Misting Matters

New research from Florida A&M University sheds light on automatic misting systems for the control of backyard mosquitoes.

By James E. Cilek, Charles F. Hallmon and Reginald Johnson

A tremendous amount of interest has been generated by pest control companies and industry in marketing and installing automatic misting systems for the purpose of reducing adult mosquitoes in residential areas. This technology has been primarily driven by homeowners who want to spend quality time in their backyards without being annoyed by host-seeking mosquitoes.

A typical automatic misting system consists of a multi-gallon reservoir connected to a continuous loop of rubber tubing attached to multiple single spray head nozzles. This array is then connected to a programmable electric pump set to automatically apply an insecticide at predetermined intervals (usually for 30 to 45 seconds at dusk and dawn when mosquitoes are most active). Nozzles are usually placed along the perimeter of a backyard and in landscaping or other areas suitable for mosquito harborage. Most systems usually apply a water-soluble synergized pyrethrins mixture.

Although most persons agree that the insecticides applied by these systems are capable of killing mosquitoes the long-term, effectiveness to reduce mosquito populations within a given area is lacking. The Florida state and local mosquito control community has questioned the effectiveness of automatic mist systems for the control of adult mosquitoes. As a result, an operational field research study recently published by the authors was funded in 2007 by the state of Florida, Department of Agriculture and Consumer Services to evaluate this technology (Cilek et al. 2008). A simulated residential backyard study with a misting system was also installed on the grounds of Florida A&M University's John A. Mulrennan, Sr. Public Health Entomology Research & Education Center in Panama City to determine the primary pathway of insecticide exposure to the mosquitoes under controlled conditions.

OPERATIONAL FIELD STUDY. The 35-week operational field study ran from March 22 to Nov. 16, 2007. A MistAway automatic misting system (Model Gen 1.2, MistAway Systems, Houston, Texas) previously installed by a local certified pest control firm in three residential backyards in northwestern Florida was the system that was evaluated. This pest control company leases the systems to homeowners and performs any maintenance, including insecticide refills.

The MistAway system is a continuous loop

system that uses 0.5 cm diameter rubber tubing connected to nondrip Hago #4023 nozzles. Backyards in the study averaged about 55 feet deep by 85 feet wide with the entire perimeter area covered by the system. The number of nozzles per backyard ranged from 26 to 43 placed at 10-foot intervals. Nozzles were mounted about 3 to 4 feet above ground surface and were oriented at 45 degrees. The application system was attached to a 55-gallon drum reservoir that contained 0.05% AI solution of Summerfrost (3% AI pyrethrins, 6% AI piperonyl butoxide, and 10% AI n-octyl bicycloheptene dicarboximide [MGK 264]). Systems were programmed to automatically apply a 45-second spray at dawn and another application at dusk. According to the manufacturer, system flow rate was 1.4 oz/minute per nozzle at 180 psi.

The display panel on the unit also could be accessed to determine if the homeowner had overridden the system for additional sprays. No additional applications were noted during the study. Each treatment backyard was paired with an untreated yard at least 100 feet away.

Mosquito populations were monitored in all backyards with one ABC suction trap (Clarke Mosquito Products, Roselle, Ill.) with the light on, powered by a 6v gel battery. All traps were baited with carbon dioxide dispensed from a 20-pound pressurized cylinder at a release rate of 500 ml/minute. This release rate is similar to that of a large mammal slightly larger than a human. Traps in treated and untreated yards were located near the back perimeter. Twenty-four hour collections were obtained twice a week and identified to species.

OPERATIONAL STUDY RESULTS. The three major pest mosquito species, in decreasing abundance, from all yards were: the black salt marsh mosquito (*Ochlerotatus taeniorhynchus)*, *Anopheles crucians* complex and *Culex salinarius*. During the first three weeks of the study mean mosquito abundance in treated yards was lower compared with untreated yards where reduction ranged from 71% to 98%. From April 27 (week 5) through most of the summer into Sept. 21 (week 26), mosquito populations remained relatively low due to drought conditions. Consistent and substantial rainfall started again in late September (week 27) with concomitant increases in mosquito abundance. As the number of mosquitoes greatly increased in the neighborhoods as a result of rainfall (starting week 28), mosquito populations in yards with the misting system remained significantly lower where reduction ranged from about 62 to 91% compared with yards without the systems.

Susan Ellis, .Bugwood.org

An adult female Asian tiger mosquito.

SIMULATED BACKYARD STUDY. Cylindrical screen cage mosquito bioassays were conducted during September in the simulated typical residential backyard (15.2 m deep by 22.9 m wide) constructed on the grounds of the Public Health Entomology Research and Education Center. This study was conducted to determine the primary method of mosquito reduction experienced in the operational study. The same make and model misting system (Model Gen 1.2 MistAway automatic misting system) was installed by the same local pest control company to operational specifications for a residential backyard. The backyard perimeter was framed by a 4-foot high polyvinyl chloride (PVC) pipe perimeter "fence" arranged in the shape of an open rectangular "U" that allowed attachment of 18 Hago nozzles placed at 10-foot intervals. A single line of 3-gallon potted wax myrtle plants was placed about 6 inches below the spray nozzles (total 85 plants) to simulate a vegetative border of a suburban backyard.

At least 15 laboratory-reared 5 to 7 day-old female Asian tiger mosquitoes (*Aedes albopictus)* and southern house mosquitoes (*Culex quinquefasciatus)* were placed into cylindrical screen cages. Separate cages were used for each species and suspended from wooden stakes about 5 feet from ground surface. Cages were arranged in a grid pattern starting 10 feet away from the spray nozzles (42 cages total) in the interior of the yard. After placement, cages were exposed to a 45-second application of SummerFrost. Ten minutes after treatment (to allow for the spray cloud to move through the area), mosquitoes were removed to clean 1 pint screened paper can cages and knockdown/mortality recorded 24 hours later. Three untreated cages of each species were used as controls for each test and were processed similarly as treatments. Tests were repeated on four different calendar dates and conducted at dusk.

To determine if residual toxicity from treated vegetation played a dominant role in the operational study, excised leaf bioassays were conducted in later studies. After a 45-second application of synergized pyrethrins from the spray nozzles, the top canopy of 10 potted southern wax myrtle plants was sampled randomly. Only plants below the nozzles were sampled to minimize variability due to sudden wind shifts causing drift during application. Thirty minutes after treatment, single leaves were placed in individual screened 250 ml glass beakers and exposed to a single leaf to at least 15 female laboratory-reared Asian tiger and southern house mosquitoes in separate beakers. Knockdown/mortality was assessed at 24 hours. Untreated wax myrtle leaves were used as controls and were handled similarly as treatments. Tests were repeated on

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For links to EPA's exposure assessment for the use of PBO, pyrethrins and permethrin in outdoor automatic mosquito mister systems, visit www.npmapestworld.org/MMS/.

Distance from Nozzle (feet)	Mean Percent Knockdown/Mortality	
	Asian Tiger Mosquito	Southern House Mosquito
10	91.2 ± 2.1	65.2 ± 11.5
20	89.4 ± 4.8	67.6 ± 12.1
30	44.9 ± 9.0	42.3 ± 12.2
40	34.3 ± 10.3	33.3 ± 7.8
50	46.4 ± 9.4	7.3 ± 3.38
60	36.4 ± 10.0	12.8 ± 5.0
70	24. 3 ± 5.6	33.8 ± 8.3

Table 1. Effect of cage distance on mean percent knockdown/mortality (±SE) of caged adult Asian tiger and southern house mosquitoes to a 45-second application of SummerFrost via the MistAway automatic misting system.

seven calendar dates and both species were tested at the same time. Mean surface area of leaves used in testing averaged about 1.8 in^2.

SIMULATED BACKYARD RESULTS. Knockdown/mortality from the insecticide application of caged mosquitoes was influenced by distance from the nozzle, i.e., mosquitoes farther from the nozzle generally exhibited less knockdown/mortality than mosquitoes closer to the nozzle. The greatest knockdown/mortality for both species occurred at 10 and 20 feet from the nozzle *(see Table 1 above)*. Generally, Asian tiger mosquitoes appeared to be more susceptible to synergized pyrethrins compared with the southern house mosquitoes. This also was true for the mean percent knockdown/mortality of Asian tiger mosquitoes exposed to treated leaves (22.3 ± 4.5%), which was greater than southern house mosquitoes (9.7 ± 3.7%) but far less than the cage bioassays. Repellency was not observed in the leaf bioassays.

ADDITIONAL THOUGHTS. Primarily, mosquito reduction in backyards with the MistAway system was achieved by the direct exposure of the mosquitoes to the spray. Level of control was not consistent but fluctuated considerably and was probably influenced greatly by mosquito population abundance as well as the behavior of the spray droplets impinging on their target (i.e., the mosquito). Median droplet size of most mosquito adulticides applied by ground ULV equipment in Florida mosquito control averages about 15 µm. We had found that the median droplet size generated by the Hago nozzles averaged about 50 µm. (This previously was determined for us via a Malvern laser by Dr. Jonathan Hornby, Lee County Mosquito Control District, Ft. Myers, Fla.). Therefore, the greater the size, the less likelihood a droplet will remain in the air column and remain available to impinge on the flying target compared with 15 µm droplets.

Little residual toxicity (<25%) occurred to mosquitoes exposed to treated leaves of the upper canopy after mist application so this was not the primary method of control in the backyards. Typical median droplet size distribution for a residual application using a fine spray is between 100 and 200 µm. Comparatively speaking, the smaller droplet size from the Hago nozzles did not appear to apply enough insecticide on the leaves to produce much of a toxic effect. Residual sprays to vegetation are commonly applied in considerably greater volume than the 1.4 oz/min/nozzle in our study. Moreover, excised leaf bioassays from the mid and lower plant canopies showed no mosquito knockdown/mortality. Obviously, spray volume and nozzle droplet size influenced those results.

Several operational issues have been raised with automatic misting systems for adult mosquito control. The frequent application of insecticides without monitoring local mosquito abundance is inconsistent with current IPM practices of the pest control industry and remains to be resolved. Professional entomological associations, such as the American Mosquito Control Association, have issued position papers on automatically timed mosquito misting systems echoing this concern (AMCA 2008). Concerns associated with the effects of chemical trespass into adjacent untreated areas warrant further investigation especially as these systems become more prevalent in residential areas.

In summary, an integrated approach for comprehensive management of mosquitoes needs to be provided by a pest control company if they are to be successful in obtaining effective and sustained reduction of local mosquito populations for their clients. Client education on identifying and removing mosquito production habitats within and, if possible, immediately adjacent to the property, should be provided, including information on personal protection. Certainly, the proximity of larval mosquito developmental sites (e.g., adjacent freshwater or saltwater marshes) and subsequent immigration of adult mosquitoes into the area to be protected will ultimately affect the level of reduction afforded by any automatic misting system. **PCT**

Editor's note: For a list of references, visit www.pctonline.com. All photos are those of the author.

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