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 with in each layer and the use of appropriate pesticide adsorption coefficients for each layer.*
2. *To evaluate the use of the model for two of the pesticides used in the previously funded USGA study.*
3. *To evaluate the effectiveness of the model to predict pesticide transport in comparison to commonly used pesticide transport models such as PRZM2 or GLEAMS.*

Mathematical models are often used to estimate potential pesticide transport before management strategies are implemented. Most agricultural pesticide transport models used to predict the transport of pesticides applied to turf either neglect the existence of thatch or average the carbon content of the thatch layer into the organic carbon content of the soil. Because of the high organic matter content of thatch this media has the potential to retain surface applied pesticides prior to their release to the less adsorptive soil layer. In highly porous media such as thatch, however, pesticide equilibrium is rarely achieved. Most regulatory agencies and environmental consulting firms use pesticide transport models based on linear equilibrium assumptions. Previous column studies conducted in our laboratory have shown that thatch has a significant effect on pesticide transport and that use of a two-site non-equilibrium model provides superior predictions of pesticide transport. Development of a model that considers non-equilibrium transport within thatch and soil should result in improved predictions of pesticide transport within turf. A problem with creating such a model, is how to address pesticide transport in field situations where it is difficult to estimate transport parameters.

We are currently in the early stages of developing a two phase model which considers equilibrium or non-equilibrium transport within a soil containing a surface layer of thatch. An extensive examination of existing pesticide transport models has been conducted to review the various numerical techniques used to estimate pesticide transport and to determine which techniques are best suited for adoption in predicting pesticide transport in turfgrass. Although models such as the Pesticide Root Zone Model (PRZM2), the Groundwater Loading Effects of Agricultural Management Systems (GLEAMS) model, and the Chemical Movement in Layered Soils (CMLS) models are commonly used by agencies such as the Environmental Protection Agency and the USDA

Agricultural Research Service, these models do not consider non-equilibrium pesticide transport.

Two available models, which do consider non-equilibrium transport, are the Root Zone Water Quality Model (RZWQM) and the HYDRUS model. Although these two models result in pesticide transport for non- equilibrium conditions, the numerical methods used for describing solute transport differ. A disadvantage of this approach is that all soil layer thickness must be an integer number and the first horizon must be equal or greater than 2 cm in thickness. Thatch layer thickness is frequently less than 2 cm. We are presently evaluating methods by which we might modify the partial displacement and mixing numerical techniques to more accurately address the retentive contributions of a thin thatch layer.

The HYDRUS model is a finite element model for simulating the multi-dimensional movement of water, heat, and multiple solutes in variety-saturated media. The model implements a Marquardt-Levenberg (i.e., least sum of squares) type parameter estimation procedure for inverse estimation of selected soil hydraulic and/or solute transport and reaction parameters from measured transient or steady-state flow and/or transport data. The procedure permits several unknown field parameters to be estimated from observed water contents, pressure heads, concentrations, and/or instantaneous or cumulative boundary fluxes (e.g., infiltration or outflow data). Although the numerical techniques appear attractive, the formulation of mesh grids is felt to generally be beyond the computational capabilities of most end users of the proposed model. We are studying the difficulties of porting similar numerical techniques in a one-dimensional finite difference approach.