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Dermal Transfer Efficiency of Pesticides from New, Vinyl Sheet Flooring to Dry and Wetted Palms

by

Jackie M. Clothier
Southwest Research Institute
San Antonio, Texas 78228

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Work Assignment Manager

Robert G. Lewis

Human Exposure & Atmospheric Sciences Division
National Exposure Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Notice

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Foreword

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The information in this research report was obtained using existing methods, as well as methods that were developed specifically for this study, to determine the transfer efficiencies of pesticide residues on vinyl floor covering to dry and wetted human skin. This information is needed for better the understanding of the bioavailability of residential pesticide residues and assessments of the potential for human exposures to pesticides used around the home.

Gary J. Foley
Director
National Exposure Research Laboratory
Research Triangle Park, NC 27711

Abstract

This report presents results of a study to determine the transfer efficiencies from sheet vinyl flooring to human skin of three pesticides commonly used for residential indoor insect control. Formulations of the insecticides chlorpyrifos, pyrethrin I and piperonyl butoxide were applied to new, sheet vinyl flooring by broadcast spray and allowed to dry for four hours. Deposition coupons were used to estimate initial surface loadings and the PUF Roller was to measure dislodgeable residues. After the 4-hour drying period, adult volunteers performed hand presses (left and right hands, palm only) with either dry or wetted skin. Water and the participant's own saliva were used as wetting agents. Transfer efficiencies for wetted palms were 2.5 to 3.5 times higher than those for dry palms. The mean (six presses) transfer efficiencies for chlorpyrifos were 5.22% for water-wetted (W), 4.38% for saliva-wetted (S), and 1.53% for dry skin (D). Similar transfer efficiencies were measured for piperonyl butoxide: W - 4.8%, S - 4.1%, and D - 1.4%. Transfer efficiencies for pyrethrin I were about twice as high as those for the other two pesticides: W - 11.9%, S - 8.9%, and D - 3.6%.

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Section 1
Introduction

Surface residues of pesticides in residential environments present a major potential risk for young children. The hands of infants and toddlers are often wet with saliva from frequent hand-to-mouth activity. Thus their hands may dislodge pesticide residues from surfaces more efficiently than the dry hands of adults. Preliminary studies have shown that presses with saliva-wetted hands give larger transfers of pesticides from new cut-pile nylon plush carpet than do presses with dry hands (Camann et al., 1996). The consistency of pesticide transfer differences between saliva-wetted and dry hands has been investigated for new and used cut-pile carpets. The same investigation must be performed on vinyl flooring and grass. It is also important to determine if the pesticide transfers with water-wetted hands are similar to those with saliva-wetted hands.

The objective of Task 7 of Work Assignment III-76 is to compare the press transfers of freshly-applied pesticide residues from treated vinyl flooring to palms of hands which are saliva-wetted, water-wetted, and dry. The focus is on pesticides approved for use on indoor surfaces (i.e., chlorpyrifos, pyrethrins, and piperonyl butoxide). For the experiment, a formulated mixture, Dursban® plus Kicker®, is applied, since it contains all three pesticides of interest.

This protocol describes experimentation for Task 7, in which press transfer efficiencies are compared for a dry palm, palms wetted with human saliva (HS) and water, and a dry PUF roller onto a section of new, vinyl sheet flooring which was recently treated with chlorpyrifos, pyrethrins, and piperonyl butoxide.

Section 2
Conclusions and Recommendations

Considering measurement variation, one dry palm press gave essentially the same mean (n = 6) transfer efficiency for chlorpyrifos (1.53%) and piperonyl butoxide (1.41%) with considerably higher transfer efficiency for pyrethrin I (3.64%). The increased transfer with a moistened palm press relative to a dry palm press is shown in Table 1 to be the same (3.4-fold) for all three pesticides when water is the moistening agent and 2.4 to 3-fold for all three pesticides when saliva is the moistening agent.

Considerable loss of pesticide residue transfer occurs with time, possibly because of increased adhesion to the vinyl surface. The loss is independent of dislodgeable residue method and wetting agent. When averaging all palm wipe samples in Tables 2 through 4, losses in transfer efficiency on the second day after application are 58.5% for chlorpyrifos, 63.5% for pyrethrin I, and 61.2% for piperonyl butoxide. When averaging losses in PUF transfer efficiency (Table 5) very similar results are obtained: 63% for chlorpyrifos, 54% for pyrethrin I, and 64% for piperonyl butoxide.

The acceptable use of the PUF roller as a mechanical means of approximating dermal exposure to pesticides from floors is further supported by results of this study. Comparing the mean (n=6) transfer efficiency of the PUF roller with dry hand presses (Table 5), the PUF roller method gives

between 1 and 3 times higher residue removal than a dry palm press but residue removal similar to that achieved with moistened palms.

When comparing transfer efficiencies of dislodgeable residue passed to palms when in contact with pesticide-laden, new carpet (Experiment 6.1) and new, vinyl sheet flooring, the amount of pesticide residue removed from the vinyl floor is considerably higher than that removed from the carpet. Based on experimental design and deposition coupon loadings, both surfaces were loaded with similar amounts of chlorpyrifos (3775 ng/cm^2 vinyl and 3110 ng/cm^2 carpet). However, three times more chlorpyrifos was removed from vinyl than was removed from plush carpet with a dry or wetted hand. For pyrethrin I, eleven times more residue was removed from vinyl with dry palms and five times more with wetted palms than was removed from carpet. For piperonyl butoxide, two to three times more residue was removed from vinyl with either dry or wetted palms than was removed from carpet. This finding was expected because carpet fibers provide more surface area for the residues to adhere. Table 6 summarizes data from application Day 3 of both Experiment 6.2 (used, plush carpet) and Experiment 7 (vinyl).

Section 3
Experimental Methods

3.1 Informed Consent

A protocol which described the experiment and a consent form were prepared and approved by the Institutional Review Board of the University of Texas Health Science Center in San Antonio. Three healthy male subjects who are supervisory employees at Southwest Research Institute volunteered to perform the palm presses. Informed consent of each volunteer subject was obtained.

3.2 Test Procedures

An empty 7' × 7' carpeted area in a 3-room trailer on the SwRI campus was used to do the experiment. Two 5' × 6' sections of new, Armstrong *Cambray* vinyl sheet flooring (A and B) were laid over the existing carpet and attached using tape.

3.2.1 Palm-Moistening Procedure

Each subject collected 5 mL of his own saliva in a Teflon bottle for use in moistening his palm with HS for some of the field sampling palm presses. The salivary fluids were stored at 4°C.

A 3.5-in. × 3.5-in. (8.9-cm × 8.9-cm) square central area of the clean bare palm of the test hand was moistened by pressing the palm onto a polyethylene surface, which was supported by small bubble wrap and on which 250 µL of the salivary fluid had been placed. The wetted surface was prepared by spiking about six drops of the fluid in the central portion of a 3.5 in. (8.9 cm) diameter circular area outlined on the underside of a polyethylene sheet. Immediately, the subject placed the palm over the wetted area and rotated the hand with moderate pressure back and forth (to the left and to the right) about six times to transfer and achieve a uniform coating of the fluid over the center of the palm. Within 6 to 10

seconds after moistening, the subject performed a single press of the moistened palm onto the test surface.

3.2.2 Palm Press and Wipe Procedure

A single press of the treated vinyl sheet was made in a reproducible manner with a palm after receiving the designated treatment [i.e., none (dry), water-moistened, or HS-moistened]. Prior to each daily pair of palm presses, each subject thoroughly washed his hands with soap and water. The subject was cautioned to avoid touching any extraneous surfaces during the palm-press-and-wipe sequence. The subject then placed a disposable powder-free latex glove over the non-test hand. The second hand was gloved to prevent contamination while performing the moistening, press, and wipe procedures with the first hand and to prevent the isopropanol wipe from abnormally drying the skin of the second hand prior to its use for a hand press. The test hand was given the designated treatment, moistening when specified as described above. A clean card-stock template (8.5-in. × 11-in. card-stock, with a 3.5-in. × 3.5-in. area cut out) was placed over the designated area to expose a 12.25 $in.^2$ (79.2 cm^2) area of vinyl. While kneeling on a cardboard mat, each subject performed one press of the palm of the test hand, with fingers extended above the template, onto the 79.2 cm^2 area of carpet exposed through the template, for 1 sec. at a pressure of ca. 1.0 psi (6,900 Pa). After all subjects had conducted one palm press, each performed a double isopropanol wipe of the test palm as a modification of Geno et al. (1996a) in a clean area away from the trailer. After washing both hands with soap and water, the glove was removed from the second hand, and a clean glove placed over the previously tested hand. The moistening, press, and wipe procedures described above were then repeated using the palm of the second hand.

The palm wipe procedure used two 4-in. × 4-in. Sof-Wick® 6-ply gauze dressing sponges that had been precleaned with isopropanol and 1:1 ether:hexane. Each sponge was laced with 10 mL of isopropanol. The subject performed a general wipe of the palm of the test hand with the first sponge. The second sponge was used for a more thorough wipe of the entire palm. Both sponges were then placed in a single container and 25 mL of Baxter pesticide grade methanol was added. The subjects performed all direct handling of the sponges from preparation through placement in the sample container, although handling via forceps was also permitted. Immediately following each palm wipe procedure, the subject thoroughly washed his hands to remove any remaining pesticide residues.

3.2.3 PUF Roller Method

A precleaned dry PUF ring (3-in. length, 3.5-in. OD, 1.62-in. ID) was fitted onto the 3-in. length × 1.75-in. OD cylindrical aluminum roller of the October 1992 model of the PUF roller sampler (Camann, 1996b). From a stationary position with the PUF ring setting on aluminum foil, the roller sampler was pushed or pulled to move the PUF ring over a 3-in. × 3-ft. (696.8 cm^2) strip of vinyl sheeting at 10 cm/sec to make one traverse. After the pass, the PUF ring was removed from the roller for analysis.

3.2.4 Broadcast Application of Formulated Mixture

On both on Day 1 and on Day 3, a broadcast spray of a chlorpyrifos/pyrethrins/piperonyl butoxide formulation was applied to the test vinyl section by licensed pest control operator following according to label directions for light infestation flea control. The formulated emulsifiable concentrate was composed of Dursban® Pro (EPA Registration No. 62719-166), which contained 22.5% chlorpyrifos, and Kicker® (EPA Registration No. 4816-707AA), which contained 6.0% pyrethrins and 60.0% technical piperonyl butoxide. It was tank-mixed at 1.33 fl. oz. (40 mL) Dursban® Pro and 0.5 fl. oz. (15 mL) Kicker® per gallon of water, to yield 0.25% chlorpyrifos, 0.025% pyrethrins, and 0.25% piperonyl butoxide in the aqueous spray. The mixture was applied approximately 40 cm above the test surface at a rate of 1 gallon of diluted mixture per 1600 ft^2 with a hand-held fan broadcast nozzle attached to an air-pressurized tank. Application was performed with a smooth back-and-forth motion to attempt uniform deposition.

The trailer was maximally ventilated for 2 hours after the application, by opening windows and the door and through operation of the air conditioning or heating unit in the fresh air mode. The windows and door were closed and air conditioning/heating returned to the normal recirculated air mode prior to sampling for the duration of the sampling period. The surface was allowed to dry for at least four hours before hand presses were performed.

Section 4
Experimental Design

4.1 Field Procedures

Task 7 was performed from October 27, 1998 (Day 0) through November 3, 1998 (Day 4). The experimental design is presented in Table 7. A PUF roller traverse, a deposition coupon, and a palm press by each subject were collected from adjacent areas termed a block. The treatment (dry, water-moistened, or HS-moistened) applied to each palm (left or right) of the three subjects is specified in Table 7. The layout of PUF roller traverses, deposition coupons, and palm press templates for all samples collected on one of the sections of treated vinyl over two sampling days is shown in Figure 1.

Six field method blanks were obtained on a day prior to the pesticide application (Day 0) by having the three subjects perform a press of each palm using one of the three treatments (for a total of six blank palm presses) onto designated areas of the untreated vinyl. Before the Dursban and Kicker mixture was applied, three 4-in. × 4-in. alpha-cellulose pads backed with aluminum foil were placed on the test area, one at the designated location in each block, as deposition coupons. The PUF roller pass was performed where designated in a block. Then the deposition coupon in the block were picked up from the vinyl as a sample just before the three palm presses were performed in that block. Before the first block of field samples on Day 1 and again after the last block on Day 4, five field spikes of the target analytes were made: three onto Sof-Wick sponge pairs simulating the three palm

treatments [wetted with 100 µL of a moistening fluid (when appropriate) and 20 mL of isopropanol] and one each onto a PUF ring and a trimmed (3-in. × 3-in.) alpha-cellulose pad.

Replicate sampling commenced upon label-allowed reentry, when the vinyl was dry (defined operationally as four hours after the application). Two blocks were sampled per day on the application days (Days 1 and 3) and one block on the succeeding days (Days 2 and 4). Section A was removed and section B laid down at the conclusion of Day 2 sampling. Only one press and wipe was permitted per subject palm per day to avoid altering skin transfer characteristics and to limit acute exposure of subjects.

A total of six replicate presses of each palm treatment were collected. Each of the three subjects thoroughly washed his hands with dispenser soap and water, dried them, and gloved the hand which was not to be used for pressing. After treating the palm as specified in Table 7, each subject made one press of the treated palm onto a 79.2 cm^2 area of treated vinyl through a clean cardstock template. As specified in Table 7, each subject had a different moistening or dry treatment of the palm of the same hand for the three palm presses onto designated areas of the vinyl comprising a block. The double isopropanol-gauze wipe method was used to wipe the residue from the pressed palm. On Days 1 and 3, after removing the glove, each subject had his other palm treated in the specified manner, pressing it through a clean template onto the vinyl.

4.2 Sample Extraction and Analysis

Wipe samples were cold-shake extracted for neutral pesticides as described in Geno et al. (1996), according to SwRI SOP 01-17-08, “Extraction of Neutral Pesticides, Acid Herbicides, and Phenols from Isopropanol Wipes”. Extracts were cleaned through a Florisil column. The extraction procedure involved adding terphenyl-d_{14} as a recovery surrogate to the sample jar, shaking for 30 min on a mechanical shaker, then decanting the methanol, and shaking the dressing sponges twice more for 1 min, each time with 50 mL portions of 1:1 ether:hexane. The sponges were squeezed, all solvent fractions combined, and concentrated in a N-Evap® vessel to a final volume of 20 mL in 10% ether in hexane. Wipe samples of dry palm presses and field and lab blanks were concentrated to a 5.0 mL final volume in 10% ether in hexane so as to lower the detection limits of chlorpyrifos and piperonyl butoxide to 0.10 µg/extract.

The aluminum foil backing and the 0.5-in. border was removed from each deposition coupon to leave a 3-in. × 3-in. alpha-cellulose pad. PUF rings and 3-in. × 3-in. alpha-cellulose pads were soxhlet-extracted with 6% ethyl ether/94% hexane. All extracts were analyzed for chlorpyrifos, pyrethrin I, and piperonyl butoxide on a Fisons MD 800 or HP 5973 GC/MS operating in selected ion monitoring mode according to SwRI SOP 01-17-02, “Determination of Pesticides, Acid Herbicides, Phenols, and PAHs by GC/MS”.

4.3 Data Evaluation

The loadings of the three applied pesticides on the treated vinyl at the time of sampling were estimated from the loading on adjacent deposition coupons: µg on coupon/coupon surface area (58.1 cm^2). Palm press transfer rates (ng/cm^2) were calculated as the amount (ng) obtained with the isopropanol palm wipe divided by vinyl area pressed (79.2 cm^2). PUF roller transfer rates (ng/cm^2) were calculated as the amount (ng) obtained from one traverse divided by the area of vinyl traversed (696.8 cm^2). The mean and standard deviation of the transfer efficiencies (%) (= transfer rate/carpet loading) were determined from the six replicates for each analyte and palm treatment.

Section 5
Results and Discussion

5.1 Data Quality

The amounts of chlorpyrifos, pyrethrin I and piperonyl butoxide found in the field blanks (collected on Day 0) and the lab blanks are presented in Table 8. Essentially, no chlorpyrifos, pyrethrin I or piperonyl butoxide was detected above the detection limit in any lab blank. All field blanks (including two PUF rings and six isopropanol gauze wipes) showed no detectable amounts of chlorpyrifos, pyrethrin I, or piperonyl butoxide. Therefore, adjustment of data collected on samples from treated vinyl were unnecessary.

Recoveries of chlorpyrifos, pyrethrin I, and piperonyl butoxide from field and lab matrix spikes of isopropanol gauze, PUF rings, and deposition coupons are given in Table 9. Recovery of chlorpyrifos, pyrethrin I, and piperonyl butoxide from PUF rings was quantitative. The type of moistening treatment (i.e., palms pressed dry or moistened with water or human saliva) appear to have no effect on recovery of target compounds from gauze wipe samples. The average of six recoveries of chlorpyrifos, pyrethrin I, and piperonyl butoxide from gauze wipe spikes was 92.8%, 112.0%, and 95.6%, respectively. Field-spiked deposition coupons show poorer recoveries, possibly because the 0.5-in. border of the coupon was not removed prior to spiking, resulting in some loss of target compounds when the border was removed prior to extraction. The efficiency of Soxhlet extraction using deposition coupons in previous experiments has previously been very good as is also demonstrated by 80-100% recoveries using laboratory matrix spikes.

5.2 Single Press Transfer of Pesticides from New, Treated Vinyl Sheet Flooring to Human Palm

The amounts of chlorpyrifos, pyrethrin I, and piperonyl butoxide recovered from each deposition coupon and the calculated surface loadings on the treated vinyl during each set of palm presses are shown in Tables 10, 11, and 12, respectively. The surface loading for Day 4 is an estimate calculated by subtracting the coupon matrix spike from the deposition coupon which was inadvertently spiked with pesticide. Coupon amounts indicate the broadcast application on Days 1

and 3 gave similar loadings of the applied pesticides to the vinyl. The amounts wiped from each subject's palm after it had been pressed once, while dry or wetted onto the treated vinyl are also shown in Tables 10 through 12. The vinyl-to-palm transfer rate calculated from each palm wipe amount is also presented in Tables 10 through 12, along with the mean and standard deviation of the transfer rates for dry palms and each palm wetting agent.

5.3 Moistened and Dry Palm Transfer Efficiency

Tables 2, 3, and 4 show palm wipe transfer efficiencies of chlorpyrifos, pyrethrin I, and piperonyl butoxide using dry and wetted palms. Means and standard deviations are reported for six samples collected over four days. However, because there appears to be an increased adhesion of the pesticide formulation to the vinyl after 24 hours, statistical comparisons are also made between samples collected on Days 1 and 3 (n = 4) and Days 2 and 4 (n = 2). This observation is apparent in the amount of pesticide detected both in PUF rings and isopropanol gauze palm wipes, regardless of moistening treatment. A similar trend occurred in dislodgeable residue studies on vinyl sheeting conducted by SwRI in 1993 (Comparison of Methods to Determine Dislodgeable Residue Transfer From Floors, EPA Contract 68-DO-0007). This trend is also summarized in Tables 2 through 4.

Mean (± standard deviation) transfer efficiencies of chlorpyrifos were 5.22% ± 3.02% for water-wetted palms, 4.38% ± 2.83% for saliva-wetted palms, and 1.53% ± 0.73% for dry palms. The same relationship was observed for pyrethrin I and piperonyl butoxide mean transfer efficiencies: largest for water-wetted palms, slightly less for saliva-wetted palms and substantially lower for dry palms. The large standard deviations indicate no appreciable differences between the mean pesticide transfer efficiencies with a saliva-moistened and a water-moistened palm. This finding suggests that it is the wetness of the saliva rather than its stickiness/viscosity that is primarily responsible for the enhanced pesticide transfer from a treated sheet of vinyl through contact with a saliva-wetted palm, compared to a dry palm.

5.4 Transfer of Pesticides from New, Treated Vinyl Sheet Flooring to Polyurethane Foam (PUF) Rings

The amounts and transfer rates of chlorpyrifos, pyrethrin I, and piperonyl butoxide recovered from PUF rings and dry palm press hand wipes are shown in Tables 13 and 14. Transfer efficiencies are listed in Table 5, however, because of the noticeable loss in amount of transfer from fresh to day old treatment, efficiency measurements are also included for Days 1 and 3 compared with Days 2 and 4 for all three pesticides. PUF ring transfer efficiencies reported from the 1993 study are also included.

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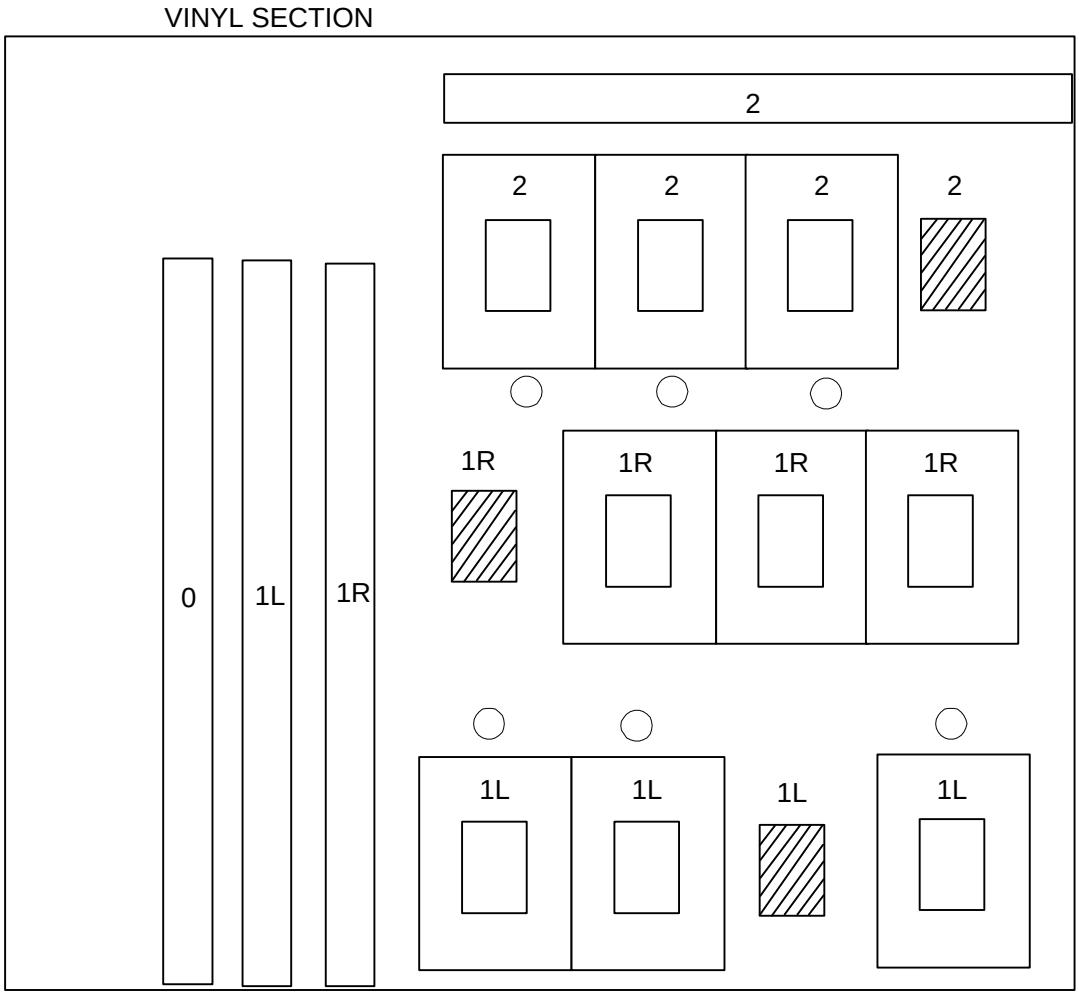

Note: 0 indicates location of Day 0 Field Blanks

Figure 1. **Scaled layout for palm press, PUF roller, and deposition coupon sampling on one 4-ft. × 5-ft. section of treated vinyl showing location of samples collected for Day 0 and Blocks 1L, 1R, and 2 on Days 1 and 2.**

Table 1. Ratio of Moistened to Dry-Palm Transfer Efficiencies of Pesticides from One Press onto New, Vinyl Sheet Flooring Treated by Broadcast Application (Mean ± Std. Dev. of Six Replicates, %)

Hand Condition	Chlorpyrifos	Pyrethrin I	Piperonyl Butoxide
Dry	1.0 ± 0.48	1.0 ± 0.61	1.0 ± 0.52
Moistened with:			
Water	3.4 ± 2.0	3.3 ± 2.0	3.4 ± 2.1
Human Saliva	2.9 ± 1.8	2.4 ± 1.3	2.9 ± 1.9

Table 2. Transfer Efficiency[1] (%) of Chlorpyrifos from New, Vinyl Sheet Flooring by Single Press of Human Palm Which was Dry or Moistened with Water or Human Saliva

Block	Dry	Water-Wetted	Saliva-Wetted	1993 Vinyl Study[2]
1L	2.04	6.74	1.81	
1R	1.65	7.97	4.90	
2L	0.83	1.53	2.60	
3R	1.35	5.24	3.75	
3L	2.62	8.24	9.74	
4R	0.71	1.61	3.48	
No. Samples, n	6	6	6	
Mean, $\bar{x}$	1.53	5.22	4.38	
Std. Dev., s	0.73	3.02	2.83	
<u>Comparison of Wipes From Application Days 1 and 3</u>				
No. Samples, n	4	4	4	6
Mean, $\bar{x}$	1.92	7.05	5.05	4.70
Std. Dev., s	0.55	1.37	3.38	3.31
<u>Comparison of Wipes From Days 2 and 4</u>				
No. Samples, n	2	2	2	6
Mean, $\bar{x}$	0.77	1.57	3.04	2.05
Std. Dev., s	0.08	0.06	0.62	1.04
% Loss	60	78	40	56

[1] Transfer Efficiency, % = 100 × (transfer rate, ng/cm^2)/(mean surface loading, ng/cm^2)

[2] Dry palm presses were conducted on 8-10-93, after pesticide application and again the following day.

Table 3. Transfer Efficiency[1](%) of Pyrethrin I from New, Vinyl Sheet Flooring by Single Press of Human Palm Which was Dry or Moistened with Water or Human Saliva

Block	Dry	Water-Wetted	Saliva-Wetted	1993 Vinyl Study[2]
1L	6.00	16.80	5.52	
1R	5.04	19.20	10.56	
2L	1.80	3.12	6.12	
3R	2.24	11.09	6.72	
3L	5.78	17.70	17.70	
4R	1.00	3.30	6.72	
No. Samples, n	6	6	6	
Mean, $\bar{x}$	3.64	11.87	8.89	
Std. Dev., s	2.21	7.25	4.66	
Comparison of Wipes From Application Days 1 and 3				
No. Samples, n	4	4	4	6
Mean, $\bar{x}$	4.76	16.20	10.13	5.48
Std. Dev., s	1.73	3.54	5.49	1.18
Comparison of Wipes From Days 2 and 4				
No. Samples, n	2	2	2	6
Mean, $\bar{x}$	1.40	3.21	6.42	1.81
Std. Dev., s	0.56	0.13	0.42	3.94
% Loss	70	80	37	67

[1] Transfer Efficiency, % = 100 × (transfer rate, ng/cm^2)/(mean surface loading, ng/cm^2)

[2] Dry palm presses were conducted on 8-10-93, after pesticide application and again the following day.

Table 4. Transfer Efficiency[1] (%) of Piperonyl Butoxide from New, Vinyl Sheet Flooring by Single Press of Human Palm Which was Dry or Moistened with Water or Human Saliva

Block	Dry	Water-Wetted	Saliva-Wetted	1993 Vinyl Study[2]
1L	1.84	5.63	1.84	
1R	1.64	7.16	4.76	
2L	0.72	1.23	2.35	
3R	1.16	5.24	3.24	
3L	2.52	8.41	9.06	
4R	0.59	1.42	3.11	
No. Samples, n	6	6	6	
Mean, $\bar{x}$	1.41	4.85	4.06	
Std. Dev., s	0.73	2.95	2.64	
Comparison of Wipes From Application Days 1 and 3				
No. Samples, n	4	4	4	6
Mean, $\bar{x}$	1.79	6.61	4.72	6.23
Std. Dev., s	0.56	1.46	3.13	4.69
Comparison of Wipes From Days 2 and 4				
No. Samples, n	2	2	2	6
Mean, $\bar{x}$	0.66	1.32	2.73	2.51
Std. Dev., s	0.09	0.13	0.54	1.14
% Loss	63	80	42	60

[1] Transfer Efficiency, % = 100 × (transfer rate, ng/cm^2)/(mean surface loading, ng/cm^2)

[2] Dry palm presses were conducted on 8-10-93, after pesticide application and again the following day.

Table 5. Transfer Efficiency[1] (%) of Pesticides from Treated, New, Vinyl Sheet Flooring onto PUF Roller and Dry Palm After Single Press

Summary of Pesticide Transfer Efficiency Using Dry Palm

	Chlorpyrifos		Pyrethrin I		Piperonyl Butoxide	
Day	PUF	Dry Palm	PUF	Dry Palm	PUF	Dry Palm
1L[2]	2.43	2.04	4.35	6.00	2.26	1.84
1R	7.05	1.65	10.61	5.04	8.47	1.64
2L	1.15	0.83	1.90	1.80	0.93	0.72
3R[2]	5.40	1.35	6.55	2.24	5.21	1.16
3L	7.64	2.62	8.69	5.78	7.70	2.52
4R	1.48	0.71	1.87	1.00	1.10	0.59
No. Samples, n	6	6	6	6	6	6
Mean, $\bar{x}$	4.19	1.53	5.66	3.64	4.28	1.41
Std. Dev., s	2.87	0.73	3.60	2.21	3.33	0.73
Summary of PUF Roller Transfer Efficiency Data From Application Days 1 and 3						
No. Samples, n	4	4	4	4	4	4
Mean, $\bar{x}$	5.63	1.92	7.55	4.76	5.91	1.79
Std. Dev., s	2.33	0.55	2.70	1.73	2.80	0.56
Summary of PUF Roller Transfer Efficiency Data From Days 2 and 4						
No. Samples, n	2	2	2	2	2	2
Mean, $\bar{x}$	1.32	0.77	1.88	1.40	1.02	0.66
Std. Dev., s	0.23	0.08	0.02	0.56	0.12	0.09
% Loss[3]	77	60	75	70	83	63
Summary of PUF Roller Transfer Efficiency Data From Day 1 of 1993 Vinyl Study						
No. Samples, n	2	6	2	6	2	6
Mean, $\bar{x}$	10.48	4.70	8.62	5.48	8.40	6.23
Std. Dev., s	7.64	3.31	2.97	1.18	6.30	4.69
Summary of PUF Roller Transfer Efficiency Data From Day 2 of 1993 Vinyl Study						
No. Samples, n	2	6	2	6	2	6
Mean, $\bar{x}$	5.26	2.05	5.84	1.81	4.60	2.51
Std. Dev., s	3.26	1.04	2.64	3.94	3.08	1.14
% Loss[4]	50	56	32	67	45	60

[1] Transfer Efficiency, % = 100 × (transfer rate, ng/cm^2)/(mean surface loading, ng/cm^2)

[2] Fresh application of pesticide made on these days

[3] (Difference between means of Days 1, 3 and Days 2 , 4/mean of Days 1, 3) × 100

[4] (Difference between means of Day 1 and Day 2/mean of Day 1) × 100

Table 6. Comparison of Palm Transfer Rates of Chlorpyrifos, Pyrethrin I and Piperonyl Butoxide from Day 3 of Experiment 6.2 Using Plush Carpet and Experiment 7 Using Vinyl Sheeting

	Chlorpyrifos		Pyrethrin I		Piperonyl Butoxide	
Palm Treatment	ng/cm^2 from Vinyl	ng/cm^2 from Carpet	ng/cm^2 from Vinyl	ng/cm^2 from Carpet	ng/cm^2 from Vinyl	ng/cm^2 from Carpet
Dry	67.1	9.1	4.3	1.3	36.1	10.0
Water Moistened	227.8	12.3	15.4	2.2	133.5	26.4
Saliva Moistened	227.9	11.3	13.1	1.4	120.2	16.6
Surface Loading	3391	3408	118	145	2074	3158

Table 7. Design for the Transfer Efficiency Test on New, Vinyl Sheet Flooring (Task 7)

Test Day Carpet Section	Human Palm Press,[1] by Palm Treatment			Dry PUF Roller[5]	Deposition Coupons
	Dry[2]	Water-Moistened[3]	Saliva-Moistened[4]		
Day 1: A[6]	1L[7]	2L	3L	1	1
	3R	1R	2R	1	1
Day 2: A	2L	3L	1L	1	1
Day 3: B[6]	1R	2R	3R	1	1
	3L	1L	2L	1	1
Day 4: B	2R	3R	1R	1	1
Field Samples	6	6	6	6	6
Field Blanks (Day 0: A)	1L, 3R	2L, 1R	3L, 2R	2	0
Field Spikes (Days 1 & 4)	2	2	2	2	2
Total Samples	10	10	10	10	8

[1] One press of treated palm through template onto 3.5-cm × 3.5-cm square of treated vinyl
[2] Dry palm moistened with subject's saliva
[3] One pass over 3-foot strip with dry PUF roller
[4] Palm dried after washing with soap and water
[5] Dry palm moistened with water
[6] Fresh treatment of this vinyl section on this day, at least four hours before palm presses
[7] Subject hand (e.g., 1L = left hand of Subject 1)

Table 8. Isopropanol Gauze Palm Wipe, PUF Ring, and Deposition Coupon Blanks (µg/sample)

Blanks			
Matrix	Chlorpyrifos	Pyrethrin I	Piperonyl Butoxide
Solvent Blank (PUF/Coupon)	<1.0	<0.63	<1.1
Solvent Blank (gauze wipes)	<0.10	<0.063	<0.11
Lab Coupon Blank (dry)	<2.1	<2.1	<2.2
Lab PUF Ring Blank (dry)	<1.0	<0.63	<1.0
Lab Gauze Blank (dry)	<0.10	<0.63	<0.11
Field PUF Ring Blank (dry)			
Day 0 (L)	<1.0	<0.63	<1.1
Day 0 (R)	<1.0	<0.63	<1.1
Field Blank for Gauze Wipe			
Dry Palm - 1L	<0.10	<0.063	<0.11
Dry Palm - 3R	<0.10	<0.063	<0.11
Water-Wetted Palm - 2L	<0.10	<0.063	<0.11
Water-Wetted Palm - 1R	<0.10	<0.063	<0.11
Saliva-Wetted Palm - 3L	<0.10	<0.063	<0.11
Saliva-Wetted Palm - 2R	<0.10	<0.063	<0.11

Table 9. Recovery of Target Analytes from Matrix Spikes

Matrix/Wetting Agent Type: Day	Chlorpyrifos	Pyrethrin I	Piperonyl Butoxide
PUF Ring	110%	119%	140%
Deposition Coupon[1]			
Lab	91%	106%	84%
Field:Day 1	75%	87%	90%
Field:Day 4	65%	57%	55%
Gauze[2] (Dry)			
Lab	91%	73%	90%
Field:Day 1	97%	132%	103%
Field:Day 4	97%	105%	97%
Gauze/Water			
Field:Day 1	91%	119%	97%
Field:Day 4	84%	92%	84%
Gauze/Human Saliva			
Field:Day 1	97%	125%	103%
Field:Day 4	91%	99%	90%

[1] Each coupon was spiked with 410 µg chlorpyrifos, 40 µg pyrethrin I, and 412 µg piperonyl butoxide

[2] Wetted Sof-Wick® sponge pairs were moistened with 250 µL of the specified fluid. Each pair was then spiked with 15 µg chlorpyrifos, 1.5 µg pyrethrin I, and 15 µg piperonyl butoxide.

Table 10. Comparison of Chlorpyrifos Transfer from New, Vinyl Sheet Flooring by Single Press of Human Palm (Dry and Moist)

	Deposition		Dry			Water			Saliva		
Block	Coupon Amount µg	Surface Loading ng/cm^2	Subject Palm	Palm Wipe Amount µg	Transfer Rate ng/cm^2	Subject Palm	Palm Wipe Amount µg	Transfer Rate ng/cm^2	Subject Palm	Palm Wipe Amount µg	Transfer Rate ng/cm^2
Day 1[1]											
1L	317	5456	1L	6.7	84.1	2L	22	278.5	3L	5.9	74.7
1R	184	3167	3R	5.4	68.4	1R	26	329.1	2R	16	202.5
Day 2											
2L	219	3769	2L	2.7	34.2	3L	5.0	63.3	1L	8.5	107.60
3R	221	3804	1R	3.6	45.6	2R	14	177.2	3R	10	126.6
Day 3[1]											
3L	173	2978	3L	7.0	88.6	1L	22	278.5	2L	26	329.1
Day 4											
4R	195[2]	3356	2R	1.9	24.0	3R	4.3	54.4	1R	9.3	117.7
No. Samples, n		6			6			6			6
Mean, $\bar{x}$		3775			57.5			196.8			159.7
Std. Dev., s		895			26.8			117.8			93.1

[1] Fresh pesticide application made on Days 1 and 3

[2] Estimated amount is the difference between the field deposition coupon (inadvertently spiked with 410 µg chlorpyrifos) and field matrix spike with 410 µg chlorpyrifos.

Table 11. Comparison of Pyrethrin I Transfer from New, Vinyl Sheet Flooring by Single Press of Human Palm (Dry and Moist)

	Deposition		Dry			Water			Saliva		
Block	Coupon Amount µg	Surface Loading ng/cm^2	Subject Palm	Palm Wipe Amount µg	Transfer Rate ng/cm^2	Subject Palm	Palm Wipe Amount µg	Transfer Rate ng/cm^2	Subject Palm	Palm Wipe Amount µg	Transfer Rate ng/cm^2
Day 1[1]											
1L	11	189.3	1L	0.50	6.33	2L	1.4	17.72	3L	0.46	5.82
1R	4.4	75.7	3R	0.42	5.32	1R	1.6	20.25	2R	0.88	11.14
Day 2											
2L	3.0	51.6	2L	0.15	1.90	3L	0.26	3.29	1L	0.51	6.46
Day 3[1]											
3R	8.1	139.4	1R	0.19	2.41	2R	0.94	11.90	3R	0.57	7.22
3L	5.6	96.4	3L	0.49	6.20	1L	1.5	18.99	2L	1.5	18.99
Day 4											
4R	5.0[2]	86.1	2R	0.085	1.08	3R	0.28	3.54	1R	0.57	7.22
No. Samples, n		6			6			6			6
Mean, $\bar{x}$		106.4			3.87			12.62			9.47
Std. Dev. s		49.8			2.34			7.68			5.02

[1] Fresh pesticide application made on Days 1 and 3

[2] Estimated amount is the difference between the field deposition coupon (inadvertently spiked with 40µg pyrethrum I) and field matrix spike with 40 µg pyrethrum I.

Table 12. Comparison of Piperonyl Butoxide Transfer from New, Vinyl Sheet Flooring by Single Press of Human Palm (Dry and Moist)

	Deposition		Dry			Water			Saliva		
Block	Coupon Amount µg	Surface Loading ng/cm^2	Subject Palm	Palm Wipe Amount µg	Transfer Rate ng/cm^2	Subject Palm	Palm Wipe Amount µg	Transfer Rate ng/cm^2	Subject Palm	Palm Wipe Amount µg	Transfer Rate ng/cm
Day 1[1]											
1L	203	3494	1L	3.6	45.6	2L	11	139	3L	3.6	45.6
1R	109	1876	3R	3.2	40.5	1R	14	177	2R	9.3	118
Day 2											
2L	119	2048	2L	1.4	17.7	3L	2.4	30.4	1L	4.6	58.2
Day 3[1]											
3R	145	2496	1R	1.8	22.8	2R	8.1	102	3R	5.0	63.3
3L	96	1652	3L	3.9	49.4	1L	13	164	2L	14	177
Day 4											
4R	100[2]	1721	2R	0.91	11.5	3R	2.2	27.8	1R	4.8	60.8
No. Samples, n		6			6			6			6
Mean, $\bar{x}$		2215			31.2			107.0			87.1
Std. Dev. s		695			15.9			65.5			50.7

[1] Fresh pesticide application made on Days 1 and 3

[2] Estimated amount is the difference between the field deposition coupon (inadvertently spiked with 412 µg piperonyl butoxide) and field matrix spike with 412 µg piperonyl butoxide.

Table 13. Transfer Amount of Pesticides from Treated, New, Vinyl Sheet Flooring onto PUF Roller and Dry Palm After Single Press

	Chlorpyrifos			Pyrethrin I			Piperonyl Butoxide		
Day	Deposition Coupon µg	PUF µg	Dry Palm µg	Deposition Coupon µg	PUF µg	Dry Palm µg	Deposition Coupon µg	PUF µg	Dry Palm µg
1L	317	70	6.7	11	3.2	0.50	203	39	3.6
1R	184	203	5.4	4.4	7.8	0.42	109	146	3.2
2L	219	33	2.7	3.0	1.4	0.15	119	16	1.4
3R	221	127	3.6	8.1	4.9	0.19	145	71	1.8
3L	173	180	7.0	5.6	6.5	0.49	96	105	3.9
4R	195	35	1.9	5.0	1.4	0.08	100	15	0.91

Table 14. Transfer Rate of Pesticides from Treated, New, Vinyl Sheet Flooring onto PUF Roller and Dry Palm After Single Press

	Chlorpyrifos			Pyrethrin I			Piperonyl Butoxide		
Day	Deposition Coupon ng/cm^2	PUF ng/cm^2	Dry Palm ng/cm^2	Deposition Coupon ng/cm^2	PUF ng/cm^2	Dry Palm ng/cm^2	Deposition Coupon ng/cm^2	PUF ng/cm^2	Dry Palm ng/cm^2
1L	5456	100.4	84.1	189.4	4.59	6.3	3494	56.0	45.6
1R	3167	291.3	68.4	75.7	11.2	5.3	1876	209.5	40.5
2L	3769	47.4	34.2	51.6	2.01	1.9	2048	23.0	17.7
3R	3804	182.3	45.6	139.4	7.03	2.4	2496	101.9	22.8
3L	2978	258.3	88.6	96.4	9.33	6.2	1652	150.7	49.4
4R	3356	50.2	24.0	86.1	2.01	1.1	1721	21.5	11.5

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