EFFICACY OF THE CENTRAL MASS. MOSQUITO CONTROL ADULTICIDE PROTOCOL – 2007

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ABSTRACT

During the summer of 2007, the Central Mass. Mosquito Control Project (CMMCP) conducted field trials for the efficacy of their adulticide product and procedure. By observing natural mosquito populations during seven week-long trial sets at application areas and control sites, it was determined that the current protocol results in a 2-3days of control before returning to pre-application levels. These results are believed to be due to the low residual nature of the product used for control and a rapid reinfestation by neighboring mosquito populations. Recent emergence of new mosquitoes is also a possibility although more unlikely than the previous scenarios. Despite these findings, the application rates are considered sufficient for non-vector control situations at this time, but it is proposed that changes in the protocol involving insecticide rates and target areas could increase the efficacy of this program during vector control situations.

INTRODUCTION

At the forefront of any vector control operation should be the efficacy of their practices. As one of several tools in any mosquito control project's integrated pest management (IPM) plan, adulticide applications are no different (Crockett 2002). Like many mosquito control projects, CMMCP uses ULV machines, the basis of which is to use the smallest effective amount of insecticide product (Mount 1998). Currently CMMCP uses 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; PHEREC 2001).

During the 2007 season, CMMCP applied ANVIL® 10+10 at a flow rate of 1.9oz at 15mph, which results in the application of .0012lbs of active ingredient per acre. This is the lowest active ingredient rate suggested on the product label (CMMCP 2007). In order to maintain proper application equipment standards, CMMCP conducts a ULV Sprayer Maintenance and Calibration Program as part of the Standard Operating Procedures Manual[MSOffice1]. This ongoing program involves monthly droplet size tests and flow rate calibration, and well as other general maintenance actions for the ULV machines such as spray head flushing and ultrasonic cleaning. In striving to monitor the strength of their protocols, CMMCP conducted an efficacy review of the 2007 adulticide program.

Efficacy trials of the past tend to use caged mosquitoes over natural populations because of their rapid, economical, and more standardized results. Despite these differences, studies have shown that the percent reduction of caged mosquitoes is the same as the reduction of the natural populations (Mount 1998). Any poor results of a ULV application could be caused by an ineffective insecticide dosage, mosquito resistance to that insecticide, unfavorable weather conditions, reduced target coverage due to dense vegetation, or quick repopulation of the area (Curtis 1996; Efird 1991; Mount 1998).

Mosquito insecticide resistance has become an issue in recent years. Routine resistance surveillance is needed to ensure that resistance is not impacting the efficacy of ULV applications (Brogdon 1998). CMMCP has started routine resistance surveillance and the results indicate that resistance to the current insecticide does not seem to be an issue with the mosquito populations in the CMMCP service area (Cornine 2007).

Weather conditions can also have a great impact on the effectiveness of an ULV application. Important factors include wind direction and velocity, temperature and temperature gradients (Mount 1998). Wind direction and velocity are important in that they are needed to create the drift for the adulticide across the target area. Velocities of 1-7mph are ideal with gusts of no more than 11mph. Ambient temperatures are important to the efficacy of ULV applications in that they influence mosquito activity as well as possibly compromising the effectiveness of the insecticide itself.

Another temperature factor is the temperature gradients in the atmosphere which can impact the inversion of the application product into the elevated levels of tree canopies (Mount 1998). This can be important for vector control efforts due to the fact that certain potential vector species of Eastern Equine Encephalitis (EEE) and West Nile virus (WNV) tend to congregate in the canopies, namely *Culiseta melanura* and *Culex pipiens* (Anderson 2004). These meteorological factors all play a part in the mosquito control efficacy of ULV applications. With these factors in mind, it is generally more advantageous to perform applications in the evenings due to mosquito activity and weather conditions (Mount 1998).

Vegetated areas can also be a factor in the efficacy of a ULV application (Mount 1998). It has been noted that a higher dosage rate may have to be used to obtain the same control level for areas where there is heavy vegetation compared to open spaces (Curtis 1996). This is due in part to the idea that the size and amount of droplets at the regular dosage rates may be unable to physically reach the adult mosquitoes in the vegetative cover. In fact, it has been reported that for a ULV application in vegetative areas compared to open spaces, the effectiveness of the normal dosage rates can be reduced by over 4 times (Curtis 1996; Mount 1998). With cost and environmental impact in mind, mosquito control personnel tend to use insecticide at the lowest suggested rates, but in situations where there is dense cover for adult mosquitoes these rates may be less effective, resulting in the need for additional applications, increasing costs and impact overall (Curtis 1996). Dense housing, fencing and other wall structures can also have similar impacts on the effectiveness of ULV ground applications as vegetation (Mount 1998).

A major problem with efficacy studies using natural populations is that mosquitoes in neighboring areas may repopulate the area after the application (Efird 1991; Mount 1998). In areas where the street layout allows a large coverage area, ULV applications can provide increased control over smaller targeted areas because of the possibility of reinfestation. In these small target areas situations, additional and more frequent applications may have to be made for adequate control (Mount 1998).

Keeping all of these factors in mind, CMMCP personnel conducted efficacy trials of the 2007 adulticide program to help determine what limiting factors may be present and if any procedural changes are consequently needed.

METHODS

To test the efficacy of the CMMCP standard adulticide procedure, two sites were chosen per week for seven weeks with mosquito collections made for both sites every weekday evening. One of these sites was selected to be sprayed in the standard manner while the other is not sprayed and is used as the control site. Collections were made for each site Monday through Friday with the experimental site being adulticided on Wednesday evenings. Test sites were chosen from service requests received, while the control sites were selected from nearby areas that the residents were informed that their property would be treated as an exclusion area for that week. Of the seven weeks of trials, four were at residential sites, two at recreational locations, and one was at a transfer station.

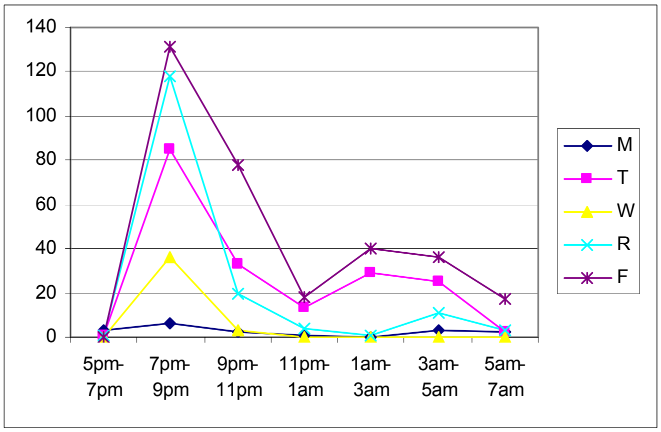
Using model 512 CDC miniature light traps baited with CO_2 (500ml/min), along with model 1512 collection bottle rotators (John W. Hock Co., Gainesville, FL), we were able to make the nightly collections that could be identified as to what time period the specimens were captured. There were seven collection time periods used for this project, programmed for 2 hour intervals from 5pm to 7am in order to observe the peak mosquito activity times as well as to have greater detail on the impact of the application.

Specimens were counted by site and collection period, with the weekly data for each site plotted. After plotting the data for both sites during the week, the graphs could be compared to help determine to what affect the adulticide application had on the local mosquito population. Then we compare for both sites, the two days before the application, the day of the application, and also the two days after the application. On the evening of applications, field technicians noted the time, temperature and wind direction prior to beginning.

EFFICACY TRIAL #1

Looking at each week's corresponding site collections, we can observe a couple trends. For MMWR 23 collections, the pre-application evening for the application site was more than double of the night of the application. This observation was different from the control site, which showed an increase during the application evening. Despite this decrease, levels for the two post-application evenings were much higher for both sites. A rain event during the first evening looks to have negatively impacted the collections from both sites, but especially from the application site (Figures 1-4).

Figure 1: MMWR 23 Application Site Collections (6/4-6/8)



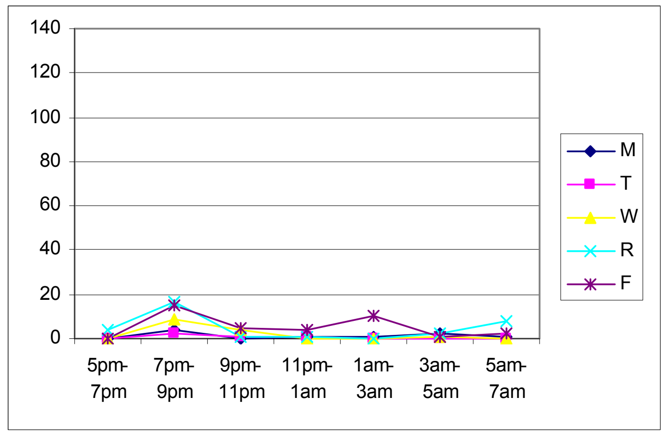
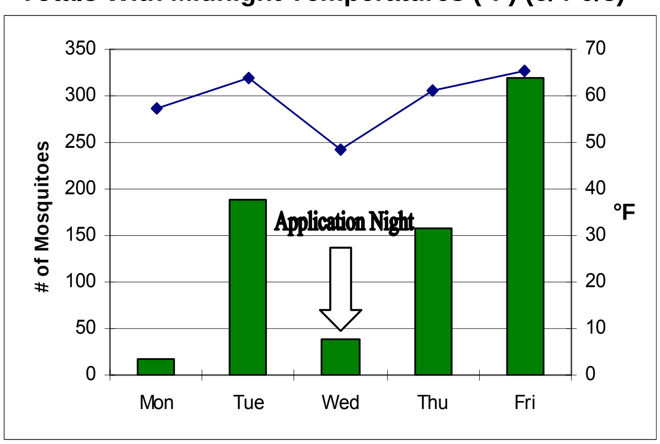


Figure 2: MMWR 23 Control Site Collections (6/4-6/8)

Figure 3: MMWR 23 Application Site Nightly Collection Totals With Midnight Temperatures (°F) (6/4-6/8)



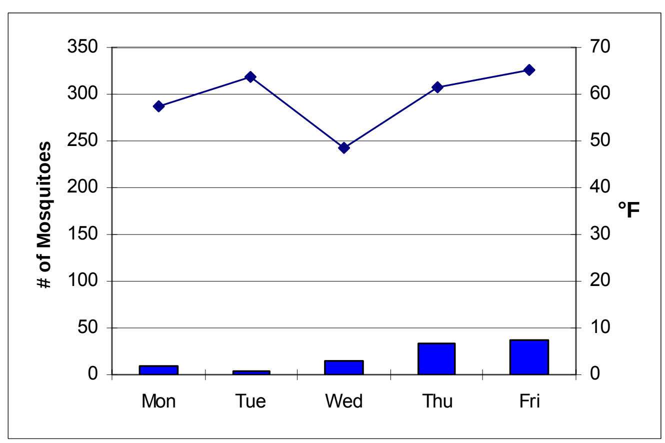
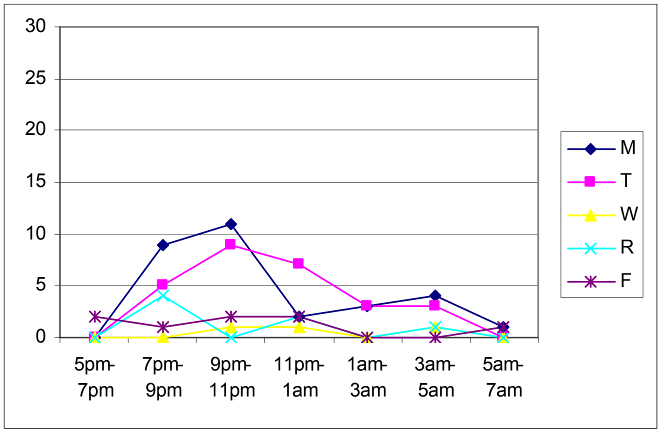


Figure 4: MMWR 23 Control Site Nightly Collection Totals With Midnight Temperatures (°F) (6/4-6/8)

EFFICACY TRIAL #2

The results from MMWR 24 were affected by evening temperatures on the application night that were much cooler than those for the rest of the week. This midweek dip in temperatures may have altered the results of the application. The post-application collections were relatively lower than pre-application, although the results were shown for both the control and application sites (Figures 5-8).

Figure 5: MMWR 24 Application Site Collections (6/11-6/15)



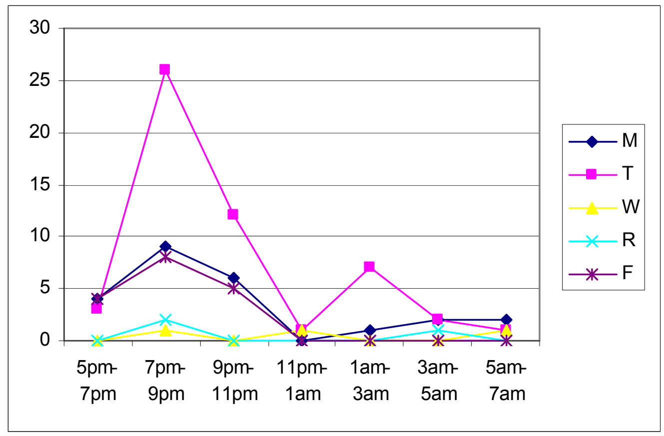
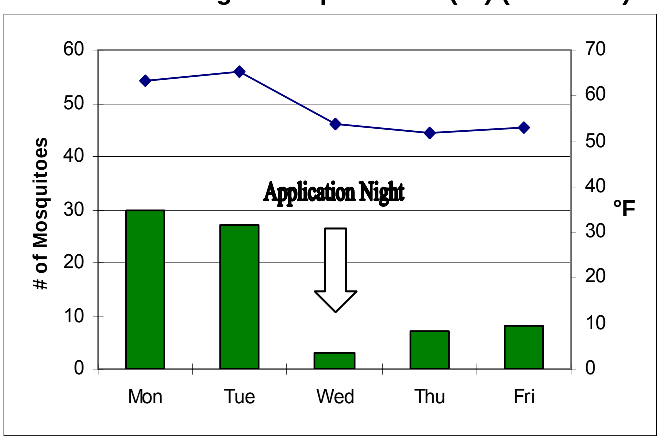


Figure 6: MMWR 24 Control Site Collections (6/11-6/15)

Figure 7: MMWR 24 Application Site Nightly Collection Totals With Midnight Temperatures (°F) (6/11-6/15)



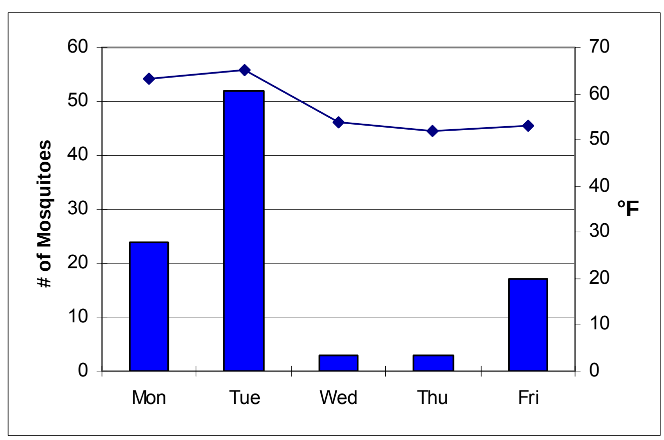
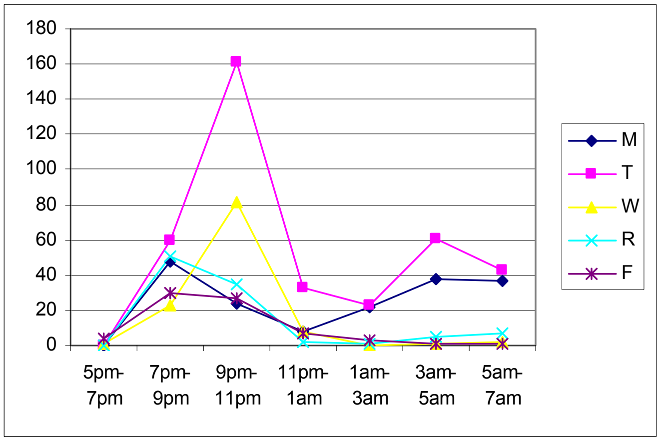


Figure 8: MMWR 24 Control Site Nightly Collection Totals With Midnight Temperatures (°F) (6/11-6/15)

EFFICACY TRIAL #3

The control obtained for MMWR 25 was relatively good for the application night as well as the two evenings after, although the second post application night had a dip that was similar to that of the control site. A rain event was recorded for the first post-application evening, possibly impacting the collection numbers of both sites. Field technicians noted the wind traveling from the spray origin toward the application site trap location (Figures 9-12). Despite these factors, the MMWR 25 trial showed good control.

Figure 9: MMWR 25 Application Site Collections (6/18-6/22)



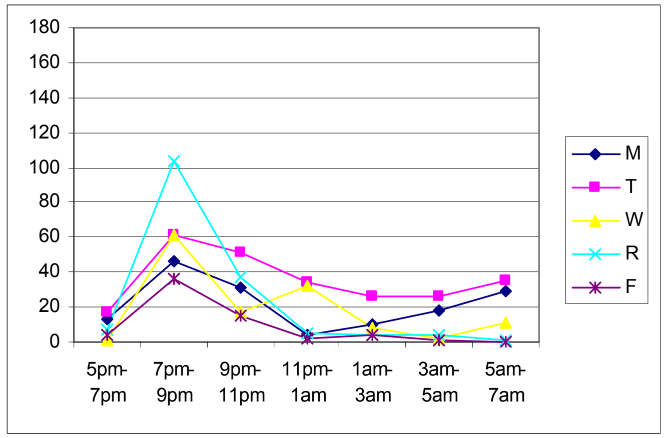
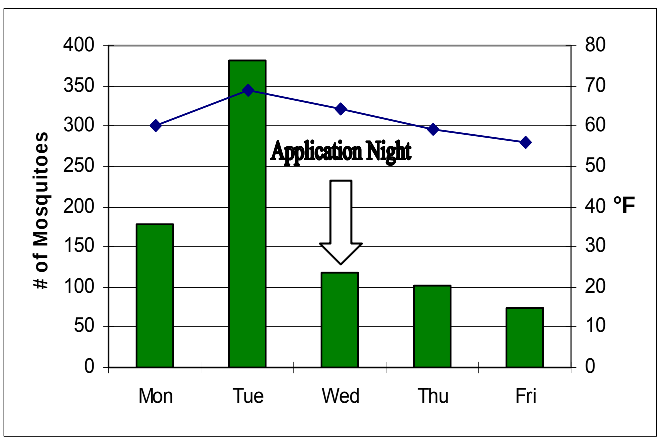


Figure 10: MMWR 25 Control Site Collections (6/18-6/22)

Figure 11: MMWR 25 Application Site Nightly Collection Totals With Midnight Temperatures (°F) (6/18-6/22)



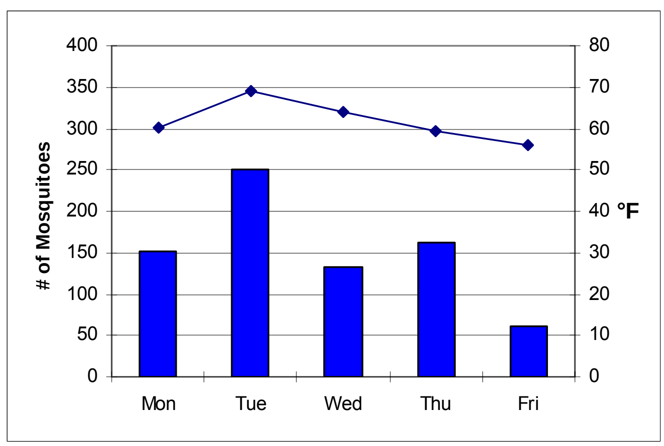
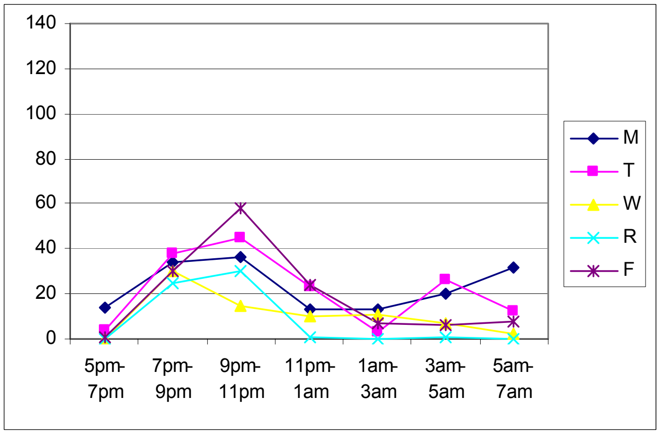


Figure 12: MMWR 25 Control Site Nightly Collection Totals With Midnight Temperatures (°F) (6/18-6/22)

EFFICACY TRAIL #4
For the MMWR 28 trial set, the application night control was good, but eventually it returned to pre-application levels, which mirrored the control site population changes as well. Field technicians noted that there was very little wind present during the application, and it was followed by a brief rain event as well. These observations may have influenced the results of the application (Figures 13-16).

Figure 13: MMWR 28 Application Site Collections (7/9-7/13)



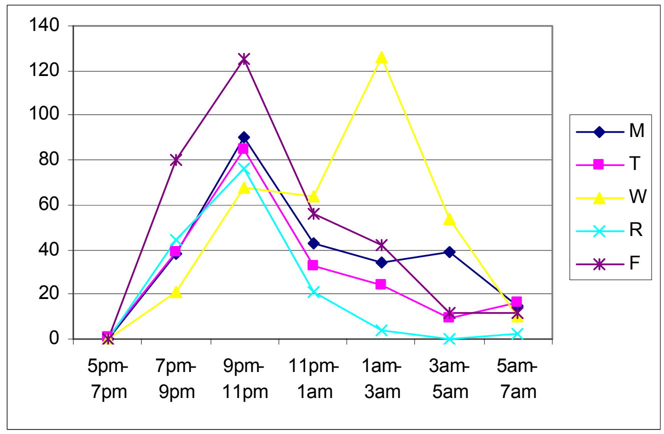
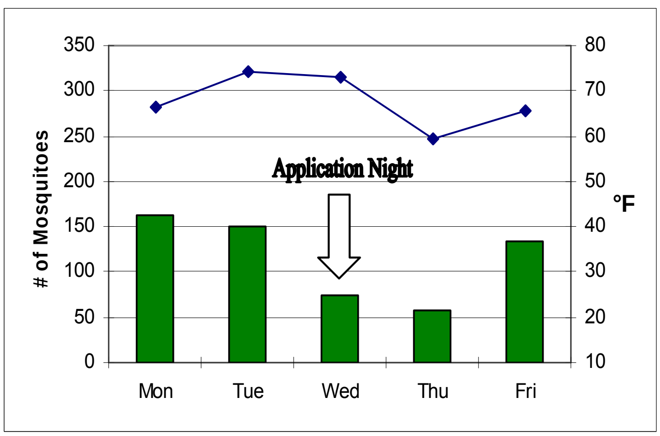


Figure 14: MMWR 28 Control Site Collections (7/9-7/13)

Figure 15: MMWR 28 Application Site Nightly Collections With Midnight Temperatures (°F) (7/9-7/13)



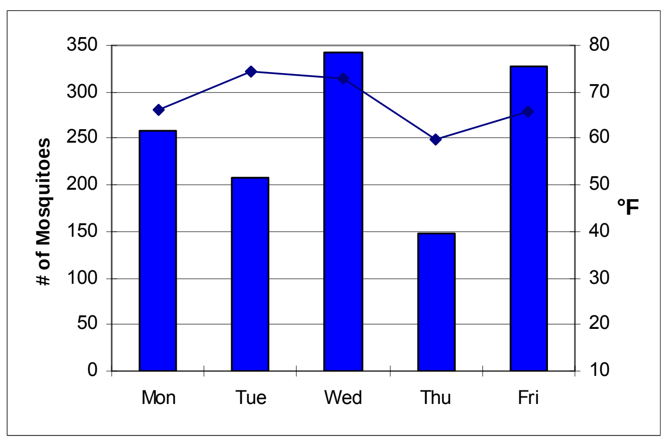
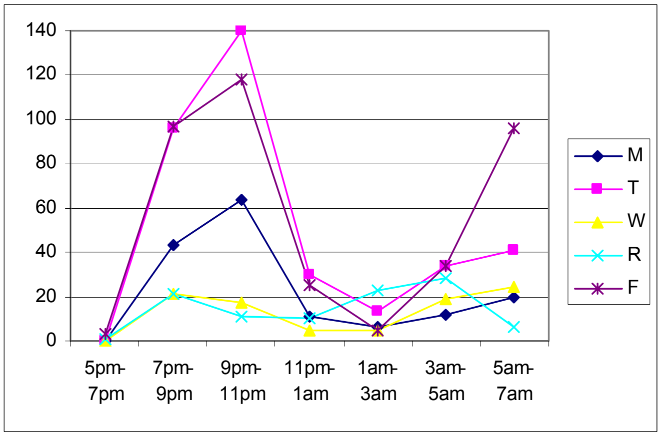


Figure 16: MMWR 28 Control Site Nightly Collections With Midnight Temperatures (°F) (7/9-7/13)

EFFICACY TRIAL #5
The MMWR 29 trial set showed good control for the application night and post-application evening before populations returned to pre-application levels. The post-application evening control may not be as significant because the corresponding night for the control site also had lowered levels from pre-application numbers. Field technicians also noted very little wind on the application evening, which could have hampered the results of the application (Figures 17-20).

Figure 17: MMWR 29 Application Site Collections (7/16-7/20)



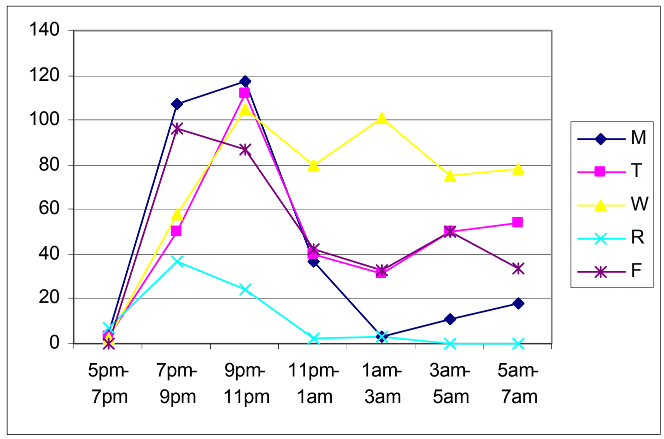
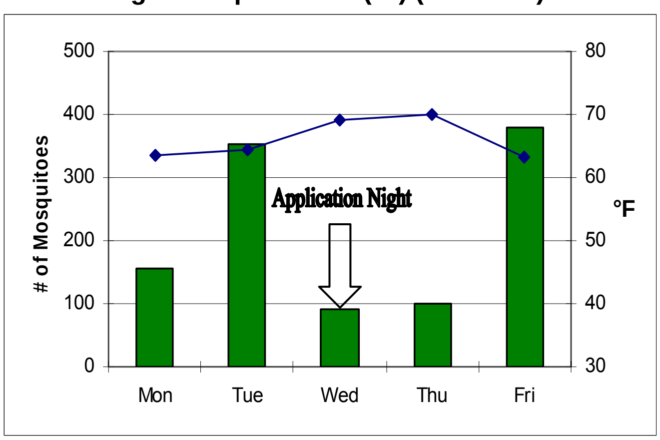


Figure 18: MMWR 29 Control Site Collections (7/16-7/20)

Figure 19: MMWR 29 Application Site Nightly Collections With Midnight Temperatures (°F) (7/16-7/20)



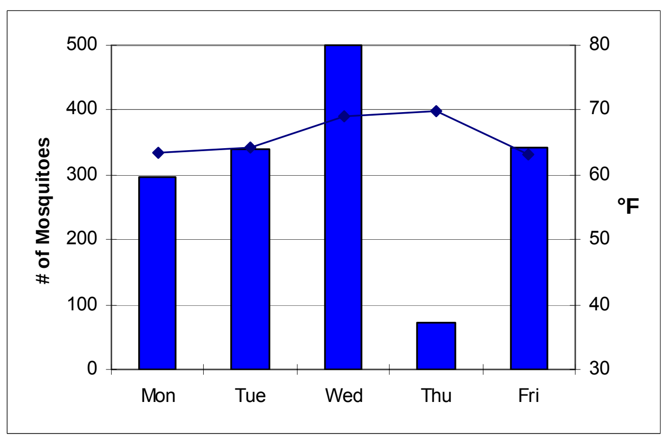
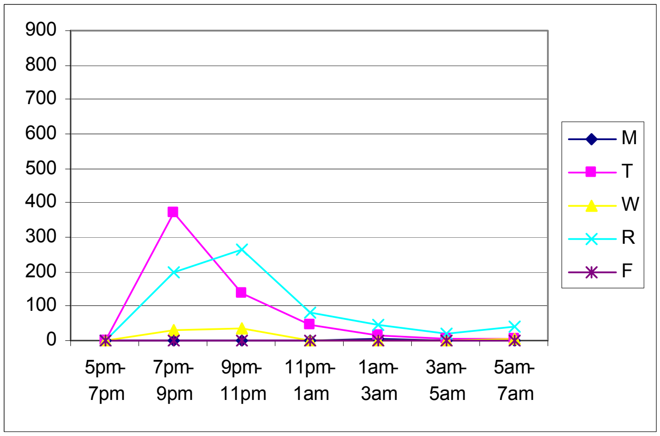


Figure 20: MMWR 29 Control Site Nightly Collections With Midnight Temperatures (°F) (7/16-7/20)

EFFICACY TRIAL #6
The MMWR 30 trial set had a similar trend to the previous weeks. The collections from the application night showed good control, but the post-application evening was not, eventually returning to pre-application levels. The wind direction was favorable during the application, although the wind speed was very low. A rain event on the last evening may have impacted the collections of that night (Figures 21-24).

Figure 21: MMWR 30 Application Site Collections (7/23-7/27)



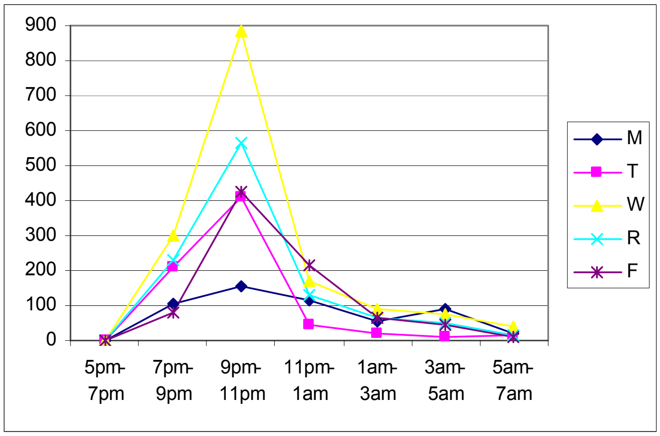
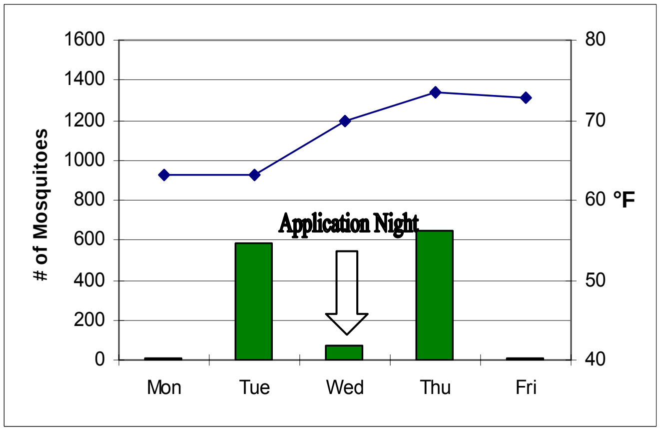


Figure 22: MMWR 30 Control Site Collections (7/23-7/27)

Figure 23: MMWR 30 Application Site Nightly Collections With Midnight Temperatures (°F) (7/23-7/27)



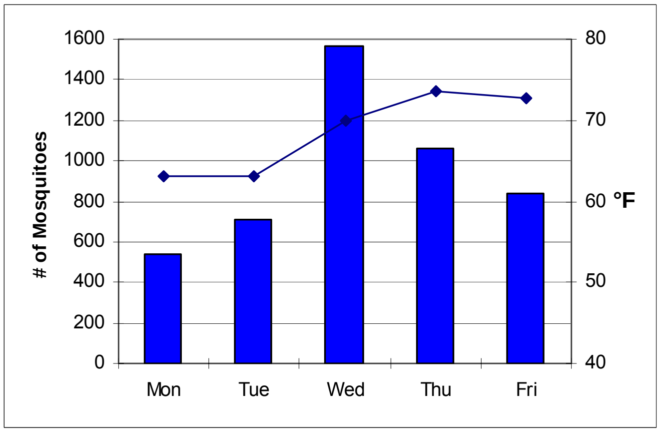
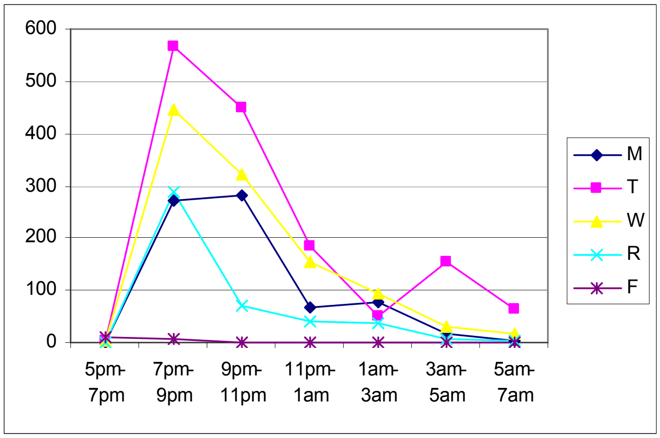


Figure 23: MMWR 30 Control Site Nightly Collections With Midnight Temperatures (°F) (7/23-7/27)

EFFICACY TRIAL #7
The MMWR 32 was the last trial set of the study and again showed similar results to the other weeks. The collections from the application night exhibited good control as did the two post-application collections. Observed wind direction during the application seemed favorable as well as wind speed. Despite the lower post-application collection numbers of the application site, the control site also exhibited similar changes during this time (Figures 25-28).

Figure 25: MMWR 32 Application Site Collections (8/6-8/10)



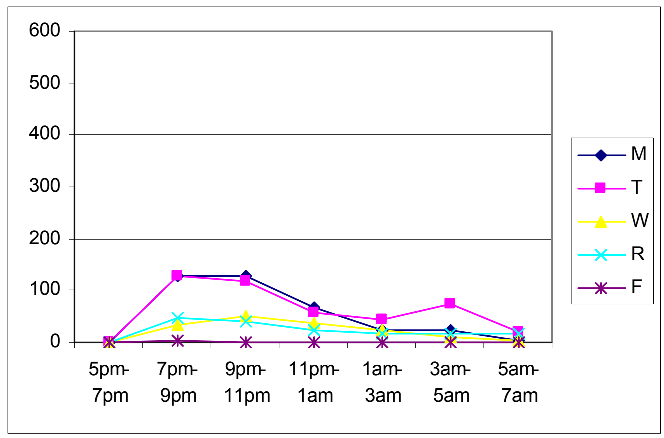
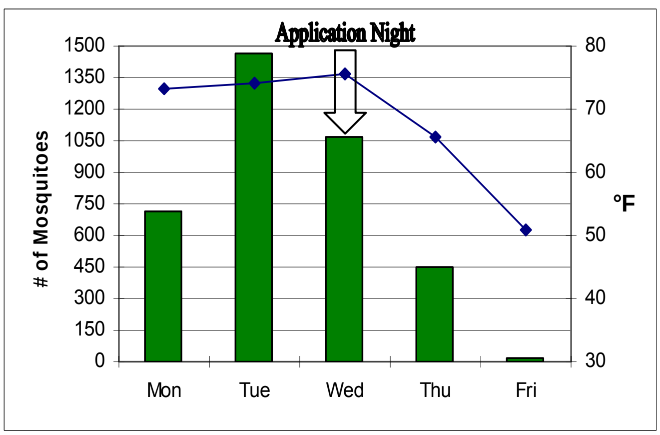


Figure 26: MMWR 32 Control Site Collections (8/6-8/10)

Figure 27: MMWR 32 Application Site Nightly Collections With Midnight Temperatures (°F) (8/6-8/10)



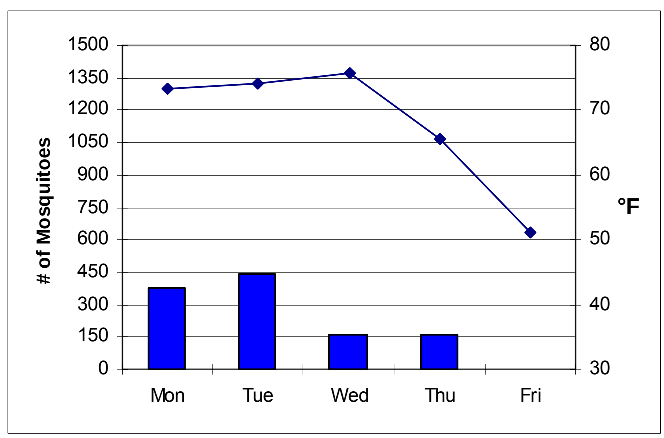


Figure 28: MMWR 32 Control Site Nightly Collections With Midnight Temperatures (°F) (8/6-8/10)

DISCUSSION

As previously discussed, many past efficacy studies of ULV applications involve using caged mosquitoes. Using caged mosquitoes has its advantages with many less variables, but doesn't necessarily give you an accurate picture of what's really happening. Caged mosquitoes can judge the efficacy of an adulticide product very well, but may not mimic the actual field results of an adulticide program. With our residential field trials one has to factor in the role that weather plays on natural mosquito populations, as well as irregular road design, vegetation and obstructions at the residence, and migration of neighboring mosquitoes to name a few. I think that many of these problems associated with natural mosquito population field trials were apparent in our study.

Overall, our study showed that control was achieved for approximately one to two nights before the mosquito populations returned to pre-application levels. This was similar to another study where one day post treatment control was good, but then after two days post-treatment populations began to return to pretreatment levels. Authors involved seemed to believe that this rebound was due to quick reinfestation of area and also some weather factors (Mount 1998).

I believe that the findings in this study were primarily a product of rapid reinfestation by neighboring mosquito populations. This migration of mosquitoes was made more easily due to the fact that the target areas were relatively small, and like other synthetic pyrethroids, leaves very little residual and has a rapid breakdown (Lesser 1998). This property of the chemical lends itself to a quicker reinfestation compared to that of a barrier treatment with higher residual characteristics. Even if the target areas were to be expanded, some of the site locations would not have provided a road network that would have allowed for a greater penetration of the insecticide into the forested areas. If applications were able to have been made on an adequate road design around the target site such as a street layout using a grid pattern with low to moderate foliage, control results would have been improved. Most of these locations also contained at least some vegetative cover, which could have impacted the results.

Despite these results it is not believed that a significant change in procedure is needed. Possibly a slight increase in dosage rate, which would still be under the allowable EPA and label rates, may improve control, especially in vegetative cover instances. This increase would also help in less than ideal weather conditions. Another possible change in procedure could be to try to increase coverage whenever allowable. Spray applicators always need to consider whether or not to apply when conditions are doubtful. Applications in unsuitable conditions may not be providing much control, wasting product and increasing the potential for negative environmental impact. If adjustments to the application procedure are not made, future spray events should not be expected to result in different control levels as compared to our study.

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