College of Tropical Agriculture and Human Resources
University of Hawai'i at Mānoa

A NEWSLETTER FOR THE
Pesticide Risk Reduction Education
PROGRAM

Key to Pesticide Safety and Education

The Pesticide Label

December 2017

IN THIS ISSUE:

Regulatory Updates

Recall of Organic Insecticide Azatrol

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August 4, 2017—On July 27, 2017 PBI-Gordon Corporation announced a nationwide recall of all Azatrol products, specifically **Gordon's Azatrol EC** insecticide and **Azatrol Hydro Botanical** Insecticide. Both of these products can be identified by the EPA Registration Number 2217-836.

PBI Gordon initiated this national recall in part due to the result of a June 2017 decision by Oregon Department of Agriculture to issue a Stop Sale, Use, or Removal (SSUR) [order] of these products after discovering the presence of five synthetic pesticide active ingredients which were not listed on the labels of these two registered organic pesticide products.

While the five conventional active ingredients found in these two products can be used on a variety of ornamental, food, and feed crops safely, because they were not identified on the labels of the Azatrol products this constitutes misbranded and adulterated product. The non-declared conventional pesticide active ingredients found in the two organic pesticide products are: quantifiable levels of permethrin, bifenthrin, cypermethrin, cyfluthrin, and chlorpyrifos. Malathion was not detected at a quantifiable level.

PBI-Gordon is asking distributors to return any unused Azatrol in their inventories, as well as any unused Azatrol returned to distributors by their customers.

EPA Initiates Rulemaking to Revise Certain Aspects of the Agricultural Worker Protection Standard (WPS)

www.epa.gov/pesticides/epa-initiates-rulemaking-revise-certain-aspects-agricultural-worker-protection-standard

December 14, 2017—The US Environmental Protection Agency (EPA) started a process to revise its set of rules known at the *Worker Protection Standard* or *WPS*. (The WPS applies where agricultural pesticides used for producing plants at greenhouses, farms, nurseries, or forests to be harvested.) By September 30, 2018, EPA expects to publish a "Notice of Proposed Rulemaking" to solicit public input on proposed revisions to the WPS requirements for minimum ages, designated representatives, and ap-

Continued on page 19

Pesticides in the Environment (recertification article)

Article starts on the next page.

The recertification article is on the next 16 pages. It is a reprint of chapter 7 of a booklet titled NATIONAL Pesticide Applicator Certification CORE MANUAL (Second Edition, 2014)*. It was published by the National Association of State Departments of Agriculture Research Foundation.*

Recertification credits may be earned by certified applicators

who score at least 70% on the open-book quiz about the recertification articles in this newsletter. These articles have a title followed by "**(recertification article)**." However, credits may not necessarily apply to the following categories: Private 2, Private 3, Commercial 7f, and Commercial 11. (The credits are also known as *continuing education units* or *CEU* credits.) The quizzes are administered by the Hawaii Department of Agriculture's staff. See the full explanation and a link to the "List of Available Quizzes" at the bottom of the Department's webpage

http://hdoa.hawaii.gov/pi/pest/pesticide-applicator-certificationrecertification-2/

under the subtitle "QUIZ SESSIONS."

To ask about earning recertification credits, call one of the Department's phone numbers:

Kauai applicators—Call Honolulu direct 973-9409 or 973-9424, or toll free 274-3141 x 39409 or 39424 followed by "#".

Oahu applicators—Call Honolulu direct 973-9424 or 973-9409.

Lanai, **Molokai**, and **Maui** applicators—Call Honolulu direct 808-973-9424 or 973-9409, or toll-free 984-2400 x 39424 or 39409 followed by "#".

Hawaii island applicators—Call Honolulu direct 808-973-9424 or 973-9409 or 973-9411; or through the Maui State Toll Free Access number 984-2400 and then extension 39409 or 39424 followed by "#."

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CHAPTER 7

PESTICIDES IN THE ENVIRONMENT

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

- Describe how pesticide applications can affect the environment.
- Explain how to prevent pesticide drift, runoff, and movement to nontarget areas.
- Identify sensitive areas that could be harmed by pesticides.
- Discuss how to prevent pesticide residue accumulation associated with mixing, loading, and equipment washing.
- State when to adjust or delay an application to minimize environmental impact and maximize effectiveness.

Applicators and the public share concerns about how pesticides may harm the environment. Initially, hazards to humans were the primary reason the U.S. Environmental Protection Agency (EPA) decided to classify a pesticide as a restricted-use product. Now, more and more pesticide labels list environmental effects (such as contamination of groundwater or toxicity to birds or aquatic organisms) as reasons for restriction. To register new pesticides, EPA requires manufacturers to submit extensive environmental tests. The agency also reviews environmental effects when reevaluating existing pesticide registrations.

THE ENVIRONMENT

The environment comprises everything that is around us. It includes not only the natural elements that the word "environment" usually brings to mind but also people, the manufactured parts of our world, and the indoor areas in which we live and work.

The environment is air, soil, water, plants, animals, houses, restaurants, office buildings, factories, and all that they contain. Anyone who uses a pesticide—indoors or outdoors, in a city or on a farm—must consider how that pesticide affects the environment. Applicators must ask three questions:

- Where will the pesticide go after it leaves its container or application equipment?
- What effects could this pesticide have on those nontarget sites it may reach?
- What can I do to minimize harmful effects?

PESTICIDE CHARACTERISTICS

To understand how pesticides move in the environment, you must first understand certain physical and chemical characteristics of pesticides and how they determine a pesticide's interaction with the environment. These characteristics are solubility, adsorption, persistence, and volatility.

Solubility

Solubility is a measure of the ability of a pesticide to dissolve in a solvent, usually water. Pesticides that are highly soluble in water dissolve easily. These products are more likely than less-soluble pesticides to move with water in surface runoff or through the soil.

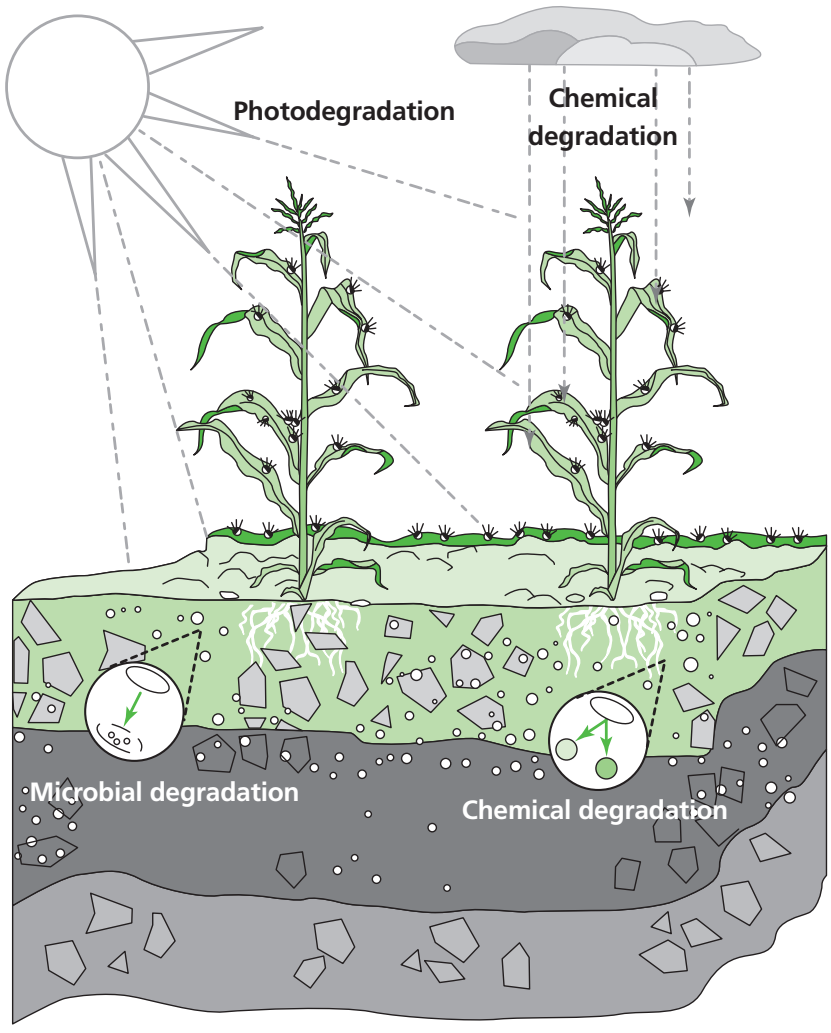


Figure 7.1
Breakdown of pesticides in the environment.

Adsorption

Adsorption is the process whereby a pesticide binds to soil particles. Adsorption occurs because of an attraction between the chemical and soil particles. Typically, oil-soluble pesticides are more attracted than water-soluble pesticides to clay particles and organic matter in soil. Also, pesticide molecules with a positive charge are tightly adsorbed to negatively charged soil particles. A pesticide that adsorbs to soil particles is less likely than one that does not adsorb tightly to soil to move from the spray site.

Persistence

Persistence is the ability of a pesticide to remain present and active in its original form for an extended period before breaking down. A chemical's persistence is described in terms of its "half-life": a comparative measure of the time needed for the chemical to break down (degrade). The longer the half-life, the more persistent the pesticide. The pesticide that remains in the environment after an application or spill is called **residue**. Sometimes residue is desirable because it provides long-term pest control and reduces the need for repeated applications. However, some persistent pesticides can harm sensitive plants or animals, including humans. Therefore, it is especially important to prevent persistent pesticides from moving offsite through improper handling, application, drift, leaching, or runoff.

Besides presenting a hazard to persons and nontarget animals entering a treated area, the application of persistent pesticides may produce illegal residues on rotational food or feed crops. To protect consumers, there are legal limits on how much residue may remain on products sold for food or feed. Check the label for statements about the persistence of the pesticide and for replanting restrictions. The rate of pesticide breakdown relates to the persistence of the pesticide.

Pesticide Breakdown

Several processes break down pesticide compounds into simpler and often less toxic chemicals. Some pesticides break down very rapidly—in a matter of days or even hours. Others linger in the environment for a year or more.

Pesticides are broken down or degraded by the following processes (Figure 7.1):

- **Chemical degradation**—the breakdown of chemicals that do not involve living organisms, usually by a chemical reaction with water.
- **Microbial action**—the breakdown of chemicals by soil microorganisms, such as fungi or bacteria.
- **Photodegradation**—the breakdown of chemicals in reaction to sunlight.

Water and temperature both affect the breakdown of pesticides. Warm, wet conditions can increase the speed of pesticide breakdown; cool, dry conditions slow down the degradation process.

Volatility

Volatility is the tendency of a pesticide to turn into a gas or vapor. Some pesticides are more volatile than others. The chance of volatilization increases as temperatures and wind increase. Volatility is also more likely under conditions of low relative humidity because evaporation increases in drier conditions.

HOW PESTICIDES MOVE IN THE ENVIRONMENT

Pesticides may move from the targeted application site in several ways: in air, in water, attached to soil particles, and on or in objects (see Figure 7.2).

Movement in Air

Pesticide movement away from the application site by wind or air currents is called **drift**. People who mix, load, and apply pesticides outdoors are usually aware of how easily pesticides may drift offsite. Those who handle pesticides indoors may not realize how readily some pesticides move offsite in the air currents created by ventilation systems and by forced-air heating and cooling systems. Pesticides may travel offsite as spray droplets, vapors, dusts or solid particles, and even on blowing soil particles.

Movement in Water

Most pesticide movement in water is either by surface movement off the treated site (**runoff**) or by downward movement through the soil (**leaching**). Runoff and leaching may occur when:

- Too much pesticide is applied or spilled onto a surface.
- Too much rainwater or irrigation water moves pesticide through the soil offsite or into groundwater.
- Highly water-soluble or persistent pesticides are used.

Runoff water in an outdoor environment may move into drainage systems, streams, ponds, or other surface water, where the pesticides can travel great distances. Pesticides that leach downward through the soil may reach groundwater.

In an indoor environment, water containing pesticides can flow into floor drains and contaminate water systems. A careless act, such as dumping a pesticide or rinsate down a sink or toilet, may contaminate an entire sewage or water-treatment facility.

Some pesticides can leach indoors. In a greenhouse, for example, pesticides may leach through the soil or other planting medium and contaminate other greenhouse surfaces.

Look for special instructions on the label that warn of pesticide hazards caused by the movement of pesticides in water. Sometimes labels require buffers or setbacks from water and wells.

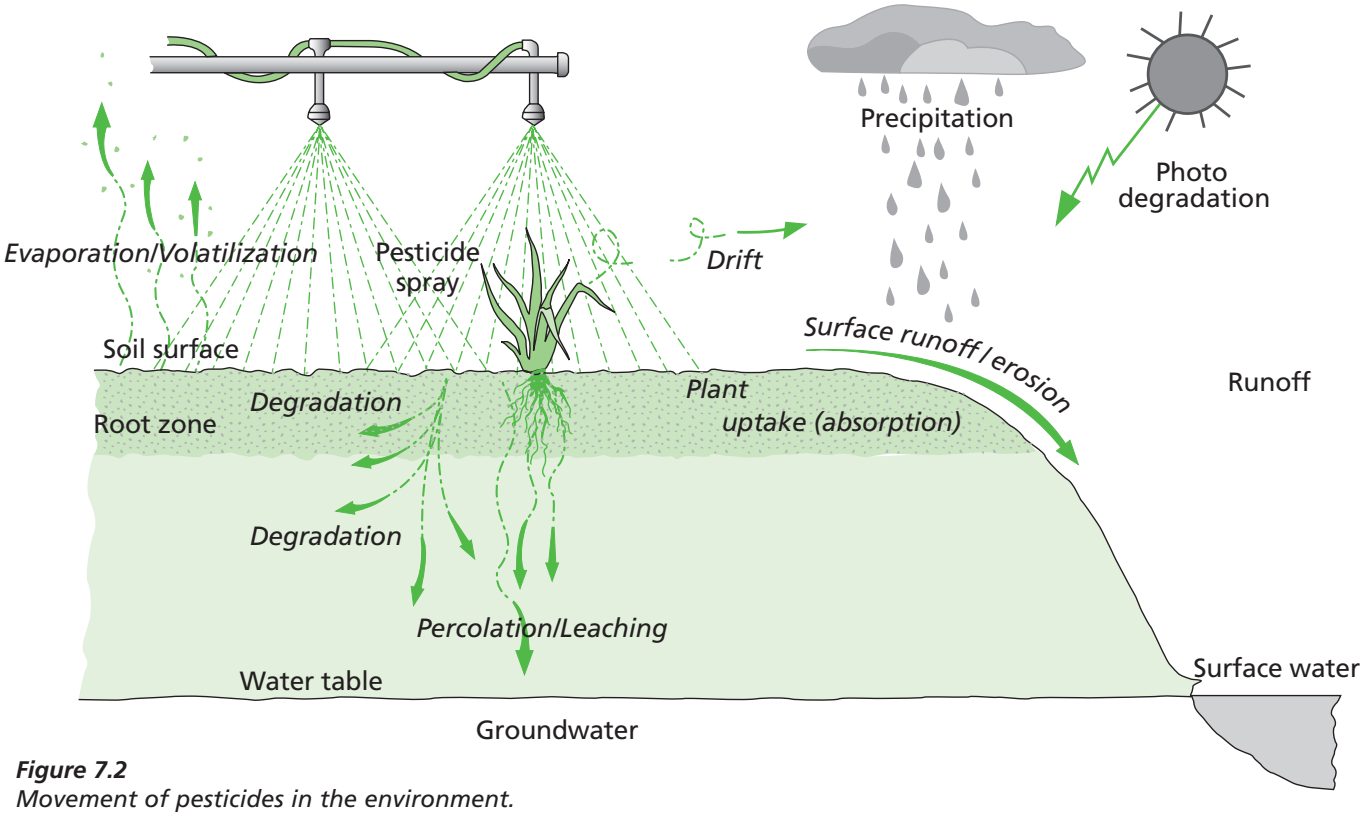


Figure 7.2
Movement of pesticides in the environment.

Movement on or in Objects, Plants, or Animals

Pesticides can also move away from the application site when they are on or in objects or organisms that move (or are moved) offsite. When pesticide handlers bring or wear home contaminated personal protective equipment, work clothing, or other items, pesticide residues may rub off on carpeting, furniture, and laundry items and onto pets and people.

PREVENTING PESTICIDE DRIFT

Studies have shown that a sizable percentage of pesticides may never reach the intended target site because of drift. Significant drift can damage or contaminate sensitive crops, poison bees, pose health risks to humans and animals, and contaminate soil and water in adjacent areas. It is impossible to eliminate drift, but it is possible to reduce it to a tolerable level.

Spray Drift

Spray drift refers to the off-target movement of a pesticide during a liquid application. This is the result of small spray droplets traveling offsite on air currents. Spray drift occurs more frequently than vapor drift or particle (dust) drift.

You can avoid most spray drift problems by paying close attention to *spray droplet size*, *wind direction*, and *wind speed*. Large spray droplets are less likely to drift than smaller ones. Selecting the proper nozzle and pressure is important to reduce drift. High pressure and nozzles with smaller orifices (openings) produce small droplets likely to drift. Conversely, large nozzle orifices and low pressures produce larger droplets.

Classification of Droplet Size

Nozzles produce a range of droplet sizes, known as the droplet size spectrum. Regardless of the type of nozzle used, a percentage of droplets created by a nozzle will be small enough to drift. Modern nozzle designs are

excellent options because they reduce the amount of droplets prone to drift during an application.

A droplet size classification system can help describe the droplet sizes produced by a nozzle. This standard (S-572.1—Spray Nozzle Classification by Droplet Size), established by the American Society of Agricultural and Biological Engineers, classifies nozzles into eight categories (see Table 7.1). Using these categories, you can select a nozzle, orifice size, and operating pressure that produce a label-recommended droplet size spectrum. Consult the label for the droplet size specifications that may be in place for a particular application.

Other Factors

The thickness of the liquid also affects droplet size. As the thickness increases, so does droplet size, thus reducing the chance of off-target movement. Fine spray droplets may begin to evaporate before reaching their target. These droplets become very small and light and may move offsite. Modern drift control additives will decrease drift potential without dramatically shifting the droplets to a larger size. Remember, however, to always follow the label directions about using a spray adjuvant intended to minimize drift. Some drift control additives may actually increase the drift potential of an applied tank mix. Also be aware that large spray droplets may reduce coverage, resulting in less pest control.

Wind speed and direction are the most important environmental factors influencing spray drift. Labels may indicate maximum and minimum wind speeds for application. Except in the case of temperature inversions (see below), the early morning and evening are often the best times to apply pesticides. This is because windy conditions are more likely to occur around midday, when the temperature near the ground increases. This causes hot air to rise quickly and mix rapidly with the cooler

ASABE STANDARD S-572.1[a]
SPRAY DROPLET SPECTRUM CATEGORIES

Category[b]	Symbol	Color Code[c]
Extra Fine	(XF)	Purple
Very Fine	(VF)	Red
Fine	(F)	Orange
Medium	(M)	Yellow
Coarse	(C)	Blue
Very Coarse	(VC)	Green
Extra Course	(XC)	White
Ultra Coarse	(UC)	Black

[a] Revised 2009. This standard defines droplet spectrum categories for the classification of spray nozzles relative to the specified reference fan nozzle. The purpose of classification is to provide the nozzle user with droplet size information primarily to indicate off-site spray drift potential and secondarily for application efficacy.

[b] Please refer to product label for specific guidelines on a droplet spectrum category required for a given application scenario.

[c] Nozzle manufacturers will provide information necessary to place their nozzle types into a droplet spectrum category based at least on orifice size and pressure. The color code is also standard.

Table 7.1
Spray Droplet Spectrum Categories.

air above it, favoring drift. The best time to spray is when spray droplets move slowly upward in the absence of windy or inversion conditions.

Low relative humidity and/or high temperatures also can increase the potential for spray drift. Under these conditions, the evaporation rate of water increases, resulting in smaller spray droplets that drift more easily. Avoid spraying during these times.

The height at which the pesticide is released above the ground or target may also affect drift. Applications that use large droplets close to the ground often produce little drift. Aerial spraying and tall tree spraying, on the other hand, are more likely to produce spray drift because they intersect large distances of air far from the ground. Drift from boom sprayers can be reduced by lowering the boom height to within 20 to 24 inches of the target crop.

Decrease outdoor drift by:

- Spraying when the wind speed is between 3 and 10 miles per hour.
- Spraying downwind from sensitive areas, such as residential properties, schools, crops, waterways, or beehives.
- Using proper nozzles and pressures.
- Using drift control additives (if appropriate).
- Lowering boom height.
- Leaving an untreated border or buffer area in the downwind target area.

To reduce drift indoors, pest control operators must consider the air circulation patterns inside buildings. Turn fans and air conditioners off and close vents where necessary to prevent pesticides from drifting to other parts of the building. Use low-volatile or nonvolatile pesticides and low-pressure treatments to reduce indoor pesticide drift.

Temperature Inversions

Applications made under low-wind conditions can sometimes produce more extensive drift than under high winds. Drift that occurs over long distances (more than a mile) is most often the result of applications made during a **temperature inversion** (under stable atmospheric conditions).

A temperature inversion exists when the air at ground level is cooler than the air above it. Under these conditions, the air is considered stable because there is little or no vertical air movement. Almost all air movement during an inversion is sideways (lateral). This causes a high concentration of small spray droplets to be suspended in this layer of cool air near the ground. These droplets can then be carried long distances, especially if wind speeds increase. When the spray droplets settle out, they may still be concentrated enough to cause damage or harm.

Inversions may occur at any time of the day and at any height above the ground. However, they most often develop during the early evening hours as the ground temperature begins to cool and the warm air has already risen.

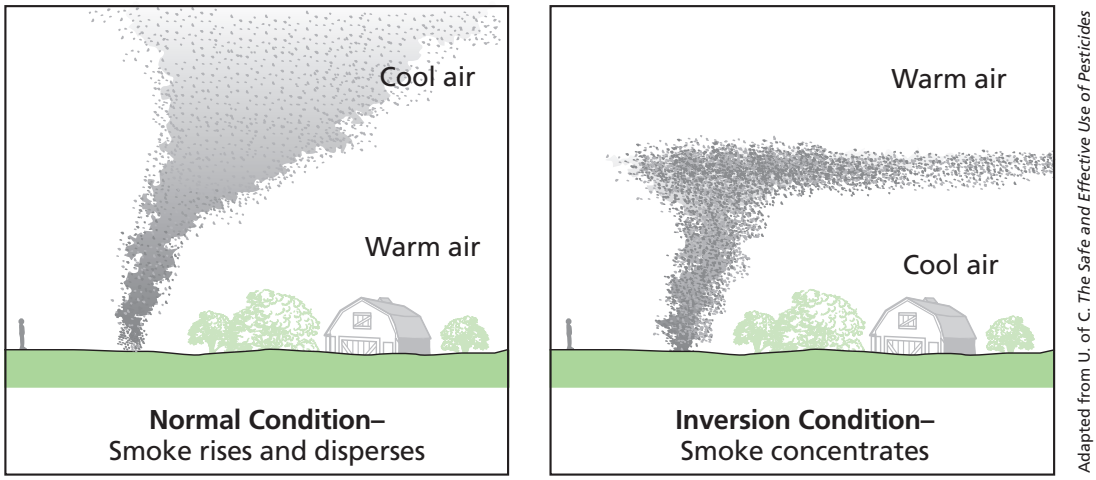


Figure 7.3 Dispersion of smoke particles under normal and inversion conditions.

Adapted from U. of C. *The Safe and Effective Use of Pesticides*

Inversion conditions intensify during the night and may persist until mid-morning, when the ground has warmed enough to start the vertical mixing of air (i.e., the wind starts to blow). This causes a dilution and separation of suspended spray droplets. Consequently, applications made during early evening, night, or morning hours under seemingly ideal conditions may result in highly damaging drift that can move long distances. This is especially true if the humidity is high. Such movement could occur up to one to three hours after the application.

You can recognize these stable air conditions (inversions) by observing the movement of dust or smoke. If dust or smoke rises little from its source and tends to hang in the air, an inversion may be present or developing (see Figure 7.3). Another way to detecting inversions is to place one thermometer at ground level and a second thermometer high above the ground. Then compare the difference in temperature. If the temperature at ground level is below that found at the elevated thermometer, a temperature inversion exists. Do not apply pesticides under such conditions.

Vapor Drift

Vapor drift refers to the movement of pesticides as gaseous vapors from the target area. Some pesticides are volatile: they change readily from a solid or liquid form into a gas under the right conditions. This usually occurs in hot weather. Pesticides that have volatilized into a vapor or gas may drift farther and for a longer time than they would have as spray droplets. Only those pesticides that are able to volatilize are susceptible to vapor drift. As air temperatures increase, the likelihood that these pesticides will volatilize and drift also increases.

Whenever possible, choose a pesticide formulated as a low-volatility product. Do not apply volatile pesticides on hot days. Some products may even volatilize several hours after application, so beware if high temperatures are predicted for later in the day (Figure 7.4). Many product labels advise against applying these products when temperatures are at or above 85°F. Remember to check label precautions for product-specific concerns about vapor drift.

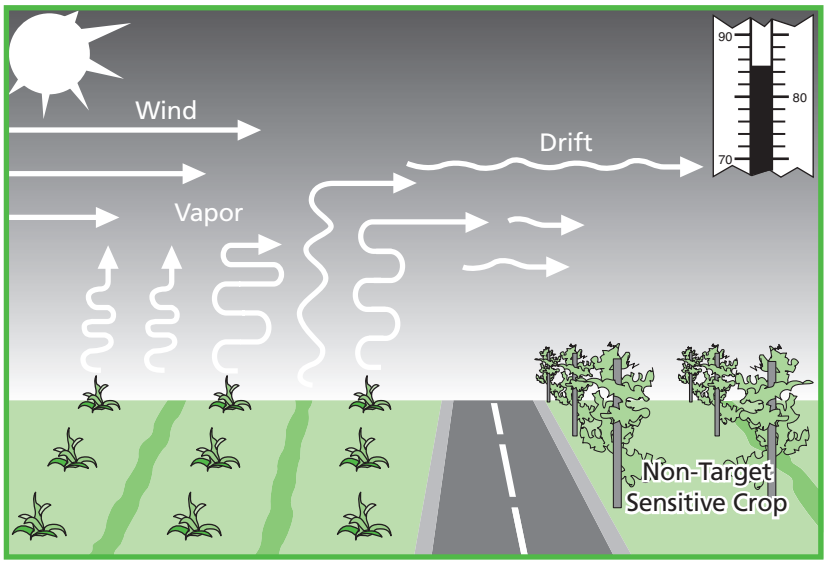


Figure 7.4
Vapor drift of pesticides is more likely as heat and wind increase and the relative humidity decreases.

Particle Drift (Dust Drift)

Particle drift refers to the movement of solid particles from the target area in the air during or just after an application. These solid particles may include pesticides formulated as dust or soil particles to which pesticides are attached. Some pesticides can remain active on soil particles long after they are applied. If particles are blown off the target site, sensitive areas may be contaminated or damaged. To prevent particle drift from outdoor pesticide applications from entering nearby buildings, be sure to close all windows and vents. Turn off all circulating fans, forced-air heating systems, and air-conditioning units.

For indoor pesticide applications, reduce particle drift by turning off fans, forced-air heating systems, and other air-circulating equipment. Check pesticide labels for statements related to these concerns.

Applicator Responsibility

As an applicator, you are legally responsible for any damages resulting from the off-target movement of pesticides. Assess the vulnerability of neighboring properties and those areas downwind of the application site. Evaluate weather conditions for tem-

perature inversions, wind direction, and wind speed before making the all-important decision about whether to spray. You may have to adjust your application equipment to reduce spray drift. Consider using low-volatile formulations or adding a drift control agent or thickener to help minimize drift. (For further discussion on equipment designed to minimize drift, see Chapter 11, Pesticide Application Procedures.) A good drift management program includes a combination of all drift reducing techniques available for a particular application.

If you apply pesticides indoors, you are also responsible for preventing drift. Ensure that:

- Pesticides do not move beyond the target site.
- All people and animals are kept out of the treatment area according to label instructions.

University of California Statewide IPM Porgram

Particle drift in a field.

SOURCES OF WATER CONTAMINATION

Surface water or groundwater contamination results from either **point-source** or **nonpoint-source** pollution (see Figure 7.5). Nonpoint-source pollution from pesticide applications is usually blamed for pesticide contamination of the outdoor environment. However, studies show that water contamination may also result from point-source pollution.

Point-source pollution comes from a specific, identifiable location, such as:

- A pesticide spill entering a storm sewer.
- Back-siphoning of pesticides into water supplies.
- Contaminated surface water entering sinkholes.
- Repeated spilling of pesticides at mixing and loading sites.
- Careless spilling of wash water at equipment cleanup sites.
- Improper handling of spills and leaks at storage sites.
- Improper disposal of containers, rinsate from containers, and excess pesticides.

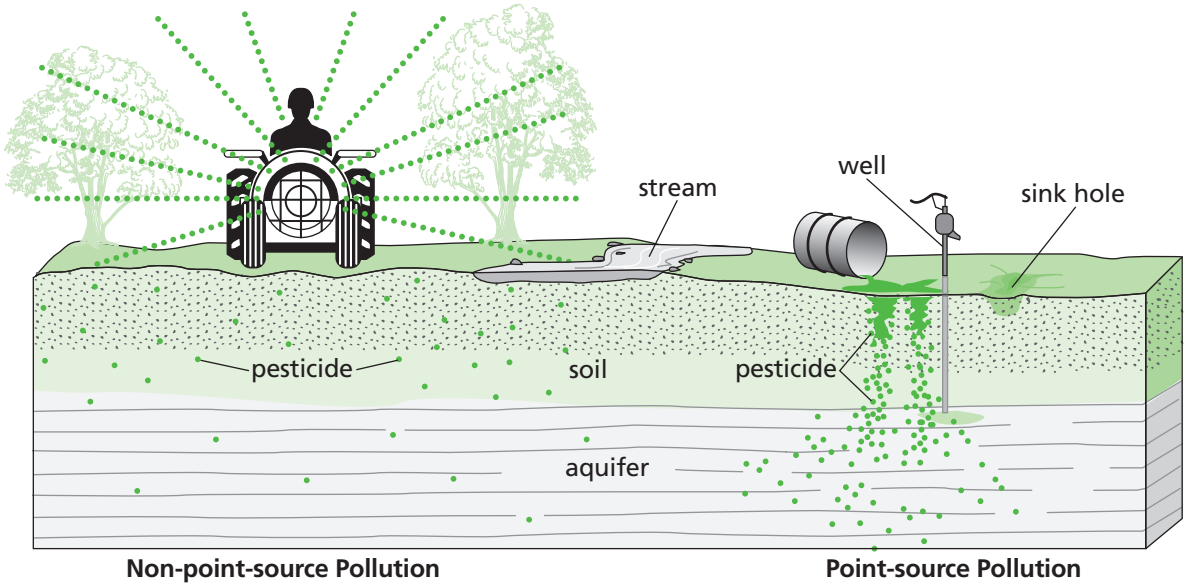
Nonpoint-source pollution comes from a widespread area. An example is the movement of pesticides into streams or groundwater after broadcast applications to large agricultural fields, rights-of-way, or turf areas.

Pesticide Contamination of Surface Water

Surface water is often a source of drinking water. Therefore, pesticide contamination of surface water (such as ditches, streams, rivers, ponds, and lakes) is a health concern. Pesticides that move in runoff water or with eroded sediment may contaminate plants and animals located downslope and reach sources of surface water.

Factors affecting runoff and erosion rates include slope, vegetative cover, soil characteristics, volume and rate of water moving downslope, temperature, and rainfall amount and intensity. These factors influence how much water runs off and how much moves into the soil (infiltration). In urban areas, runoff may occur on hard surfaces when granules are left on sidewalks and streets.

Runoff is a potential problem for most outdoor application sites. In areas



Adapted from U. of C. *The Safe and Effective Use of Pesticides*

Figure 7.5
Non-point-source pollution comes from a widespread area, while point-source pollution comes from a specific, identifiable location.

treated with any type of pesticide, it is critical that runoff does not carry the pesticide into water sources or other vulnerable areas.

Generally, runoff risk is greatest when heavy rains immediately follow pesticide applications or when the ground is saturated or frozen. Although surface waters are most likely to be contaminated by runoff, groundwater may also be affected when surface streams connect with shallow groundwater.

Pesticide Contamination of Groundwater

Groundwater provides 70% of the water used for public and private water supplies, irrigation, and industry. Like surface water, groundwater must be protected from contamination. Once groundwater is contaminated, correcting the problem is difficult or even impossible. Groundwater is found underground in cracks in the bedrock and in the spaces between soil particles, gravel, and rocks. It is the source of water for wells and springs.

The layer of soil, sand, gravel, or fractured bedrock in which all available spaces are filled with water is the **saturated zone**. The boundary between the saturated zone and the overlying unsaturated rock and soil is known as the **water table**. The overall geologic formation from which groundwater can be drawn is called an **aquifer** (see Figure 7.6).

Leaching

Some pesticides reach groundwater by moving through the soil in a process called leaching. A pesticide that leaches into groundwater must move down through the soil in water and resist binding to soil particles and breaking down into nontoxic compounds. Pesticides that have high solubility, low adsorption, and/or are persistent are more likely to leach. They typically have a label statement describing these concerns. A pesticide that adsorbs or binds itself strongly to soil particles will not leach as easily. Besides the characteristics of the pesticide, soil properties and environmental conditions also affect whether and to what extent a pesticide will leach.

Soil Properties

Four soil properties affect a pesticide's potential for leaching: texture and structure, organic matter, depth to groundwater, and geology.

Texture and Structure

Soil texture is the relative proportions of sand, silt, and clay-sized particles. Percolating water moves faster in sandy soils. Sand also has fewer binding sites available for the adsorption of dissolved chemicals than do clay or silt soils. Though sandy soils are more prone to pesticide movement, leaching may also occur in clay or silt soils.

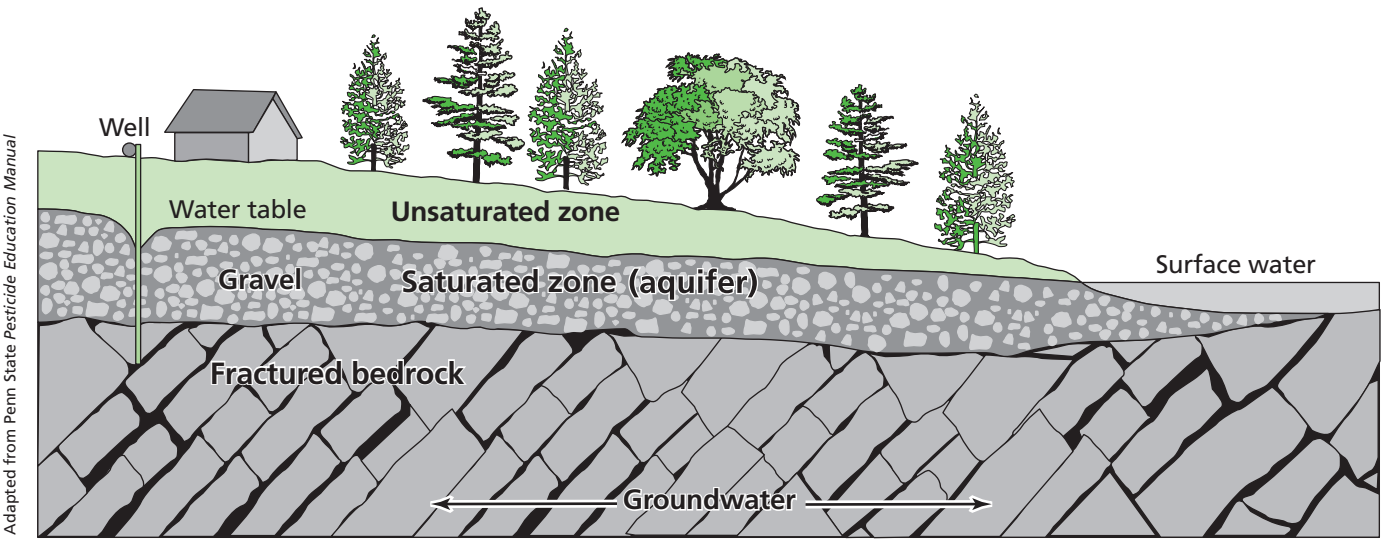


Figure 7.6
Where groundwater occurs.

Soil structure is the shape or arrangement of soil particles. It plays a big role in determining the size and shape of the pores through which water moves. Small amounts of pesticides may also move through soil cracks, worm holes, and root channels. These features are called macropores.

Organic Matter

Organic matter consists of decaying plant material. The higher the soil organic matter content, the greater the ability of the soil to hold both water and adsorbed pesticides. Pesticides held in the root zone are less likely to leach into groundwater and may be taken up by plants.

Depth to Groundwater

Areas with a shallow water table have a greater chance for groundwater contamination because less soil is available to act as a filter. There are fewer opportunities for pesticide degradation or adsorption. When using pesticides in areas where the groundwater is close to the surface, choose a product with a low leaching potential.

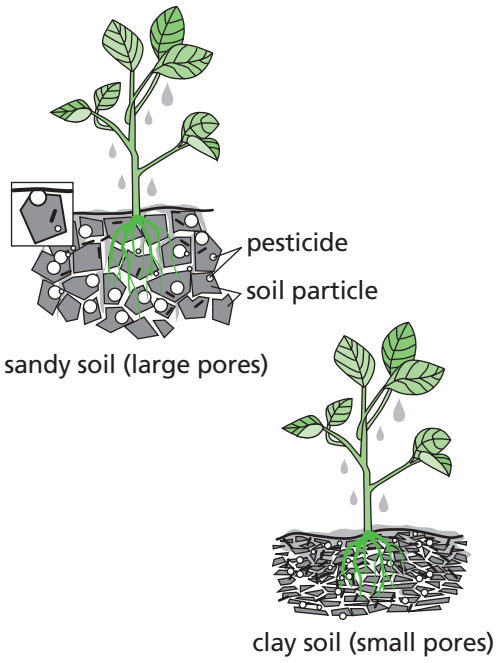


Table 7.2 Soil Properties

TEXTURE (affects movement of water particles)	ORGANIC CONTENT (measures volume of water and soil's ability to adsorb pesticides)	PERMEABILITY (measures speed of water's downward movement)
coarse (sand)	**low organic content=** faster water flow and little adsorption of pesticides	↓ **high permeability** (fast flow)
smooth (clay, silt)	**high organic content=** higher water retention and greater adsorption of pesticides	↓ **low permeability** (slow flow)

OSU *Pesticides and Groundwater Contamination*

Take extra precautions during mixing, application, and cleanup.

Geology

The **permeability** of the geologic layers lying between the surface of the soil and the groundwater is also an important factor. Highly permeable materials (such as gravel deposits) allow water and dissolved pesticides to move freely downward to groundwater. Layers of clay, which are much less permeable, can inhibit and slow the downward movement of water.

PREVENTING SURFACE WATER AND GROUNDWATER CONTAMINATION

To help prevent surface water and groundwater contamination, EPA requires all pesticide products labeled for outdoor uses to include the following environmental hazard statement on the label:

"Do not apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water supplies when cleaning equipment or disposing of equipment wash waters."

Pesticides that could contaminate groundwater must bear groundwater warning statements on their labels. When such statements appear on product labels, choose pesticides appropriate for use in sandy soils or where extra precautions are needed to reduce the risk of water contamination.

You can minimize the risk of point- or nonpoint-source contamination by following best management practices (BMPs). BMPs are effective, commonsense procedures that emphasize proper mixing, loading, application, and disposal of pesticides. Following BMPs reduces the chance that pesticides will harm the environment.

Use Integrated Pest Management Principles

Apply pesticides only when and where necessary, and only in amounts adequate to control pests. Use nonchemical control methods whenever possible. When using pesticides:

- Determine the type of pest, the density of the pest population, and the proper control method.
- If a pesticide is necessary, choose the least toxic product that will do the job.
- Calibrate pesticide application equipment regularly.
- Use spot treatments or band applications, if possible, to reduce pesticide use.

Identify Vulnerable Areas

The presence of sandy soil, sinkholes, wells, streams, ponds, and shallow groundwater increases the chance of groundwater contamination. Never dispose of empty pesticide containers in sinkholes, or dump or rinse sprayers into or near sinkholes (see Chapter 10, Planning the Pesticide Application). Also take care to avoid contaminating drainage ditches and other potential sources of runoff to streams and waterways. ***Never*** clean tanks or intentionally discharge water from a tank of any vehicle into a street, along a road, or into a storm drain.

Do Not Mix and Load Near Water

Mix and load as far as possible (at least 50 feet) from wells, lakes, streams, rivers, and storm drains. When possible, do so at the application site. Consider using a sealed permanent or portable mixing and loading pad to prevent seepage into soil.

Keep Pesticides Away from Wells

Do not store or mix pesticides around wells. Poorly constructed or improperly capped or abandoned wells

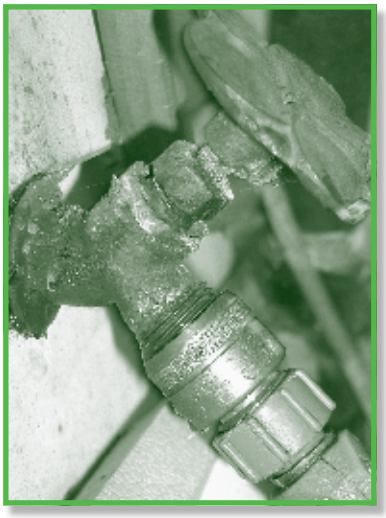
may allow surface water containing pesticides and other contaminants direct entry into groundwater. Note that wells are sometimes located in or near treated fields and other application sites.

Avoid Back-siphoning

Back-siphoning is the reverse flow of liquids into a fill hose. It sucks tank contents (including pesticides) back into the water supply. Back-siphoning starts with a reduction in water pressure and can draw very large quantities of pesticide directly into the water source. This happens when the end of the water hose is allowed to extend below the surface of the spray mixture when filling a spray tank. The simplest way to prevent backflow is to maintain an air gap between the discharge end of the water supply line and the pesticide solution in the spray tank. An air gap prevents contamination of the hose and keeps pesticides from back-siphoning into the water source if a drop or loss of water pressure occurs. Keep the air gap at least twice the diameter of the discharge pipe. Another method to prevent back-siphoning is to use a backflow prevention device or check valve (see Chapter 10).

M.J. Weaver, Virginia Tech Pesticide Programs

Maintain an air gap between the discharge end of the water supply line and the spray tank to prevent backflow of pesticides.



Ed Crow, Maryland Department of Agriculture

Use an anti-backflow device (check valve) to prevent back-siphoning.

Improve Land Use and Application Methods

Terraces and conservation tillage practices can reduce water runoff and soil erosion. Ideally, growers should leave as much plant residue as possible on the soil surface to lessen erosion. Where conservation tillage is not possible, decrease runoff potential by incorporating a low concentration of the pesticide into the soil. In ornamental plantings, consider using mulches to reduce water runoff and soil erosion.

Grass buffer strips are very effective in reducing pesticide runoff because they trap sediment containing pesticides and slow runoff water. This allows more runoff water to infiltrate the soil. Leaving untreated grass strips next to streams, ponds, and other sensitive areas can trap much of the pesticide running off of treated areas.

Time Pesticide Applications According to the Weather Forecast

Pesticides are most susceptible to runoff from heavy rains or irrigation during the first several hours after application. Do not apply to saturated or frozen ground. To avoid overspraying an area and causing drift, check the pesticide label for application precautions or restrictions during windy conditions. Wind speed, temperature, and humidity all affect the off-target movement of pesticides.

Select Products Wisely

Whenever possible, use pesticides that are less likely to leach. Read labels for such warnings.

Handle Pesticides Safely

Follow these guidelines to prevent surface water or groundwater contamination:

- Immediately contain and control pesticide spills.
- Check application equipment regularly for leaks or damage.
- Mix and load pesticides away from water sources.
- After the pesticide application is complete, follow label directions for proper equipment cleanup and container disposal.
- After applying granular pesticides, sweep or blow any granules from sidewalks, driveways, or patios onto the treatment area.

Whenever possible, clean sprayers at the application site at a safe distance from wells, ponds, streams, and storm drains. Spray the rinsate on the treated area or on another site listed on the pesticide label, or use in the next tank mix. Be sure not to exceed label rates.

PREVENTING HARMFUL EFFECTS ON SENSITIVE AREAS AND NONTARGET ORGANISMS

To avoid harming the environment, you must be aware of sensitive areas, nontarget plants and animals (especially endangered species), and damaging effects on habitat.

Sensitive Areas

In addition to water sources, sensitive areas include sites where living things could easily be injured by a pesticide. Outdoor sensitive areas include:

- School grounds, playgrounds, and recreational areas.
- Habitats of endangered species.
- Apiaries (honey bee sites), wildlife refuges, and parks.
- Areas where domestic animals and livestock are kept.
- Ornamental plantings, public gardens, and sensitive food or feed crops.

Indoor sensitive areas include places where:

- People live, work, shop, or are cared for (such as hospitals and daycare centers).
- Food or feed is processed, prepared, stored, or served.
- Domestic or confined animals live, eat, or are otherwise cared for.
- Ornamental or other sensitive plants are grown or maintained (such as in malls and buildings).

Sometimes pesticides must be deliberately applied to a sensitive area to control a regulated pest (such as mosquito abatement or gypsy moth forest treatments). Only well-trained applicators should perform these applications.

At other times, the sensitive area may be part of a larger target site. Whenever possible, take special precautions to avoid treating the sensitive area. Leaving an untreated buffer zone around a sensitive area is a practical way to avoid contaminating it.

In still other instances, the sensitive area may be near a site used for mixing and loading, storage, disposal, or equipment washing. Be very careful to avoid contaminating the sensitive area. Check the label for statements that alert you to special restrictions around sensitive areas.

Sensitive area—apiary.

Sensitive area—wildlife habitat.

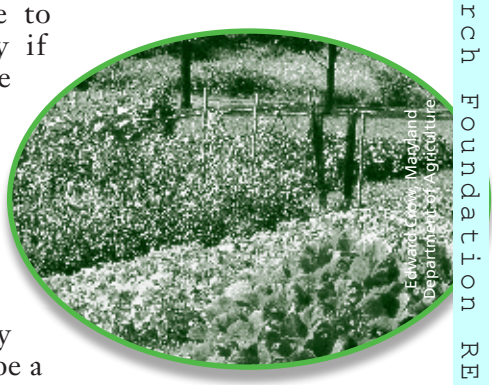
Sensitive area—playground.

Pesticide Effects on Nontarget Organisms

Pesticides may affect nontarget organisms directly, causing immediate injury. Or they may produce long-term consequences through environmental pollution. Pesticides may build up in the bodies of animals or in the soil. For example, if you use the same mixing and loading site or equipment cleaning site over a long period, pesticides are likely to accumulate in the soil. When this occurs, plants and animals that come into contact with the soil may be harmed. The following sections discuss the effects of pesticides on nontarget plants; bees and other beneficial insects; and fish, wildlife, and livestock.

Nontarget Plants

Nearly all pesticides can cause plant injury (phytotoxicity) due to chemical exposure, particularly if applied at too high a rate, at the wrong time, or under unfavorable environmental conditions. Phytotoxicity can occur on any part of a plant—roots, stems, leaves, flowers, or fruits. Most phytotoxic injury is due to herbicides. Although damage to crops or other nearby plants is primarily caused by drift, it may sometimes be a consequence of surface runoff and root uptake.



Avoid pesticide effects on non-target plants.

Bee hazard icon on labels indicate use restrictions.

Bees and Other Beneficial Insects

Besides making honey and beeswax, bees pollinate many fruit, nut, seed, vegetable, and field crops. You must be aware of bee activity when planning pesticide applications. There has been increasing concern about the decline of bee colonies and the role pesticides may play. Preventing bee loss is the joint responsibility of the applicator, the grower, and the beekeeper. Bees may travel as far as 3 miles from their hive to find blooming flowers. Before applying pesticides labeled as toxic to bees, notify beekeepers in the area so they can protect or move their bee colonies. Some states have laws requiring notification and registries for beekeepers.

Bees and other insect pollinators may be exposed to pesticides through different routes, including:

1. Direct contact during foliar applications.
2. Contact with residues on plant surfaces after applications.
3. Drift from the application into the hive entrance.
4. Ingestion of residues in nectar, pollen, or guttation water (dew) when the pesticide is applied as a seed treatment, soil or tree injection, or foliar application.

Avoid spraying when bees are actively foraging.

Insecticides are generally toxic to bees, but some are more hazardous than others. Herbicides are unlikely to harm bees directly. Fungicides do not appear to affect adult bees but may affect larval development. Tank mixing insecticides and fungicides may create a mixture that is more toxic to bees than either product used alone.

Minimize bee kills from insecticide poisoning by following a few basic principles:

- Pay careful attention to pesticide labels. For each application site, look for the bee hazard icon in the "Directions for Use" section for specific use restrictions and instructions to protect bees and other pollinators.
- Do not apply insecticides to crops in bloom.
- Apply insecticides in the evening or at night when bees are not foraging. (Early morning application may protect honey bees, but wild bees forage at or before dawn.)
- Do not apply insecticides when weeds or other plants around the treatment site are in bloom.
- Do not allow the pesticide to drift onto attractive habitat, natural areas, or beehives.
- Choose the least hazardous insecticide, formulation, and application method.

Pesticides can harm other beneficial insects in addition to bees. These beneficials may be valuable allies in keeping pest populations below damaging levels. A pesticide application often harms the beneficial insect population as much as the target pest. So do not spray when beneficial insects are in the target area unless it is unavoidable. Alternatively, choose a product that does not harm beneficials.

Fish, Wildlife, and Livestock

Pesticides can harm all kinds of animals. Most injuries occur from the direct effects of acute poisoning. Fish kills often result from water pollution by a pesticide. Insecticides are the most likely cause, especially when small ponds or streams are under conditions of low water flow or volume.

Bird kills resulting from pesticide exposure may happen in a number of ways. Birds may: ingest pesticide granules, baits, or treated seeds; be exposed directly to sprays; consume treated crops or drink contaminated water; or feed on pesticide-contaminated insects and other prey. Granular or pelleted formulations are a particular concern because birds and other animals often mistake them for food. Liquid formulations may be safer when birds and other wildlife are in or near the treated area. Remove pet dishes from spray areas. Place baits properly so

they are inaccessible to pets, birds, and other wildlife.

Animals may also be harmed when they eat plants or animals carrying pesticide residues. Predatory birds or mammals feeding on animals killed by pesticides are a special concern. Pesticide residues remaining on or in the bodies of the dead animal may harm predators. This is called secondary poisoning. Check the pesticide label for statements about **secondary poisoning**.

The less obvious effects resulting from long-term exposure to pesticides are a major concern. For example, certain pesticides have been banned because of fish and bird kills and the reproductive failures of several bird species.

The most important source of livestock pesticide poisoning has been through contaminated feed, forage, and drinking water. Contamination often occurs as a result of improper or careless transportation, storage, handling, application, or disposal of pesticides.

PROTECTING ENDANGERED SPECIES

Certain plants and animals have been identified as endangered or threatened species. Be very careful not to harm these populations. Because all living things are part of a complex, delicately balanced network, removing a single species may set off a chain reaction that affects many other species. The full significance of extinction is not always readily apparent, and the long-term effects are often difficult to predict.

An **endangered species** is one on the brink of extinction throughout all or a significant part of its range. A **threatened species** is one likely to become endangered. The reasons for a species' decline are usually complex, and thus recovery is difficult. A major problem for most wildlife is the destruction of habitat, usually the result of industrial, agricultural, residential, or recreational development.


Protecting Endangered Species
Interim Measures
Harford County, Maryland

Consulting a county bulletin is necessary for pesticides that might adversely affect endangered species.

Each state is responsible for implementing the federal Endangered Species Protection Program in cooperation with EPA to protect endangered and threatened species from the harmful effects of pesticides. Under this program, pesticide products that might harm an endangered species carry a label statement instructing applicators to consult a county bulletin to determine if they must take any special precautionary measures when using the product. EPA develops these bulletins, which identify precautionary measures required in each county where one or more pesticides could affect an endangered or threatened species. Precautionary measures may include buffer strips, reduced application rates, and timing restrictions. Or an applicator might be prohibited from using the pesticide within the identified habitat altogether. Check with your state, tribe, or territory department of agriculture; local Extension Service; or the EPA website (www.epa.gov) to find out the status of available county bulletins.

Pesticides can be harmful to all kinds of animals.

SUMMARY

An important part of using pesticides legally and responsibly is considering where the pesticide may end up once it leaves the container and whether it might harm or damage nontarget sites, plants, or animals. By applying pesticides at the right time, in the right place, and with the proper application technique, you can greatly reduce—or even prevent—drift, runoff, and leaching.

Endangered species need to be protected from pesticides.

Pesticides that enter groundwater and surface water are hazardous to aquatic organisms, plants, and wildlife. Therefore, you should implement best management practices to prevent runoff and leaching of pesticides.

Sensitive areas include places such as schools, playgrounds, endangered species' habitats, and ornamental plantings. Nontarget organisms include plants, bees and other beneficial insects, fish, wildlife, and livestock. Because of the greater risk of injury to people, plants, and animals, you must know when and how to properly apply pesticides in or near such areas.

Always check the label for statements on endangered and threatened species. You may need to consult a county bulletin that details the procedures for protecting them. It is your responsibility not only to follow label directions but also to use the best management practices that present the least risk to the environment while achieving effective pest control.

Continued from page 1

plication exclusion zones (AEZ). The compliance dates in the revised WPS published on November 2, 2015, remain in effect; the Agency does not intend to extend them.

* * *

Below are notes about those three aspects of the Worker Protection Standard (WPS)

NOTES about Three Aspects of the Current Worker Protection Standard (WPS)

MINIMUM AGES

Handlers and early-entry workers must be at least 18 years old. (Members of owner's immediate family are exempt from this and most other requirements of the WPS.)

A handler is any person, including a self-employed person, who is employed by an agricultural employer or commercial pesticide handler employer and performs any of the following activities:

- *Mixing, loading or applying pesticides,*
- *Disposing of a pesticide,*
- *Handling opened containers of pesticides, emptying, triple-rinsing, or cleaning pesticide containers according to pesticide product labeling instructions or disposing of pesticide containers that have not been cleaned,*
- *Acting as a flagger,*
- *Cleaning, adjusting, handling, or repairing the parts of mixing, loading or application equipment that may contain pesticide residues,*
- *Assisting with the application of pesticides,*
- *Entering an enclosed space after the application of a pesticide and before the inhalation exposure level listed in the labeling has been reached or one of the ventilation criteria established by WPS or the labeling has been met to operate ventilation equipment, monitor air levels, or adjust or remove coverings used in fumigation,*
- *Entering a treated area outdoors after application of any soil fumigant during the labeling-specified entry-restricted period to adjust or remove coverings used in fumigation, and*
- *Performing tasks as a crop advisor during any pesticide application or restricted-entry interval, or before the inhalation exposure level listed in the pesticide product labeling has been reached or one of the ventilation criteria established by WPS or the pesticide product labeling has been met.*

A worker is any person, including a self-employed person, who is employed and performs activities directly relating to the production of agricultural plants on an agricultural establishment. (Some examples of worker activities are planting, weeding, pruning, irrigating, and harvesting.)

Early entry means entry by a worker into a treated area on the agricultural establishment after a pesticide application is complete, but before any restricted entry interval (REI) for the pesticide has expired.

DESIGNATED REPRESENTATIVE

A designated representative is any person designated in writing by a worker or handler to exercise a right of access on behalf of the worker or handler to request and obtain a copy of the pesticide application and hazard information required by 40 CFR 170.309(h) in accordance with 40 CFR 170.311(b).

APPLICATION EXCLUSION ZONES

An application exclusion zone (AEZ) is the area surrounding the application equipment that must be free of all persons other than appropriately trained and equipped handlers during pesticide applications. (For a complete explanation, see p.38 of the booklet titled ***How to Comply With the 2015 Revised Worker Protection Standard For Agricultural Pesticides***, which may be downloaded from *http://www.epa.gov/pesticide-worker-safety/pesticide-worker-protection-standard-how-comply-manual*.)

*This rule took effect on January 2, 2017 but it becomes stricter beginning January 2, 2018, as follows: Since January 2, 2017, during pesticide applications, agricultural **employers** must keep workers and other persons out of the AEZ surrounding the pesticide application equipment **within** the establishment's property boundary. But beginning one year later, on January 2, 2018, the rule becomes stricter by requiring **handlers** to suspend applications if anyone, other than a trained and equipped handler involved with the application, is in the AEZ which can **extend beyond** the establishment's property boundary.*

* * *

Articles in Previous Issues

Titles of recertification articles are underlined. You may download the issues free of charge from: *http://pestworld.stjohn.hawaii.edu/pat/oldissue.html*.

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