

VECTOR CONTROL FOR DENGUE AND OTHER MOSQUITO-BORNE DISEASES

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Abstract Dengue is transmitted to humans by day-biting mosquitoes, primarily *Aedes aegypti* and *Aedes albopictus*. Primary prevention of this debilitating disease is through vector (mosquito) control: spraying for adult mosquitoes and applying larvicides to standing water. This presentation provides an overview of the problem of dengue fever, including the geographic distribution, the cause of the increasing spread of the mosquito vectors, the dangers of the spread, and the limitations of governmental treatments. Specific topics covered include, the limitations of area wide control, and the need for consumer to be able to purchase protection for his property. Specifics concerning the limitations of larvicides and adulticides will be discussed. The wide range of mechanical controls used by governmental agencies will be discussed, and the effectiveness for the individual consumer will be outlined. Research developed by the United States Center for Disease Control and the United States Department of Defense will be presented. Specific attention will be directed to the role of professional pest control operators in managing the vectors, including the type of equipment, application techniques, nozzle sizes, and application pressure. The specific areas to treat around residential and commercial accounts will be outlined along with the habits and biology of the mosquito that makes this type of treatment most effective. Built in automated mosquito misting systems will be discussed and the reasons that they do not provide the most effective long term control and are also not the most profitable solution for the pest management professional.

Key Words Mosquito control, *Aedes aegypti*, *Aedes albopictus*

INTRODUCTION

Treatment for mosquitoes has in many western cultures come to be more feared than the diseases that are borne by the pest. In many western countries, unlike developing countries, people are two to three generations removed from seeing our friends, families and loved ones die from insect-borne diseases. In the United States many citizens believe that there is no danger left out there and not only do not worry about these disease vectors but do not believe in vaccinations for the most common of childhood diseases. This is the most serious problem facing public health at this time and this presentation is primarily about just one type of threat that we face.

Control of the primary insect vectors of dengue and other diseases begins with understanding its basic biology and habits, because its biological makeup and habits can be used effectively against it. So for a short review of the biological makeup of mosquitoes: they have a complete life cycle (egg, larvae, pupae, adult); only females bite and spread disease organisms; females are attracted to CO₂ from 100-150 ft. (30-46 meters) away from an attractive source; they puncture the human skin with their mouthparts (proboscis); they spend eight to ten hours a day hanging upside down on vertical surfaces; they prefer to fly to within a short distance of their intended victim and stop and alight on a surface for a short period of time prior to biting. The primary mosquito-borne diseases emphasized in this presentation are: Dengue fever; encephalitis; heartworm; malaria; West Nile virus; and, yellow fever.

DENGUE FEVER

Aedes aegypti and *Aedes albopictus* are the primary mosquitoes that are responsible for the transmission of this disease. The most important item to recognize is that Dengue Fever does not have any natural pool to draw the infection from. It is harbored in humans only and is transmitted from one infected person to another. The pattern for the replication and transmission of Dengue Fever is: the virus replicates in mosquito midgut and is transmitted to human in mosquito saliva, once in the host animal the virus replicates in target organs: white blood cells and lymphatic tissues, and it is released and circulates in blood. A bite from a second mosquito ingests virus with blood.

Distribution and Symptoms

Dengue occurs in Asia, Africa, Caribbean, and Central and South and North America. It is wide spread in Mexico and is currently being found in Texas, U.S.A. However, it is not currently endemic in the U.S, but imported cases are not uncommon. Severe hemorrhagic manifestation can occur. This is known as Dengue hemorrhagic fever. Contracting one form of the Dengue Serotype does make the person immune to that Serotype but does not give immunity to any of the other Serotypes. The most common symptoms of dengue fever are: intense headache; fever 3-5 days, rarely more than 7, often biphasic; gastro-intestinal tract disturbances; myalgia, arthralgia; retro-orbital pain; anorexia; and a rash.

Once one type of the disease is contracted and the individual survives to contract another serotype the odds are very high that it will be the Hemorrhagic form which can be fatal. Dengue Hemorrhagic Fever is characterized by: Dengue Shock Syndrome (DSS), which is the result of sequential infection by more than one dengue virus serotype. It is characterized by fever, excessive capillary permeability, hypovolemia, and abnormal clotting mechanisms. For some reason occurs especially in children ages 6 to 14. There is no specific treatment for dengue; DHF may require intervention for hypovolemic shock. Prevention and control involve personal protection and reducing populations of *Ae. albopictus* and *Ae. aegypti*. Susceptibility: universal; recovery from one serotype provides lifelong immunity but does not provide protection against other serotypes.

To treat for the Mosquito Vector you must take a number of items into consideration and plan what combination you will use to be most effective long term. The four main types of control are larvacides, source reduction, biological controls, adulticides and barrier treatments.

Larvacides

Control at the breeding site is key to most mosquito control programs. As the name implies, larvacides are used to treat mosquito larvae in an attempt to reduce the adult population. Treatments are performed by specialized equipment using liquids, granules or pellets to standing water that has been identified as a breeding site. Applications can also be made to areas that will contain and retain standing water after an anticipated rain. Usually this kind of treatment is applied by a public entity like a city, county or national governments departments. Several treatments may be required each season. In the past this type of treatment has been regarded as one of the most effective but it does not kill all of the pests.

Adulticides

These materials are used to treat active adults. They are labeled for applications from specialized equipment (airplanes, trucks); the material is applied in various forms from Liquids, ULV, Mist Fog or aerosol form (the particle size of the material determines the form and this is usually measured in microns). Generally the applications are made in the early evening when the adult Mosquitoes are flying about. Relief is generally only very temporary with more adults appearing later in the evening and the next night. Consequently it is not effective long or short term in lowering disease vector risk.

Source reduction. Is actively eliminating or altering breeding sites in such a way that reduces the numbers of larvae that can be supported and allowed to develop: 1) Can permanently impact control; 2) Requires public education and cooperation to allow complete access to all breeding sites and the follow through by all citizens on the required changes in their current life style; 3) Very effective environmentally sound approach if citizens will cooperate.

Barrier Treatments

To be effective, the chemicals used for a barrier treatment must be readily available, easy to apply, have a long residual activity on a variety of substrates, and not stain those substrates, be non-repellent to adult

mosquitoes, have little or no odor, and have little or no phytotoxicity. This treatment is most currently used in third world countries and has not been used frequently in the USA in the past. The technique is mostly used as part of a total mosquito eradication program. It can be performed with equipment most pest management professionals have on hand and it consists of applying a residual treatment to the natural mosquito resting sites around commercial and residential structures. It has significant value as part of IMM (Integrated Mosquito Management) program in that; it is a targeted approach that is not widely being used. While it does not kill all the vectors it does eliminate a great deal of mosquitoes that would not normally be killed.

When this treatment technique is used with the right residual it continues to reduce the population over time which is something that doesn't happen with the other treatment techniques so the addition of a barrier treatment offers an enhancement to the IMM approach. Most governmental agencies do not perform this type of treatment because it would require them to go on private property. There is however, a great need for this type of treatment as a valuable tool in the reduction of mosquitoes and the potential transmission of disease. Barrier treatments compliment and enhance the efforts of the public entities.

Insecticides. The following data is presented primarily to show the effectiveness of barrier treatments and although there are many different types of chemicals registered in different countries to be used the reader will note that my preference is Bifenthrin. I have done this because my personal experience in the Southeastern USA. has shown me how effective it is in control.

The conclusion section of the 2001 World Health Organization Pesticide Evaluation Scheme Report addresses the non repellency of bifenthrin. This is an important benefit of Bifenthrin especially when considering the value barrier treatments. Mosquitoes are not repelled therefore they rest on the treated surface for a sufficient amount of time for the mosquito to receive a lethal dose. If a material repels the mosquito, they leave before receiving a lethal dose. The 2001 WHOPES report states "Bifenthrin consistently provided a high kill by allowing the mosquitoes to rest on the treated surfaces for longer periods." Control Evaluation of Bifenthrin 10WP Indoor Residual Spraying in India, *Anopheles culifacies* results indicate the level of efficacy of bifenthrin treatments performed to mud walls in homes/houses in India. This rate is equivalent to the high label rate of 1 oz/1,000 sq ft. Mosquitoes were held on the treated walls at several time intervals for 30 minutes and then monitored for 24 h mortality. Bifenthrin provided long lasting control even on Mud surfaces for extended periods of time. Data showed 67% control on mud walls 24 weeks after application.

In a test bifenthrin was applied to different surfaces, cement, bamboo, palm thatch, and Wood at the equivalent rate of 1 oz /1,000 sq ft rate and tested to determine the residual efficacy over time. Even under the worst conditions the bifenthrin formulation still provided 16 weeks of greater than 75% control on cement, 18 weeks on bamboo, 19 weeks on palm thatch, and 20 weeks on wood (surfaces are treated and mosquitoes ore subjected to the treated surface over time and mortality is measured). In Australia a random test using pairs of homes were selected. One home would be treated the other would serve as the control A total of 4 homes were treated. Randomized pairs: 1 Treatment + 1 Control x 4 = 8 Houses, NRA Permit: 5547.

Fences and shrubs around the homes to be treated were treated creating a barrier. Bifenthrin applied as large droplets (150 to 200 µm) to the point of run-off to the sides of houses, fences and shrubs. Mosquitoes and midges were collected and counted to measure the percent reduction. Midges were reduced by 65% and the mosquitoes were reduced by a whopping 94%. This barrier treatment was performed not in conjunction with a larvacides treatment.

For an effective barrier treatment you would treat any surface area of the structure that a mosquito would rest on or near. Use a properly labeled material to treat with a hand or a power sprayer. Treat limbs of shade trees, flower beds, shrubs, tall grass and shaded areas around buildings where mosquitoes congregate. These treatments should be focused to the area 15 feet out and 15 feet up — around the outside perimeter of the structure. Do not apply to water or areas where run-off into water might occur. The conclusion from my experience is that the use of Barrier Treatments is extremely important if you wish to perform effective disease vector control.

REFERENCES

WHOPES 2001. Report of the 5th WHOPES Working Group Meeting. WHO/CDS/WHOPES/2001.4. http://whqlibdoc.who.int/hq/2001/WHO_CDS_WHOPES_2001.4.pdf

