Washoff potential of pyrethroid products from external building materials and driveway concrete under indoor simulated rainfall conditions

Jennifer R Task1, Paul Hendley2, Russell L Jones3, Christopher M Harbourt1, Joseph R Chepega4, Megan J Cox1, and Paul Miller1

1Waterborne Environmental, Leesburg, VA USA 2Phasera Ltd., Bracknell, Berkshire UK 3Bayer CropScience, Research Triangle Park, NC USA

Introduction
Studies (Weston et al., 2008; Weston and Luly, 2010) have found pyrethroid residues in runoff from residential neighborhoods although the sources were not identified while other studies (Jorgenson and Young, 2008, 2010; Jang and Grau, 2012; Luo et al., 2014) have investigated the potential for pyrethroid residues to wash off from concrete surfaces. In these studies, factors such as surface formulation, surface conditions, and the effects of time were potential contributors to the differences observed in washoff; however, conclusions were limited to a small number of products, formulations, and surfaces.

The Pyrethroid Working Group sponsored a two-part small-scale indoor study to investigate: 1) the effects of ten different building materials on pyrethroid washoff (Task et al., 2014) and 2) the extent to which product formulation and active ingredient (AI) differences from 17 commercial products impact the washoff potential of pyrethroid residues from driveway and concrete surfaces.

Experimental Site and Procedures
The two small scale indoor studies (Study 1: External Building Materials; Study 2: Driveway Concrete) were conducted at the University of Illinois in Champaign, IL.

Test slab dimensions were constructed to a nominal size of 20 cm (L) by 61 cm (W) and of varying thicknesses. Typical pyrethroid active ingredient (AI) label rates were applied and diluted to achieve a 1 gal per 400 square foot base application rate equivalent.

Applications of pyrethroid products were made using a highly reproducible laboratory cold spray and were allowed to air dry.

Rainfall simulations, which occurred 24 hours following application, were conducted using a three-story tall indoor rainfall simulator.

Test slabs were positioned on test stands and subjected to a one-hour 25 mm simulated rainfall event.

Runoff from each test slab was collected individually for analysis of pyrethroid active ingredients and the amount of active ingredient that washed off was expressed as percent of the total amount applied of active ingredient.

Results
For both studies, masses of pyrethroids in runoff water were added to the mass of pyrethroids recovered from sample containers to obtain a total amount of pyrethroid and then expressed in terms of percent applied potential washoff to the entire building material surface, products, and formulations.

Study 1 showed (Task et al., 2014):
- Clean unpainted and unpainted wood generated the highest and lowest percent losses, respectively, for both formulations. (LOD = 1.03 µg/L).
- Washoff from building materials applied with Cynoff EC were less than washoff from building materials applied with CWP with the exception of clean vinyl.
- Smoother surfaces (i.e., vinyl, aluminum, unpainted wood) had higher washoff losses than textured and more porous materials (concrete and wood).

Study 2 showed:
- Products containing the same AI (e.g., cypermethrin) generated a wide range of washoff potentials suggesting the hypotheses that intrinsic properties of the pyrethroid AI are not a major contributor to washoff potential.
- 7 of the 17 products had percent losses of AI (as applied active ingredient) of less than 1% while the remaining products varied between 8.4 and 27.2%.
- In general, EC formulations had lower washoff than other product formulations.
- WP formulations had a greater potential for washoff than other product formulations.

The products studied were in general agreement with Trask et al (2014), Jorgenson and Young (2010), and Luo et al. (2014), which all examined informal washoff from building materials.

For both studies, washoff potential ranged from 0.01% to 97.6%.

Study 2: Driveway Concrete

This study further investigated the effects of formulation on different building material surfaces. In this study, product washoff rates were determined on three building materials: concrete, wood, and stucco. For each building material, six slabs were prepared and subjected to a single application of the track sprayer.

A similar setup as Study 1 was used except one small scale study to investigate: 1) the effects of ten different building materials on pyrethroid washoff (Task et al., 2014) and 2) the extent to which product formulation and active ingredient (AI) differences from 17 commercial products impact the washoff potential of pyrethroid residues from driveway and concrete surfaces.

Study 1: External Building Materials

Two commercial pyrethroid products (Cynoff EC [cypermethrin], Cynoff WP [cypermethrin]) were selected for this study and applied to six different building materials with up to three surface types.

For each building material surface, three slabs were prepared for each formulation and single application applied to the test surface by the track sprayer.

Just prior to application, each test slab was outfitted with stainless steel framing on three sides of the slab with the remaining frame side left to allow for a wind shield protection the collection device and sample container from direct rainfall on the test surface.

Test slabs were positioned on test stands and subjected to a one-hour 25 mm simulated rainfall event conducted, three for each formulation. For each slab, runoff was collected from the entire washoff event; these were analyzed independently for the presence of pyrethrom.

Conclusions
Two of these laboratory studies demonstrate that losses of pyrethroid active ingredients from residential surfaces do occur and the extent of this occurs is dependent on the formulation of the product and the properties of the surface to which the product is applied.

These indoor comparison studies provide useful information but there are remaining questions that need to be understood before changes can be made as a potential solution to helping to reduce pyrethroid transport from residential surfaces to runoff (e.g. effect of scale, environmental conditions, VOC content, longevity of biological activity).

References
Environ Sci Technol

Table 1: Building Material Surface Tested

<table>
<thead>
<tr>
<th>Material</th>
<th>Surface</th>
<th>Clean Unpainted</th>
<th>Clean Painted</th>
<th>Stucco Clean-Standard siding</th>
</tr>
</thead>
</table>

Table 2: Comparison of Pyrethroid Washoff

<table>
<thead>
<tr>
<th>Product Name / Formulation</th>
<th>Active Ingredient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tempo® WP Ultra Insecticide</td>
<td>Bfenfen</td>
</tr>
<tr>
<td>Tempo® SC Ultra Insecticide</td>
<td>Bfenfen</td>
</tr>
<tr>
<td>Westoe® TC Flowable</td>
<td>Cyfluthrin</td>
</tr>
<tr>
<td>Talstar® Professional Insecticide / WP</td>
<td>Cyfluthrin</td>
</tr>
<tr>
<td>Talstar® Professional Insecticide / SC</td>
<td>Cyfluthrin</td>
</tr>
<tr>
<td>Cynoff® EC Insecticide / WP</td>
<td>Cymethrin</td>
</tr>
<tr>
<td>Cynoff® EC Insecticide / SC</td>
<td>Cymethrin</td>
</tr>
<tr>
<td>Demon® Max / EC</td>
<td>Deltamethrin</td>
</tr>
<tr>
<td>Demon® WP Insecticide / WP</td>
<td>Deltamethrin</td>
</tr>
<tr>
<td>Demon® WP Insecticide / SC</td>
<td>Deltamethrin</td>
</tr>
<tr>
<td>Scimitar® GC / MS</td>
<td>Lambda-Cyhalothrin</td>
</tr>
<tr>
<td>Dragnet® TC Flowable / LC</td>
<td>Etofenprox</td>
</tr>
<tr>
<td>Demon®®</td>
<td>Dimethoate</td>
</tr>
<tr>
<td>Talstar® Professional Insecticide / MS</td>
<td>Lambda-Cyhalothrin</td>
</tr>
</tbody>
</table>

Notes:
- Data are presented as mean values ± standard deviation.
- The Pyrethroid Working Group (PWG) is a US task force whose members include eight primary pyrethroid registrants.