Managing Pesticide Exposure from Treated Turf

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Objectives:

1. Examine the relationship between dislodgeable foliar residues (DFRs), airborne residues, and actual golfer exposure to develop an accurate exposure model using experimentally determined transfer and penetration factors.
2. Determine the validity of this model for pesticides with a wide range of physical and chemical properties.

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

This study seeks to determine actual levels of pesticide exposure to golfers following application of turfgrass pesticides. A major deliverable of this research is to develop a model for use by the turf industry and regulatory agencies that accurately predicts golfer exposure using easily collected environmental residue data. Dermal exposure and inhalation of airborne pesticide residues are the primary routes by which golfers are exposed to turfgrass pesticides following application.

The fate of pesticides after application largely determines how much of it is available for potential human exposure. This is influenced by many factors including post-application irrigation, application rate and strategies such as partial course application, as well as the physicochemical properties such as water solubility and volatility of the pesticide itself. To understand these factors, we have analyzed pesticide residues in the air and on turfgrass (dislodgeable foliar residues, DFRs) in over 35 pesticide applications using either chlorpyrifos, carbaryl, cyfluthrin, chlorothalonil, 2,4-D, MCPP-p, dicamba, and imidacloprid.

To determine precisely how much of these environmental residues were actually transferred 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). Regulators and health professionals now consider biomonitoring data the "gold-standard" for measuring pesticide exposure, and we have used this to validate our TF model for chlorpyrifos, carbaryl, and cyfluthrin. Biomonitoring results for 2,4-D, chlorothalonil and imidacloprid have not yet been evaluated. This season (2006), we determined exposure in 24 rounds of golf following application of imidacloprid with post-application irrigation. With the empirically-derived TF model, pesticide exposure, referred to as dose, can be predicted solely using environmental residues (airborne and DFRs).

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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 (Rfd). HQs less than or equal to 1.0 indicate that the exposure resulted in a pesticide dose at which adverse effects are unlikely. 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, cyfluthrin, 2,4-D and chlorothalonil have been 20- to 300-fold below 1.0, indicating safe exposure levels using the EPA Hazard Quotient criteria. A TF model and subsequent HQ calculations for our recent experiment with imidacloprid have not yet been completed. However, experimentally derived TFs from our previous research range from a low of 570 (2,4-D) to a high of 6,300 (chlorpyrifos). Transfer factors have also been calculated for chlorothalonil (600) and cyfluthrin (580), resulting in HQs of < 0.01.

We hope to group pesticides by their physical and chemical properties and develop golfer-specific TFs for each group, allowing us to establish exposure to a wide-range of pesticides based solely on the collection of environmental residue data. Not all pesticides are amenable to biomonitoring. Some pesticides do not possess a good urinary metabolite, or the pharmacokinetics (absorption, distribution, metabolism and excretion) of the compound may not be worked out. In these cases the TF model will still allows us to calculate a hazard quotient in a meaningful fashion.

Summary Points

- Researchers have evaluated exposure in 72 rounds of golf following the application of chlorothalonil, cyfluthrin, 2,4-D, MCPP-p, dicamba, and imidacloprid and are combining this information with the results of previous experiments on chlorpyrifos, cyfluthrin, 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 (DFRs and airborne residues).
- Hazard quotients calculated for 2,4-D, chlorothaloni,l and cyfluthrin (without post application irrigation) are all less than 1.0. These conclusions must still be validated using our biomonitoring results.