Update

SPRING 2010

Stone Environmental News on Agrochemical Fate and Exposure Issues

Inside:

Study Investigates Lawn Irrigation Link to Pyrethroids

A lush green lawn is the dream of many homeowners and garden landscapers, but achieving this vision must be balanced with good environmental stewardship.

The Pyrethroid Working Group (PWG), a coalition of manufacturers of pyrethroid insecticides, hired Stone to investigate the extent to which excessive lawn irrigation in central California in the summer could be contributing to the presence of pyrethroid residues detected in urban creek sediments.

Pyrethroids are used to control a wide range of pests in agricultural and urban settings. Some pyrethroids with residential applications such as home perimeter treatments, lawn treatments, and treatments of ornamentals in landscapes among their labeled uses have been detected in urban creek sediments.

Because the contribution of each of the labeled uses of these products to detected pyrethroid residues is not well known, the California Department of Pesticide Regulation required studies to be submitted to satisfy the need for data to differentiate the potential magnitude of contributing sources. Since a potential source of residues from lawns is in runoff water from over-irrigation, the PWG's study focused on determining the runoff losses from excessive lawn irrigation.

continued on page 2

Modeling Vegetative Buffer Strips

A guest editorial by Russell L. Jones, Fellow, Bayer CropScience

Regulators in North America and Europe involved in the registration of crop protection products are increasingly focused on the effects of those products and their metabolites on aquatic organisms in adjacent streams.

One potential mitigation practice for reducing movement to streams via runoff is the establishment of vegetative buffer strips, and recommendations and requirements for vegetative buffer strips are now being included on product labels. Industry scientists are therefore very interested in quantifying the effectiveness of buffer strips so that this information can be used to produce more refined risk assessments.

While vegetative buffer strips have been used for decades to remove sediment from runoff water, only in the last 20 years have they been widely considered for pesticide removal. With the increased use of vegetative buffer strips, there has been interest in understanding the functioning of these strips and in predicting the reduction of pesticide movement to surface water. Numerous experiments have been done and scientists have tried to generalize the results. Pesticide modules have been added to the buffer strip models REMM and VSFMOD, SWAT and APEX have been adapted to include pesticide retention on buffer strips, and the model PRZM-BUFF has been developed to predict retention of pesticides in buffer strips.

This field and modeling work has changed the understanding of buffer effectiveness, at least from a regulatory perspective. Until recently, the buffer strip width and the ratio of the field area to the buffer area were considered to be the two most important factors affecting the effectiveness of vegetative buffer strips. Now we realize that hydrologic response of the buffer at the time of the storm event is as important as the buffer

continued on page 2

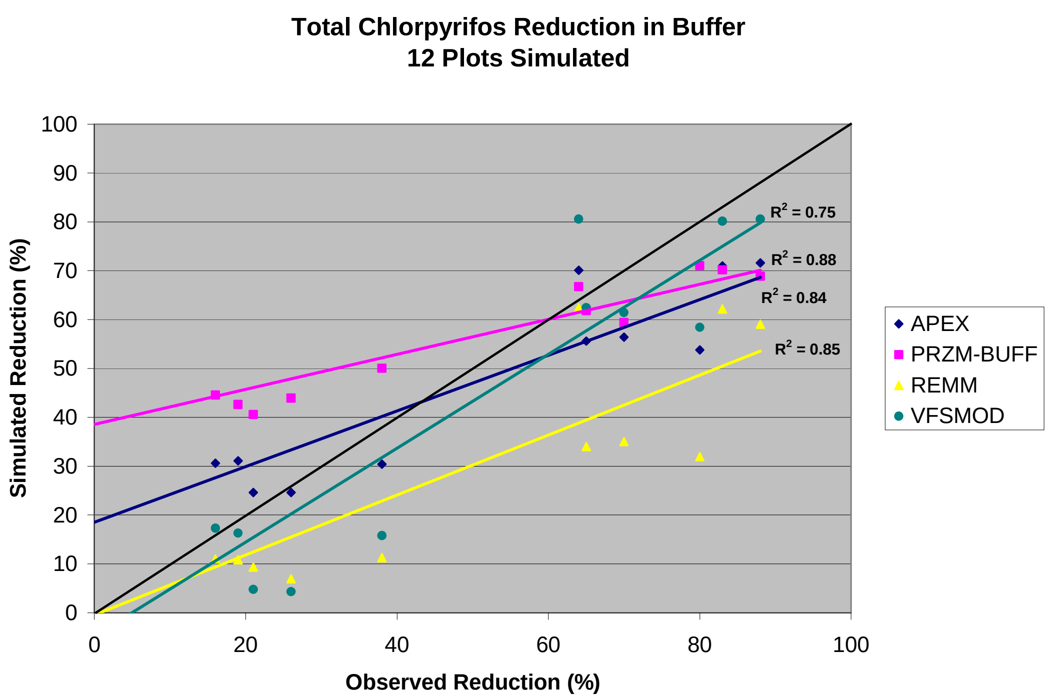


Figure 1: Results from a study site in Sioux County, Iowa, show the model-simulated reduction in chlorpyrifos versus the observed reduction.

width, with the effectiveness of buffer strips decreasing with increasing antecedent moisture content and rainfall. Therefore, the effectiveness of a buffer strip must be determined for each event, rather than considered to be a constant factor as a function of width.

Over the past two years, scientists from both CropLife America and the European Crop Protection Association have joined with scientists from academia and consulting companies to jointly work on improving the understanding of buffer strip effectiveness. A portion of this effort has been a comparison of five models (APEX, PRZM-BUFF, REMM, SWAT, and VSFMOD) which can be used to estimate the effectiveness of buffer strips[1]. A follow-up project is testing four of these models (APEX, PRZM-BUFF, REMM, and VSFMOD) with common data sets. This work has been managed by Michael Winchell and Tammara Estes of Stone, but I would also like to acknowledge the work of those who have provided expertise and conducted the test simulations with the models:

- APEX: Michael Winchell, Stone Environmental
- PRZM-BUFF: Mark Cheplick and Amy Ritter, Waterborne Environmental
- REMM: Tammara Estes, Stone Environmental
- VSFMOD: George Sabbagh, Bayer CropScience

Model simulation results from one of the three study sites, Sioux County Iowa, are presented in Figure 1. This site consisted of 12 separate plots which received simulated rainfall and simulated run-on. These 12 plots consisted of four different scenarios, with field to buffer area ratios of 15 to 1 and 30 to 1 and sheet flow or concentrated flow conditions simulated. Each of the four scenarios was repeated three times. Figure 1 shows the model-simulated reduction in chlorpyrifos, a strongly sorbed pesticide, versus the observed reduction. The linear trend lines for each model are also shown. While the coefficient of determination (r-squared) is high for all models, the slope and y-intercept of those lines varies, with the trend lines of some models overall closer to the desired 1:1 line.

In general, the comparisons in these figures show that all four models predicted significant reductions of pesticides in the buffer consistent with the observed reductions, providing strong support for the use of these models as tools for estimating buffer effectiveness.

Another component of the analysis of these models was a sensitivity analysis on several key model inputs. The objective of this exercise was to both gain a better understanding of the uncertainty in the model predictions given uncertainty in the model inputs and to determine if the model input uncertainty partly explained any deviation of the model predictions from the observations.

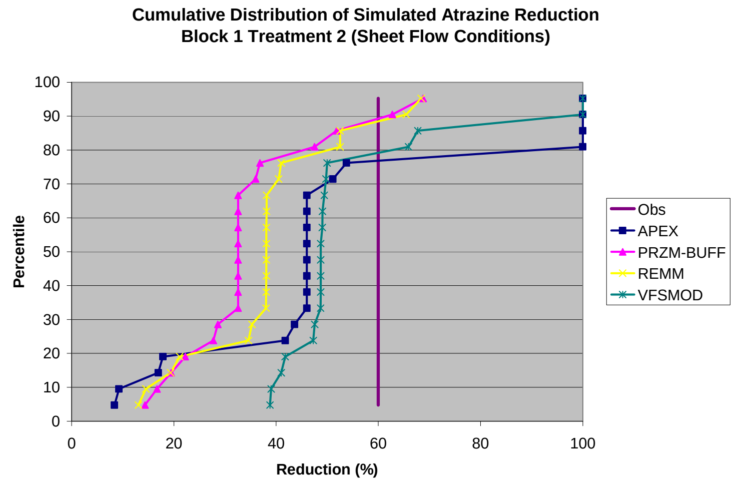


Figure 2: Effects of buffer model input parameter uncertainty on simulated atrazine reduction in the buffer.

Figure 2 shows an example of the uncertainty of the predicted reduction in atrazine to combined changes in three parameters: the soil saturated hydraulic conductivity or runoff curve number, Manning's roughness, and antecedent soil moisture. This figure shows that all four of the models predict the observed atrazine reduction at some point within their cumulative distribution of simulations. In addition, we see that the model predictions become quite sensitive to the three inputs evaluated, particularly near the tails of the distributions.

The results suggest that these models will generally perform well using "uncalibrated" inputs selected near the means of their suggested ranges, however improved results can be achieved through calibration.

These results and others have been presented in scientific conferences in both the US and Europe, and will be compiled in a written report provided to the US EPA. Various software tools are already available for including model predictions of buffer effectiveness in routine modeling simulations used for regulatory risk assessment.

Industry scientists now believe that the existing information justifies the consideration of buffer effectiveness in aquatic and terrestrial risk assessments.

[1] Winchell M.F., T. L. Estes (2009). A Review of Simulation Models for Evaluating the Effectiveness of Buffers in Reducing Pesticide Exposure, Report No. # 092136-F, Stone Environmental, Montpelier, VT, USA. Available upon request from russell.jones@bayercropscience.com.

Pyrethroids

from page 1

Some researchers have suggested that some pyrethroid formulation types may be more vulnerable to runoff than others, so the study design included both liquid and granular formulations of beta-cyfluthrin and bifenthrin.

Beta-cyfluthrin is the active ingredient in the insecticides Advanced PowerForce® Multi-Insect Killer (granular formulation) and Tempo® SC Ultra Insecticide (liquid formulation). Bifenthrin is the active ingredient in the insecticides Talstar® PL (granular) and Talstar® Professional (liquid). The Advanced PowerForce product is registered for use by homeowners in California and the other three products are registered for use by professional applicators in California.

The study also included a runoff event representative of a winter rainfall storm, which may also be a potential route of residue transport.

Stone selected a test site consisting of four treated turf plots, 20 x 40 feet each, on a residential lawn in Penryn, California.

continued on page 3

A rainfall simulator was set up to represent a winter rainstorm.

Pyrethroids

from page 2

Liquid bifenthrin application.

Each plot received an application of either Advanced PowerForce® or Talstar® PL at their respective maximum label rates. Each plot received an application of either Tempo® SC Ultra or Talstar® Professional. Each liquid formulation was applied at an active ingredient rate equivalent to the rate used for the granular formulation that contains the same active ingredient. Prior to test substance application, each turfgrass plot was hydrologically isolated from surrounding areas by metal flashing installed to a depth of approximately three inches around the sides and upslope ends of the plots. The downslope end of each plot delivered runoff to a runoff collection system.

Temporary, above-ground irrigation systems were built for the plots receiving over-irrigation.

Generally, runoff did not occur at irrigation rates of 0.8 inches/hour but did occur when the irrigation rates were increased to about 1.5 inches/hour, generating chemical losses in the first runoff event of up to 0.58 and 0.08 percent of applied for beta-cyfluthrin and bifenthrin, respectively.

Chemical runoff losses dropped significantly between over-irrigation events with the third over-irrigation event chemical runoff losses representing 0.026 and 0.015 percent of applied for beta-cyfluthrin and bifenthrin, respectively. Runoff losses were generally less for liquid formulations than granular formulations, but within a factor of three.

Additionally, the study examined runoff eight weeks after application using simulated rainfall to represent a winter rainstorm.

Chemical runoff losses were 0.01% of applied or less for all plots, with lower losses for plots where runoff did not occur during the irrigation season indicating that whether over-irrigated or not, summer lawn applications of pyrethroids are not major contributors to residues detected in winter rainstorm runoff.

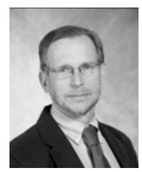
NEWS BRIEFS

Michael Winchell
Hydrology, Spatial Analysis

John Hanzas
Geology, Hydrology

Kim Watson
Quality Assurance, Health & Safety

Tammara Estes
Modeling, Statistical Analysis, Regulatory Support



Chris Stone
Geology, Regulatory Support

Staff Changes

John Hanzas was promoted to leader of Stone's Agrochemical Fate & Exposure group in December 2009. John has a background in geology and hydrology, holds a B.S. in Business Administration, and has 16 years of experience in agchem field studies.

Conferences

March 2010—ACS Spring Meeting, San Francisco: Mike Winchell presented a paper titled "Comparison of Models for Estimating the Removal of Pesticides by Vegetative Buffer Strips." **Tammara Estes** co-authored a poster titled "Use of the Riparian Ecosystem Management Model (REMM) to Predict Novaluron Off-Field Loading Trapment by a Vegetative Filter Strip Using Data from a Simulated Rainfall Vegetative Filter Strip Effectiveness Study".

April 2010—SQA Annual Meeting, Cincinnati: Kim Watson chaired a session and served as vice-chair of the GLP specialty section.

November 2009—SETAC Annual Meeting, New Orleans: **Mike Winchell** presented a poster titled "Development and Application of a GIS-Based Analysis Tool for Use in Endangered Species Risk Assessments".

August 2009—ACS Fall Meeting, Washington DC: Chris Stone, John Hanzas, Tammy Estes, and Mike Winchell attended the meeting. Mike Winchell presented "Development and Application of a Minimal Calibration Approach for Watershed-Scale Modeling of Pesticides with SWAT." John Hanzas presented "Runoff Transport of Pyrethroids from a Residential Lawn in Central California." Tammy Estes presented "Kinetic PRZM: Calibration and Extrapolation Modeling, Study and Decision-Making Tool."

(Unless stated otherwise , all presentations can be viewed at stone-env.com/agchem/agres.html#prespaperabs.)

Pesticide Ecological Modeling Course

Thirty-one scientists from industry, regulatory agencies, and consultancies attended a training course presented by Stone and the AGRO division of ACS. The course focused on models and methodologies that are typically used to assess the risk of pesticide exposure in the environment. Attendees learned to reproduce and interpret pesticide environmental risk assessments. Course instructors included Dr. Ronald Parker of US EPA OPP, Dr. Richard Lowrance and Randall Williams of USDA-ARS, Dr. Dwayne Moore of Intrinsik Environmental Sciences, and **Tammara Estes and Mike Winchell** of Stone.

STONE ENVIRONMENTAL INC

535 Stone Cutters Way
Montpelier, Vermont
05602

Tel: 802.229.4541
E-mail: sei@stone-env.com
Web Site: www.stone-env.com

Officers
Christopher Stone, President
David Healy, Vice President
Seth Pitkin, Vice President
Bruce Douglas, Vice President

Editor
John Hanzas
update@stone-env.com

Printed on recycled paper

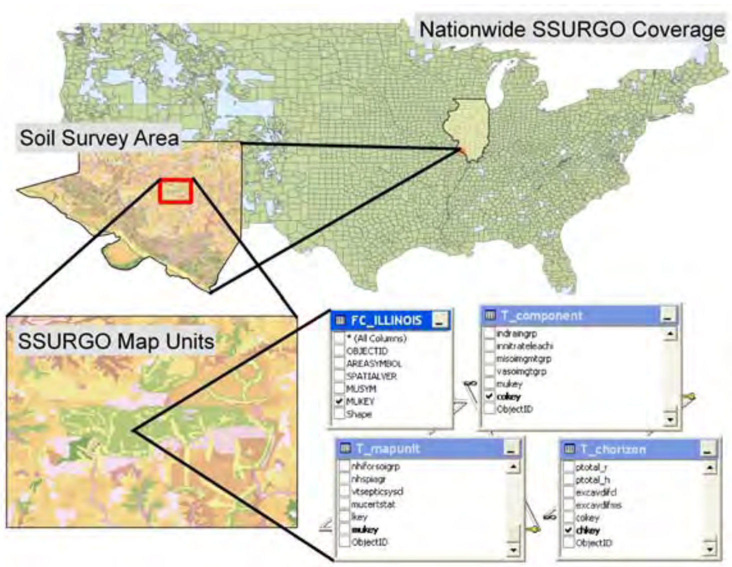
535 Stone Cutters Way
Montpelier, Vermont 05602
USA

STONE ENVIRONMENTAL INC

Nationwide SSURGO Soils Compiled in Enterprise Database

Stone staff have recently compiled an enterprise SSURGO (Soil Survey Geographic) spatial database for the conterminous United States, streamlining many of the modeling and analysis tasks that rely on high-resolution soil data.

Built using ESRI ArcSDE and Microsoft SQL Server 2008 database architectures, the database is compatible with existing Stone applications and future/ongoing application and database development. Staff developed tools to accomplish complex summary and extraction tasks quickly, from point-based attribute extraction to watershed-level soils characterization. In addition, Stone is using the database to parameterize the Soil and Water Assessment Tool (SWAT) User Soil Table, an integral part of the modeling system that provides the soil component and horizon parameters required by SWAT. Our team also developed an algorithm to mine the database using scale-invariant distance metrics and applied it to fill in missing soil parameter values required for hydrologic modeling. This algorithm locates a soil series with complete data most similar to a soil record with missing data and uses the information from that soil series to estimate the most appropriate value for the missing parameter. This unbiased and more rigorous approach to filling in missing data will improve accuracy and lower the often frustrating overhead in model parameterization. Stone will continue building tools to leverage the SSURGO database for use in tier 3 and tier 4 pesticide exposure risk assessments.



Stone has compiled a nationwide SSURGO spatial database using enterprise GIS technology. The database contains approximately 35 million polygons with 727,000 soil components containing two million component horizons.

GIS and Modeling Application Updates

Working with CropLife America, Stone has developed a **proximity analysis tool** for use in endangered species risk assessments. The GIS-based tool identifies the acreage of potential pesticide use-sites falling within a given buffer distance to user-defined surface waters. The tool was designed to integrate directly with the NHDPlus hydrography dataset. Michael Winchell presented a poster describing the tool at the SETAC 2009 meeting.

The **Aldworth-Jackson Fitting Tool** has been updated for Microsoft Excel 2007 compatibility and is available on Stone's web site (stone-env.com/agchem/agres.html). The Fitting Tool is a set of statistical tools used for fitting degradation kinetics from environmental fate datasets.

The **GeoSTAC Toolset extension** has been updated for ArcGIS 9.3.1. In addition, new raster and vector datasets recently added to the GeoSTAC database have been integrated with this version of the GeoSTAC Toolset. Go to www.geostac.org to download it.

In conjunction with Texas A&M Spatial Sciences Lab, the **ArcSWAT interface to the SWAT model** has been upgraded to incorporate the SWAT 2009 codebase updates. These include new methods for simulating management operations (including vegetated filter strips and grassed waterways) as well as a new septic system component model. This latest version of ArcSWAT is compatible with ArcGIS 9.3.x and can be obtained at swatmodel.tamu.edu.