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COMPARISON OF ELECTROSTATIC VERSUS NONELECTROSTATIC ULV SPRAYS OF AQUA RESLIN® AGAINST *ANOPHELES QUADRIMACULATUS* ADULTS[1]

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ABSTRACT. An electrostatic truck-mounted spray system (Spectrum, Houston, TX) and a nonelectrostatic spray system (Micro-Gen G-4, San Antonio, TX) were tested to determine the feasibility of electrostatically charging Aqua Reslin®, a water-based permethrin insecticide, and ascertain whether an electrostatic charge would increase the efficiency of Aqua Reslin against *Anopheles quadrimaculatus* adults. Parameters tested for both machines included mean mass median diameter (MMD) of droplets, number of drops per cm^2, and posttreatment percent mortality at 1, 12, and 24 h. Results indicated that the electrostatically charged droplets produced greater mortality at each distance and hour posttreatment. Correlation coefficients and linear equations were calculated for distance–mortality, MMD–mortality, drops per cm^2–mortality, distance–drops per cm^2, distance–MMD, and MMD–drops per cm^2. Results indicated that the electrostatic drops demonstrated strong correlations between each paired variable, whereas the nonelectrostatic drops showed poor correlation between drops per cm^2–mortality, distance–drops per cm^2, and MMD–drops per cm^2. However, from this trial, these differences cannot be attributed purely to the electrostatic charge because significant differences in droplet size can affect spray performance.

KEY WORDS Adulticide, electrostatics, permethrin, mosquito control, mass median diameter

INTRODUCTION

The use of electrostatics to generate charged sprays to agricultural crops improved underleaf deposition of pesticide drops (Coffee 1979). Additional studies have sought to improve deposition on artificial targets and plants (Lane and Law 1982). Most, however, do not emphasize the benefits of electrostatic droplet application as an integral component of effective mosquito control programs. The ultimate goal of pesticide dispersal in mosquito control is to produce the highest mortality using the lowest application volume without sacrificing economics or safety efficiency (Downer et al. 1993). The purpose of this test was to determine the feasibility of electrostatically charging Aqua Reslin® for adult mosquito control.

MATERIALS AND METHODS

Four applications of an electrostatically versus nonelectrostatically charged spray were made to caged mosquitoes in a knee-deep grass-covered field at Stuttgart, AR, on July 22–23, 1997. Tests were conducted between 1900 and 2300 h on both nights.

The electrostatically charged spray was produced by a Spectrum electrostatic sprayer built for this project by Southwest Electrostatic Sprayers, Inc., Houston, TX. The sprayer is characterized by a roller pump allowing up to 26.5 liters/min, a centrifugal blower with a 305 km/h output, and blower distance of up to 15.2 m. The electrostatic power supply (rectifier circuit and RC filter) was connected to the nozzle electrodes placed on opposite walls of the air stream. Liquids released from the nozzle were simultaneously atomized and electrostatically charged.

The nonelectrostatically charged spray was generated by a Micro-Gen G-4 sprayer (Micro-Gen, San Antonio, TX), a standard cold aerosol generator with a swirl-type turbulence chamber and nozzle allowing up to 21.3 liters/min at 4 psi. Voltage was validated by connecting a volt-ohm meter to a bronze wire grid and attaching the grid to a squash racquet frame measuring 0.25 m in diameter. The device was activated and held in the aerosol cloud and the reading noted. The Spectrum electrostatic sprayer averaged 3.49 ± 0.8 μamp over 5 readings, whereas no current was recorded for the Micro-Gen nonelectrostatic sprayer. A high-voltage probe was grounded to the machine and contact was made with the electrode to register 7,500 V (+) to insure that the circuit was working.

Each sprayer was calibrated to deliver 3.9 g AI/ha. A dilution of 1 part Aqua Reslin to 4 parts water was made, and the Spectrum electrostatic sprayer was adjusted to a flow rate of 0.24 liter/min and 16 km/h vehicle speed. The Micro-Gen nonelectrostatic sprayer with a lower delivery capacity required a slower speed of 4.8 km/h to deliver the 3.9-g AI/ha rate.

Adults of *Anopheles quadrimaculatus* Say sensu lato were collected in 237-ml paper cans using a backpack aspirator (U.S. Department of Agricul-

[1] The opinions and assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the University of Arkansas, Louisiana State University, the Navy Department, and the Naval Service at large.

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Table 1. Posttreatment mortality of *Anopheles quadrimaculatus* adults at 1, 12, and 24 h for Aqua Reslin sprayed with electrostatic (Spectrum) and nonelectrostatic (Micro-Gen) sprayers.

Machine	Distance (m)	Posttreatment mortality (%)[1] 1 h	12 h	24 h
Electrostatic (Spectrum)	30.5	88.2 ± 21.8 (75.9–100.5)[2]	98.4 ± 5.4 (95.3–101.5)	100 ± 0
	60.9	82.3 ± 24.4 (68.5–96.1)	90.3 ± 25.3 (66.8–113.8)	91.5 ± 25.6 (77.0–105.9)
	91.4	63.6 ± 40.1 (40.9–86.3)	74.6 ± 41.6 (51.1–98.1)	75.9 ± 42.3 (51.9–99.8)
Nonelectrostatic (Micro-Gen)	30.5	46.0 ± 28.5 (27.4–64.6)	68.4 ± 19.8 (55.5–81.3)	73.5 ± 17.5 (62.1–84.9)
	60.9	45.5 ± 20.7 (31.9–59.0)	62.6 ± 13.7 (53.6–71.6)	66.7 ± 10.9 (59.6–73.8)
	91.4	43.7 ± 43.2 (15.5–71.9)	60.5 ± 19.4 (47.8–73.2)	63.3 ± 18.4 (51.3–75.3)

[1] Control mortality was <2% at 1 h and <6% at 24 h.
[2] Confidence interval.

ture, Medical and Veterinary Entomology Research Laboratory, Gainesville, FL) from a livestock barn 14.5 km south of the Stuttgart area. The paper cans containing the mosquitoes were transferred from the collection site to the laboratory in insulated chests for later segregation into screened test cages. About 20 field-collected *An. quadrimaculatus* (s. l.) were placed in the cylindrical, screened cages measuring 5.2 cm in diameter by 8.6 cm in length (Sandoski et al. 1983). The test cages containing the mosquitoes were held at room temperature (22°C) prior to the test.

Test cages and slide rotators (Hock Equipment Co., Gainesville, FL) were placed on 3.1-m stakes located 30.5, 60.9, and 91.4 m perpendicular to the driven path of the spray truck. Three rows of 3 stakes, cages, and rotators were used for each application. Four separate applications were made during each of the 2 successive nights. Each application alternated between the electrostatic and nonelectrostatic sprayers.

Prior to the insecticide applications, screened cages of mosquitoes used as controls were placed on the stakes within the test plot for 15 min, removed, and transported to the laboratory. Immediately prior to each insecticide application, cages of *An. quadrimaculatus* (s.l.) were attached to all stakes within the plot, and slide rotators were activated. After spraying, 15 min were allowed for the aerosol cloud to disperse throughout the plot. Caged mosquitoes were returned to the laboratory, transferred to clean paper cans, supplied with cotton balls containing a 10% sucrose solution as a carbohydrate source, and observed for mortality at 1, 12, and 24 h posttreatment.

Aerosol droplet data were collected from each distance and location in the field where mosquitoes were exposed to the Aqua Reslin spray. After insecticide application, slides were covered with gaskets and a plain glass slide to prevent evaporation (Anonymous 1985). Slides were read the following week. A minimum of 100 drops per slide was measured, and drops per cm^2 were calculated (Brown et al. 1993). A spread factor of 0.61 was used to calculate the mass median diameters (MMD).

Environmental conditions were only marginally favorable during the test. Although temperatures and relative humidities were appropriate, winds never exceeded 0.89 m/sec and were often erratic.

RESULTS AND DISCUSSION

At 1 h posttreatment, percent mortality ranged from 63.6 to 88.2% with the electrostatic sprayer and 43.7 to 46.0% with the nonelectrostatic sprayer (Table 1). Percent mortality at 24 h posttreatment for the electrostatic sprayer ranged from 75.9 to 100% and 63.3 to 73.5% for the nonelectrostatic sprayer. The electrostatic sprayer at a distance of <60.9 m produced 80% mortality, whereas mortality with the nonelectrostatic sprayer was <80%. The low mortality provided by the Micro-Gen sprayer may have been due to much smaller droplets than recommended for Aqua Reslin.

Aqua Reslin was atomized by both machines at the 3.9-g AI/ha rate with the electrostatic sprayer producing much larger droplets (Table 2). Aqua Reslin aerosol droplet size decreased slightly as the downwind distance increased from 30.5 to 91.4 m. This was demonstrated with both the electrostatic sprayer (17.4–13.6 μm) and the nonelectrostatic sprayer (9.3–5.7 μm). More droplets per cm^2 were produced with the electrostatic (ES) sprayer (166.3–57.3) versus the nonelectrostatic (NE) sprayer (15.6–14.7) (Table 3). Means demonstrated good agreement with the confidence intervals in all cases. Control mortality remained low throughout the test (<2% at 1 h and <6% at 24 h).

An inverse relationship was demonstrated with distance–mortality. An increase in distance was highly correlated (24 h: ES = −0.99, NE = −0.98) with a corresponding decrease in mortality for both

Table 2. Mass median diameters for Aqua Reslin sprayed with electrostatic (Spectrum) and nonelectrostatic (Micro-Gen) sprayers.

Machine	Distance (m)	Mass median diameter (μm ± SD)
Electrostatic (Spectrum)	30.5	17.4 ± 4.1 (16.9–17.9)[1]
	60.9	14.5 ± 8.2 (13.4–15.6)
	91.4	13.6 ± 7.4 (12.6–14.6)
Nonelectrostatic (Micro-Gen)	30.5	9.3 ± 3.8 (8.8–9.8)
	60.9	7.4 ± 4.5 (6.8–7.9)
	91.4	5.7 ± 5.5 (4.9–6.4)

[1] Confidence interval.

Table 3. Drops per cm² for Aqua Reslin sprayed with electrostatic (Spectrum) and nonelectrostatic (Micro-Gen) sprayers.

Machine	Distance (m)	Drops per cm²
Electrostatic (Spectrum)	30.5	166.3 ± 79.1 (156.1–176.5)[1]
	60.9	79.7 ± 53.1 (72.9–86.5)
	91.4	57.3 ± 40.3 (52.1–62.5)
Nonelectrostatic (Micro-Gen)	30.5	15.6 ± 12.2 (14.0–17.2)
	60.9	10.7 ± 8.4 (9.6–11.9)
	91.4	14.7 ± 31.1 (10.7–18.7)

[1] Confidence interval.

electrostatic and nonelectrostatic particles. A positive relationship was demonstrated with MMD–mortality (24 h: ES = 0.89, NE = 0.99). There was a decrease in MMD over distance and a corresponding decrease in mortality for both electrostatic and nonelectrostatic drops. It is difficult to determine whether this decrease in mortality was due strictly to a decrease in MMD, increased distance, or an interaction between the 2. No interaction statistics were performed. Mortality was highly correlated with electrostatic drops per cm² (24 h: ES = 0.88), but the correlation between mortality and nonelectrostatic drops was poor (24 h: NE = 0.36). There was a strong inverse correlation between distance and electrostatic drops per cm² (ES = −0.95). The nonelectrostatic drops per cm² remained approximately the same over the test distance (NE = −0.17). Both the electrostatic (−0.96) and nonelectrostatic (−0.99) drops demonstrated a strong inverse correlation between distance and MMD. Electrostatic droplets demonstrated a strong correlation between MMD and drops per cm² (0.99). As the electrostatic droplet decreased in size (17.4–13.6 μm) over the test distance, the drops per cm² also decreased (166.3–57.3). Poor correlation was shown between MMD and drops per cm² (0.2) with the nonelectrostatic drops. As nonelectrostatic drops decreased (9.3–5.7 μm), the drops per cm² remained approximately the same (15.6–14.7).

Droplet size from the electrostatic machine (13.6–17.4 μm) was in relative agreement with the recommendation of the manufacturer (20 μm). However, the droplet size generated by the nonelectrostatic machine was considered too small (5.7–9.3 μm). A low flow rate relative to the machine pressure likely caused this small droplet size. Machines were calibrated 4 times prior to the test thereby providing confidence that it was done correctly. A slight flow rate difference between the machines was accommodated by a slower sprayer truck speed during the nonelectrostatic spray application.

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