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Chlorpyrifos in the Air and Soil of Houses Eight Years after Its Application for Termite Control

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Chlorpyrifos; Dursban®; (0,0-diethyl 0-(3,5,6-trichloro-2 pyridyl) phosphorothioate) has been used extensively for almost 25 years to control termites in buildings. Initial studies were conducted in 1984 to determine chlorpyrifos levels in the air of kitchens and bedrooms of houses where the soil under and around the houses had been treated with this insecticide for termite control. Data through 2 and 4 years showed no ambient air level above the National Academy of Sciences (NAS) proposed guideline level of 10 $\mu g/m^3$ (Wright et al 1988, 1991). Chlorpyrifos detected in the soil adjacent to the exterior and interior foundation walls for all houses at 4 years after treatment ranged from 0 to 1640 ppm and 0 to 1684 ppm (Wright et al 1991). No soil samples were taken prior to 4 years, therefore no comparison of chlorpyrifos levels with time was possible. This paper reports chlorpyrifos levels present in ambient air and treated soils 8 years after termiticide application.

MATERIALS AND METHODS

Air sampling and analysis of the samples were the same as reported by Wright et al (1988). Soil samples were collected and analyzed following techniques given by Wright et al (1991). Efficiency of the analytical methods for air and untreated soil samples was determined as reported by Wright et al (1991). An analytical standard of chlorpyrifos (100%) was secured from the Dow Chemical Co. (Midland, MI) and diluted to appropriate concentrations for quantitations. Varying amounts of chlorpyrifos (0.1 to 5.0 μg) were added to 15 blank adsorbent tubes to determine the efficiency of the analytical method and averaged 91.6%. In addition, 15 untreated soils were fortified at levels ranging from 5.0 to 1200 ppm and carried through the analytical procedure with the soil samples. Recoveries from the soil averaged 89.9%.

A self-contained, compact laboratory psychrometer (Vista Scientific Corp., Ivyland, PA) was used to measure the temperature and relative humidity in each room during air sampling.

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The Tukey HSD test, a test preferred when analyzing unequal replications (Wilkinson 1989), was used to analyze the data.

RESULTS AND DISCUSSION

Temperatures and relative humidities in rooms during air sampling ranged from 21 to 29°C and 55 to 78%, respectively.

Chlorpyrifos levels detected in the breathing zone, ambient air (90 cm from the floor) of kitchens and bedrooms 8 years after its application to houses for termite control are given in Table 1. Chlorpyrifos levels in the rooms ranged from <0.1 to 0.7 $\mu g/m^3$. When chlorpyrifos levels in the ambient air at 8 years were compared with those from earlier post application sampling times of 1, 2 and 4 years (Fig. 1) it is seen that the maximum level detected in any house and average level for all houses combined at 8 years were less than at any of the earlier sampling times. There were no differences in chlorpyrifos levels present in the air of houses built over sand rather than clay soils, by house construction type (slab, crawl or slab-crawl) or room type (kitchen or bedroom). At 4 years there was significantly (P=0.01) more chlorpyrifos present in the air of houses built over sand than over clay, with no significant differences in house construction or room types (Wright et al 1991).

Chlorpyrifos detected in the soil adjacent to the exterior and interior foundation walls for all houses at 8 years ranged from 0 to 396 ppm and 0 to 439 ppm, respectively (Table 1). There were no significant differences in chlorpyrifos levels detected from all houses constructed on sand versus all houses constructed on clay soils nor for all soils adjacent to the exterior versus those collected from interior foundation walls. At 4 and 8 year sampling times there was a wide range in chlorpyrifos levels in soils. Other researchers have reported similar variations (personal communications).

There was a general decrease in residues of chlorpyrifos in soil between 4 and 8 years from many of the houses. However, in several instances, data indicate the chlorpyrifos levels for a particular house site increased after 8 years compared to 4-year samples. Even though the quantities detected for a house were greater at 8 years, there would likely have been an actual overall decrease around the house, as would be the case if some of the sites sampled at 8 years initially had larger quantities of chlorpyrifos present than other sites which were sampled at 4 years. Therefore, it is more likely that chlorpyrifos levels actually decreased between 4 and 8 years after application. The findings indicate less of an overall decrease in chlorpyrifos along the inside foundation walls 4 and 8 years after application when compared to outside walls of houses with crawl spaces. This could be due to a more stable or constant environment when conditions were compared to those outside. Houses with the greater concentrations of chlorpyrifos around the exterior walls did not necessarily have the higher concentrations around the

Table 1. Mean concentration of chlorpyrifos detected in the ambient air and soil 8 years after its application for termite control in houses.

Type of soil and construction	No.	Chlorpyrifos detected							
		Ambient air ($\mu g/m^3$)[a]				Soil (ppm)[a,b]			
		K		B		O		I	
		Range	Avg	Range	Avg	Range	Avg	Range	Avg
Sand, Slab	3	<0.1-0.1	0.1±0.0	<0.1-0.7	0.3±0.3	3.0-14.8	7±5[c]	-	-
Sand, Crawl	3	0.1-0.2	0.1±0.1	0.1-0.5	0.3±0.2	1.9-61.3	22±28	4.6-439.2	281±19
Clay, Crawl	4	<0.1-0.5	0.2±0.2	<0.1-0.6	0.3±0.3	1.8-177.2	73±72	1.3-254.5	112±106
Clay, Slab-Crawl	4	<0.1-0.2	0.1±0.07	<0.1-0.1	0.1±0.0	179.7-396.4	295±101	2.6-132.0	69±63

[a]Mean ± standard error of 4 houses by each soil-construction type. K and B = kitchen and bedroom and O and I = outside and inside soil adjacent to the foundation wall, sampled respectively.
[b]Unable to sample soil under the slab of slab-constructed houses, soil samples taken around the exterior of slabs.
[c]Three replications, owner did not want air or soil samples taken.

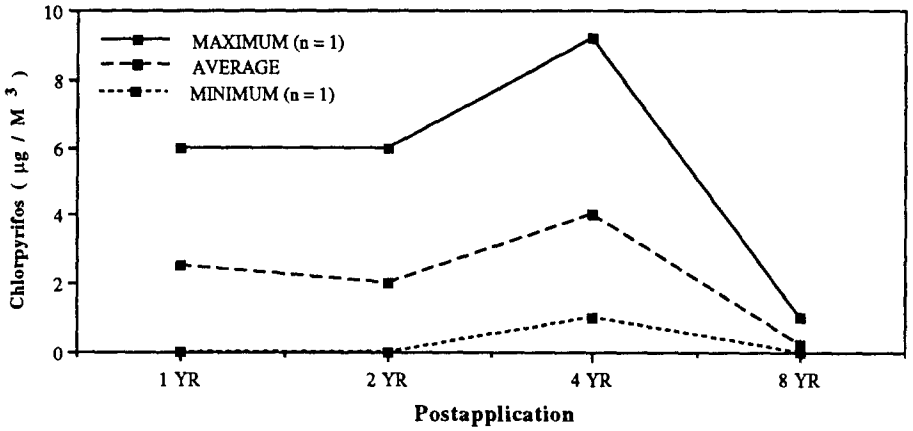

Figure 1. Maximum and minimum levels in air of houses after a 1% application to soil for termites (NAS Proposed Guideline: 10 $\mu g/m^3$)

interior walls. Some soil samples contained no detectable chlorpyrifos. We can only speculate that the random sampling process included areas where chlorpyrifos was not present or at undetectable trace levels. Several factors, such as a variation in the application rate and technique, sampling locations around the houses and site soil characteristics, might contribute to the extreme variation in detectable levels of chlorpyrifos. Such variation is cause for concern because termites may encounter areas with sublethal or inadequate chlorpyrifos levels along the foundation walls and readily enter a structure. These findings reveal the importance of applying the correct concentration and quantity based upon label recommendations and of recognizing structural factors in the building which might affect insecticide efficacy.

Acknowledgement. Use of trade names in this publication does not imply endorsement of the products named or criticism of similar ones not mentioned.

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