

Dissipation of DDVP and Propoxur Following the Use of a Home Fogger: Implication for Safe Reentry

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The "home foggers," "indoor foggers," or "bug bombs" are pressurized insecticide canisters readily available to the public from supermarkets and hardware stores, for the control of household pests including fleas, flies, mosquitoes, roaches, ants, spiders and moths. The entire contents of the insecticidal aerosol are designed to rapidly dispense into a room without user intervention, aside from the initial setting and triggering. In California there are about 62 foggers registered by 20 firms for sale to home owners. Thirteen chemicals were listed as active ingredients formulated alone or in various combinations, with the highest content by weight of an active ingredient in any one product as follows: allethrans 0.6%, DDVP 0.5%, fenvalerate 0.2%, methoprene 0.15%, MGK 264 1.67%, propoxur 1.0%, pyrethrins 0.1%, phenothrins 0.4%, petroleum distillate 14.47%, piperonyl butoxide 2.5%, resmethrins 0.56%, ronnel 2.0%, and tetramethrins 0.2%.

Public concern has been expressed regarding the possible health hazards presented by the use of room foggers. There have been numerous reports to poison control centers in California concerning exposures and illnesses related to the release of these home foggers (Maddy and Smith 1984). DDVP seems to be the active ingredient most often associated with these reported exposures. Complaints of headaches and nausea upon reentry of mushroom houses fogged with DDVP have also been reported and investigated (Maddy et al. 1981a). DDVP, or dichlorvos (2,2-dichlorovinyl o,o-dimethyl phosphate, CAS #62-73-7), is an organophosphorus insecticide

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of moderate toxicity, with an acute oral LD₅₀ of 56-80 mg/kg (female rat), and a dermal LD₅₀ of 75-107 mg/kg (female rat) (Gaines 1960). It is highly volatile, with a vapor pressure of 1.2×10^{-2} mm Hg at 20° C. Propoxur (o-isopropoxyphenyl N-methyl carbamate, CAS #114-26-1), another common chemical component in foggers, is a moderately toxic N-methyl carbamate insecticide with an oral LD₅₀ of 86 mg/kg and a dermal LD₅₀ of >2400 mg/kg (Gaines 1969). It is considerably less volatile than DDVP (vp 1.0×10^{-2} mm Hg at 120° C). We selected a fogger with DDVP and propoxur for this study, and report their dissipations in air and horizontal surfaces following the release of the room fogger according to label directions. An aerosol propellant, methylene chloride, was also monitored in the air samples. We discuss study methodology and whether the 30-minute aeration period two hours after application (as prescribed on the label) is sufficient to allow safe reentry into the room.

MATERIALS AND METHODS

Tests were conducted in a two-bedroom apartment in Davis, California, USA on January 2 and 9, 1985. Rooms used were unoccupied, unfurnished, and located on the second floor. The measurements of the rooms are as follows: livingroom + kitchen (21'x13'x8'), master bedroom (13'x16'x8'), and guestroom (13'x12'x8'). The front door that leads into the kitchen and livingroom, the sliding door in the livingroom, and the windows and doors in the bedrooms provided openings for ventilation. A widely available fogger which contains 0.5% DDVP and 1.0% propoxur was used. It was used according to label directions: 1) set up at least one canister 6 oz (170 g) for each 6,000 cu ft (750 sq ft) room; 2) place can in a upright position; close all doors, windows and ventilators; release fog and leave building at once; and 3) after 2 hours, open all doors and windows and allow to air for 30 minutes. Six-oz canisters were used in the living room, the master bedroom, and guestroom. The cans were weighed before and after release to make sure that all chemicals were discharged. Individual cans were set on 1/4-folded newspapers in the middle of each room and twenty-six pieces of heavy-duty household aluminum-foil, each measuring 10x10 cm, were evenly distributed on the carpeted floor mid-way between the can and the walls. These aluminum foil pieces served

as collecting pads for pesticides deposited on horizontal surfaces. Two random samples (of aluminum foil) per room were taken pre-fog and at 15 min., 30 min., and 1, 2, 3, 4, 6, 8, 10, 12, 24, and 48 hours post-fog. Individual samples were placed in 8-ounce jars, tightly sealed and stored on ice until delivery to the laboratory for analyses of DDVP and propoxur residues within 24 hours. The empty pesticide containers and newspapers were removed from the rooms two hours after triggering.

Air samples were collected by drawing air through XAD-4 resin tubes with a MSA Fixt-Flo® Model 1 personnel air pump. Charcoal tubes were used for collecting methylene chloride. The tubes were connected to the pumps using 4-1/2 ft lengths of beverage grade polyethylene tubing; tube assemblies were supported upright such that air at the 5 ft breathing zone was sampled. Four pumps per room were placed on the floor; evenly spaced and mid-way between the fogger and the wall. At each sampling time two samples were taken and two other pumps were activated such that sampling was not interrupted. Air samples were collected at pretreatment for 15 minutes and for times (durations) after triggering at 0-15 min, 15-30 min, 30-60 min, 1-2 hr, 2-3 hr, 3-4 hr, 4-6 hr, 6-8 hr, 8-12 hr, 23-24 hr, and 47-48 hr. All air-flow was set at 1 liter/minute as calibrated before and after sampling using a Kurz® 540-S Flow Calibrator, which automatically compensates for temperature, barometric pressure, and relative humidity. Samples were capped with parafilm and placed in sealed glass jars and stored on ice until analysis within 24 hours. Analytical procedures for surface and air residues were as reported in Goh et al. (1986a, b) and Maddy et al. (1981a), respectively.

RESULTS AND DISCUSSION

Some of the variabilities reported in previous studies (Maddy et al. 1981, 1984) were minimized by conducting the test in an empty apartment, have adequate replication, providing uniform placement of the sampling pads and pumps, and turning heat and fan off, thus maintaining the room temperature at $15\pm5^{\circ}\text{C}$ and relative humidity of $75\pm5\%$. Under such conditions, the dissipation of DDVP in air was similar for both rooms as fitted by the regression shown in figure 1. The conditions were ideal as the immediate DDVP

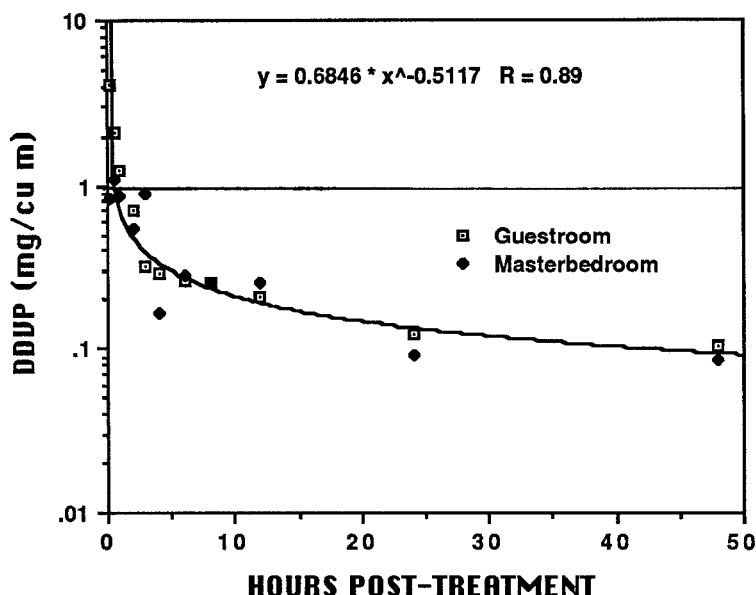


Figure 1. Regression for the dissipation of DDVP in air after the release of a 6 oz. can of room fogger in each room. Horizontal line at 1 mg/m³ is the permissible exposure level. Davis, CA., Jan 9, 1985.

level reached 4 mg/m³ as compared with the calculated maximum attainable level of 5.9 mg/m³, assuming perfect distribution. The air level of DDVP dropped below 1 mg/m³ after 60 minutes. This number is the exposure level established by the American Conference of Governmental Industrial Hygienists (ACGIH) as the threshold limit value (TLV) for an 8-hour workday and 40-hour workweek time weighted average (TWA). It is also adopted by the California Safety and Health Administration (CAL OSHA) as the permissible exposure level (PEL). There are however no reference levels established for prolonged, non-occupational exposure, such as in home use of a room fogger, to either DDVP, propoxur or methylene chloride. By extrapolating the TLV-TWA or PEL level to a 24-hour day/7-day week (i.e. reducing the level to 1/4) and adding a safety margin for infants and the elderly (i.e. reducing the level by a factor of 10), the exposure guideline estimated by Maddy et al. (1984b) was 25 µg/m³. With this estimate seven hours would have to elapse before unprotected reentry is permissible, approximating an earlier study by Maddy et al.

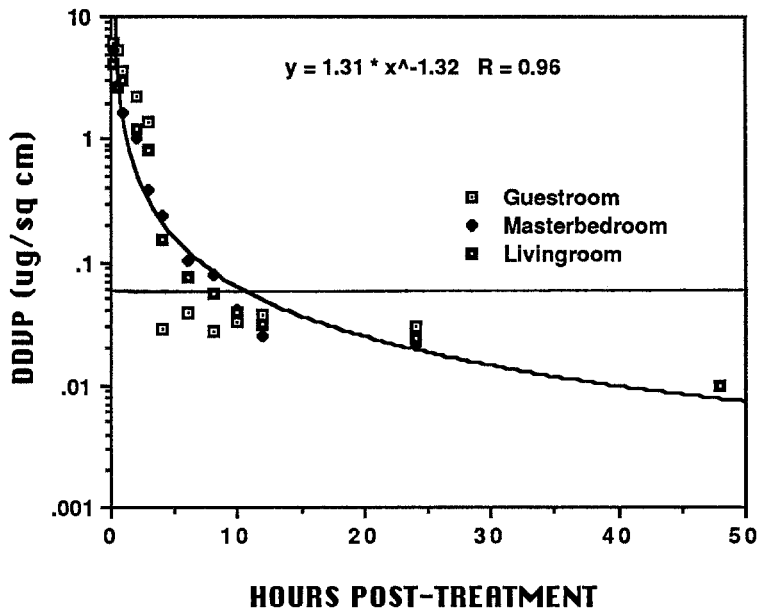


Figure 2. Regression for the dissipation of dislodgeable DDVP residue on horizontal surfaces as collected on aluminum foil and analyzed at various time intervals after the release of a room fogger for each room, Jan 2, 1985. Horizontal line at 0.06 $\mu\text{g}/\text{cm}^2$ is the estimated safe level.

(1981b) which showed that 10 hours might be necessary. Propoxur and methylene chloride were not detected at any time in the air samples; detection limits were 7 $\mu\text{g}/\text{m}^3$ and 400 $\mu\text{g}/\text{m}^3$ respectively. The results of DDVP on horizontal surfaces as monitored with the aluminum collecting pads were not significantly different ($p=0.01$) between the three rooms. Data were fitted with a regression line (fig. 2). Using the estimated safe level for the dislodgeable foliar residue for DDVP of 0.06 $\mu\text{g}/\text{cm}^2$ (Maddy 1985), it would seem that safe reentry level was not reached until 10 hours after triggering of the foggers. As shown in Fig. 3, the dissipation of propoxur varies consistently for each room, and a general trend was indicated by the fitted curve. Propoxur does not present significant hazard with reentry when used according to label directions. The level was well below the estimated safe level of 12 $\mu\text{g}/\text{cm}^2$ after 2 hours.

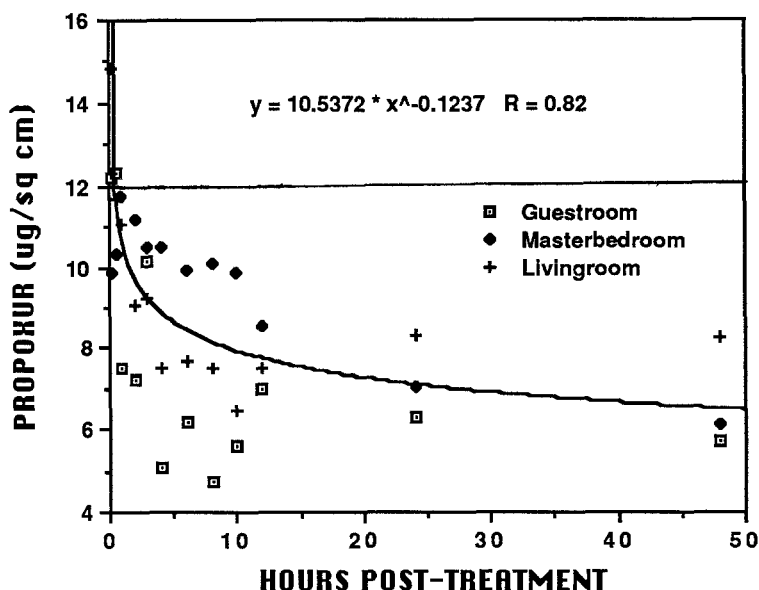


Figure 3. Dissipation of propoxur from horizontal surfaces as collected on aluminum foil and analyzed at specified time intervals after the release of a room fogger, Jan 2, 1985. The horizontal line at 12 $\mu\text{g}/\text{cm}^2$ indicates the estimated safe level.

The estimated safe levels discussed are dynamic and should be used with the following precautions: 1) they are extrapolated to men from studies on acute toxicity on laboratory animals; 2) these levels are subject to change as new data on the pesticide's toxicology, environmental fate and user exposure studies become available; 3) they are established for agricultural and industrial settings. Therefore under certain conditions as indicated in this and earlier tests (Maddy et al. 1981b), longer reentry period might be necessary in a home use situation. It might be necessary to wait for 10 hours before reentry after the use of a DDVP+propoxur fogger as indicated in this study. However, it is suggested that detailed data on use rate, use pattern, room conditions, exposure and biostatistics of occupants, and associated illnesses from illness reports or complaints from the use of room foggers should be further collected and analyzed.

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