces, through the lack of obstructions, could likely achieve the same level of control with a lower flow rate. The level of control between open and vegetated area can be as great as four times (Curtis 1996; Mount 1998). Although an IMM plan may favor using the lowest application label rate, in dense vegetation a higher flow rate should be considered or risk ineffective and/or multiple required treatments (Curtis 1996).

The potential for mosquitoes outside the application area to re-infest after treatment is one of the most significant issues when conducting an efficacy trial using field populations (Efird 1991; Mount 1998). The wider the target area, the longer it will take for foreign mosquitoes to repopulate the treatment area. However, relatively small applications could result in limited control and the increased need for additional treatments (Mount 1998). To help determine the efficacy of the CMMCP residential adulticide program, field trials of both Anvil® 10+10 and Zenivex® E20 were conducted during the summer of 2015. Potential procedural changes were determined as well as any significant differences in control level between the two adulticide products.

METHODS

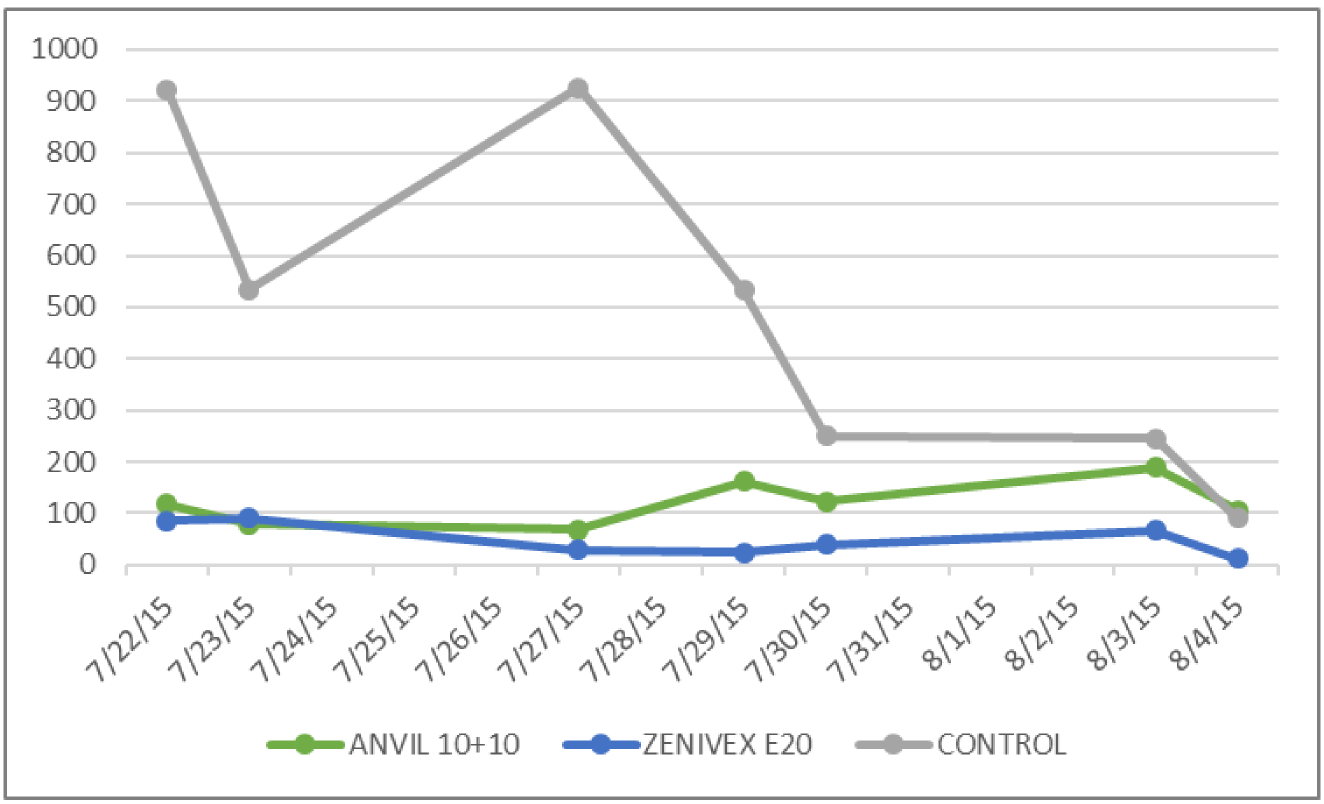
As with past efficacy trials of the CMMCP residential adulticide program, multiple field sites were chosen for the study with several mosquito collections made every week throughout the duration of the project. Two primary sites were selected to be treated during the CMMCP residential adulticide program, with another being left untreated, for use as a control site. One of these treatment sites would be treated with Anvil® 10+10, while the other Zenivex® E20. The sites designated for treatment were selected from areas with elevated numbers of service requests received, while the control site was selected from an area with similar mosquito habitat. To ensure that this control sites was not in the application zone, it was treated as an exclusion location by field technicians.

At the treatment and control sites, mosquito surveillance was conducted using model 512 CDC miniature light traps baited with CO_2 (500ml/min) (John W. Hock Co., Gainesville, FL). Mosquito specimens were identified by species, with the trap location and date of collection noted. Multiple collections were made before and after treatments to help determine the level of control. Once data for both the treatment sites and the control site are plotted, comparisons can be made to help gauge the impact of the adulticide applications on the local mosquito population.

RESULTS

Multiple collections were made at the Anvil® 10+10 and Zenivex® E20 treatment sites as well as the control site prior to the applications. Despite attempts to organize an earlier trial, both treatment sites were scheduled for their coordinated applications on July 28th, 2015. Both treatment sites experienced remarkably similar mosquito collections prior to and following their respective applications. Mosquito species for these two sites were also very close in nature. The control site however, was experiencing significant emergence of *Coquillettidia perturbans* prior to the spray date, which decreased through the remainder of the mosquito season (Figure 1).

Figure 1: Collection Comparison for Treatment Site #1 and Control Site



DISCUSSION

Caged mosquitoes are used in many field trials to help determine the efficacy of a ULV application. This method does have advantages over using field populations, which were used in this study, but lack many inherent issues associated with real world applications. As mosquito activity is heavily influenced by weather conditions present, our field studies accurately reflect daily meteorological changes, whereas the mosquito specimens in cage studies do not. The field studies conducted within the CMMCP residential adulticide program also involve sporadic road networks, varying vegetation amounts, and most importantly the immigration of mosquitoes from outside the treatment zone. This scenario helps determine the level of control experienced by residents following a ULV adulticide by CMMCP.

The results of this field trial indicated that control was achieved on local mosquitoes within the spray zone. The Zenivex® E20 set of mosquito collections experienced slightly greater control than the Anvil® 10+10, although comparable. The overall findings in this study were relatively consistent with the CMMCP efficacy trials of past seasons. Other studies, such as Mount (1998), similarly found that control was achieved initially, but populations rebounded two days after the application. A relatively quick repopulation was proposed as the primary reason for this rebound (Mount 1998).

Both the Anvil® 10+10 and Zenivex® E20 trial sets experienced a minor repopulation of the application area from mosquitoes outside the coverage zone, much like Mount (1998). This is to be expected, considering the focused applications, and the quick breakdown of Anvil® 10+10 and Zenivex® E20 as synthetic pyrethroids (Lesser 1998; CMMCP 2016). Unlike a barrier treatment, which retains its ability to knockdown mosquitoes for potentially weeks, these ULV products do not persist, allowing foreign mosquitoes to migrate into the treated area once settled. Although larger applications zone would likely have offered longer control, irregular road design, as well as various residential and natural obstructions very well could have limited any potential gains. This disadvantage may have been further compensated for by using higher flow rates as well, as the current rates are on the lower end of the allowable spectrums.

The level of control achieved through this program is consistent with expectations. The success of each trial within the study is directly related to the conditions present at the time of application. One slight adjustment to the program that could take place without significant transformation would be an increase in flow rate from the ULV equipment. Considering the nature of these residential adulticide applications, especially localized nature and various obstructions, an increase in flow rate would help combat these associated issues. With meteorological conditions playing such a significant part in the success of a ULV adulticide event, an applicator must take the weather into consideration when deciding the worthiness of any specific treatment, or risk an ineffective, wasteful application.

To ensure member communities receive efficient and effective public health protection, CMMCP will continually monitor the efficacy of the residential adulticide program. Whether the CMMCP will use Anvil® 10+10 or Zenivex® E20 as the primary ULV adulticide product in subsequent seasons will likely depend on costs and projected application rates. Although their levels of control are comparable, Zenivex® E20 does have the advantage of being effective without the use of PBO. CMMCP will continue to look on improving our ability to control mosquitoes and suppress vector-borne disease in central Massachusetts.

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