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Effectiveness of Detergent and Detergent Plus Bleach for Decontaminating Pesticide Applicator Clothing[1,2]

T. H. Lillie, R. E. Hampson, Y. A. Nishioka, and M. A. Hamilton

U.S. Air Force Occupational and Environmental Health Laboratory, Brooks AFB, TX 78235

A significant amount of pesticide residue can be removed from contaminated clothing with home laundering techniques (FINLEY et al. 1974). The majority of washing studies have been conducted with methyl parathion. Two washings in 60°C washwater with high alkaline detergent and bleach have been recommended for removing methyl parathion residues (FINLEY et al. 1977). The degree of methyl parathion removed can be increased by pre-rinsing the contaminated fabric for 2 min prior to washing (EASLEY et al. 1981). A trend toward increased residue removal with increased washwater temperature has been shown with other pesticides (LILLIE et al. 1981).

In this study, we compared the removal of various pesticides from 100% cotton fabric in 3 washwater temperatures with detergent, detergent and bleach, or nothing added to the wash. Physical properties of the fabric are reported elsewhere (LILLIE et al. 1981).

MATERIALS AND METHODS

Fabric Treatment and Washing Procedures

Insecticide preparations of 0.5% diazinon were prepared from 47.5% commercially formulated emulsifiable concentrate (EC), 0.5% chlorpyrifos from 22.4% EC, 1.0% chlordane from 71.5% EC, and 10 mg/ml Guthion^{R} from 99.8% wettable powder. A 21.9% oil formulation of bromacil was used to prepare a 5.0% solution. Deionized water was used as the diluent for all preparations. The preparations were applied to 5 x 5 cm cloth swatches in a manner previously described (LILLIE et al. 1981).

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[1]The opinions and assertions contained herein are those of the authors and are not to be construed as views, either official or unofficial, of the U.S. Air Force or the Department of Defense.

[2]Mention of a proprietary product in this paper does not constitute an endorsement of the product by the U.S. Air Force or the Department of Defense.

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The treated cloth swatches were allowed to air dry for 24 h before washing. Four replicates for each pesticide were washed together in a one-speed General Electric® washing machine (model no. WWA5600VBLWH) with detergent (50 g) (Table 1), detergent (50 g) plus bleach (5.25% sodium hypochlorite) (120 ml) or nothing added to the washwater. The water temperature was 30 (cold), 43 (warm) or 60°C (hot). After a 14 min wash in 30 liters of water followed by 2 rinses (35 min total time), the swatches were dried for 30 min in a General Electric gas dryer (model no. DDG5380VALWH). The swatches were then individually wrapped in aluminum foil and placed in refrigerated storage (5°C) prior to analysis. Four replicates for each pesticide were also prepared and analyzed without washing to establish a baseline for comparison.

TABLE 1

DETERGENT INGREDIENTS REPORTED ON CONTAINER LABEL

COMPONENT	%
Sodium Carbonate (washing soda)	38.0
Sodium Chloride	30.0
Ethoxylated Nonionic Surfactant	10.0
Sodium Metasilicate	6.1
Sodium Perborate	6.1
Moisture	5.4
Sodium Carboxymethylcellulose	2.7
Borax	2.0
Optical Brighteners	0.5
Perfume	0.2
No chlorine, enzymes, or phosphate	

Analytical Procedures

Each washed or unwashed swatch that was treated with Guthion was soaked for 30 min in 100 ml of benzene. All other swatches were soaked individually for the same duration in 100 ml of pesticide grade hexane. The extract was then analyzed by gas chromatography. An external reference standard of each pesticide was

used for all analyses. The type of detector was dependent upon the chemical structure of a given pesticide (Table 2). All procedures were in accordance with EPA guidelines (BONTOYAN 1976). A 5 µl injection volume was used on the gas chromatographic instruments.

TABLE 2

SUMMARY OF ANALYTICAL APPARATUS

Pesticide	Detector	Detection Limit (µg)	Column
Diazinon	Flame Photometric	10	3% OV-210 on 80/100 Gas Chrom Q
Chlordane	Electron Capture	0.2	3% OV-101 on 80/100 Gas Chrom Q
Chlorpyrifos	Electron Capture	0.02	4% SE-30 and 6% SP-2401 on 100/120 Supelco AW
Bromacil	Nitrogen/Phosphorus	200	0.5% Carbo Wax 20M on 100/120 Gas Chrom Q
Guthion	Nitrogen/Phosphorus	5	0.5% Carbo Wax 20M on 100/120 Gas Chrom Q

Statistical Tests

The amount of pesticide residue extracted from the cloth swatches after washing was compared with the amount extracted from the unwashed swatches to determine the effectiveness of the washing procedures. The data were analyzed using an analysis of variance (ANOVA) and Duncan's multiple range test (STEEL and TORRIE 1960). The ANOVA test included an analysis for temperature/additive interaction. Statistical significance for the ANOVA test was $p < 0.01$ and for the Duncan's test $p < 0.05$.

RESULTS AND DISCUSSION

A significant amount of pesticide residue was removed from the cloth swatches (Table 3) in all washing tests. The ANOVA test for temperature/additive interaction was significant. There was a trend toward increased pesticide residue removal

TABLE 3

AMOUNT OF PESTICIDE RESIDUE (mg ± standard error) REMAINING IN CLOTH SWATCHES AFTER WASHING AND THE PERCENTAGE OF RESIDUE REMOVED BY WASHING

Pesticide (Baseline*) Treatment	COLD WATER (30°C)		WARM WATER (43°C)		HOT WATER (60°C)	
	Residue	Removed	Residue	Removed	Residue	Removed
	mg	%	mg	%	mg	%
Chlorpyrifos (1.76 ± 0.12)						
Detergent	0.85 ± 0.03	52	0.55 ± 0.11	69	0.42 ± 0.02	77
Detergent and Bleach	0.72 ± 0.08	59	0.65 ± 0.05	63	0.57 ± 0.04	68
No Detergent or Bleach	0.69 ± 0.11	61	0.73 ± 0.15	58	0.81 ± 0.20	54
Diazinon (2.61 ± 0.38)						
Detergent	0.53 ± 0.04	80	0.41 ± 0.03	84	0.17 ± 0.03	93
Detergent and Bleach	0.57 ± 0.02	78	0.13 ± 0.01	95	0.11 ± 0.02	96
No Detergent or Bleach	0.41 ± 0.02	84	0.24 ± 0.04	91	0.24 ± 0.05	91
Chlordane (9.37 ± 0.65)						
Detergent	1.69 ± 0.27	82	1.51 ± 0.19	84	1.47 ± 0.57	84
Detergent and Bleach	2.98 ± 0.24	68	2.27 ± 0.45	76	2.76 ± 0.07	71
No Detergent or Bleach	3.34 ± 0.30	64	6.56 ± 1.31	30	5.18 ± 0.39	45

*Amount of pesticide residue (mg ± standard error) on unwashed cloth swatches.

with increased washwater temperature when detergent or detergent and bleach were added to the wash. When no wash additives were used, pesticide residue removal did not increase as the water temperature increased.

There was little difference between the results for the 3 wash treatments in a given water temperature when chlorpyrifos or diazinon treated swatches were washed (Table 3). For example, 78-84% of the diazinon residue was removed by washing in cold water. The difference was significant, however, when the results for a given treatment in different temperatures were compared. Significantly more chlorpyrifos was removed in the warm and hot water washes than in the cold water wash when detergent was used.

In contrast, the difference in chlordane removal as a result of washwater additive is apparent for a given water temperature (Table 3). The amount of chlordane removed when detergent was added to the wash was significantly greater in all temperatures when compared with the amount removed when nothing was added. More chlordane residue was removed when detergent alone was used than when detergent and bleach were used but the difference between these treatments was not significant in warm or hot water.

The use of detergent in washwater $\geq$60°C is recommended for removing chlorpyrifos and diazinon residues from applicator clothing. Diazinon removal may be improved slightly with the addition of bleach but the difference is not significant when compared with the use of detergent alone. Water temperature is less critical for chlordane removal. Pesticide applicators such as those involved with termite control which routinely apply chlordane, may choose to lower the temperature of their hot water heater to 43°C.

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