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Project Summary

Simulation of Track-in of Lawn-Applied Pesticides from Turf to Home: Comparison of Dislodgeable Turf Residues with Carpet Dust and Carpet Surface Residues

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Microenvironmental transport of lawn-applied pesticides into the home via walking over treated turf (track-in) was measured five different times up to 1 week after application. Pesticides and application methods evaluated included spray application of the herbicide acids dicamba and 2,4-dichlorophenoxyacetic acid (2,4-D), granular application of the insecticide chlorpyrifos, and spray application of chlorpyrifos and the fungicide chlorothalonil. A new sampling tool, the Polyurethane Foam (PUF) Roller, was used to collect dislodgeable residues from both turf and carpeting. Replicate measurements of turf dislodgeable residues showed deviations of 2% to 60% percent from the mean, which is considered very good given the nonuniformity of a turf surface. Turf dislodgeable residues were approximately 0.2% of applied levels for nonvolatile pesticides and approximately 0.006% for volatile chlorpyrifos at 4 to 8 hours after application. The transfer of turf dislodgeable residues to carpet dust was 2.6 ± 0.8% (n=5); the transfer efficiency of turf dislodgeables to the carpet surface was 0.27 ± 0.08% (n=5). For herbicide acids, both carpet dust levels and carpet surface dislodgeable residue levels were highly correlated with turf dislodgeable residue levels.

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This Project Summary was developed by EPA's National Exposure Research Laboratory's Atmospheric Processes Research Division, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see project report ordering information at back).

Introduction

Agricultural use of pesticides has stimulated numerous studies of pesticide transport and translocation through plants, soil, water, and air. Although pesticide applications are designed for deposition onto a target surface (plant, soil, insect), studies have described spray drift, soil resuspension, phase redistribution, long-range transport, and deposition from air to water, soil, fog, and rain as micro and macroenvironmental transport mechanisms.

Some of the most frequently used agricultural pesticides include: 2,4-D (postemergence herbicide), pendimethalin (preemergence herbicide), diazinon and chlorpyrifos (insecticide). A recent survey of lawn care companies and retailers of residential lawn care products in the Columbus, OH, area showed that these agricultural pesticides are also the pesticides of choice for lawn care by professionals and homeowners in the Columbus area.

The same transport phenomena that occur for agricultural pesticides may also be expected for lawn-applied pesticides.

However, inadvertent deposition will not be limited to neighboring crops and turf but will include the indoor residential environment. One transport route from turf into the home that has not been investigated thoroughly, and may be important in the residential setting, is track-in on shoes and feet.

Numerous pesticides have been identified in house dust and indoor air. In some cases, the presence of insecticides (e.g. chlorpyrifos) can be ascribed to the indoor use of whole-room foggers and sprays. The presence of other pesticides indoors (e.g. chlordane, heptachlor) appears to be due to infiltration and migration into the home of materials that were originally applied to foundations. The presence of pesticides such as permethrin and carbaryl, which are often applied at sites distant from the house (e.g. garden), suggests that track-in of turf and soil residues may explain in part their presence indoors. Once these pesticides are brought indoors, carpeting, carpet dust, and home furnishings may become long-term sinks, as environmental weathering factors such as wind, rain, soil microbes, and sunlight are not available.

While pesticide formulations contain materials to increase adhesion to the target surface, a fraction of the formulation will be “dislodgeable”. Dislodgeable pesticide residues are typically measured to ascertain safe reentry times for workers or homeowners into pesticide-treated areas. Dislodgeable residues have been measured on turf, ornamental plants, and fruit, and in some cases the dislodgeable levels have been compared with subsequent dermal and urinary levels. In those studies, the collection of dislodgeable residues involved vigorous scrubbing of the treated vegetation. That approach to sample collection may not be representative of actual human contact with the vegetation.

Objective

The study described here was conducted to determine the temporal profile of dislodgeable turf residues of four commonly used pesticides (dicamba, 2,4-D, chlorpyrifos, and chlorothalonil), and determine whether these materials can be tracked into a home with normal walking and entry into the home. This study was designed to evaluate a new dislodgeable residue collection method and determine the comparability of dislodgeable turf residue levels with levels that are tracked into the home under the conditions used here.

Results

For the herbicide acids and chlorothalonil, dislodgeable turf residues increased slightly between 4 hours and 8 hours after application, possibly due to increased drying of the applied material. For chlorpyrifos, dislodgeable turf residues were lower at 8 hours relative to 4 hours, presumably because of lower volatilization rates at that time of day, i.e. evening.

For the herbicide acids, the reduction in dislodgeable turf residues between 8 hours and 1 day after application was approximately 50%. While some of the decrease between 8 hours and 1 day measurements may be attributable to rain, decreasing amounts of dislodgeable turf residues have been measured over time without rain or irrigation. A second phenomenon due to rain was observed that runs counter to the wash-off effect observed with the initial rain. In particular, after two additional episodes of rain, slight increases in dislodgeable residue were observed for all analytes in subsequent sampling. Studies of pesticide dissipation from soil have indicated that water increases dissipation by displacement of the analyte from the soil surface, and this effect may be occurring here, as well as, on turf.

For both chlorpyrifos and chlorothalonil, turf dislodgeable residues decreased over the 14-day sampling period, although the reduction in turf residues was greater for the more volatile chlorpyrifos. Despite volatilization losses of chlorpyrifos, trace residues were collected from the turf for 14 days. Track-in of nonvolatile chlorothalonil remained constant over the 5 day track-in test period.

The reproducibility of the PUF Roller method for collection of dislodgeable residues was quite high. Analyte amounts collected from the same turf plot showed good reproducibility (1% to 25% deviation from the mean for duplicate samples) given the expected variability of collection via contact with a nonuniform surface. Deviation from the mean for duplicate samples from chlorpyrifos and chlorothalonil plots was 3% to 70%. The somewhat greater variability in duplicate samples from the granular-applied chlorpyrifos plot may reflect differences in the extent to which chlorpyrifos was washed into the soil during the initial plot irrigation (used only for granular application).

The data for 2,4-D resulting from simulated track-in from turf to home demonstrate that both the dislodgeable carpet residues and the carpet dust residues track the profile of the dislodgeable turf residues. The entry-way mats reduced dislodgeable carpet surface residues by approximately 25% at 4 hours, 8 hours, and 1 day after application. With volatile chlorpyrifos, the entry-mats appeared to serve as a pool or sink from which residues were carried onto the carpeting. Because of this effect, the weighted sum of the carpet surface residue and the carpet dust residue was the quantity correlated with turf dislodgeable residue levels (r^2=0.86 for the granular chlorpyrifos application).

Turf dislodgeable chlorothalonil levels were not as closely correlated (r^2=0.43) with carpet dust levels. The PUF Roller turf dislodgeable residues decreased over time, but human track-in appeared constant.

Conclusions and Recommendations

This study demonstrated that track-in on shoes is a reasonable mechanism by which lawn-applied pesticides are carried into the home. Environmental weathering played an important role in reducing turf dislodgeable residues. Rain effectively removed turf herbicide acid residues; in this study, dislodgeable turf residues after the rain were 1% to 5% of those found at 4 to 8 hours after application. Chlorpyrifos turf residues were lost primarily through vaporization. Despite these losses of turf residues, track-in of residues was measured at 5 to 6 days after application. These studies suggested that limited contact with treated turf until rain has occurred or several days have passed, together with the use of entry mats, may decrease the amount of lawn pesticides tracked into the home.

This study also demonstrated the utility of a simple mechanical device for collection of turf dislodgeable residues. In several cases, turf dislodgeable residue levels were highly correlated with the dust-bound residues and carpet surface dislodgeable residues generated under these simulation conditions.

Based on the results obtained in this study, it is recommended that additional studies be conducted to evaluate the relative importance of different transport mechanisms from turf to the indoor environment.

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The complete report, entitled "Simulation of Track-in of Lawn-Applied Pesticides from Turf to Home: Comparison of Dislodgeable Turf Residues with Carpet Dust and Carpet Surface Residues," (Order No. PB98-103120; Cost: $25.00, subject to change) will be available only from:
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