NPURG - A Computer Program to Assess Risk of Pesticides to Ground and Surface Water

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A priority of society today is the protection of water resources including prevention of ground and surface water contamination by pesticides. Yet, the Environmental Protection Agency (EPA) has reported finding as many as 74 pesticides in ground water in 38 states with 46 of these linked to agricultural uses (Williams, 1988).

Frequent and prominent media attention to such studies has prompted public outcry to limit or ban the use of pesticides. This in turn has spurred an increasing number of state and federal regulations regarding what, where and how pesticides are used.

Consequently, agricultural producers are required to be more informed about the pesticides they apply and the potential risks those chemicals pose to ground and surface water supplies. Determining potential risks involves evaluation of pesticide and soil properties, site conditions and management practices.

PROPERTIES OF PESTICIDES

The ability of an applied pesticide to reach ground or surface water sources is determined in large part by its chemical and physical properties. The principal factors influencing the fate of applied pesticides are solubility, adsorption and degradation rate.

Solubility is the capacity of a pesticide to dissolve in water. The more readily a chemical goes into solution the more likely it is to leach or move through soil. Solubility is measured in terms of milligrams of chemical that will dissolve in one liter of water. It may also be expressed as parts per million (ppm).

Adsorption is the ability of a chemical pesticide to attach itself to the surface of a soil particle. The proportion of chemical dissolved in soil water compared to the amount bound to soil is expressed as a coefficient, K_d. However, since adsorption is most affected by the amount of organic matter in soil, the expression K_{oc}, which factors in the percent organic carbon in soil, is more commonly used to measure adsorption.

Degradation rate determines how long a pesticide persists once applied. The slower the rate of degradation the longer a chemical will remain in the environment and be subject to leaching or surface runoff. Degradation is measured in terms of half life, that is, the number of days it takes for an applied chemical to be reduced to 50% of its original amount.

Knowing the quantitative values for each of these pesticide characteristics does not in itself indicate the actual risks of ground and surface water contamination. However, when compared against a set of criteria, qualitative judgements can be made. According to EPA established criteria for groundwater contamination potential, pesticides with solubility greater than 30 ppm, K_{oc} value less than 500 and a half life greater than 20 days are considered to pose a significant risk of leaching.

SOIL AND SITE CHARACTERISTICS

An evaluation of potential for leaching or surface loss of applied pesticides would not be complete without consideration given to soil characteristics. Soil texture, structure, permeability and percent organic matter are characteristics which determine vulnerabilities of a given soil to leaching or runoff.

Obviously coarse textured soils are more permeable and therefore more vulnerable to leaching than fine textured soils. However, surface runoff probabilities will be less. Soils with high organic matter content will retard the movement of chemical pesticides not only because of their capacity to absorb water but also the tendency of the electrically charged pesticide molecules to adsorb to surfaces of organic particles.

Site features influencing the potential for pesticide leaching or surface runoff include depth to the water table and slope. High water tables are vulnerable to pesticide contamination simply due to their proximity to surfaces where pesticides are applied. Shallow water tables also mean shorter time intervals for leachate to reach subsurface water and therefore less time for chemical and biological factors to degrade the pesticides.

Generally slopes greater than 15% increase the chances of surface runoff although the potential for pesticide leaching may be reduced. Soil texture and permeability will influence these processes to some extent.

NPURG

Clearly, there is a considerable amount of information that must be processed in order to predict probability of water contamination from applied pesticides. Since all of these factors can be represented quantitatively, it has been possible to develop algorithms to express the interaction of these factors However, it is at best a formidable task for the pesticide user to find all pertinent data on pesticides and soils, much less the equations involved in calculating potentials for water contamination.

In 1988, specialists from University of Massachusetts Cooperative Extension and the Soil Conservation Service (SCS) developed a computerized information delivery system to synthesis pesticide and soil data, and predict the potential for applied pesticides to move by leaching and surface runoff (Jenkins and Lyons, 1988). The program is called NPURG, an acronym for National Pesticide/Soils Database and User Support System for Risk Assessment of Ground and Surface Water Contamination.

NPURG consists of two databases. The first is a pesticides properties database which includes information on over 230 pesticides. The other is the Soil Conservation Service State Soil Survey Database.

From these databases, the user can select pesticides and soil types As each selection is made, pesticide and soil properties data are displayed via windows. NPURG can compare pesticide and soils and display relative ranking of leaching and surface runoff potentials for each pesticide/soil combination.

This analysis is based on the SCS Soil-Pesticide Interaction Screening procedure developed by Dr Don Goss, SCS Research Soil Scientist (Goss, 1988). A simple three part rating system is used to indicate relative potential for pesticide loss on the given soil through leaching or surface runoff. A rating of "Potential 1" indicates high probability of pesticide movement, "Potential 3" indicates a low probability while

"Potential 2" rating is intermediate. Detailed explanations of the rating system and the "Potentials" are provided through pull down menus and HELP screens within the NPURG program.

NPURG also allows for selection of more than one pesticide and soil type at a time, and will display and print a matrix of leaching and surface loss ratings for each pesticide/soil combination. The matrix permits easy comparison of pesticides when alternative products are under consideration. Printout of the matrix is in the form of a worksheet so that the information can be customized (Fig. 1).

The NPURG program permits the user to modify the soils database when site specific soils information can be collected. This can mean more accurate analyses of a given situation but also allows the user to evaluate how soil modifications such as increasing organic matter content may influence the potential for pesticide leaching. The chemical database may also be modified by adding new chemicals or the editing of the chemical database as new data become available.

Another feature of NPURG is the inclusion of extensive educational information available through the use of pull down menus and windows. Information regarding data sources, definition of terms and concepts, calculations used to determine ratings, and interpretations of ratings is available.

NPURG APPLICATIONS

As a pest management tool, NPURG can function as a quick-retrieval source of information on specific pesticides and soils. But its primary value is to "red flag" pesticide use situations that could be troublesome It is in this capacity that we have been using NPURG in Massachusetts when working with nursery producers and other growers. We use NPURG analyses as a beginning point in the development of comprehensive pest management strategies which are sensitive to environmental vulnerabilities, specifically ground and surface water contamination. This also presents an opportunity to discuss alternative approaches to pest control including chemical, biological and cultural. In this capacity, NPURG can be a useful tool in further development of IPM (Integrated Pest Management) programs for growers

This latter application of NPURG will be more practical with impending development by University of Massachusetts Extension specialists of a third database for inclusion in the computer program. This database will interject information on application methods and alternative pest control strategies by crop whenever analyses of a specific pesticide/soil interaction yields a high potential risk rating.

AVAILABILITY

NPURG is currently available only in the New England states through SCS and Cooperative Extension agents who are using it in consultations with growers to arrive at best pest management practices.

NPURG

Pesticide/Soil Interaction Ratings for Ground and Surface Water Protection

Chemical database name USDA2-03 DBF Date of issue Tue Aug 13 11 54 58 1991
Soil database name MASOILS DBF Date of issue Tue Aug 13 10·03:36 1991

Pesticide User _____ Date Thu Dec 05 10 00 12 1991
Address· _____ Crop _____
Location· _____ Target Pest· _____
% of field for Soil Type #1 _____ % #2 _____ % #3. _____ %
Ave Slope _____ % pH _____ Drained/Undrained
Water Resource Ground/Surface Type _____ Distance _____
_____ Soil/Pesticide Leaching Potential (SPLP) _____

NPURG 9 500 Soil
Database 2.031 Series. ADAMS PITTSFIELD WINOOSKI
Texture LFS L SIL

Pesticide:	**Hydro - A**	**Hydro - B**	**Hydro - B**
ALACHLOR	1 *	2 *	2 &
BENEFIN (BENFLURALIN)	2 *	3 *	3 &
BENSULIDE	1 * E	2 * E	2 & E
DCPA (CHLORTHAL-DIMETHYL)	2 *	3 *	3 &
METOLACHLOR	1 *	1 *	1 &
NAPROPAMIDE	1 *	2 *	2 &
ORYZALIN	2 *	3 *	3 &
OXADIAZON	2 *	3 *	3 &

*max slope is > 15%, & depth to seasonal high water table < 6 ft , + ponded G (guessed) / E (estimated) database values used in the computations.

These ratings are first tier relative rankings of pesticide/soil interactions They are intended for use by SCS and CES personnel as one component of an environmental risk analysis Please see attachment NPURG RATING SUPPLEMENT to help evaluate these ratings

Planner _____ Agency _____ Phone ( ) -

Figure 1. Printout of NPURG leaching potential analysis for several preemergent herbicide/soil combinations Worksheet format allows inclusion of site-specific information.

LITERATURE CITED

Jenkins, J.J. and **J.P. Lyons.** 1988 Use of an expert system to derive pesticide groundwater contamination recommendations. Proc of Workshop. Integration of Expert Systems with Conventional Problem Solving Techniques Agriculture San Antonio, TX. Aug 10-12,1988.

Goss, D. 1988 Pesticide-Soil Interaction: Potentials For Loss USDA-SCS National Bulletin No 430-9-3, National Soil Survey Center, Lincoln, NE

Williams, W.M. 1988. Pesticide in Ground Water Data Base 1988 Interim Report. USEPA-OPP Environmental Fate and Effects Division, Washington D.C

MONDAY AFTERNOON 9 DECEMBER 1991

The afternoon session was convened at 1:45 p.m. with Dale Deppe serving as moderator.

Environment-Friendly Plant Production System: The Closed, Insulated Pallet

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Editor's Note: This paper was also presented in the Southern Region and can be found on page 304.