# *Best Management of Post-Application Irrigation on Turfgrass to Minimize Exposure to Volatile and Dislodgeable Foliar Pesticide Residues and Their Breakdown Products*

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**Objectives:**

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

**Start Date:** 2000
**Project Duration:** 3 years
**Total Funding**: $74,867

Accurate assessment of pesticide exposure to golfers requires knowledge of the availability of pesticide residues following application, transfer and absorption dynamics of these residues, as well as major routes of entry into the body. Our past research has included using dislodgeable foliar and volatile pesticide residues to estimate pesticide exposure to golfers. The research has established that there are volatile and dislodgeable foliar residues available for golfer exposure, and that not all of these exposures can be deemed safe using the USEPA Hazard Quotient (HQ) criteria.

We are currently evaluating the optimal use of post-application irrigation, re-entry intervals (e.g., evening pesticide applications), application of less toxic pesticides, and application strategies that result in less than full coverage (e.g., tees and greens only) to minimize exposure.

We have also concurrently evaluated exposure in over 100 rounds of golf over a three-year period following the application of three major insecticides, chlorpyrifos (Lorsban), cyfluthrin (Tempo) and carbaryl (Sevin) in cooperation with the USDA and the New England Turfgrass Foundation. This part of the project emphasizes dosimetry (measuring pesticide residues on full body cotton suits and personal air samplers) and biomonitoring (measuring urinary metabolites) to determine transfer and penetration factors. The direct and simultaneous determination of dosimetry and biomonitoring data provides a novel and complete database on how much pesticide is actually transferred to and absorbed by a individual during a round of golf.

This exposure data, together with dislodgeable and volatile residue data, has allowed us to develop a new golfer exposure model. Using the total pesticide dose derived from biomonitoring data, this model can be used to accurately predict golfer exposure based solely on dislodgeable foliar residues. With this information, a simple cheesecloth wipe sample from the grass surface is sufficient to realistically predict exposure in most situations.

*Research at the University of Massachusetts found that exposure estimates using biomonitoring data are 3-15-fold less than previous estimates using volatile and dislodgeable foliar residue data.*

Exposure estimates derived from these methods are 3 - 15 times less than previous estimates using volatile and dislodgeable foliar residue data. We have also replaced the "cheesecloth wipe" method for measuring dislodgeable foliar residues with the EPA recommended California Roller method. This new method consistently measures about 50% less pesticide residues available for transfer to golfers, further reducing total exposure estimates.

Dermal pesticide exposure has been found to be the most significant route of exposure to golfers (> 92 %) for all pesticides studied. However, dislodgeable residues rapidly decline over the first hour "drying-in" period and the potential for dermal exposure is dramatically reduced following a one-hour post-application and irrigation interval. The lower legs and hands are the most vulnerable routes of exposure.

Exposure estimates based a one-hour re-entry interval following full-course and full-rate applications of chlorpyrifos and cyfluthrin are substantially below USEPA HQ and Acceptable Daily Intake (ADI) values, indicating safe exposures. Additionally, there was an 83-92% reduction in the amount of chlorpyrifos absorbed following application to only tees and greens.

These encouraging results show that operational practices such as reentry intervals, reduced application area, and use of less toxic pesticides, do attenuate exposure and hazard. We are now in the process of completing the carbaryl exposure model. Planned experiments include evaluating exposure to golfers playing the morning following an evening pesticide application, as well as evaluating additional pesticides, including bifenthrin, imidacloprid, and chlorothalonil.

## Summary Points

- Exposure estimates using biomonitroing data are 3-15-fold less than previous estimates using volatile and dislodgeable foliar residue data.
- Several management practices, including the use of post-application irrigation, enforcement of a one-hour re-entry period, and partial course applications can significantly attenuate exposure.