Protecting Groundwater from Pesticide Contamination

Groundwater is the source of water for wells and springs. It fills spaces between particles of soil or cracks in bedrock. Geologic formations containing groundwater are called aquifers. Groundwater is widely used for household and other water supplies. Approximately half the population in the United States relies on groundwater for drinking water, and more than 90% of rural residents obtain their water from groundwater through wells and springs.

Factors Affecting Groundwater Contamination

Four major factors determine whether a pesticide is likely to reach groundwater:

- Properties of the pesticide
- Properties of the soil
- Conditions of the site
- Management practices

Pesticide Properties

Solubility

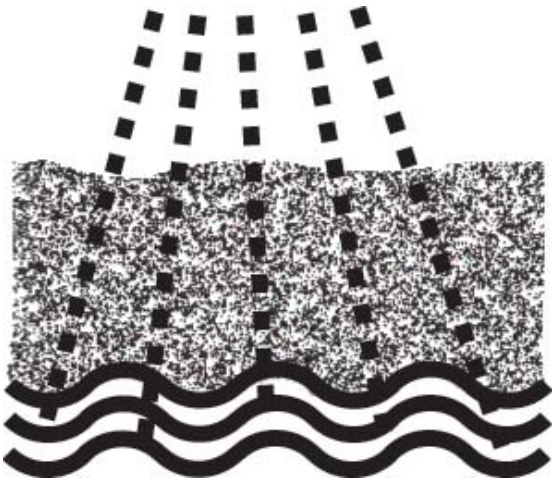
Chemicals which dissolve readily in water are said to be highly soluble. As water seeps downward through soil, it carries with it water-soluble chemicals. This process is called leaching. Highly soluble pesticides, therefore, have a tendency to be leached from the soil to groundwater.

Adsorption

Many pesticides do not leach because they are adsorbed, or tightly held, by soil particles. Adsorption depends not only on the chemical properties of the pesticide, but also on the soil type and amount of soil organic matter present.

Volatility

Highly volatile chemicals are easily lost to the atmosphere, similar to the evaporation of water. If a pesticide is highly volatile and not very water soluble, it is likely to be lost to the atmosphere, and less will be available for leaching to groundwater. Highly volatile compounds may become groundwater contaminants, however, if they are highly soluble in water.



Degradation

Another chemical property affecting leaching potential is the pesticide's rate of degradation in soil. Pesticides are degraded, or broken down into other chemical forms, by sunlight, by microorganisms in the soil, and by a variety of chemical and physical properties. The longer the compound lasts before it is broken down, the longer it is subject to the forces of leaching. Many chlorinated hydrocarbons are highly persistent in soil, but they have not been found in groundwater because of their low solubility and strong adsorption to soil particles.

Soil Properties

Soil Texture

Soil texture is determined by the relative proportions of sand, silt and clay. Texture affects movement of water through soil, and therefore also movement of dissolved chemicals such as pesticides. The coarser the soil, the faster the movement of percolating water, and the less opportunity for adsorption of dissolved chemicals. Soils with more clay and organic matter tend to hold water and dissolved chemicals longer. These soils also have far more surface area on which pesticides can be adsorbed. The coarser-textured the soil, therefore, the greater the chance of the pesticide reaching groundwater.

Soil Permeability

Soil permeability is a measure of how fast water can move downward through a particular soil. Water moves quickly through soils with high permeability, so frequent irrigation may be necessary. They also lose dissolved chemicals with the percolating water. In highly permeable soils, the timing and methods of pesticide application need to be carefully designed to minimize leaching losses.

Organic Matter Content

Soil organic matter influences how much water a soil can hold and how well it will be able to adsorb pesticides. Increasing the soil's organic content, through practices such as application of manure or plowing under the cover crops, increase the soil's ability to hold both water and dissolved pesticides in the root zone where they will be available to plants and to eventual degradation.

Site Conditions

Depth to Groundwater

The shallower the depth to groundwater, the less soil there will be to act as filter. Also, there will be fewer opportunities for degradation or adsorption of pesticides. Extra precautions must be taken to protect groundwater in areas where it is close to the ground surface. In humid regions, groundwater may be only a few feet below the surface of the soil. If rainfall is high and soils are permeable, water carrying dissolved pesticides may take only a few days to percolate downward to groundwater. In arid regions, groundwater may lie several hundred feet below the soil surface, and leaching of pesticides to groundwater may be a much slower process.

Geologic Conditions

In addition to depth to groundwater, it is important to look at the permeability of the geologic layers between the soil and groundwater. Highly permeable materials, such as gravel deposits, allow water and dissolved pesticides to freely percolate downward to groundwater. Layers of clay, on the other hand are much less permeable and thus inhibit the movement of water. Groundwater quality is most vulnerable in areas where permeability of geologic layers is rapid.

Climate

Areas with high rates of rainfall or irrigation may have large amounts of water percolating through the soil so are highly susceptible to leaching of pesticides, especially if the soils are highly permeable.

Management Practices

Application Methods

Another factor in determining leaching potential is the way in which a pesticide is applied. Injection or incorporation into the soil, as in the case of nematicides, makes the pesticide most readily available for leaching. Most of the pesticides which have been detected in groundwater are ones which are incorporated into the soil rather than being sprayed onto growing crops.

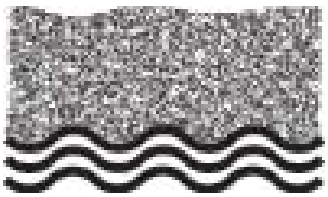
Pesticides Rates and Timing

The rate and timing of a pesticide's application also are critical in determining whether it will leach to groundwater. The larger the amount used, and the closer the time of application to a time of heavy rainfall or irrigation, the more likely that some pesticide will leach to groundwater. Particular care should be taken when practicing chemigation because of the risks of back-siphoning and leaching.

Summary of Factors Affecting Groundwater Contamination

Greatest vulnerability

Pesticide
High solubility
Low adsorption
Persistence



Soil
Sandy
Low in organic matter

Site
Shallow depth to groundwater
Wet climate or extensive irrigation management
Pesticide injection or incorporation into soil

Preventative Measures

Evaluate the need, method and frequency of chemical control.

Use pesticides only when necessary and only in amounts that will control pests adequately. Pesticides that are applied in low concentrations and less frequently are less likely to leach into the groundwater.

Identify the vulnerability of the soil.

Well-drained or sandy soils low in organic matter have a high potential for groundwater contamination. Consider the location of the pesticide application in relation to ground and surface water.

Keeping pesticides away from water sources helps to prevent their introduction into groundwater. Consult your Cooperative Extension Service or Soil Conservation Service to determine the depth to groundwater in your area.

Become familiar with pesticides that may leach.

Pesticides with a high potential for leaching are more likely to contaminate groundwater. For example, some carbamate pesticides are more likely to leach and cause groundwater contamination than other pesticides. Check the pesticide label for warnings about potential to leach to groundwater. In addition, your Cooperative Extension Service or USEPA can provide information on the leaching potential of different pesticides.

Follow the directions on the pesticide label.

Many pesticide labels contain use instructions or precautions designed to avoid groundwater contamination. If you do not follow the label, you risk contaminating the groundwater.

Apply the pesticide at the appropriate time.

Fewer applications are required if they are carefully timed in relation to stages in the pest's life cycle. Extension or EPA can provide information to help you determine the right time.

Measure the pesticide properly and carefully.

Avoid the temptation to use more product than the label directs. Using more will not do a better job of controlling pests. It will only increase the cost of pest control, the resistance of pests to chemical controls, and the chances that the groundwater will become contaminated.

Calibrate and maintain equipment properly.

Correctly calibrating application equipment before applying pesticides reduces your chances of applying too much. Check your application equipment regularly for leaks, malfunctions and calibration. You will save money and help prevent groundwater contamination.

Avoid spills and back-siphoning.

Avoid spills, especially near wells or other water sources. Prevent back-siphoning of pesticide-contaminated water into the water source by keeping the end of the fill hose above the water level in the spray tank. Install a backflow device (such as an air gap or check valve) on the filling pipe to prevent backflow problems.

Direct the application to the target site.

Avoid overspraying the ground and possible drift to reduce the chance of contaminating the groundwater.

Dispose of pesticides properly.

Triple rinse or pressure rinse pesticide containers and return the rinse water to the spray tank. Follow the label for proper disposal of leftover pesticides so they do not cause groundwater problems. The best precaution against pesticide disposal problems is good planning. Buy and mix only the amounts you need.

Store pesticides safely.

Store pesticides in their original containers in a cool, well-ventilated, protected location away from pumps and water sources.

Maintain records of pesticide use.

Maintain records, by date, of the identity and quantity of pesticides applied to each area.

Additional methods to prevent groundwater contamination

Delay irrigation after pesticide application.

Because pesticides frequently move with water down through the soil, it is better not to irrigate immediately after pesticide applications. For example, delaying irrigation for one or more days after applying a pesticide can minimize the chances of the pesticide reaching the groundwater.

Avoid irrigation runoff.

Runoff should be avoided by not using an excessive amount of irrigation water. Avoiding irrigation runoff will reduce soil erosion and pesticide entry into the surface and groundwater. This is especially critical for clay soils which are subject to rapid runoff.

Exercise care when practicing chemigation.

Particular care should be used when practicing chemigation. The irrigation water may carry the pesticides downward through the soil into groundwater. Devices should be used to prevent possible back-siphoning of the pesticides into the water supply system.

Check the well system.

Properly seal new and inspect old wells to ensure that the seal is adequate. This will help to keep contaminated surface water from entering the well and groundwater.

USE of IMP

Integrated Pest Management, or IPM, is a recommended alternative to purely chemical pest control. IPM integrates available pest control techniques in a manner which is economically and ecologically sound. IPM uses scientifically sound strategies, such as economic thresholds and pest monitoring, to determine the proper time for pesticide applications. For example, by using traps to monitor the tobacco budworm, growers in North Carolina have been able to time pesticide applications better. This effort has resulted in a 53% decrease in pesticide use against the budworm. Tomato growers in California using an IPM

program have increased their net returns by about $7.00 per acre and have used 22% less insecticide.

Summary

Some applicator practices which serve as preventive measures

1. Use pesticides only when needed.
2. Identify soil type.
3. Identify nearby water sources.
4. Check the well system.
5. Do not use a "leacher."
6. Follow the label.
7. Apply at the right time.
8. Measure carefully.
9. Accurately calibrate spray equipment.
10. Avoid spills.
11. Avoid overspraying.
12. Delay irrigation after pesticide applications.
13. Avoid irrigation runoff.
14. Triple rinse tanks; dispose of pesticides and containers properly.
15. Store pesticides safely.
16. Maintain records.

Information in this handout was taken from the initial groundwater educational package sponsored by the U.S. Department of Agriculture and U.S. Environmental Protection Agency, and developed by the New York State Water Resources Institute, Cornell Cooperative Extension, and Office of Pesticide Information and Coordination, University of California Cooperative Extension.

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Pub. 2352 **(Online Only)** **7/05 Rev.**

Issued in furtherance of Cooperative Extension work, Acts of Congress of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture. The Louisiana Cooperative Extension Service provides equal opportunities in programs and employment.