Model Calibration and Validation for Turf Pesticides in Runoff and Leachate - Interim Final Report

submitted to

Green Section Research Committee
United States Golf Association
Stillwater, Oklahoma

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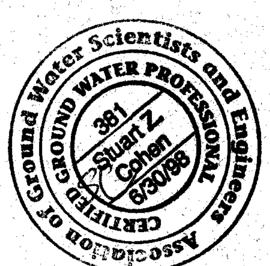

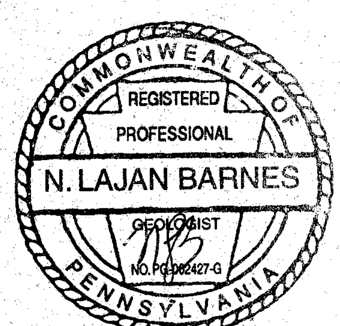

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EXECUTIVE SUMMARY

The purpose of this study is to evaluate the applicability of two pesticide fate models to turf, models that were developed and have been mostly used for assessing agricultural pesticides.

The models are PRZM (EPA's Pesticide Root Zone Model) and GLEAMS (USDA's Ground Water Loading Effects of Agricultural Management Systems model). The first phase of this project was completed last year. A comprehensive, two-volume report was issued April 12, 1996. We had good results calibrating the GLEAMS model against Dr. Al Smith's results from 12 runoff turf plots. We only had mixed success calibrating PRZM against the U. Georgia leachate data from different plots. However, we have recently received soil moisture curve data from Dr. Smith that, after clarification, will allow us to reexamine and possibly improve our previous analyses.

Second Phase (Current)

Model Selection. We are using EPA's latest version of PRZM, version 3.0, for our runoff assessment as well as our leaching assessment. This version of PRZM should become widely available within the next six months. We had previously used version 2.0 for our leaching assessment only. This version was known to overestimate pesticide runoff which was one reason why we chose GLEAMS to assess pesticide runoff in that phase. We are not using GLEAMS in the current phase for two reasons: the runoff problem with PRZM has been resolved, and EPA prefers to use PRZM (although EPA will still accept GLEAMS assessments with proper documentation).

Runoff. We are calibrating PRZM against data generated by Linde, Borger, and Watschke at Penn State. Creeping bentgrass and perennial ryegrass were maintained at ¾ inch height. Simulated rainfall was applied at the rate of 6 in/hr. The pesticides MCPP (mecoprop), isazofos, and triadimefon were applied and analyzed. The triadimefon metabolite triadimenol was also detected. Generally, 0.5-10% of the applied pesticide ran off. There were insufficient data available on the soil properties, so we (Tom Durborow) sampled the soils and had them analyzed.

We have put much effort into reproducing the hydrology (actual event-specific runoff water volumes) and we have obtained moderate success (Figures 1 and 2). More calibration work was required than desired due to one or both of the following factors.

- The PRZM crop model is not as conducive to describing turf as GLEAMS' crop model. For example, GLEAMS gives the option of growing a perennial crop whereas PRZM does not. One is not able to directly model turf going dormant with PRZM. GLEAMS focuses more on the management of the crop and PRZM focuses more on the processes.

- The Penn State researchers did not measure the actual irrigation/rainfall applied to the surface. We could only estimate the actual water received by the surface based on the rainfall simulation design and the length of time the system was turned on. It is possible that a significant fraction of the fine droplets drifted off site.

We have just begun to model the pesticide runoff.

Leachate. We are calibrating PRZM against the results of Dr. Garald Horst at U. Nebraska. Field turf plots (Kentucky bluegrass in a silty clay loam) were harvested for the greenhouse experiment in 1992. Porous ceramic plates were attached to the bottom of the soil cores to simulate the field environment matric potentials and to avoid creating a perched water table at the bottom of the cores.

Seven pesticides were applied to the lysimeters (soil cores) and two irrigation regimes were used. We are modeling the cores irrigated at two inches every three days, and treated with the following four pesticides: MCPP, 2,4-D, isazofos and chlorpyrifos.

Observed vs. predicted water leachate volumes on a daily basis are plotted in Figure 3. Agreement was excellent - the coefficient of variation was 10.4%, despite the fact that no calibration (tweaking of the model) was done. However, it should be noted that: 1. PRZM predictions are slightly to moderately high on all but three dates; and 2. the spread of observed percolate volumes was not large, thereby somewhat reducing the 'toughness of the test' for PRZM.

Surprisingly, we are having difficulty matching predicted vs. observed pesticide leachate. We say "surprisingly" because the general rule of thumb in this field is that successful and easy hydrology calibration usually leads to good chemical leachate (or runoff) predictions. We are continuing to examine this significant discrepancy.

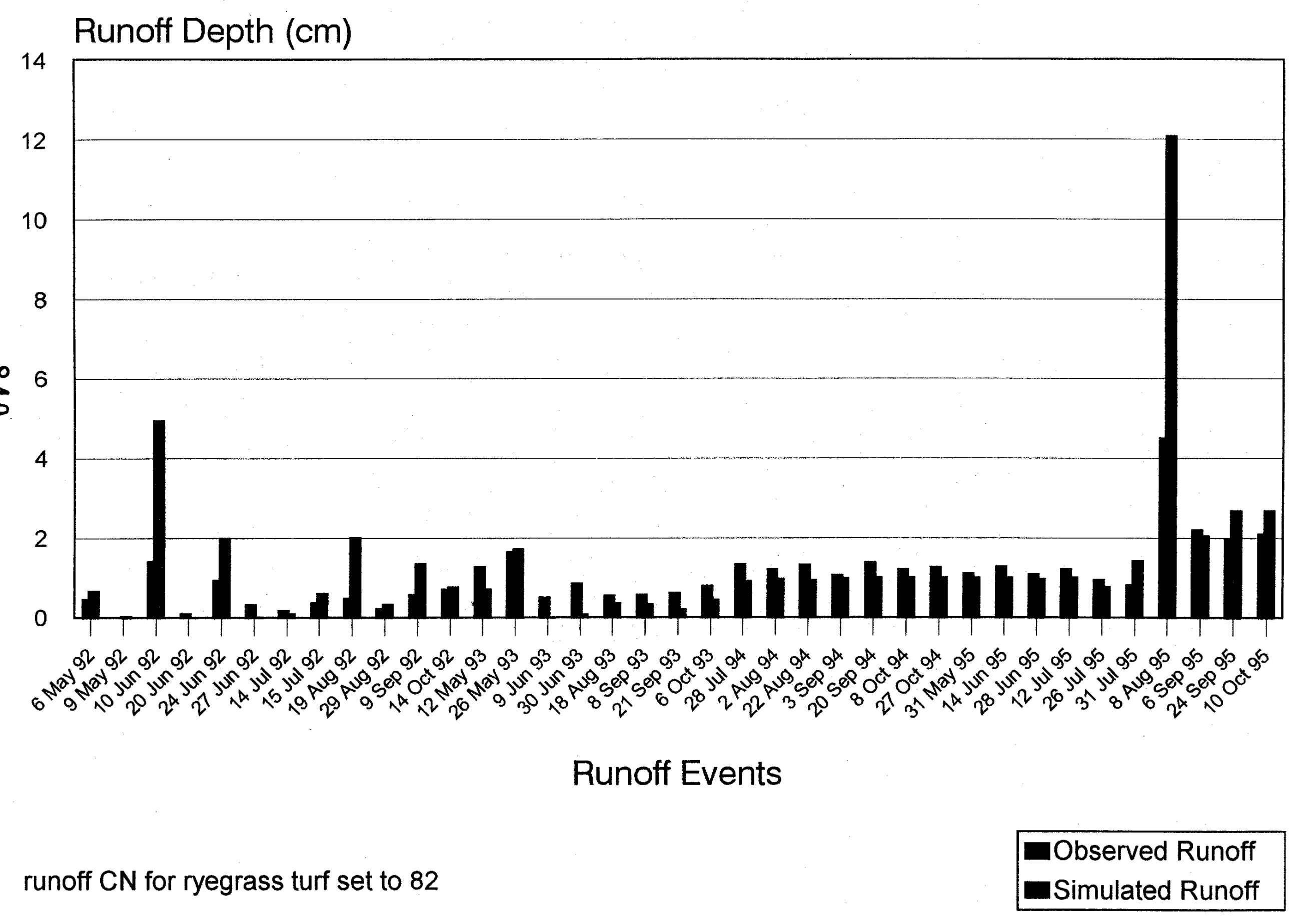
Preliminary Observations on Modeling Turf

Model Structure. As stated above, the crop model in PRZM is not entirely appropriate for turf. We have questioned before whether the evapotranspiration algorithm is appropriate.

Model Use. We are more concerned about this subject. A thatch layer can be added to PRZM and GLEAMS but the user must know how to do so. The thatch layer must be appropriately described in terms of bulk density and effective organic matter, i.e., organic matter available for sorption. Little data are available on foliar decay, pesticide washoff, and pesticide volatility from turf, yet these are important input parameters. The data that are available are usually not known to most pesticide fate model users. PRZM and GLEAMS can accommodate enhanced degradation in the turf root zone, but users must stop using agricultural-based degradation rate constants without scrutiny.

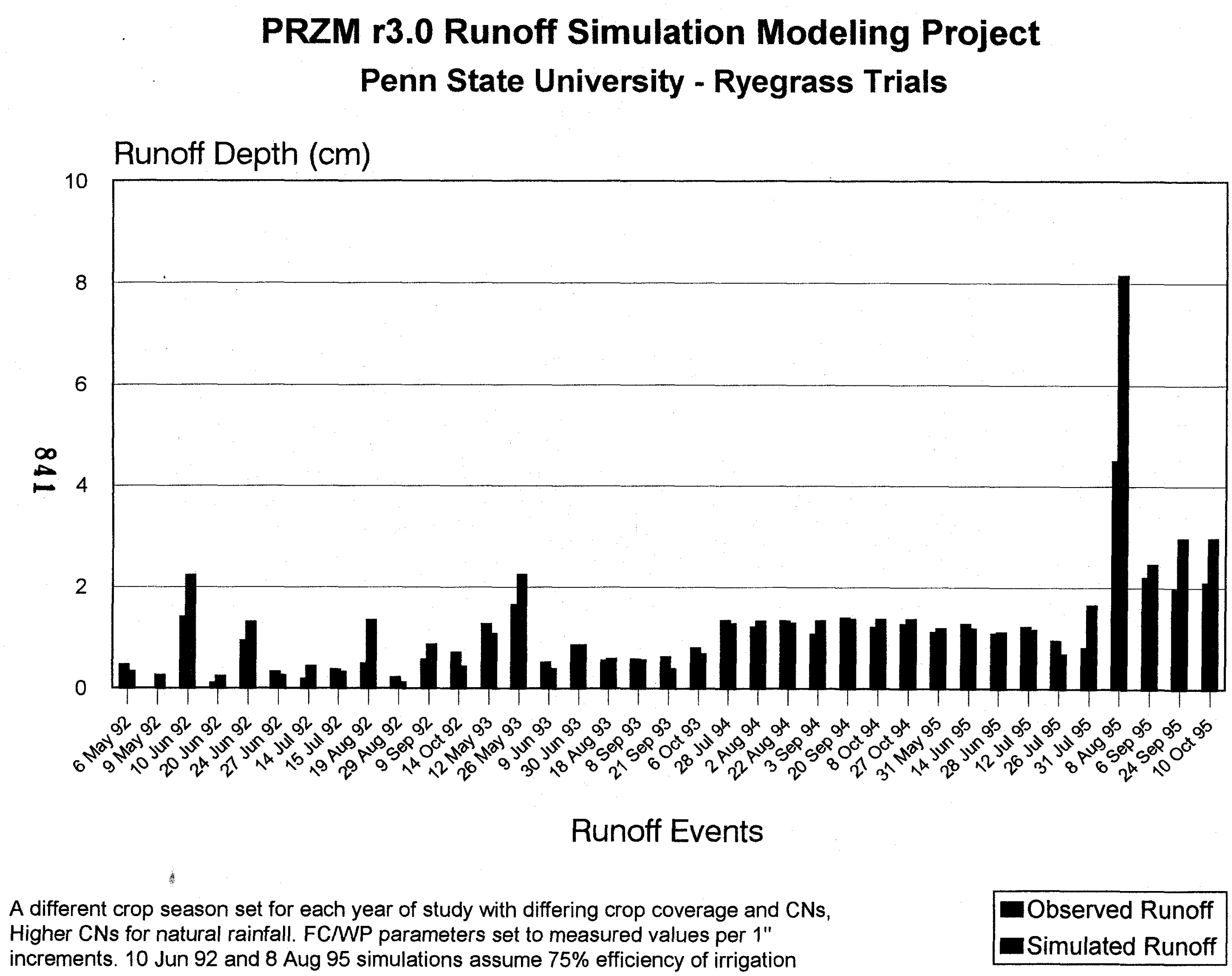
PRZM r3.0 Runoff Simulation Modeling Project

Penn State University - Ryegrass Trials



runoff CN for ryegrass turf set to 82

840



A different crop season set for each year of study with differing crop coverage and CNs, Higher CNs for natural rainfall. FC/WP parameters set to measured values per 1" increments. 10 Jun 92 and 8 Aug 95 simulations assume 75% efficiency of irrigation

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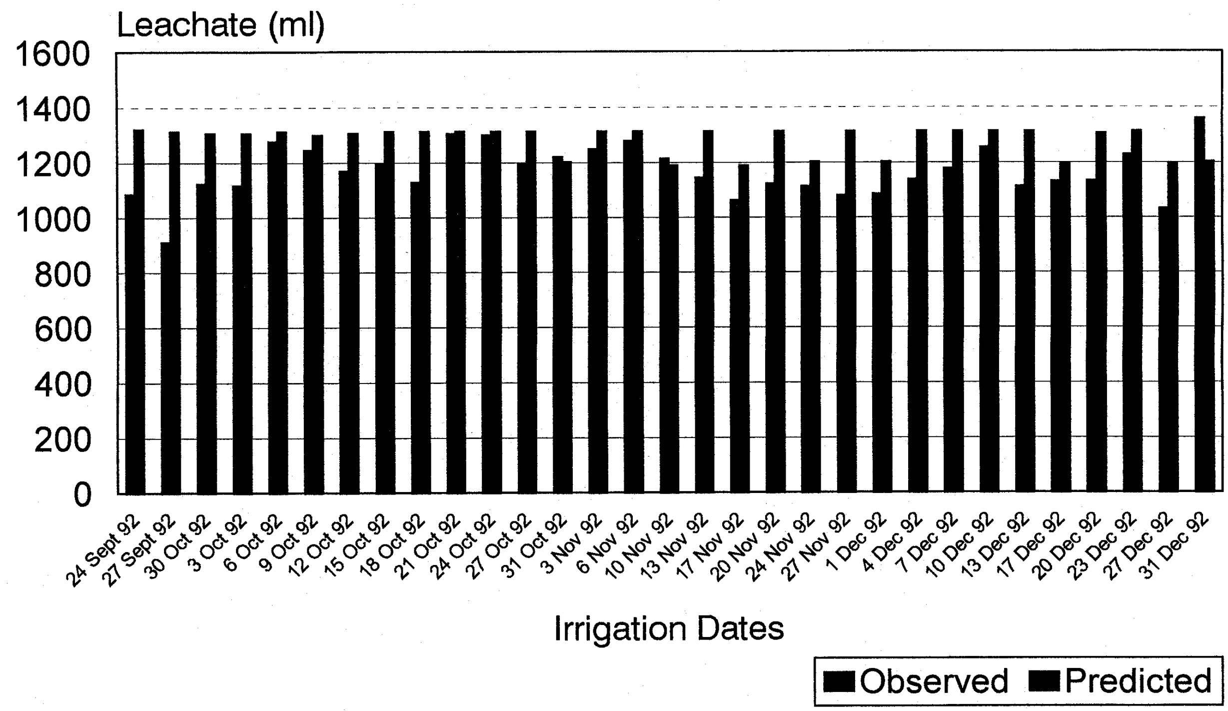
PRZM 3.0 LEACHING SIMULATION MODELING PROJECT

University of Nebraska - Kentucky bluegrass - Greenhouse Plots



Observed leachate is the sum of irrigation collected on and after the day of irrigation application