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

University of Maryland

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Start Date: 1998
Number of Years: 2
Total Funding: $49,880

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.*

Pesticides applied to mature turf move into the soil only after being washed off foliage and move through turfgrass thatch. Any attempt to predict the movement of pesticides applied to turf requires that the retention characteristics of the pesticide to foliage and thatch be known.

In 1997 and 1998, a series of sorption and transport studies were conducted to characterize the movement of carbaryl in soils containing a surface layer of turfgrass thatch. The sorption studies were conducted using a device called a mechanical vacuum extractor. This device precisely controls the rate at which a solution moves through a column of porous media.

The adsorption and desorption properties of a 3½ year old, 2.3 cm thick *SOUTHSHORE* creeping bentgrass thatch, and a 6 year old, 3.4 cm thick *MEYER* zoysiagrass thatch were compared with the soil residing below each thatch layer.

The adsorption kinetics of carbaryl to thatch and soil were similar. Sorption equilibrium was achieved within 4 hours in all media. The thatch from both turfgrass species had much higher carbaryl adsorption capacities than the underlying soil. There was, however, no difference in the adsorptive capacities of the two turfgrass species thatch. The normalized sorption coefficients of the four media were similar suggesting that differences in the carbaryl sorptive capacities of thatch and soil were solely due to differences in the organic carbon content of the media.

Desorption losses were evaluated by subjecting columns of thatch or soil to three successive leaching events. The leaching events took place after allowing carbaryl to adsorb to the thatch or soil for 24 hours. The amount of carbaryl detected in the leachate was used to determine the proportion of carbaryl that was desorbed from the sample. Carbaryl retention in soil was much lower than in thatch during the first leaching event. By the end of the third leaching event, there was little difference in the proportion of carbaryl retained in the bentgrass thatch and soil. In contrast, zoysiagrass thatch always retained a greater proportion of carbaryl than the underlying soil. This suggests that carbaryl is more tightly bound to zoysiagrass thatch than to the underlying soil (Figure 8).

Undisturbed columns of soil, or soil plus a surface layer of thatch, were used to determine the effect of thatch on the carbaryl transport in soil. Columns having a surface layer of zoysiagrass thatch were more effective in reducing carbaryl transport than columns having a surface layer of creeping bentgrass thatch. Visual examination of the bentgrass site columns revealed extensive earthworm burrowing. The channels present in these columns likely reduced the effectiveness of bentgrass thatch to inhibit carbaryl transport.

Bromide and carbaryl breakthrough curves obtained from the transport study were used to evaluate the performance of the linear equilibrium (LEM) and the two-site non-equilibrium (2SNE) models to predict carbaryl transport. The latter model uses a non-equilibrium form of the convective-dispersion equation to predict solute movement in porous media while the former uses a linear equilibrium form of the equation to predict solute movement. The carbaryl breakthrough curve (BTC) data were also used to compare the use of column

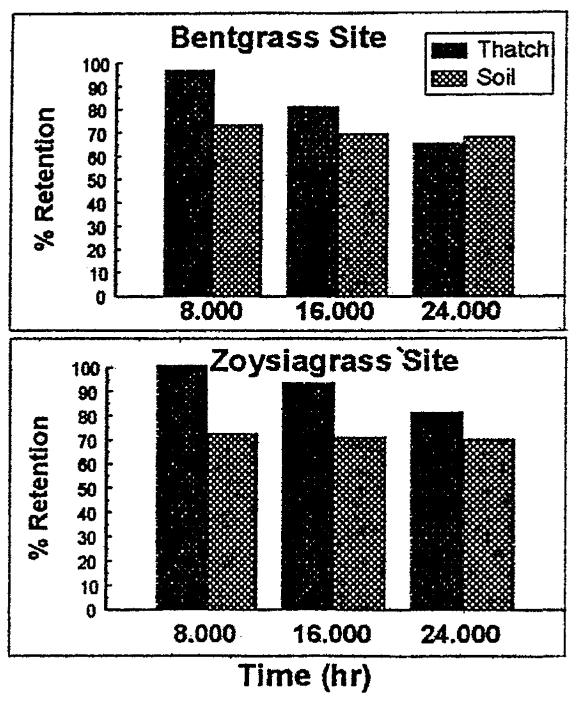

Figure 8. Cumulative proportion of carbaryl retained to thatch and soil following three successive 8 hour leaching events.

retardation factors (R) based on our laboratory measured thatch and soil sorption coefficients with model fitted R's to predict carbaryl transport.

Modeling of bromide transport presented strong evidence of significant two-domain flow in all columns except the zoysiagrass soil columns. In columns exhibiting two-domain flow, use of retardation factors based on laboratory measured adsorption coefficients accounted for 74 to 94 percent of the variability in carbaryl transport. Slightly improved estimates of carbaryl transport were obtained when R was kept as a fitting parameter. In columns where two-domain flow was not apparent, the LEM model satisfactorily described carbaryl transport only when R was curve-fitted. Use of R's based on laboratory derived adsorption coefficients resulted in poor LEM estimates of carbaryl transport. The 2SNE model gave reasonable estimates of carbaryl transport when R was calculated using the adsorption coefficients determined in our sorption studies.

Nitrogen and Phosphorus Leaching and Runoff from Golf Greens and Fairways

University of Georgia

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Start Date: 1998
Number of Years: 3
Total Funding: $75,000

Objectives:

1. *Quantify the amounts of nitrogen and phosphorous that leach from USGA greens under various management practices.*
2. *Determine the amounts of nitrogen and phosphorous that runoff from a Southeastern piedmont soil under various management practices including the effect of buffer zone width and irrigation scheduling with respect to fertilizer application.*
3. *Determine the effects of forms of phosphorous, dissolved organic carbon (DOC), soil compaction and crusting, and climatic variables on phosphorous leaching and runoff. This information will be incorporated existing fate prediction models.*
4. *Develop best management practices to limit leaching and runoff on nitrogen and phosphorous form golf course greens and fairways.*

A project was initiated to determine the potential transport of nitrogen and phosphorus by runoff of surface water from fairways and by leaching through golf greens. The research especially emphasizes studies on phosphorus transport. Experiments are being carried out at four research venues developed by Dr. Albert Smith to study pesticide fate. The results from three of these areas are reported here summarizing preliminary data, since this is the first year of the project.

Runoff of phosphorus was greatest at the first simulated rainfall event from bermudagrass plots with a 5 percent slope and receiving three rates of a 10-10-10 fertilizer (Figure 9). The runoff decreased dramatically during subsequent rainfall events. Step-wise increases in phosphorous concentrations in the runoff were found for the 5 and 11 kg ha^{-1} rates for the first runoff event. The total mass of phosphorous transported for all four events was 10.6 and 11.5 percent of that added for the 5 and 11 kg ha^{-1} rates, respectively. Nitrate runoff followed a different pattern resulting in a higher mass of nitrate during the second rainfall event, when the runoff water volume was highest. Since the ammonium form of nitrogen was applied, the amounts of nitrate in the runoff would depend on rates of nitrification as well as transport parameters.

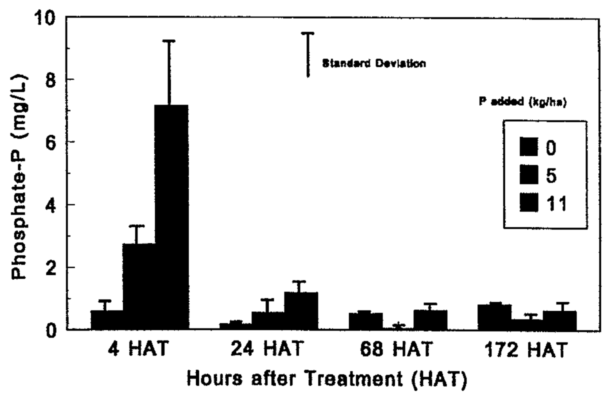

Figure 9. Phosphate concentration in runoff for three rates of 10-10-10 fertilizer. Simulated rainfall at two inches for 4 hours after treatment (HAT), two inches at 24 HAT, and one inch at 68 HAT, and one inch at 172 HAT.

A greenhouse experiment was carried out with columns made to USGA specifications for greens and sodded with bermudagrass. Two sources of balanced fertilizers were applied at four rates to determine potential leaching. The sources applied were a water-soluble fertilizer and a sulfur and poly-coated micro-granular fertilizer to study both fast and slow-release types. These rates were added every other week for a total of six weeks with the last treatment being made at week eleven. Phosphorus concentrations in the leachate were much higher for the soluble source at the end of the eleventh week of the experiment (Figure 10). The difference is especially great at the lowest phosphorous rate (5 kg ha^{-1}). In fact, phosphorous concentrations in the leachate were not different from the control at the granular source rate.

Leaching of nitrogen and phosphorus has been monitored for two working putting greens at an Atlanta Country Club since January 1995. The bentgrass greens were constructed in