Managing Pesticide Exposure from Treated Turf

J. Marshall Clark and Jeffery Doherty
University of Massachusetts

Objectives:

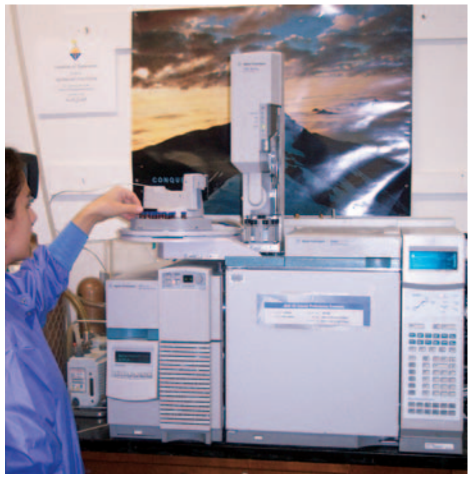
1. Evaluate management practices that reduce the potential for golfer exposure to airborne and dislodgeable foliar residues of turfgrass pesticides.
2. Examine the relationship between dislodgeable foliar and airborne residues and actual golfer exposure, and develop an accurate exposure model using experimentally determined pesticide transfer and penetration factors.

Start Date: 2004
Project Duration: three years
Total Funding: $75,000

This study seeks the best management practices that reduce the potential for golfer exposure to turfgrass pesticides. Golfer exposure occurs primarily through the skin (dermal) and inhalation of airborne pesticides following application to turfgrass. What happens to the pesticide after it is applied largely determines how much of it is available for potential human exposure. We have analyzed pesticide residues in the air and on turfgrass (dislodgeable foliar residues, DFR) in over 30 pesticide applications using various management strategies with either chlorpyrifos, carbaryl, cyfluthrin, chlorothalonil, or 2,4-D.

To determine exactly how much of these environmental residues actually transfer to golfers during a round of golf, we measured exposure to volunteer golfers using dosimetry (measuring pesticide residues on full body cotton suits and personal air samplers) and biomonitoring (measuring urinary metabolites). This work was done in cooperation with the New England Regional Turfgrass Foundation. Dosimetry and biomonitoring, together with concurrently collected dislodgeable foliar and airborne residue data, provides a unique database on golfer exposure and has allowed us to develop a golfer exposure model.

The central predictor of exposure in the model is the transfer factor (TF), which is ratio between the pesticide residues measured in the environment versus the amount that actually ends up transferring to the golfer (as measured by dosimetry). By combining information previously collected on chlorpyrifos, cyfluthrin, and carbaryl (with post-application irrigation), along with last season's



Analyses were carried out at the Massachusetts Pesticide Analysis Laboratory at the University of Massachusetts at Amherst.

2,4-D data and this season's chlorothalonil and cyfluthrin data (without post-application irrigation) and a subsequent data set for imidacloprid (summer, 2006), we will validate our golfer exposure model and amend it for use with a wide range of pesticides that vary in their physical and chemical properties.

Regulators and health professionals now consider biomonitoring data the "gold-standard" for measuring pesticide exposure, and we have validated this approach using our TF model for chlorpyrifos, carbaryl, and cyfluthrin. Biomonitoring results for 2,4-D and chlorothalonil have not yet been evaluated. This season (2005), we determined exposure in 24 rounds of golf following application of chlorothalonil and cyfluthrin without post-application irrigation. Preliminary results indicate an approximately 85% reduction in cyfluthrin exposure when ½-inch post-application irrigation is employed versus no post-application irrigation.

The hazard associated with a given exposure is evaluated using the hazard quotient (HQ), which is determined by dividing the dose received by the US EPA reference dose (R_{fd}). HQs less than or equal to 1.0 indicate that the exposure resulted in a pesticide dose at which adverse effects are unlikely, even if that dose is received every day over an individuals lifetime. A HQ greater than 1.0 does not necessarily infer the exposure will cause adverse effects, but rather that the absence of adverse effects is less certain.

To date, all HQs determined for chlorpyrifos, carbaryl, and cyfluthrin have been significantly below 1.0, indicating safe exposure levels. A TF model and subsequent HQ calculations for our recent experiments with 2,4-D and chlorothalonil have not yet been completed. However, experimentally derived TFs from our previous research range from a low of 1600 (carbaryl) to a high of 6,300 (chlorpyrifos). Using the worst case transfer factor (6,300) derived from our chlorpyrifos studies, a preliminary HQ for 2,4-D can be calculated as 0.16, which again is less than 1.0, indicating a wide margin of safety. Preliminary transfer factors have also been calculated for chlorothalonil (1162) and cyfluthrin (2893), and result in HQs of < 0.01.

Summary Points

- Researchers recently evaluated exposure in 48 rounds of golf following the application of chlorothalonil, cyfluthrin, and 2,4-D, and are combining this information with previous experiments on chlorpyrifos and carbaryl to improve a golfer exposure model.
- This newly developed model should accurately predict golfer exposure based solely on the analysis of environmental residues.
- Preliminary hazard quotients calculated for 2,4-D, chlorothalonil, and cyfluthrin (without post-application irrigation) are all less than 1.0. These results must still be validated using biomonitoring results.