RESIDUE STUDIES OF ULTRA-LOW VOLUME APPLICATIONS OF PERMETHRIN IN COUNTY PARKS IN SAGINAW, MICHIGAN

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ABSTRACT

Residue levels of Ultra-Low Volume (ULV) permethrin were measured with filter papers placed on 30 common playground and park objects. The highest detectable residue level measured was 4.48ng/sq.cm. at 15 minutes post-treatment. A risk analysis based on the World Health Organization’s Acceptable Daily Intake (ADI) was conducted using the highest residue collected. This analysis concludes that ULV spraying for adult mosquito control presents minimal risk to humans.

INTRODUCTION

Ultra-low volume (ULV) application of insecticides from ground equipment is a standard method used to control adult mosquito populations. The ULV approach, both in terms of method of application and the formulations of insecticides used is not intended to leave insecticide residues on surfaces. The objective is to make the application in the air, where drift will occur, and mosquitoes in flight will come into contact with the micron size droplets of insecticide. These applications present a low health risk to humans because of the low dermal exposure and low mammalian toxicity of the insecticide. ULV applied insecticides are thought to have low deposition onto surfaces compared with expected, or “theoretical” values (Tucker et al. 1987, Moore et al. 1993, Tietz et al. 1994). Tietz et al. (1996) found malathion deposits on filter paper in front yards (about 11 m from the street) averaged 88.8 ng/cm² immediately after application. Studies conducted by Knepper et al (1996) determined that ULV applications of malathion and permethrin over grass surfaces resulted in neither compound persisting much beyond 36 hours post-treatment. However, questions continue to arise as to whether ULV applied insecticides deposit onto surfaces and form residues. If so, how long do these residues persist, and what risk do they pose to human health. Therefore, studies were conducted to determine residues of permethrin applied by ULV ground equipment. The studies were conducted in two county parks (Figure 1) located in Saginaw, Michigan. Residue levels were determined by placing filter papers on equipment located in the parks. After ULV applications of two permethrin insecticide formulations the filter papers were collected and analyses for residue levels was conducted.

Figure 1. View of park area sprayed during study.
MATERIALS AND METHODS

The study was conducted in two county parks located in Saginaw County, MI in September 1999. The first park utilized was Immerman Park, where Biomist™ 4+4 (4% permethrin, 4% PBO, oil based formulation) was applied at an application rate of 5.0 fl.oz./min (0.0019 lbs Al/acre). The second park was Harvey Randall Wicks, where Aqua-Reslin (20% permethrin, 20% PBO, water based formulation) was mixed at a ratio of 1 part Aqua-Reslin: 2 parts water and applied at 4.4 fl.oz./min (0.0019 lbs Al/acre).

Fifteen surfaces (Table 1) were selected at each park with two circular shaped filter papers (185 mm diameter) placed on each surface (Figure 2) and collected at 15 minutes and 12-hour post-treatment sampling.

![Figure 2. Filter papers placed on swing seat prior to ULV application.](image)

<table>
<thead>
<tr>
<th>Immerman Park</th>
<th>Distance</th>
<th>H.R. Wicks Park</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picnic Table Seat</td>
<td>28 feet</td>
<td>Picnic Table Seat</td>
<td>73 feet</td>
</tr>
<tr>
<td>Picnic Table Seat</td>
<td>44 feet</td>
<td>Picnic Table Seat</td>
<td>72 feet</td>
</tr>
<tr>
<td>Picnic Table Top</td>
<td>30 feet</td>
<td>Picnic Table Top</td>
<td>75 feet</td>
</tr>
<tr>
<td>Picnic Table Top</td>
<td>46 feet</td>
<td>Picnic Table Top</td>
<td>50 feet</td>
</tr>
<tr>
<td>Children’s Slide</td>
<td>42 feet</td>
<td>55 gal. Trash Can: side</td>
<td>52 feet</td>
</tr>
<tr>
<td>Children’s Play Digger</td>
<td>49 feet</td>
<td>Cooking Grill</td>
<td>58 feet</td>
</tr>
<tr>
<td>Play Equipment Rail</td>
<td>49 feet</td>
<td>Water Fountain</td>
<td>32 feet</td>
</tr>
<tr>
<td>Play Equip: Tic-Tac-Toe</td>
<td>54 feet</td>
<td>Seat of Swing</td>
<td>56 feet</td>
</tr>
<tr>
<td>Soccer Cone: Vertical</td>
<td>43 feet</td>
<td>Soccer Cone: Vertical</td>
<td>32 feet</td>
</tr>
<tr>
<td>Soccer Cone: Horizontal</td>
<td>43 feet</td>
<td>Soccer Cone: Horizontal</td>
<td>48 feet</td>
</tr>
<tr>
<td>Play Set Frame</td>
<td>46 feet</td>
<td>Play Set Frame</td>
<td>54 feet</td>
</tr>
<tr>
<td>Lawn Chair Seat</td>
<td>47 feet</td>
<td>Lawn Chair Seat</td>
<td>50 feet</td>
</tr>
<tr>
<td>Basketball</td>
<td>20 feet</td>
<td>Basketball</td>
<td>32 feet</td>
</tr>
<tr>
<td>Lawn Chair Back</td>
<td>48 feet</td>
<td>Lawn Chair Back</td>
<td>51 feet</td>
</tr>
<tr>
<td>Hand Held Slider Rail</td>
<td>67 feet</td>
<td>Dumbo Spring Rider</td>
<td>21 feet</td>
</tr>
</tbody>
</table>

Table 1. Surface areas sampled during study.
The surface areas sampled at Immerman Park varied from 20-67 feet from spray truck during application. At Harvey Randall Wicks Park, surface areas sampled varied from 21-75 feet from application truck. Seven additional surface areas were sampled a few miles away to serve as controls.

Prior to application, ULV machine had droplet characterization performed using the hand wave method with teflon coated slides (Summit Chemical Co., Baltimore, Maryland). During application, two rotating impingers (John W. Hock Co., Gainesville, Florida) were placed in spray area to capture insecticide droplets for further characterization information.

Filter papers (Figure 3) were collected by hand with wearer using a clean latex glove for each individual sample. Filter papers were then placed into clean 8 oz. glass jars fitted with aluminum foil seals inside the lids. Jars were then placed on wet ice for transportation back to the laboratory and stored at –10 C. Filter paper samples were analyzed at the National Food Safety and Toxicology Center at Michigan State University. Each sample was analyzed by using gas chromatography for cis- and transpermethrin.

RESULTS & DISCUSSION

Weather data was collected hourly during this study. During insecticide applications, temperatures were 17-18 C, relative humidity ranged from 34-46% with wind velocity very low at 0-1 mph. Weather during the entire test period had a temperature range of 18-13 C, winds calm at 0-2 mph with no precipitation or morning dew.

One truck mounted ULV machine was used to spray both parks. Droplet characterization performed prior to application determined that mass median diameter was 19.91 µ for Biomist and 18.31 µ for Aqua-Reslin. The slide rotator placed at Immerman Park during the Biomist application collected a total of 496 droplets with a mass mean (± SE) ng permethrin.

Figure 4. Post-treatment permethrin residues.
median diameter of 23.62 µ. At Harvey Randall Wicks Park the slide rotator collected a total of 137 droplets with a MMD of 16.53 µ for Aqua-Reslin.

### Table 2 – Hypothetical Risk Assessment

- WHO Acceptable Daily Intake (ADI) of permethrin is 0.05 mg/kg/day (50,000 ng/kg) for the lifetime of an individual.
- Assume that a child weighing 25 kg (55 lbs) plays with a ball 28.2 cm in diameter (equals 2,498 sq.cm. surface area).
- If one-half the ball is covered with mean 12-hour level of permethrin detected (0.5794 ng/cm), then total residue would be 723.7 ng (0.5794 ng × 1,249 sq.cm)
- Assume 12-hours after application a child plays with the ball and comes in contact with the permethrin.
- Assume that 10% of the permethrin is absorbed through the child’s hands
- Total amount of permethrin entering the child’s body is 72.37 ng (0.1 × 723.7 ng)
- Actual exposure compared to ADI equals 2.8948 ng/kg (72.37 ng/25 kg body weight)
- If ADI equals 50,000 ng/kg
- Exposure is 17,272 times less than ADI on a daily basis.

Results from filter paper analysis showed that residues of permethrin of both formulations were detected. Residues were detectable in the range of 0-4.48 ng/cm. per filter paper. A risk analysis (Table 2) based upon the World Health Organization (WHO) Acceptable Daily Intake (ADI) of 0.05 mg permethrin/kg body weight/day was conducted using the maximum measured level of permethrin on a playground object which was 1.2 µg per filter paper (4.48 ng/sq.cm) at 15 minutes post-treatment (Figure 4). ADI is defined as the maximum dose of a substance that is anticipated to be without health risk to humans when taken daily over the course of a lifetime. Thus, levels of permethrin absorption to sample child are 17,272x’s less than the than ADI for one day and over 6 million times less when annualized for a year’s exposure.

The ADI value is based on lifetime daily exposure and assumes 100% absorption through skin upon contact. In real life conditions permethrin applications occur infrequently and exposure does not always occur. Additionally, permethrin breaks down rapidly in the environment and absorption through skin is likely to be much
less than 100%. Finally, exposure is likely to occur only a limited number of days per year rather than 365 days per year. This means that the average daily exposure is lower than the amount measured on the surface of the ball. Thus, the measured levels really correspond to values much less than the daily and yearly levels as calculated above. Accordingly, residues of permethrin resulting from ULV applications in mosquito control programs are unlikely to pose a significant health risk to children or adults.

ACKNOWLEDGMENTS

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REFERENCES CITED


