Ground ULV & Backpack Application Trials of Etofenprox (Zenivex™ E20) in Sonoma County, California

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ABSTRACT: Three ULV field trial applications and one operational field application of Zenivex™ E20[1] (etofenprox) were conducted on September 22 – 24, 2009 in Sonoma County, California at an application rate of 0.0035 pounds active ingredient per acre (AI/ac), delivered by a truck mounted ULV Beecomist sprayer and ULV backpack sprayer calibrated to deliver a $DV_{0.5}$ of 22.5 and 19.2 microns, respectively. Weather conditions were monitored at all three trials at a six foot elevation. Four to seven stations with bioassay cages containing 25 mosquitoes per cage, combined with 3 mm spinning impingers to monitor droplet flex values, were deployed throughout the trial application sites. Additionally, pre- and post-treatment trap counts were monitored and evaluated to determine the effectiveness of the adulticiding efforts in two of the three trials and the actual field application.

Treatment bioassay results with caged *Culex pipiens* and *Culex erythrothorax* mosquitoes showed variable mortality rates (sometimes as high as 88 - 100%) at all three application sites. In the ULV operational field application, pre- and post-treatment trap results demonstrated at average control of the adult population of *Culex erythrothorax* of 93.7 to 99.2 % up to one week after the application of Zenivex™.

INTRODUCTION

In mid-September 2009, the non-ester pyrethroid Etofenprox (Zenivex™ E20, a trademark of Wellmark International d/b/a Central Life Sciences) became registered for use in California for adult mosquito control. Marin/Sonoma Mosquito and Vector Control District (MVCD) was interested in evaluating this new adulticide product because of its low toxicity to mammals and birds (oral LD_{50}mg/kg >5,000 according to the manufacturer, Wellmark International) and because it was classified by the EPA as a reduced risk insecticide. Additionally, Zenivex™ has a unique formulation in that it does not contain piperonyl butoxide (PBO) as a synergist, yet it is still applied at ultra low volumes by ground and aerial equipment for effective adult mosquito control.

Initially, one site located in Healdsburg, CA was selected to perform a field trial with Zenivex™ by truck mounted ULV ground fogging on September 22 with a Beecomist® sprayer (Clarke Mosquito Control, Roselle, IL 60172). After reviewing the initial results, it was determined to include another trial, this time by utilizing a ULV backpack sprayer the following day, September 23. Both trials were conducted around a one half acre waste water treatment pond privately owned and maintained by Rio Lindo Academy, a nearby dormitory style high school. The main target species was *Culex pipiens*, although *Culex tarsalis* and *Culex stigmatosoma* were also found breeding in this area. A third trial was also conducted at District headquarters in Cotati, CA on September 23; this trial was outlined as a two by three grid, and the target species, *Culex erythrothorax*, was placed in cages within the grid. Droplet analysis for all three field trials was evaluated with DropVision™ technology (Leading Edge Associates, LLC, Waynesville, NC, 28785). Wind speed and direction, ambient temperature and relative humidity were recorded at six foot elevation for all three field trials. A truck mounted ULV operational application of Zenivex™ was made on the evening of September 24 at a large waste water treatment plant located near Petaluma, CA. The treatment plant was entirely covered in heavy vegetation (bulrush) and was producing large numbers of *Cx. erythrothorax*. Pre- and post-treatment trappings were used to evaluate and monitor the application of Zenivex™. This paper details the efficacy of etofenprox on natural populations of *Cx. pipiens* and *Cx. erythrothorax* by utilizing caged adult mosquitoes and incorporating droplet analysis (i.e. DropVision™) to evaluate the effectiveness of a new synthetic pyrethroid recently made available to mosquito control districts in California.

MATERIALS AND METHODS

Trial Sites and Mosquito Surveillance. Three field trials were conducted for the purposes of this study; two located at Rio Lindo Academy near Healdsburg, CA near the Russian River and one located at the District headquarters in Cotati, CA. The Rio Lindo site had four waste water ponds measuring 0.25 – 0.50 acres which are flooded alternately during the season. During this trial, only two of the ponds (one 0.25 ac. and one 0.5 ac.) contained water and were producing mosquitoes. The larger pond was mostly surrounded by cattails with some areas of vegetation being 10 feet deep into the perimeter of the pond. Larviciding treatments earlier in the season with biorational products produced less than satisfactory results, possibly due to high organic loads in the pond and the difficulty in treating effectively amongst the dense vegetation. Pre- and post–trapping at the Rio Lindo site were conducted with four EVS, two CDC miniature light and three BG Sentinel traps (BioQuip Products, Rancho Dominguez, CA 90220). The EVS and CDC traps were set along the perimeter

Figure 1. BG Sentinel trap at Rio Lindo waste pond.

road which circumvented the pond, and one EVS trap was hung on a cat walk above the pond. The three sentinel traps were placed on floating stations directly in the pond; two were located deep within the cattails (Fig. 1) and one in the open in the middle of the pond. All traps used dry ice placed in buckets above the trap and were set overnight to be collected early the next morning. The traps were monitored once a week for two weeks and then daily one week prior to the trial. Wild caught female *Cx. pipiens* were collected at the site and used in the bioassay cages of both trials at this location.

The grid trial located in Cotati, CA was performed in the early evening of September 23 and utilized wild caught, adult female *Cx. erythrothorax*. This trial was conducted in a relatively flat, open grass field that is owned and maintained by the District. There was no water at this location at the time of application, and trapping for adult mosquitoes was not performed pre- or post-treatment. All mosquitoes for the grid trial were collected from one EVS and two BG Sentinel traps at a large waste water treatment plant near Petaluma, CA. This same waste water treatment site was also the location of the actual field application by truck mounted ULV fogging which was conducted on the evening of September 24. The operational field application site contained a large 14 acre pond which was completely planted with bulrush to facilitate water filtration by the facility. This facility has been monitored regularly as a mosquito breeding habitat with trapping conducted weekly at various sites around the plant. For the purpose of this paper, trap results were reported two days prior to the application of Zenivex™, the next day following the treatment and one week post–treatment to evaluate percent control of the *Cx. erythrothorax* population.

Treatment bioassay, weather data and product application. For the three field trials, 25 female mosquitoes were placed in four inch diameter cardboard bioassay cages with tulle screening provided by Central Life Sciences (Central Life Sciences, Schaumburg, IL 60173). Five foot PVC t-post stations were set up with two bioassay cages per station, and a spinning impinger with two 3 mm Teflon slides was attached on top of the t-post between the two cages to capture and evaluate the droplet spectrum. At the Rio Lindo site, seven stations were set up for the truck mounted ULV fogging on September 22, and four stations were used for the ULV backpack fogging performed on September 23. At the District property, six stations were arranged in a 2 X 3 grid trial and set up with three rows of two t-post stations 50 feet apart at 100, 200 and 300 feet downwind from the spray truck. Additionally, four control cages of 25 mosquitoes each were placed within one quarter mile of the treatment areas at each of the three trial locations. Weather was documented prior to, during and 20 minutes following all trial applications. Temperature and relative humidity at Rio Lindo were 59˚F and 12% RH for the truck mounted ULV spraying on September

22, and for the ULV backpack application on September 23 the weather was recorded at 74˚F and 46% RH. A critical difference between the two trials at Rio Lindo was the documentation of wind (or lack thereof); virtually no wind was recorded during the truck mounted ULV application, and a 7 MPH wind occurred the next day during the ULV backpack spraying. The weather data for the grid trial was 68˚F, 46% RH and a 7 MPH wind speed. At the Petaluma treatment plant, winds were variable and gusting up to 10 MPH during the operational ULV field application. All three trials and the operational application were performed at the same mid-label application rate for Zenivex™ at 0.00345 lbs/acre with a flow rate of 1.8 ounces at 10 MPH. Droplet flux values were determined with the DropVision™ software after each of the three field trials, but not for the operational application of Zenivex™ at the Petaluma site.

RESULTS AND DISCUSSION

The initial trial performed on September 22 at the Rio Lindo pond generated mixed results in evaluating the efficacy of Zenivex™. Four of the seven t-post stations were staked along the rim of the pond, and all of these revealed an excellent mortality rate of 94 - 100% in the caged mosquitoes. However, three of the seven t-post stations were placed deep in the cattail vegetation, and a mortality rate of 4 - 52% was observed at these stations. While the average droplet size of 19.38 microns recorded at all seven impinger stations was within the desired range of 10 - 30 microns (as defined by the Zenivex™ label), the $DV_{0.5}$ (VMD) was significantly different from the four stations set along the rim of the pond as compared to the droplet densities recorded in the three stations down in the vegetation. Droplet densities of less than 3.97 drops/mm^2 squared correlated to low mortality rates of less than 4% in the bioassay cages at these stations. Conversely, cages that were determined to have a mortality rate of 100% showed average droplet densities of 86 - 100 drops/mm^2, and these were all found to be in the stations along the rim. Another primary cause of loss of mortality in the bioassay cages was the lack of wind to assist in moving the material down into the dense vegetation. Therefore, we conducted a second trial the next day, this time with a ULV backpack sprayer which enabled the field technician to walk near the edge of the pond and apply the material into the vegetation. This trial proved only slightly more successful with mortality rates ranging from 8 - 96% and droplet densities from 18 - 102 drops/mm^2, respectively. Fortunately, the trapping results at this location showed an overall reduction in the adult population occurring at the pond (Fig 2).

The grid trial conducted at the District property on September 23 was very successful against the wild caught *Cx. erythrothorax*. Mortality was recorded at 92 - 100% at 100 feet downwind distance from the spray truck, 80 - 92% mortality at 200 feet and 76 - 88% mortality at 300 feet. The lower mortality rates further downwind are indicative of the wind direction (SE) at the time of application and the 7 MPH wind speed that assisted movement of the material across the bioassay cages and impingers. Additionally, this site was an open grass field that was devoid of dense vegetation as noted in the previous two trials at Rio Lindo.

The truck mounted ULV operational application on September 24 at the Petaluma waste water treatment plant proved to be the most successful of all the of Zenivex™ trials for the District. While the treatment pond was completely covered in heavy vegetation (Fig. 3), there was still sufficient wind to help carry the product into the bulrush and cattails; this provided adequate

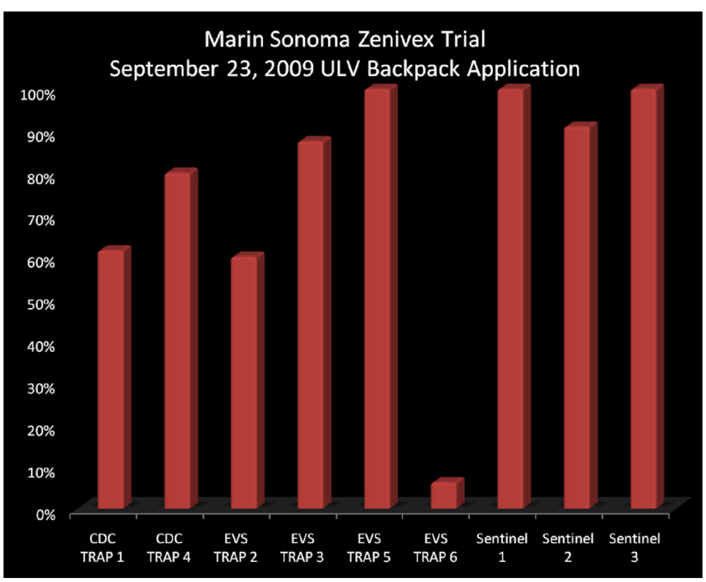

Figure 2. Trapping results showing percent reduction of adult mosquitoes at the Rio Lindo site.

Figure 3. Petaluma waste water treatment facility pond covered with bulrush.

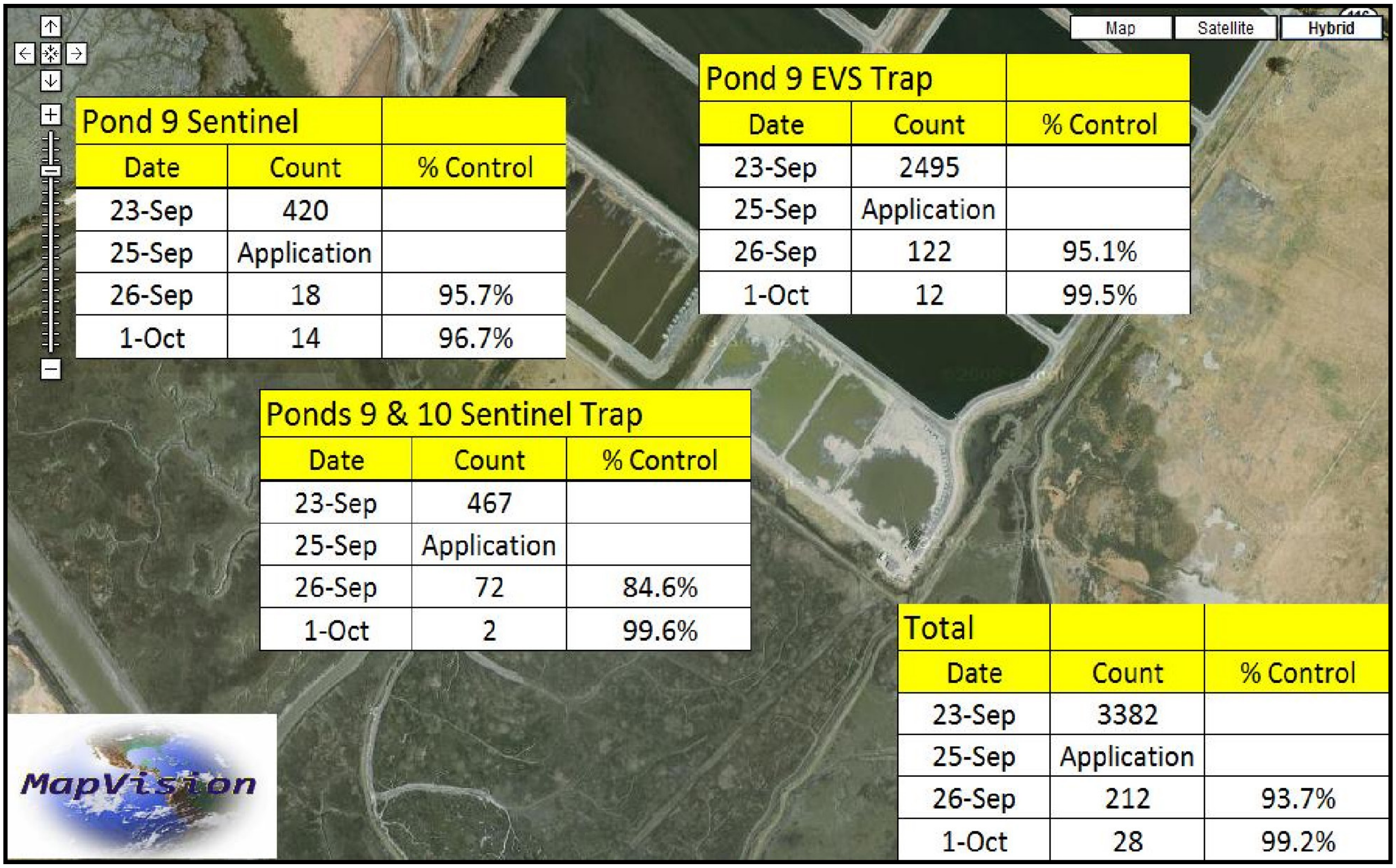

Figure 4. MapVision™ image overlay with trapping results at the Petaluma treatment facility *(MapVision™ imagery courtesy of Leading Edge Associates, LLC Waynesville, NC 28785).*

control of the adult population of *Cx. erythrothorax*, reducing the population from 3,382 to 212 adults per trap night. An overall control of 93.7% was reported on September 26, and control of the adult mosquito population was still evident one week later at 99.2 % control (Fig. 4).

CONCLUSION

The three trials and one field application of Zenivex™ produced promising results for this new adulticide product, particularly against *Culex* mosquitoes that are found commonly in Sonoma County. It became apparent that droplet analysis (i.e., DropVision™) correlated very well with the bioassays of caged mosquitoes and was instrumental in defining the mortality rates during the field application process, as well as setting standards for droplet flux values with the adulticiding equipment used by the District. We hope to complete more trials in the future on other mosquito species such as *Aedes sierrensis* utilizing Zenivex™ and the DropVision™ technology.

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