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Chlorpyrifos and Diazinon Detection on Surfaces in Dormitory Rooms

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Insecticides present on selected non-target surfaces in rooms have been ascertained by placing aluminum pie plates in several sites of rooms prior to insecticide application. Following insecticide application, plates were removed from rooms, their upper surfaces rinsed with solvent and the rinse analyzed for insecticide (Wright and Jackson, 1971, 1975, and 1976). There are no data relative to non-target sites, such as small areas on cabinet and refrigerator walls or table and counter tops, in insecticide-treated rooms being swiped (lightly rubbed) with an "insecticide-trapping material" and this material being analyzed to detect the presence of insecticide removed from the swiped area. Preliminary research (unpubl.) by the authors has indicated the utility of developing a standardized rub or swipe procedure, which could be used for detecting insecticides on surfaces in buildings. Reported herein are the results secured in testing the swipe procedure for insecticide detection in rooms treated with the insecticide. The procedure has the potential for becoming a standard insecticide detection protocol.

METHODS AND MATERIALS

Twelve rooms in a vacant three-story dormitory at North Carolina State University were used. Rooms contained one 6-drawer dresser, two student desks, two closets, and either two single beds hinged to form openings to an enclosed storage area beneath or a single metal bunk bed. The drawers of the dresser and desk were removed during application and left in this manner during the length of the test. Closet doors were open. Each room contained two windows, which remained closed during treatment, with shades lowered to the bottom of the window.

A personnel-type air sampler with polyurethene foam plug as the trapping agent was placed in each test room prior to insecticide application (Monitaire Sampler, Model S, manufactured by the Mine Safety Appliances Company, Pittsburgh, Pennsylvania 15208). Ambient air samples were collected for 2 h to determine any background levels for the insecticide using the technique by Leidy _et al._ (1982).

Chlorpyrifos (Dursban®) and diazinon were applied as emulsions or self-pressurized, aerosol-type crack and crevice sprays containing 0.5 or 1.0% concentrations. The emulsions, applied with a 3.8-L (1-gal) compressed air sprayer, were directed as a pin stream to the cracks and crevices (Multeejet nozzle, no. 1/8" T-5700, manufactured by Spraying Systems Company, Bellwood, Illinois 60104). Aerosol-type sprays were applied using the Whitmire PT System III (Aerosol-type pressurized spray with a liquified-gas propellent system formulated specifically for crack and crevice applications, supplied by the Whitmire Research Laboratories, Inc., Saint Louis, Missouri 63122). With the applicator tube tip placed in the cracks and crevices, the insecticides were applied to sites in the rooms usually inhabited by cockroaches. Each treatment was replicated three times.

Prior to treatment of the room, six pieces of stainless steel and six of formica (7.6 x 35.6 cm) were placed in separate rows on a table positioned in the center of the room. A rectangle (2.5 x 30.5 cm), to be used as a swipe area, was outlined in the center of each piece. After the rooms were treated, two successive swipe samples were taken from one surface of each type material. The swipes were taken from the outlined area in order to determine the effectiveness of one swiping vs. two swipings over one surface.

Swipes used to remove insecticide from the formica and stainless steel were made by placing a sterile cosmetic cotton ball in a clean shell vial. Ten ml of 2-propanol were placed in the vial with the cotton. The ball was allowed to become totally saturated with the alcohol. After saturation, the cotton ball was removed from the alcohol with sterile forceps, placed on the top inside of the vial, and squeezed with the forceps to remove a portion of the excess alcohol. After squeezing, the cotton ball was removed with the fingers, which were covered by a disposable sterile polyurethene glove. The swipe was drawn across the pre-marked surface, being careful not to squeeze out the alcohol. The swipe was then turned over and the surface again swiped. Next, the swipe was returned to the vial (Swipe 1). This swiping procedure was repeated with a second swipe (Swipe 2). Swipes were taken immediately after application, and at 1-, 3-, 7-, 14-, and 42-day intervals. The stainless steel and formica pieces were randomly assigned to the different day intervals. Also, prior to treatment two aluminum pie plates were placed in the room on the table. These were removed and analyzed for residue immediately after treatment and at one day.

Swipe samples were analyzed for the insecticide as follows. A cotton swipe was taken from the vial using sterile forceps. The swipe and 2-propanol were then placed in a Soxhlet thimble, which was extracted for 4 h with 200 ml ethyl acetate at 10 turnovers per hour. Following Soxhlet extraction the solvent was evaporated to 2 to 3 ml at 48°C under reduced pressure. The residue was transferred quantitatively into conical tubes with 1-3 ml and 3-2 ml fractions of ethyl acetate. The efficiency of the extraction was determined by adding known amounts of standards and comparing the extracts to equivalent amounts which had not been extracted. Gas chromatography was according to the method described by Wright and Leidy (1978). Pie plates were rinsed with hexane and the rinse analyzed for insecticide (Wright and Jackson 1971).

A completely randomized analysis of variance was performed to determine significant differences (1% level) in insecticide residues.

RESULTS AND DISCUSSION

Plates in the treated rooms contained more insecticide at Day 0 than Day 1 (Table 1). At Day 0 the plates in the 0.5% chlorpyrifos-treated rooms contained more insecticide than did plates in the 1.0% diazinon-treated rooms. At Day 1 there was no difference in insecticide recovered. The difference at Day 0 is probably explained by vapor pressures, chlorpyrifos (v.p. 1.87 x 10^{-5}mm Hg at 25°C) being about 10X less volatile than diazinon (v.p. 1.4 x 10^{-4}mm Hg at 20°) and thus diazinon could volatize at a greater rate and not be available to move as droplets onto the surfaces. There was no difference between application methods (aerosol-type sprays versus emulsion sprays). Earlier research (Wright and Jackson 1975) showed more diazinon and chlorpyrifos on plates in rooms treated with the emulsions than with the aerosol-type sprays. The reason for this variation is unknown; however, the plates were positioned at different heights (6' above the floor and on the floor in the earlier research versus table top in this study) and there were fewer replications in this research. Also, this condition may be explained by the fact that an unauthorized person entered the dormitory and turned on a window fan in the bathroom next to the three diazinon-emulsion treated rooms, initiating air currents which may have removed amounts of diazinon before it had time to settle on the test surfaces. The rooms treated with the aerosol-type sprays were away from the running fan, thus these sprays probably were not influenced by forced air currents.

Table 1. Insecticide (μg/cm^2) detected on pie plates present in rooms during treatment[a]

Days after treatment	1% Diazinon[b] A	1% Diazinon[b] S	0.5% Chlorpyrifos[b] A	0.5% Chlorpyrifos[b] S
0	.03 (± .009)	.02 (± .009)	.10 (± .045)	.10 (± .031)
1	ND	ND	.002 (±<.001)	.001 (±<.001)

[a]Mean for 3 replications with the s.d. in parenthesis. Significantly (1% level) more detected at Day 0 than Day 1 and chlorpyrifos than diazinon at Day 0.
[b]A = Aerosol-type pressurized spray applied into cracks and crevices and S = compressed air sprayer pin stream spray directed at cracks and crevices.

Table 2. Insecticide ($\mu g/cm^2$) present on formica and stainless steel non-target surfaces following their application in dormitory rooms[a].

Surface type	Application method	Swipe no.[b]	Days 0	1	3	7	14	42
			0.5% CHLORPYRIFOS					
FORMICA								
	SPRAYER	1	2.6 (1.9)	0.17 (0.01)	0.28 (0.27)	0.08 (0.02)	0.13 (0.01)	0.06 (0.05)
		2	0.83 (.08)	0.09 (0.03)	0.01 (0.09)	0.05 (0.01)	0.20 (0.06)	0.04 (0.03)
	AEROSOL	1	0.70 (0.09)	0.40 (0.02)	0.05 (0.02)	0.05 (0.0)	[c] -	[c] -
		2	0.30 (0.01)	0.06 (0.01)	0.04 (0.01)	0.05 (0.12)	[c] -	[c] -
STAINLESS STEEL								
	SPRAYER	1	1.30 (0.61)	0.25 (0.13)	0.12 (0.04)	0.08 (0.01)	0.16 (0.04)	0.0 (0.0)
		2	0.81 (0.30)	0.08 (0.01)	0.05 (0.17)	0.05 (0.01)	0.18 (0.03)	0.02 (0.02)
	AEROSOL	1	0.89 (0.26)	0.17 (0.04)	0.12 (0.10)	0.05 (0.01)	[c] -	[c] -
		2	0.43 (0.16)	0.07 (0.03)	0.02 (0.01)	0.0 (0.0)	[c] -	[c] -
			1.0% DIAZINON					
FORMICA								
	SPRAYER	1	0.54 (0.26)	0.32 (0.08)	0.43 (0.12)	0.24 (0.16)	0.18 (0.02)	0.64 (0.37)
		2	0.44 (0.10)	0.23 (0.05)	0.20 (0.05)	0.11 (0.04)	0.13 (0.02)	0.34 (0.31)
	AEROSOL	1	0.84 (0.21)	0.23 (0.02)	0.12 (0.03)	0.36 (0.07)	0.37 (0.01)	0.58 (0.08)
		2	0.59 (0.16)	0.12 (0.01)	0.07 (0.03)	0.30 (0.06)	[d] -	[d] -
STAINLESS STEEL								
	SPRAYER	1	0.37 (0.12)	0.49 (0.26)	0.24 (0.01)	0.22 (0.08)	0.18 (0.07)	0.32 (0.31)
		2	0.33 (0.22)	0.15 (0.03)	0.12 (0.02)	0.07 (0.02)	0.13 (0.05)	0.35 (0.35)
	AEROSOL	1	1.12 (0.46)	0.20 (0.06)	0.15 (0.03)	0.36 (0.07)	0.30 (0.16)	0.57 (0.05)
		2	0.44 (0.15)	0.10 (0.01)	0.05 (0.01)	0.29 (0.04)	[d] -	[d] -

[a]Mean for 3 replications with s.d. in parentheses. Significant difference (1% level) by time and Swipe 1 over Swipe 2 for sampling. No difference for type of surface, method of application or insecticide.
[b]Swipe 1 followed by Swipe 2 over the same area.
[c]Formica and stainless steel surfaces contaminated between Day 7 and 14 due to water vandalism. No further samplings available.
[d]Second swiping not taken.

Chlorpyrifos and diazinon were present on swipes through the 42-day test period (Table 2). Significantly lower amounts of chlorpyrifos and diazinon were removed from the formica and stainless steel surfaces at each successive sampling time after insecticide application. Sampling of surfaces was stopped at 42 days since the rooms were needed for summer activities; therefore, it is not known how much longer the insecticides might have been detected on the surfaces. Surface samplings in rooms where the 0.5% chlorpyrifos aerosol-type spray had been applied ceased after 7 days due to contamination of the test surfaces by water vandalism. Swipe 1 contained more insecticide than did Swipe 2. Earlier unpublished research showed that ca. 97% of the insecticides applied to the two surface types was removed with two successive swipings following application of a known amount of diazinon or chlorpyrifos to an area.

There were no differences at any given sampling interval for the amount detected by: (1) formica vs. stainless steel surfaces, (2) diazinon vs. chlorpyrifos spray or (3) application technique (the aerosol-type spray injected into voids vs. the emulsion spray applied with the compressed air sprayer and directed towards cracks and crevices), except as noted hereafter.

When insecticide amounts on the two surfaces are compared, one difference appears. There was more chlorpyrifos immediately after application on the test surfaces in the rooms where the emulsion spray was applied than in the rooms where the aerosol-type sprays were applied. This was probably due to the larger-sized particles in the emulsion settling more quickly than the smaller ones in the other type of formulation. This agrees with data secured by Wright and Jackson (1975). However, the reverse was true when the two formulations were compared in the diazinon-treated rooms. Again, this difference may be explained by the forced air movement near the diazinon emulsion treated rooms as discussed earlier. Wright and Jackson (1976) and Wright et al. (1981) showed that forced air movement via fans or air-conditioning caused higher levels of insecticides in the ambient air of structures than with no forced air. It has also been shown by the authors (1978) that with no forced air, higher amounts of insecticide are present in the ambient air of rooms immediately following aerosol-type spray application than with emulsion sprays and that at later air samplings the reverse is true, with more present in emulsion treated rooms.

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