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IMPACT OF ELECTROSTATIC AND CONVENTIONAL SPRAYERS CHARACTERISTICS ON DISPERSION OF BARRIER SPRAY[1]

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ABSTRACT. A study was conducted to analyze the performance of 3 electrostatic (Electrolon BP-2.5™, Spectrum Electrostatic 4010, and Spectrum Electrostatic head on a Stihl 420) and 2 conventional (Buffalo Turbine CSM2 and Stihl 420) sprayers for barrier sprays to suppress an adult mosquito population in an enclosed area. Sprayer characteristics such as charge-mass ratio, air velocity, flow rate, and droplet spectra were measured while spraying water. Dispersion of the spray cloud from these sprayers was determined using coverage on water-sensitive cards at various heights (0.5 m, 1.0 m, 1.5 m, 2.0 m, 2.5 m, and 3.0 m) and depths (1 m, 3 m, and 5 m) into the under-forest vegetation while spraying bifenthrin (Talstar™ 7.9% AI; FMC Corporation, Philadelphia, PA) at the rate of 21.8 ml/300 m of treated row. The charge-mass ratio data show that Electrostatic head on a Stihl 420 did not impart enough charge to the droplets to be considered as an electrostatic sprayer. In general, the charged spray cloud moved down toward the ground. The Electrolon BP 2.5 had significantly lower spray coverage on cards, indicating lack of spray dispersion. This sprayer had the lowest air velocity and did not have the air capacity needed to deliver droplets close to the target for electrostatic force to affect deposition. The analysis shows that these 2 sprayers are not a suitable choice for barrier sprays on vegetation. The results indicate that the Buffalo Turbine is suitable for barriers wider than 3 m, and the Spectrum 4010 and Stihl 420 are suitable for 1–3-m–wide barriers.

KEY WORDS Charge-mass ratio, evaluation, barrier sprays, residual spray, mosquito control

INTRODUCTION

Barrier treatments against adult mosquito and sand fly vectors involve the use of residual insecticides applied to vegetation or natural/manmade surfaces used as resting sites by these insects. Barrier treatments have been considered as a major contributor to mosquito population suppression when integrated with other control techniques (Britch et al. 2009). Effectiveness of barrier treatments, however, would depend on spray delivery and deposition on these surfaces. In theory, the electrostatic charge on droplets causes attraction between droplets and target and assists in the deposition. However, because of many uncontrollable factors, the expectations from theoretical concepts are not always met. Droplets in the spray cloud, after release from a sprayer, interact with the surrounding air while traveling to the target. This interaction can be summarized as mass, heat, and momentum transfer between the droplets and the surrounding air. Goering et al. (1972) has listed many forces acting on spray droplets during travel from the sprayer to the target, the most significant of which are gravity, buoyancy, and drag. Force due to an electrical gradient is one of the generally nonsignificant forces acting on the droplets. This electrical gradient is enhanced in electrostatic spraying to take advantage of the resulting force and to minimize the effect of the other significant forces. Law (1989) listed 3 basic requirements for a successful agricultural electrostatic spray application: 1) generation and electrification of spray droplets, 2) droplet transport to the vicinity of the target, and 3) deposition of droplets on the target.

The magnitude of the electrostatic force between droplets and the target is directly proportional to the product of charges on the two and inversely proportional to the square of the distance between them. For electrostatic force to become strong enough to overcome other significant forces such as gravity, buoyancy, and drag, the droplets have to be within a certain distance from the target (Law 1983), which can be called the threshold distance. The threshold distance depends on the size and charge of the droplets (Chadd and Matthews 1988). For this reason, an electrostatic sprayer must be capable of delivering charged droplets within the threshold distance.

The effectiveness of residual pesticide spray applications, such as providing a barrier, is limited by the amount of active ingredient (AI) deposited on the target surface. This is the portion of AI available to the insects coming in contact with these surfaces. During spray appli-

[1] Mention of a trademark, vendor, or proprietary product does not constitute a guarantee or warranty of the product by the US Navy and does not imply its approval to the exclusion of other products that may also be suitable. The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, or the U.S. Government.

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cations on vegetation, the spray predominantly deposits on the foliage, and a very small portion of the AI directly impinges upon insects (Graham-Bryce 1977). Matthews (1989) noted that uncharged droplets sprayed into a target area may deposit on horizontal surfaces because of gravity, or impinge on vertical surfaces while moving in air currents.

It has been shown that deposition of charged droplets onto vegetation was 1.6–2.5 times more than normal uncharged droplets (Law 1983, Brown et al. 1997). Kirk et al. (2001) showed that spray deposits with an electrostatic system were higher than with conventional aerial application, but the increased deposition did not always improve insect control. Whitmore et al. (2001) found that electrically charged sprays increased the knock-down of house flies and mosquitoes in the laboratory but did not affect their mortality. Hoffmann et al. (2009) have shown that sprayers producing larger droplets and higher air velocities have proven better for droplet penetration and deposition on vegetation irrespective of charge. Matthews (1989) noted that the main advantage of using electrostatic sprayers is the increase in deposition of smaller droplets. To justify charging droplets, electrostatic sprayers producing smaller droplets from lower volume rates should result in comparable deposition to conventional sprayers or should result in higher deposition than conventional sprayers, if both are producing comparable size droplets. Hoffmann et al. (2009) showed that smaller handheld electrostatic sprayers producing smaller droplets had very low deposition on vegetation compared to that of backpack sprayers. Using equal application rates, Britch et al. (2009) showed similar performance of a barrier from both electrostatic and conventional sprayers.

The objectives of this study were to develop a system for measuring charge on the droplets imparted by the charging system of different mist sprayers used to create residual insecticide barriers against mosquitoes and sand flies, and to determine the impact of droplet characteristics, droplet charge, flow rate, and sprayer air velocity on spray dispersion into vegetative barriers, using 3 electrostatic and 2 conventional sprayers.

MATERIALS AND METHODS

Five sprayers were evaluated in this study to determine their electrostatic capabilities. Three of these sprayers are categorized as electrostatic by their manufactures.

The Electrolon BP-2.5™ (Electrostatic Spraying Systems, Watkinsville, GA), an electrostatic backpack sprayer (Fig. 1a), is equipped with an induction charge nozzle. The spray liquid is delivered to the nozzle by gravity. The air supplied to the nozzle from a secondary source at 0.24–0.28 m^3/min (8.5–10.0 ft^3/min) atomizes the spray liquid. During atomization, the droplets get negatively charged by the use of two 9-volt batteries. This sprayer has a tank capacity of 9.5 liter (2.5 gal), a rated flow rate of 250 ml/min (8.5 oz/min), and a spray range of 7.6 m (25 ft).

The Stihl (Model SR 420; Andreas Stihl, Waiblingen, Germany), a backpack blower and sprayer (Fig. 1b), uses a 2.6 kW (3.5 hp) gasoline engine for power. The sprayer is rated for an air flow of 21.0 m^3/min (742 ft^3/min) producing an air velocity of 364 km/h (226 mph) at the nozzle exit. The sprayer is equipped with an air-shear nozzle head, and different baffle screens can be attached to the outlet to alter the shape of the spray. The flow rate can be varied from 0.12 to 1.8 liter/min (4.7–61 oz/min) in 6 discrete steps of a control knob near the head. The sprayer weighs 11.1 kg (24.5 lb), its pesticide tank can hold up to 14 liters (3.7 gal) of spray liquid, and its spray range is 12 m (40 ft). The conventional head on the Stihl SR 420 (Fig. 1b) was replaced with a Spectrum Electrostatic 3010 head (Spectrum Electrostatic Sprayers, Houston, TX; Fig. 1c) to make an electrostatic back pack sprayer. The Spectrum 3010 head is based on the same principle as the one used for the Spectrum 4010.

The Spectrum Electrostatic 4010 (Spectrum Electrostatic Sprayers, Houston, TX), a truck-mounted electrostatic sprayer (Fig. 1d) uses a 10.4 kW (13.5 hp) gasoline engine. The sprayer uses an air-shear high-voltage conduction-type electrostatic nozzle for atomization. The rated air velocity of this sprayer at nozzle exit is 306 km/h (190 mph). The sprayer has an empty weight of 113 kg (250 lb) and a tank capacity of 114 liter (30 gal) and can deliver up to 26.5 liter/min (7.0 gal/min).

A trailer-mounted Buffalo Turbine sprayer (Model CSM2; Buffalo Turbine, Springville, NY) is powered by a 13.4 kW (18 HP) diesel engine (Fig. 1e). It was equipped with a cluster of 4 TeeJet® 8502 nozzles (Spraying Systems Co., Wheaton, IL) discharging along the center of the air stream. The air stream has a rated speed of 280 km/h (174 mph). The sprayer can deliver a flow rate up to 37.9 liter/min (10 gal/min) at 2,758 kPa (400 psi) pressure, and its tank can hold up to 190 liters (50 gal) of formulation.

Charge-mass ratio determination

The charge-mass ratio was determined from the sprayer flow rate and droplets' electrical charge. For measurement of the charge, a test bench was built to act as a spray collector. The bench (Fig. 2) consists of a metal enclosure open at one side for spray entrance (Fig. 3). It has 2 perforated sheets inside the enclosure to interfere with the incoming spray. The front sheet has larger holes than the back sheet. The enclosure is

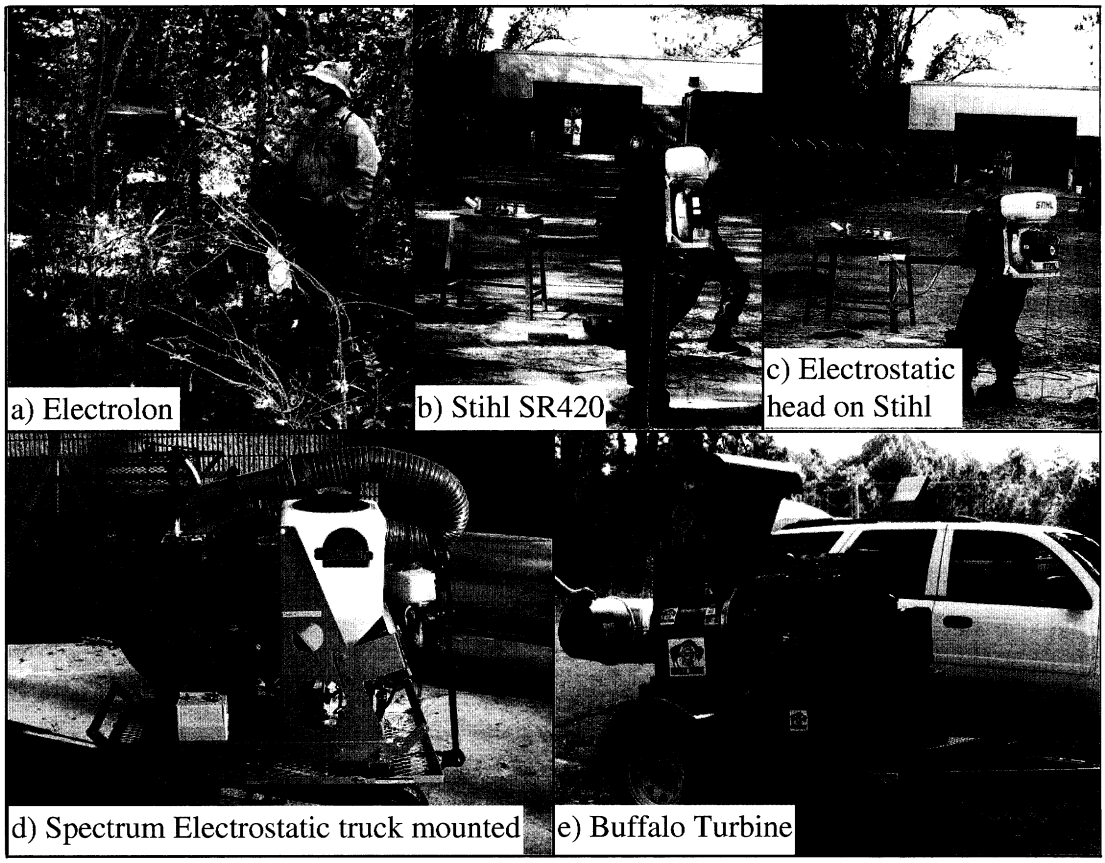

Fig. 1. Sprayers used in the study.

mounted on a utility cart that has insulated tires. A current meter (Multimeter Model 430; Extech Instruments, Waltham, MA) is connected between the ground and the bench to measure the current generated as a result of droplets impinging on the bench. To avoid draining water conducting to the ground, the water is collected in a pan during testing. For evaluation, all sprayers were operated at field settings (Hoffmann et al. 2009), and the spray was directed into the enclosure of the bench through the open side from a distance such that the whole spray cloud enters the bench. The resulting current flow from the bench to the ground was recorded.

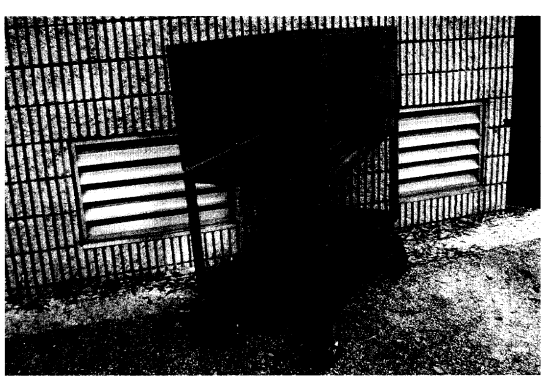

Fig. 2. Test bench.

The flow rate for each sprayer was measured 3 times by filling the tank with water up to a known mark and running the sprayer for 1 min. The sprayer tank was filled to the same level with a measured amount of water. The volume required to refill the tank in liters was recorded as the flow rate. The current and liquid flow rates from the sprayer were used to calculate the charge-mass ratio using the following formula:

$$CMR = \frac{60A}{1000QD},$$

where

CMR = Charge-to-mass ratio, 10^{-4} C/kg
A = Current, μAmps
Q = Liquid flow rate, liter/min
D = Density of water, kg/liter.

Fig. 3. Spray directed to the test bench during sprayer evaluation.

Air velocity measurements

The velocity of air generated by all the sprayers (except the Electrolon) was measured at 0.6 m, 3.0 m, and 6.1 m (2 ft, 10 ft, and 20 ft) from the sprayer outlet. These distances were 0.1 m, 0.6 m, and 3.0 m (4 in., 2 ft, and 10 ft) from the sprayer outlet for the Electrolon sprayer due to low velocity. The air velocities were measured with a hot-wire anemometer (VelociCalc Model 9555 P; TSI Inc. Shoreview, MN).

Droplet size measurement

The droplet size spectrum for each sprayer was measured with a DCIII portable droplet counter (KLD Labs, Huntington, NY), while spraying water. The DCIII utilizes a hot-wire probe that is cooled by impinging droplets (Mahler 1985), resulting in an electronic signal proportional to the droplet size. For these measurements, the probe was held perpendicular to the spray direction in front of the nozzle. The appropriate air velocity range for the DCIII is 5–7 m/s (11–16 mph). The distance between the atomizer and probe was adjusted to match this air velocity except for the Electrolon sprayer, for which it was 0.3 m (1.0 ft) because of the lower than required air velocity. The instrument was set to measure approximately 1,000 droplets. All measurements were replicated 3 times. The DCIII software computed mass median diam (volume median diam $Dv_{0.5}$), $Dv_{0.1}$, and $Dv_{0.9}$. The $Dv_{0.5}$ is the droplet diam (μm), where 50% of the spray volume is contained in droplets smaller than this value (Standard E1620, ASTM 2004). Similarly, the $Dv_{0.1}$ and $Dv_{0.9}$ values are the diameters at which 10% and 90%, respectively, of the spray volume is contained in droplets of this size or less. Percentage of volume in droplets <50 μm was calculated from the data.

Spray dispersion

The trial was conducted on vegetation consisting mainly of *Leucothoe racemosa* (fetter-bush), *Vaccinium arboreum* (sparkleberry), *Smilax bonanox* (catbrier), *Smilax auriculata* (greenbrier), *Vitis rotundifolia* (muscadine), *Serenoa repens* (saw palmetto), *Ilex vomitoria* (yaupon holly), and *Myrica cerifera* (wax myrtle) under a natural mixed pine and hardwood stand at Camp Blanding Joint Training Center, Starke, FL (29°59′N, 81°57′W). Applications with 5 sprayers were replicated 3 times, making a total of 15 plots. Replications were split between 2 test sites selected for vegetation similarity and availability of the area. One site accommodated 2 replicates, and the other was used for the third. All applications within a replication were randomized in time and space. Each spray plot was 60 m long and consisted of vegetation on both sides of an abandoned road. Two sampling lines in each plot, one on each side of the road, were selected at least 15 m from each plot edge. The spray material included diluted bifenthrin (Talstar™ 7.9% AI; FMC Corp., Philadelphia, PA) at label rates of 21.8 ml/300 m of treated row. The nozzle flow rates used for the sprayers are given in Table 1. The ground speeds for all applications were adjusted to maintain the label rate.

The displacement of the spray in the space measuring 1–5 m away from the sprayer and 3 m above ground was measured with water-sensitive

Table 1. Flow rate, current, and charge to mass ratio of 5 sprayers.

Sprayer	Flow rate, liter/min	Current, μA	Charge-to-mass ratio (10^{-4} C/kg)[1]
Buffalo Turbine	5.70 ± 0.07	0.00 ± 0.00	0.00 ± 0.00
Electrolon BP 2.5	0.19 ± 0.01	2.27 ± 0.06	7.34 ± 0.08
Spectrum Electrostatic 4010	3.66 ± 0.01	9.67 ± 0.32	1.58 ± 0.05
Spectrum Electrostatic Head on Stihl 420	0.71 ± 0.03	0.17 ± 0.06	0.14 ± 0.05
Stihl 420	2.28 ± 0.03	0.00 ± 0.00	0.00 ± 0.00

[1] Threshold charge-to-mass ratio = 1.0×10^{-4} C/kg (Gaunt and Hughes 2004) that qualifies the Electrolon BP and Spectrum Electrostatic 4010 as electrostatic sprayers.

cards. The cards were attached to 3-m-tall PVC poles at 2 sampling lines in each plot at 1 m, 3 m, and 5 m depths into the vegetation. Six cards at 0.5 m intervals up to 3 m height (i.e., 0.5 m, 1.0 m, 1.5 m, 2.0 m, 2.5 m, and 3.0 m) were attached to the poles just before spraying. The cards were removed as soon as they dried. Cards were read using Stainalysis (REMSpC Spray Consulting, Ayr, Ontario, Canada) software and an HP Scanjet G4050 flatbed scanner which produced stain size and density. The stain sizes were used to calculate droplet sizes with the following equation (Salyani and Fox 1999):

$$d = 0.95D^{0.91},$$

where d = droplet diameter and D = stain diameter.

The droplet size and density were used to calculate percent of coverage on cards. Coverage on the cards was adjusted to bring all applications to the same volume application rate. Statistical analysis was performed with JMP software (v.5; JMP, Cary, NC). The means were compared using a t-test at 95% level of confidence.

RESULTS

Charge-mass ratio

Liquid flow rate, current (charge flow rate), and charge-mass ratio of the 5 sprayers are presented in Table 1. The Buffalo Turbine had the highest flow rate followed by the Spectrum electrostatic 4010 sprayer. The Electrolon produced the lowest flow rate of the sprayers tested. It is interesting to note that the installation of electrostatic head on Stihl 420 reduced the flow rate by a factor of 3.

The 2 conventional sprayers (Buffalo Turbine and Stihl 420 with standard head) did not have any current measureable with the instrument used. Among electrostatic sprayers, the Spectrum 4010 produced the highest current, and the Spectrum electrostatic head on the Stihl 420 produced the lowest current. Only the Spectrum 4010 and the Electrolon sprayer imparted enough charge to droplets to be categorized as the electrostatic sprayers (Table 1). The Electrolon sprayer, despite dispensing the lowest flow rates, added 4.5 times more charge to the droplets compared to the Spectrum 4010 electrostatic sprayer.

Air velocity

As expected, the air velocity from most sprayers dramatically changed with increasing distance away from the sprayer (Fig. 4). In general, the Electrolon produced considerably less air velocity than the other sprayers. At 0.6 m (2.0 ft) from the outlet, the Electrolon had less than 1 m/s (2.2 mph), whereas all other sprayers had ~30.0 m/s (67 mph). Among other sprayers, the rate of reduction was the lowest for the Buffalo Turbine, and it was the highest for the Stihl. The difference in reduction rate can be attributed to the air volume discharge rate of the sprayers. The Buffalo Turbine discharges air at a much higher volume rate compared to other sprayers studied that dissipate slowly in the atmosphere. Among electrostatic sprayers, the Spectrum 4010 had the highest air movement, and the Electrolon had the lowest. In general, the Spectrum Electrostatic 4010 and the Buffalo Turbine resulted in similar air velocity profiles. Replacement of the conventional head on the Stihl 420 with the Spectrum electrostatic head increased the air velocity slightly.

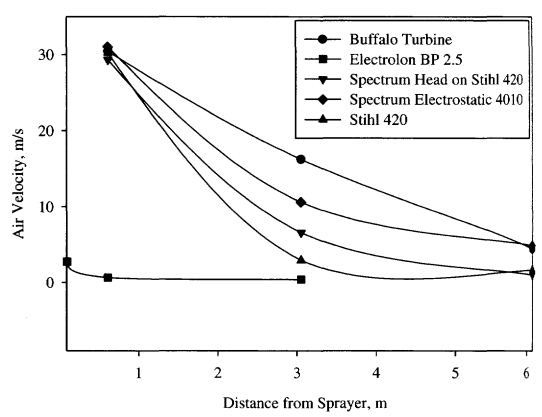

Fig. 4. Change in air velocity with distance for 5 sprayers.

Table 2. Droplet size characteristics of 5 sprayers measured by DCIII portable droplet counter.[1]

Sprayer	$DV_{0.1}$ (μm ± SD)	$DV_{0.5}$ (μm ± SD)	$DV_{0.9}$ (μm ± SD)	% vol. < 50 μm
Buffalo Turbine	105.6 ± 35.8 a	213.3 ± 61.3 a	390.8 ± 63.3 ab	1.7 ± 0.3 b
Electrolon BP 2.5	12.7 ± 4.7 d	55.5 ± 22.7 d	122.8 ± 50.0 d	48.6 ± 17.5 a
Spectrum Electrostatic 4010	79.2 ± 4.3 ab	183.0 ± 1.5 ab	480.2 ± 77.1 a	3.9 ± 0.6 b
Spectrum Electrostatic Head on Stihl 420	51.1 ± 9.7 c	132.6 ± 12.6 cd	239.6 ± 50.7 cd	9.9 ± 3.5 b
Stihl 420	59.1 ± 10.5 bc	146.8 ± 30.1 bc	223.4 ± 50.8 bc	7.5 ± 3.9 b

[1] Means followed by the same letter in a column are not significantly different ($\alpha < 0.05$).

Droplet spectrum

The Electrolon sprayer resulted in the finest droplet size spectra, having a volume median diam ($Dv_{0.5}$) of 49.7 μm and 51% volume in droplets smaller than 50 μm (Table 2). The Buffalo Turbine produced the largest droplets, with 204.7 μm $Dv_{0.5}$ and 2.3% volume in droplets <50 μm. Three electrostatic sprayers ranked for droplet size from large to small are the Spectrum Electrostatic 4010, the Spectrum electrostatic head on the Stihl 420, and the Electrolon. The Buffalo Turbine produced a relatively similar droplet size distribution as the Spectrum Electrostatic 4010. Installation of the Spectrum Electrostatic head on the Stihl 420 slightly reduced the droplet size but not significantly (Table 2).

Spray dispersion

Percent coverage of water-sensitive cards by spray droplets at various distances from the spray line (depths into vegetation) and heights is used as an indicator of spray displacement in space. The analysis of variance showed that sprayer, foliage depth, and height above ground significantly affected the spray coverage ($P = 0.05$). Averaging for all depths and heights produced mean spray coverage of 12.4% for the Buffalo Turbine, 2.6% for the Electrolon, 20.8% for the Spectrum electrostatic truck mounted, 11.4% for the Spectrum electrostatic head on the Stihl, and 23.0% for the Stihl. The Spectrum electrostatic truck mounted and the Stihl, and the Spectrum electrostatic head on Stihl and Buffalo Turbine, had statistically similar coverage. Averaged for the height, the coverage for all sprayers reduced with increasing depth (Fig. 5). The Stihl SR 420 had the most coverage at 1 m from the sprayer, whereas the Electrolon had the least. Coverage from the Spectrum electrostatic head on Stihl, Buffalo Turbine, Spectrum electrostatic truck mounted, and Stihl, all at 1 m depth, ranged between 20% and 50%; the coverage was reduced to 5% at a depth of 4.0–4.7 m. The Electrolon gave 5% coverage around 1.7 m from the sprayer. Variation in coverage with height indicated that the electrostatic sprayers had the highest coverage at approximately 1.25 m height, the Buffalo Turbine at 2.0 m, whereas the Stihl rather had mostly uniform coverage without any peak. When the coverage is examined collectively at 3 depths and 6 heights (Fig. 6), it shows that the spray clouds from the electrostatic sprayers moved downward toward the ground, whereas the spray cloud from the Buffalo Turbine and Stihl moved upward.

DISCUSSION

The analysis of spray dispersion in light of charge-mass ratio, flow rates, droplet size distributions, and air velocities indicated that both the Electrolon sprayer and the Electrostatic head on the Stihl 420 lacked one of the necessary components of an electrostatic sprayer mentioned by Law (1989). Lower deposition reported by Hoffmann et al. (2009) from these 2 sprayers could also be attributed to these 2 factors. These deficiencies and their impact on spray delivery as well as other related aspects are discussed below.

The Electrolon BP-2.5 had low air velocity at the nozzle exit that approached ambient conditions within 0.6 m from the nozzle. It has been reported (Law 1983) that the electrostatic force comes in to play only when the droplets are within the threshold distance of the target. The Electrolon spray system did not have enough air capacity to transport droplets close enough to the

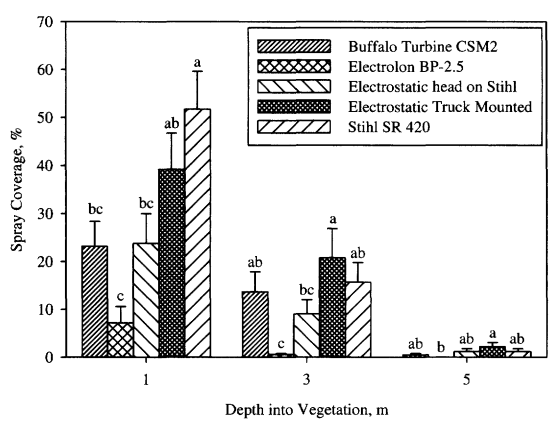

Fig. 5. Percent spray coverage at 3 vegetation depths for 5 sprayers. (Means at each vegetation depth with same letter are not significantly different; t-test, $\alpha = 0.05$).

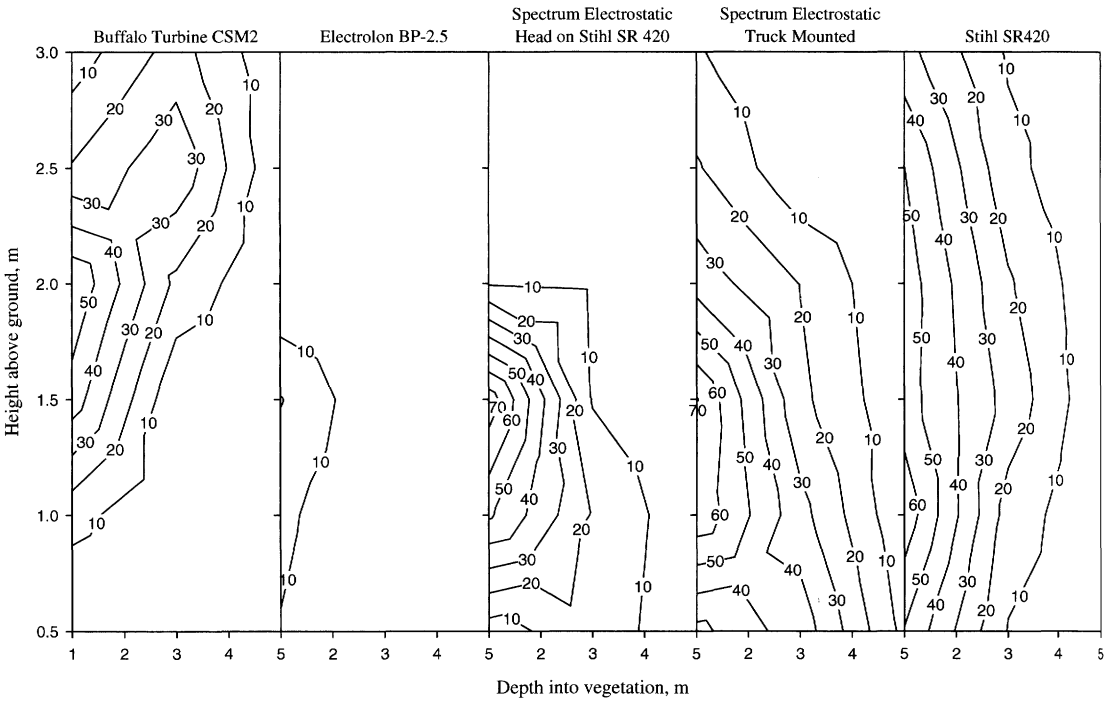

Fig. 6. Mean percent spray coverage on water-sensitive cards at different heights and depths from 5 sprayers.

target; thus, the electrostatic charge was not able to make an impact. The droplet size spectrum generated by the Electrolon sprayer is in the driftable size range. Driftable size is defined as the droplet size such that all droplets smaller than that size are expected to drift (Farooq et al. 2001a). According to Greenleaf Technologies (2009), droplets <105 μm are generally considered driftable. The droplets generated by the Electrolon sprayer had a greater tendency to pass around the targets in the levels of air velocities produced by this sprayer. Weaker electrostatic attraction due to larger distances between droplets and the target in this case resulted in poor spray coverage on water-sensitive targets. These results are in agreement with deposition on vegetation reported by Hoffmann et al. (2009).

The Spectrum Electrostatic nozzle on the Stihl 420 did not deliver enough charge to the droplets for the sprayer to be categorized as an electrostatic sprayer. The addition of an electrostatic head reduced the flow rate to 31% of the normal rate, which resulted in a slight decrease in droplet size. The spray dispersion from this sprayer was comparable to some other sprayers (Fig. 5), but its low deposition as reported by Hoffmann et al. (2009) could be attributed to the combined effect of droplet size, flow rate, and air flow. For similar droplet size spectra, reduced flow rate results in lighter density of the spray cloud. Farooq et al. (2001a) reported that larger droplets in a dense cloud acted as a curtain and protected the smaller droplets from being dragged. According to Farooq et al. (2001b), the droplet dynamics in a cloud can change significantly with cloud density. Smaller droplets in a light-density cloud are more prone to drift, resulting in lower deposition. This sprayer had a similar droplet size spectrum and air flows but only 31% of the flow rate of the conventional Stihl 420 sprayer. The resulting spray had one-third the density of the spray cloud from the Stihl 420 with the droplets exposed to the wind to a great extent. The spray dispersion (Fig. 6) indicates similar coverage from this sprayer near the nozzle compared to the Spectrum Electrostatic truck mounted and the Stihl 420. The downward trend in Fig. 6 shows the fallout of larger droplets and the coverage deep into the vegetation (Fig. 5) was contributed by the smaller blown-away droplets. The presence of enough electrostatic charge can counter these effects and result in considerable more deposition than reported by Hoffmann et al. (2009).

The data in this study indicated that the Spectrum Electrostatic 4010 truck-mounted sprayer imparted charge and momentum to the droplets sufficient for delivery and deposition. Spray dispersion from this sprayer was relatively uniform along the vegetation depth (Fig. 5). The spray cloud produced by this sprayer descended to the ground (Fig. 6) and had the highest volume in large droplets, as indicated by $Dv_{0.9}$ values (Table 2). As reported by Hoffmann et al. (2009),

the descent of large droplets shown by dispersion pattern in Fig. 6, combined with electrostatic force, resulted in highest deposition at the front edge of vegetation close to the ground. Small droplets blown away by wind from this sprayer and the Stihl 420 moved relatively horizontally and impacted on water-sensitive cards, resulting in higher percent coverage by this sprayer deeper into the vegetation.

Based on the analysis of spray dispersion results in this study, Electrolon BP-2.5 and Spectrum Electrostatic head on the Stihl 420 did not appear as viable options for barrier sprays because of their configuration used in this study. This observation is in concurrence with the findings of Hoffmann et al. (2009), based on the spray penetration and deposition. Additionally, the Buffalo Turbine was found suitable for larger barrier widths. For barrier widths of 1–3 m, either the Stihl SR 420 or truck-mounted Spectrum Electrostatic 4010 could be used. Selection, however, could be affected by the area treated as the Spectrum Electrostatic 4010 has a 2.5 times higher work rate.

ACKNOWLEDGMENTS

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