Development of a Layered Model to Predict Pesticide Transport in Turfgrass Thatch

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Objectives:

1. To develop a two-phase layered pesticide transport model which considers equilibrium or non-equilibrium transport within each layer and uses appropriate pesticide adsorption coefficients for each layer.
2. To evaluate the use of the model for two of the pesticides used in a previously funded USGA study.
3. To evaluate the effectiveness of the model to predict pesticide transport compared to commonly used pesticide transport models such as PRZM2 or GLEAMS.

Start Date: 1998
Project Duration: 2 years
Total Funding: $49,880

Modeling non-equilibrium pesticide transport requires at least two additional transport parameters beyond that needed to estimate pesticide transport using a linear- equilibrium approach. These parameters are usually obtained from curve fitting procedures involving field tracer and pesticide leachate data or from sorption studies specifically designed to investigate non-equilibrium adsorption.

When transport parameters are obtained from field data, a least sum-of-squares optimization procedure is generally used to estimate the required transport parameters. Incorporating sub-routines that estimate non-equilibrium field transport parameters from least sum-of-squares optimization procedures is complex. In addition, formulating a model that uses this approach inevitably elevates the complexity of model to a level where the end user of the model needs to have considerable expertise in porous media solute transport processes.

Water in porous media moves in response to a hydraulic gradient at a rate dependent upon the hydraulic conductivity of the soil. The latter is a rate parameter used in mechanistic transport models used to calculate instantaneous water movement in soil. A popular approach used to simplify water movement in many models is to predict water movement based on differences in the water content of soil layers. In these models, downward water movement in a layer of soil may be specified to occur only when the water content of a soil layer exceeds a specified value such as field capacity. Models that use capacity factors to simplify water and solute transport are called functional models. A primary advantage of these models is that the models require less data input and computer expertise to perform transport simulations than models that use rate-based equations.

We are in the process of constructing a functional transport model that considers non-equilibrium sorption of pesticides to thatch and soil. The model partitions thatch and soil water into mobile and immobile phases and considers time-dependent pesticide sorption using two-site sorption kinetics. A "tipping bucket" methodology will be used to simulate pesticide transport in the thatch and soil layers of the model.

A secondary objective of this project is to compare the predictive transport of pesticides obtained using PRZM2 and GLEAMS models with predictions obtained from the two-phase model being developed. A preliminary comparison of the predictive capabilities of PRZM2 and GLEAMS was completed this year. Carbaryl and 2,4-D leachate data collected from previously conducted laboratory column studies were used to evaluate the pesticide transport predictive capabilities of the two models. The columns were 12 to 15 cm in length and contained soil only or soil plus a 2 to 3 cm surface layer of thatch.

PRZM2 and GLEAMS model simulations were conducted by evaluating pesticide leaching through a bare-layered soil devoid of a turfgrass canopy. The columns containing a surface layer of thatch were characterized in model simulations by using the actual measured thatch layer values as the input parameters for the column surface layer.

The presence of thatch in turfgrass systems requires that pesticide leaching and runoff models be adjusted to account for the ability of thatch to adsorb chemicals.

The GLEAMS model underestimated observed pesticide leachate losses in the columns containing a surface layer of thatch by 82%. This difference was slightly higher, but not statistically different, from the amount observed in the soil columns devoid of the thatch layer (69%). PRZM2 always overestimated pesticide leaching in the soil columns devoid of the thatch layer. The presence of thatch had no consistent effect on PRZM2 model performance. The performance of PRZM2 and GLEAMS will be compared with functional two-phase model currently under development.

Summary Points

- GLEAMS model underestimated pesticide leaching in every column examined.
- The PRZM2 model always overestimated pesticide leaching in the soil columns devoid of the thatch layer. Same result was obtained regardless of the transport option used to predict the PRZM model solute transport.
- The presence of thatch had no consistent effect on PRZM2 model performance.