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

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## Introduction

Studies (Weston et al., 2008; Weston and Lydy, 2010) have found pyrethroid residues in runoff from residential neighborhoods although the sources were not identified while other studies (Jorgenson and Young, 2008, 2010; Jiang and Gan, 2012; Luo et al., 2014) have investigated the potential for pyrethroid residues to wash off from concrete surfaces.

In these studies, factors such as formulation, surface conditions, and the effects of time were potential contributors to the differences observed in pyrethroid 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 residential building materials on pyrethroid washoff (Trask et al., 2014) and 2) the extent to which product formulation and active ingredient from 17 commercial products may impact the washoff potential of pyrethroid residues from driveway concrete surfaces.

## Experimental Site and Procedures

The two small scale indoor studies (Study 1: External Building Materials; Study 2: Formulation Washoff) were conducted at the University of Illinois at Urbana-Champaign.

Test slab dimensions were constructed to a nominal size of 23 cm (L) by 61 cm (W) and of varying thickness.

Typical pyrethroid active ingredient (AI) label rates were applied and diluted to achieve a 1 gallon per 400 square foot application equivalent.

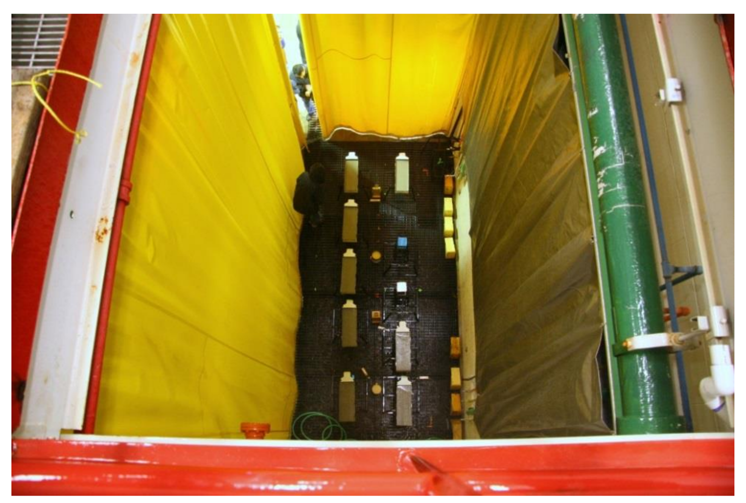
Applications of pyrethroid products were made using a highly reproducible laboratory research track sprayer and were allowed to air dry.

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.

**Laboratory Research Track Sprayer**



**Indoor Rainfall Simulator**

## References

Jiang, W. and J. Gan, 2012. Importance of Fine Particles in Pesticide Runoff from Concrete Surfaces and Its Prediction. *Environ Sci Technol* Published online: May 9, 2012.

Jorgenson, B.C. and T.M. Young, 2008, 'Wash-Off of Pyrethroid Insecticides From Urban Hard Surfaces'. California Storm Water Quality Association (CASQA) 2008 Conference, Oakland, CA, September 24, 2008.

Jorgenson, B.C. and T.M. Young, 2010. Formulation Effects and the Off-Target Transport of Pyrethroid Insecticides from Urban Hard Surfaces. *Environ Sci Technol* 44(13), 4951-4957.

Luo, Y., Brant C. Jorgenson, D.Q. Thuyet, T.M. Young, F. Spurlock, and K.S. Goh. 2014. Insecticide washoff from concrete surfaces: characterization and prediction. *Environ Sci Technol* 48(1), 234-243.

Weston DP, Holmes RW, Lydy MJ. 2008. Residential runoff as a source of pyrethroid pesticides to urban creeks. *Environ Pollution* 157: 287-294.

Weston DP, Lydy MJ. 2010. Urban and agricultural sources of pyrethroid insecticides to the Sacramento-San Joaquin Delta of California. *Environ Sci Technol* 44: 1833-1840.

Trask, J.R., C.M. Harbourt, P. Miller, M. Cox, R. Jones, P. Hendley and C. Lam. 2014. Washoff of cypermethrin residues from slabs of external building material surfaces using simulated rainfall. *Environ Toxicol Chem* 33(2):302-307.

## Study 1: External Building Materials

Two commercial pyrethroids products (Cynoff® EC (cypermethrin); Cynoff® WP (cypermethrin)) were selected for this study and applied to six different residential building materials with up to three surface types.

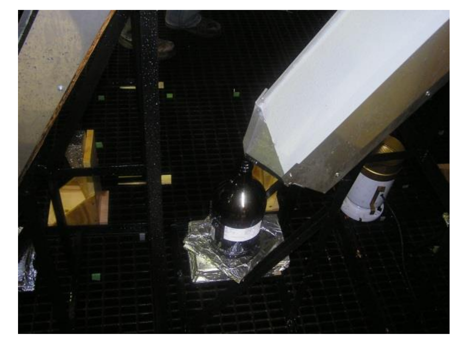
**Building Material Surface Tested**

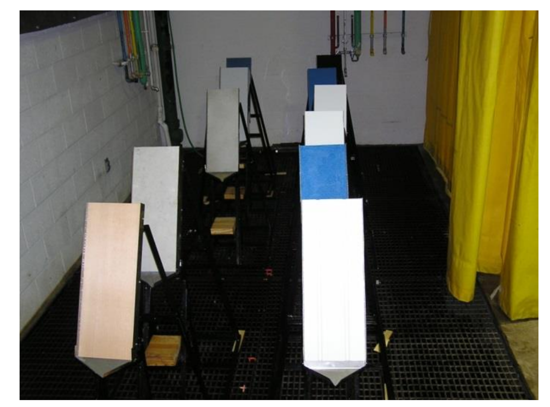
| Material | Surface |
|---|---|
| Concrete | Clean Painted |
| | Clean Unpainted |
| Asphalt | Typical driveway surface finish |
| Wood | Clean Painted |
| | Clean Unpainted |
| | Dusty Painted |
| Vinyl | Clean 3 board grooved soffit |
| Stucco | Clean Painted |
| | Clean Unpainted |
| Aluminum | Clean Standard Siding |

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

Just prior to application, each test slab was outfitted with stainless steel flashing on three sides of the slab with the remaining end containing the runoff collection device. Rain shields protected the collection device and sample container from direct rainfall collection.

Test stands, located at 11 positions inside the rainfall simulator, held the test slabs at a 60-degree angle from the horizontal. This simulated wind causing rainfall to impact a vertical surface. Six discrete rainfall simulations (one-hour at 25 mm/hr) were conducted, three for each formulation. For each slab, runoff was collected from the entire washoff event; these were analyzed independently for the presence of cypermethrin.



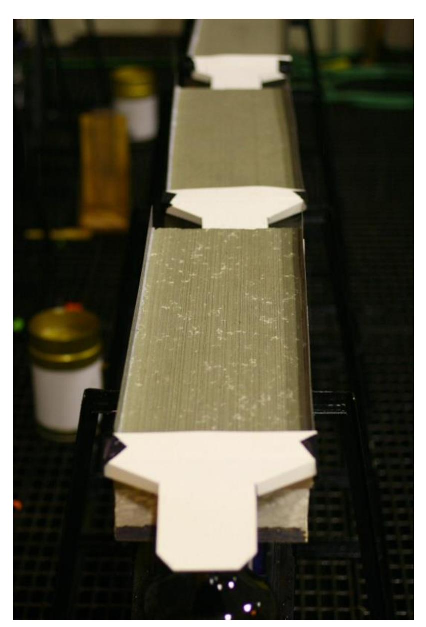


## Study 2: Formulation Washoff

This study further investigated the effects of formulation on driveway concrete using 17 commercial products with varying formulations and AIs. Many of the products (14 of 17) are labeled for structural pest control use.

Spray Mix Application Rates. In order to reduce variation due to a wide range of recommended application rates/ treatment volumes between products, AI rates per slab were standardized to one of three values (depending on intrinsic AI activity) and treatment volume was fixed at 1 gal. to 400 $ft^2$ (matching Study 1).

For each product, three slabs were prepared and had a single application applied to the test surface by the track sprayer except for the Ready-to-Use product which had 2 applications per test slab.



A similar setup as Study 1 was used, however, test slabs were held at a 5-degree angle from the horizontal to simulate sloped driveways and pavement in the Sacramento Valley area.

Six discrete rainfall simulations (one hour at 25 mm/hr) were conducted for the 51 test slabs. For each slab, runoff was collected from the entire washoff event; these were analyzed independently for pyrethroid AI.

**Products Applied**

| Commercial Product Name / Formulation[1] | Active Ingredient |
|---|---|
| Tempo® WP Ultra Insecticide / WP | Beta-Cyfluthrin |
| Tempo® SC Ultra Insecticide / SC | |
| Wisdom™ TC Flowable (Total Choice) / LS | Bifenthrin |
| Talstar® Professional Insecticide / L | |
| Cy-Kick® CS / FMC | Cyfluthrin |
| Cynoff® EC Insecticide / EC | Cypermethrin |
| Cynoff® WP Insecticide / WP | |
| Demon® Max / EC | |
| Demon® WP Insecticide / WP | |
| Suspend® SC Insecticide / SC | Deltamethrin |
| Ortho® Bug-B-Gon® / RTU | Esfenvalerate |
| Danitol® 2.4 EC Spray / EC | Fenpropathrin |
| Demand® CS Insecticide / MS | Lambda-Cyhalothrin |
| Scimitar® GC Insecticide / MS | |
| Warrior Insecticide with Zeon Technology® / MS | |
| Prelude® Termiticide/ Insecticide / EC | Permethrin |
| Dragnet® SFR Termiticide Insecticide / EC | |

[1] WP=Wettable Powder; SC=Suspension Concentrate; LS=Liquid Suspension; L=Liquid; FMC=Flowable Micro-encapsulated Concentrate; EC=Emulsifiable Concentrate; RTU=Ready-to-Use Spray; MS=Micro-encapsulated Suspension

## 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 mass lost from the test slab. This loss was then expressed in terms of percent applied pyrethroid for all building materials, products, and formulations.

**Study 1 showed (Trask et al., 2014):**

- Clean vinyl siding and unpainted stucco generated the highest and lowest percent losses, respectively, for both formulations. (LOQ = 1.03 µg/L)
- Washoff from building materials applied with Cynoff EC were less than building materials applied with Cynoff WP with the exception of clean vinyl.
- Smoother surfaces (i.e., vinyl, aluminum, unpainted wood) had higher washoff losses than textured and more porous materials (i.e., stucco, concrete).

**Study 2 showed:**

- Products containing the same AI (e.g., cypermethrin) generated a wide range of washoff potentials supporting the hypothesis that intrinsic properties of the pyrethroid AI are not a major contributing factor 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 inhomogeneous mixing in spray tanks.
- The results of this study are in general agreement with Trask et al (2014), Jorgenson and Young (2010), and Luo et al (2014), which all examined washoff under similar conditions.
- Formulation "types" are not a generally useful category to use to estimate washoff potential given their variability between manufacturers.

### Study 1 Product Washoff

| Building Material | Washoff (% of applied active ingredient) | |
|---|---|---|
| | Cynoff EC | Cynoff WP |
| Clean Vinyl Siding | 14.1 | 5.4 |
| Clean Unpainted Wood | 1.6 | 2.7 |
| Clean Aluminum Siding | 1.0 | 3.6 |
| Dirty Painted Wood | 0.3 | 0.65 |
| Clean Unpainted Concrete | 0.14 | 1.3 |
| Clean Painted Wood | 0.10 | 0.42 |
| Clean Asphalt | 0.06 | 0.57 |
| Clean Painted Concrete | 0.06 | 0.08 |
| Clean Painted Stucco | 0.04 | 0.22 |
| Clean Unpainted Stucco | <0.01 | 0.04 |

### Study 2 Product Washoff

| Commercial Product Name / Formulation | Washoff (% of applied active ingredient) |
|---|---|
| Tempo® WP / WP | 27.2 |
| Tempo® SC / SC | 19.1 |
| Wisdom™ TC Flowable / LS | 19.9 |
| Talstar® Professional / L | 8.37 |
| Cy-Kick® CS / FMC | 8.98 |
| Cynoff® EC / EC | 0.15 |
| Cynoff® WP / WP | 13.7 |
| Demon® Max / EC | 0.13 |
| Demon® WP / WP | 14.6 |
| Suspend® SC / SC | 20.2 |
| Ortho® Bug-B-Gon® / RTU | 0.50 |
| Danitol® 2.4 EC Spray / EC | 0.35 |
| Demand® CS / MS | 13.2 |
| Scimitar® GC / MS | 14.8 |
| Warrior® / MS | 0.39 |
| Prelude® / EC | 0.12 |
| Dragnet® SFR / EC | 0.14 |

## Conclusions

These two laboratory studies demonstrate that losses of pyrethroid active ingredients from residential surfaces do occur and the extent to which 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 regarding formulation change as a potential solution to helping to reduce pyrethroid transport from residential hard surface treatments (e.g. effect of scale, environmental conditions, VOC content, longevity of biological activity). See accompanying poster (213)

***The Pyrethroid Working Group (PWG) is a US task force whose members include eight primary pyrethroid registrants (AMVAC Chemical Corporation, BASF Corporation, Bayer CropScience LP, Cheminova A/S, DuPont Crop Protection, FMC Corporation, Syngenta Crop Protection, LLC, Valent U.S.A. Corporation).***