THE MOVEMENT OF DIAZINON RESIDUES INTO HOMES FOLLOWING THE APPLICATION OF A GRANULAR FORMULATION TO RESIDENTIAL LAWNS

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ABSTRACT

A pilot study was conducted to examine the movement of diazinon following applications of a granular formulation to residential lawns. The objectives included evaluating methods for collecting environmental samples and examining the transport and fate of diazinon from a source to the indoor living areas of homes. Although not discussed here, the study also emphasized the role of pet dogs as vehicles for the translocation of diazinon residues and potential human exposures.

Measures included the formulation, soil, particles from doormats, transferable residues from residential turf and indoor flooring, indoor air from living rooms and children's bedrooms, and vacuum dislodgeable dust. Samples were collected from six single family homes located in the mid-Atlantic region of the USA in the summer of 2001. Environmental samples were collected prior to the application and at days 1, 2, 4, and 8 following the application. Soil concentrations, an indicator of source strength, were highest immediately following the application and declined by an average of 51% by day 8. Polyurethane foam (PUF) roller samples collected from turf ranged from 0.1 to 970 ng/cm^2 over the study period. Particle-associated residues collected from doormats located at entryways into the home declined from day 1 to day 8 by an average of 75%.

Doormat concentrations demonstrate the movement of residues from the source towards the indoors of the homes. Indoor air concentrations reached maximal levels from 1 to 2 days following the application and declined over the remainder of the study. Indoor PUF roller measures showed little to no increase above background. Concentrations in vacuum dislodgeable dust were variable over time, but consistently above background concentrations.

Results demonstrate that both the physical translocation of particle-bound residues and the intrusion of volatilized diazinon contribute to indoor levels. Physical processes such as pet activity and foot traffic moved particle-bound residues to the entryway of the homes. Increased airborne concentrations demonstrate the intrusion of diazinon from the outdoor source. Elevated diazinon concentrations measured from vacuum dislodgeable dust suggests the movement and deposition of volatilized and/or particle-bound residues. In summary, applications to residential lawns resulted in an increase of diazinon above background concentrations in all homes. Lawn applications are a source for potential occupant exposures both on treated lawns and inside homes.

INTRODUCTION

Pesticide applications in and around homes result in the movement of residues away from the point of application onto untreated locations (Lewis, 2001; Mason and Stout, 2003). Pesticides move from their point of application and disperse into the environment according to their physical properties (vapor pressure, the composition of the formulation and partition coefficients, etc.). Environmental factors such as rates of indoor/outdoor air exchange, ambient temperatures and the relative humidity also influence transport processes. Physical processes such as foot traffic, indoor/outdoor occupant activity levels as well as pet activity (Morgan et al., 2001) may result in the intrusion of residues from exterior sources to indoor locations. Furthermore, residue movement is also influenced by the substrates to which applications are made, the type formulation, the location of the application, and the application technique.

Pesticides located indoors may be more persistent due to removal from the primary degrading factors found outdoors (photolysis, hydrolysis, and microbial degradation). Studies have shown (Lewis and Lee, 1976; Lewis and MacLeod, 1982) that pesticides found indoors persist sorbed onto surfaces and/or particles in "sinks" at concentrations from 10 to 100 times greater than those measured from out of doors.

Diazinon, (O,O-diethyl O-[2-isoprpyl-6-methyl pyrimidin-4-yl] phosphorothioate), CAS No. 333-41-5, is a broad spectrum organophosphate insecticide with an anticholinesterase mode of action. It has been marketed since 1954 to control a wide variety of home and garden insect pests. The US EPA estimated in 1989 that 6 million pounds of diazinon were applied to home and commercial turf. Applications to residential lawns are performed to control insect pests that include ants, crickets, grubs, ticks, fleas and others. Applicators typically disperse granulated formulation over lawns using manually operated mechanical devices.

Diazinon applied to turf grass was shown to have a half life of about 7 days (Kuhr and Tashiro, 1978) and in soil about 2 to 4 weeks (Bartsch, 1974; Branham and Wehner, 1985) and generally does not penetrate below 1.3 cm into the soil column. It may remain biologically active in the soil for up to 6 months and may persist for longer under reduced temperature, moisture, high alkalinity and lack of degrading microbes.

Diazinon concentrations collected following turf applications to 6 homes are reported to demonstrate the fate and transport of a granular application of diazinon Another objective of the investigation focused on the role of pet dogs as vehicles for transporting pesticide residues from an outdoor source to indoor locations.

Since the inception of this study diazinon registrations have been severely restricted. On December 5, 2000 the US EPA announced an agreement to phase out diazinon. Beginning in March 2001 the marketing of formulations registered for indoor use would cease and all lawn and turf uses would end by December 2003.

STUDY DESIGN

The study was conducted from April to August, 2001 within a 50 mile radius of Research Triangle Park, NC USA. Six participants residing in single family homes were recruited through advertising who had planned on performing granular application to their lawns. The homes were monitored outdoors and in two rooms indoor at intervals over 9 days prior to and following granular applications of diazinon (Table 1). The samples collected included the formulation, soil, PUF roller outdoors, door mats (located outdoors at the entryway to the home), indoor air from the family room and children's room HVS3 dust samples and PUF indoors (collected in the family room).

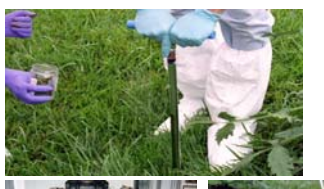


Table 1. The sample type and the day the sample was collected following the application.

	Sampling Interval				
Sample Type	**Pre**	**1**	**2**	**4**	**8**
Formulation		X			
Soil	X	X	X	X	X
PUF (Outdoor)	X	X	X	X	X
Doormat			X	X	X
Air (Indoor)[a]	X	X	X	X	X
PUF (Indoor)	X	X	X	X	X
HVS3 Dust	X		X	X	X

[a]Air monitors were placed in the room most commonly occupied by the participants and the child's bedroom.

RESULTS

Table 2. Application parameters for each home and the resulting application rate.

House	Total Amount of Formulation Applied (kg)	Theoretical a.i. Applied (g)	Area Treated (m^2)	Participant Application Rate (g/m^2)[a]
1	2.040	104	1022	0.10
2	5.310	268	465	0.58
3	9.120	454	139	3.26
4	12.700	640	648	0.98
5	9.070	454	1303	0.35
6	2.310	113	437	0.26

[a]Labeled rate of 2 lbs./ 1000 ft^2 (907 g/ 93 m^2) or 0.5 g/ m^2.

Figure 1. Mean diazinon residues measured from soil following granular applications to the turf of six homes. [a]

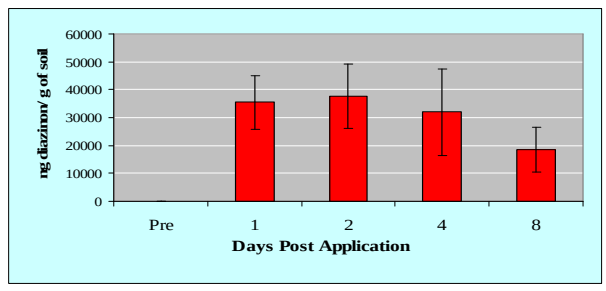
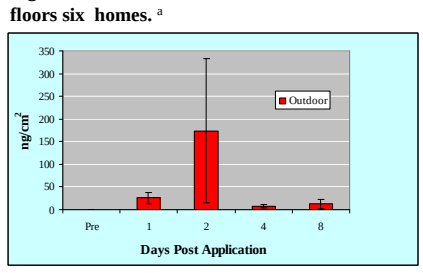


Figure 2. Mean transferable diazinon residues measured from residential turf and indoor floors six homes. [a]



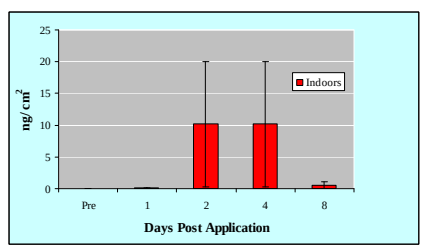


Figure 3. Mean dislodgeable residues measured from doormats of six homes. [a]

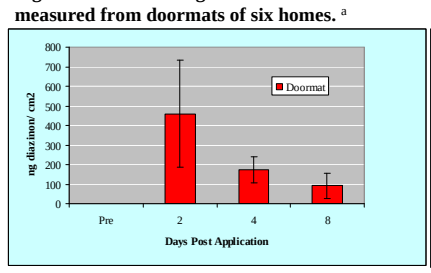
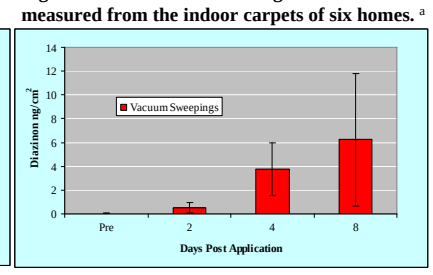
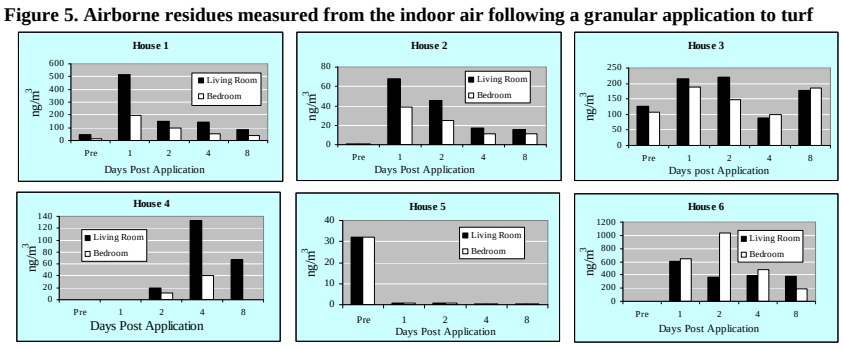


Figure 4. Mean vacuum dislodgeable diazinon residues measured from the indoor carpets of six homes. [a]



[a]Vertical bars represent ±standard error

Figure 5. Airborne residues measured from the indoor air following a granular application to turf



DISCUSSION

1 The applications performed by the study participants tended to be lower than labeled rates. However, findings demonstrate the potential for homeowner applicators to greatly exceed labeled rates.

2 Average soil concentrations exhibited a decay curve similar to findings reported in literature (soil half life of 7-14 days), and represented a source of diazinon throughout the study.

3 PUF roller measures collected from outdoor turf show that diazinon residues were transferable at low levels throughout the study. Indoor PUF roller measures show that diazinon intruded from the outdoors and was transferable at low levels. For both measures the highest transferable residues were collected at day 2 post application.

4 Residues collected from doormats show the movement from the source to the outdoor/indoor interface. Residues associated with particles were likely to physically translocate through the activities of the occupants and/or their pets.

5 Particles measured from doormats showed a declining temporal trend, while residues from vacuum dislodgeable particles (HVS3) exhibited an increasing temporal trend.

6 Airborne concentrations were variable between houses. Low air concentrations suggested that other factors were influencing infiltration of residues into the living area. Bedrooms tended to have lower levels of diazinon than rooms of highest occupant activity.

7 Diazinon has a vapor pressure of 1.4 X 10^{-4} (mm Hg at 20°C) and would be expected to volatilize and move as an airborne residue. Measures associated with particles suggest physical translocation into the homes.

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Disclaimer

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