

If Pennsylvania growers are to produce a commercially acceptable and profitable product, they often rely on the use of pesticides. Many growers in the state practice integrated pest management (IPM) where pesticides play a vital role. Applicators must realize the legal and moral obligations when using pesticides. Furthermore, applicators who implement pesticide safety practices and take adequate precautions will greatly reduce the possibility of accidents.

USING PESTICIDES SAFELY

General Guidelines for Pesticide Safety **ALWAYS READ THE LABEL!**

Only use pesticides when necessary. Before using any pesticide product, always read the label, as it is a legal document. The label provides information on which pests can be controlled, on which crops the pesticide product can be used, and the recommended rates and times of application. Any “off label” use is a violation of both Federal and state laws. Correct use of pesticides is essential to protect human, animal, and plant health as well as to protect the environment. Additionally, proper use will ensure chemical residues on crops and animals do not exceed legal limits (tolerances).

- Before using any pesticide, READ THE LABEL.
- Become familiar with current federal and state pesticide laws and regulations.
- Follow all safety precautions on the label.
- Wear protective clothing and use protective equipment (both are referred to as PPE) according to instructions on the pesticide label.
 - Minimum clothing requires long pants, long-sleeved shirt, socks, and shoes. In addition, chemically resistant gloves (nitrile, butyl, or neoprene) and unlined rubber boots should be worn.
- Be careful when handling pesticide materials to avoid spilling on skin or clothing.
- Never eat, drink, smoke, or use tobacco products while applying pesticides.
- When selecting pesticides, consider type of formulation and the application equipment required.
- Avoid drift to nontarget areas, which may endanger other plants or animals. Dusts drift more than sprays and airblast sprayers create more drift than boom sprayers.
- For record-keeping requirements, record the date, time, location, amount of each pesticide used, and any other required information as soon as possible.
- Bathe or shower in hot, soapy water after applying pesticides.
- Wash clothing worn while applying pesticides separate from other laundry, in hot, soapy water. Contaminated clothing must be handled with the same precautions as the pesticide itself.

PESTICIDE TOXICITY

For all pesticides to be effective against the pests they are intended to control, they must be biologically active, or toxic. Because pesticides are toxic, they are also potentially hazardous to humans and animals. Any pesticide can be poisonous or toxic if absorbed in excessive amounts. Pesticides can cause skin or eye damage (topical effects) and can also induce allergic responses. However, if used according to label directions and with the proper personal protective equipment (PPE), pesticides can be used safely. For this reason, people who use pesticides or regularly come in contact with them must understand the relative toxicity and the potential health effects of the products they use.

The risk of exposure to pesticides can be illustrated with the following simple equation:

$$\text{Hazard of Pesticide Use} = \text{Toxicity} \times \text{Actual Exposure}$$

Toxicity is a measure of the ability of a pesticide to cause injury, which is a property of the chemical itself. Pesticide toxicity is determined by exposing test animals to different dosages of the active ingredient. Tests are also done with each different formulation of the product (for example, liquids, dusts, and granulars). Pesticide toxicities are listed in milligrams of exposure to kilograms of animal body weight. By understanding the difference in toxicity levels of pesticides, a user can minimize the potential hazard by selecting the pesticide with the lowest toxicity that will control the pest.

Applicators may have little or no control over the availability of low-toxicity products or the toxicity of specific formulated products. However, exposure can be significantly reduced or nearly eliminated by using personal protective clothing and equipment. For example, over 90 percent of all pesticide exposure comes from dermal exposure, primarily to the hands and forearms. By wearing a pair of chemically resistant gloves, this exposure can be reduced at least 90 percent. Therefore, by wearing the correct PPE, the hazard of pesticide use can be reduced to an insignificant level for the applicator.

Acute toxicity and acute effects

Acute toxicity of a pesticide refers to the chemical’s ability to cause injury to a person or animal from a single exposure, generally of short duration. The four routes of exposure are dermal (skin), inhalation (lungs), oral (mouth), and eyes. Acute toxicity is determined by examining the dermal toxicity, inhalation toxicity, and oral toxicity of test animals. In addition, eye and skin irritation is also examined.

Acute toxicity is usually expressed as LD₅₀ (lethal dose 50) or LC₅₀ (lethal concentration 50). This is the amount or concentration of a toxicant required to kill 50 percent of a test population of animals under a standard set of conditions. LD₅₀ values of pesticides are recorded in milligrams of pesticide per kilogram of body weight of the test animal (mg/kg), or in parts per million (ppm). LC₅₀ values of pesticides are recorded in milligrams of pesticide per volume of air or water (ppm). To put these units into perspective, 1 ppm is analogous to 1 inch in 16 miles or 1 minute in 2 years.

The LD₅₀ and LC₅₀ values are found in the product's Material Safety Data Sheet (MSDS), which is available from the supplier or product manufacturers when pesticide products are purchased. Most are also available from various online sources, including the manufacturer's Web site or through various search engines as listed on our Web site at <http://www.pested.psu.edu/resources/web/labels.shtml>. For many reasons, especially in an emergency situation, maintaining a file with copies of the label and MSDS for each pesticide product used is highly recommended.

The LD₅₀ and LC₅₀ values are useful in comparing the toxicity of different active ingredients as well as different formulations of the same active ingredient. The lower the LD₅₀ value of a pesticide, the less it takes to kill 50 percent of the test population, and therefore the greater the acute toxicity of the chemical. Pesticides with high LD₅₀ values are considered the least acutely toxic to humans when used according to the directions on the product label.

Signal words

Acute toxicities are the basis for assigning pesticides to a toxicity category and selecting the appropriate signal word for the product label. Pesticides that are classified as "highly toxic," on the basis of either oral, dermal, or inhalation toxicity, must have the signal words **DANGER** and **POISON** (in red letters) and a graphic of a skull and crossbones prominently displayed on the package label. **PELIGRO**, the Spanish word for danger, must also appear on the label of highly toxic chemicals. Acute oral LD₅₀ values for pesticide products in this group range from a trace amount to 50 mg/kg. An exposure of a few drops of a highly toxic material taken orally could be fatal to a 150-pound person.

Some pesticide products are labeled with the signal word **DANGER** without the skull and crossbones symbol. A **DANGER** signal word does not provide information about the LD₅₀ value of the chemical. Instead, this signal word alerts the user of potentially more severe skin or eye effects from the product (caused by its irritant or corrosive properties).

Pesticide products considered "moderately toxic" must have the signal words **WARNING** and **AVISO** (Spanish) displayed on the label. Acute oral LD₅₀ values range from 50 to 500 mg/kg. An exposure of 1 teaspoon to 1 ounce could be fatal to a 150-pound person.

Pesticide products classified as either "slightly toxic or relatively nontoxic" are required to have the signal word **CAUTION** on the pesticide label. Acute oral LD₅₀ values are greater than 500 mg/kg.

Chronic toxicity and chronic effects

Any harmful effects that occur from repeated small doses over a period of time are called chronic effects. The chronic toxicity of a pesticide is determined by observing symptoms of test animals that result from long-term exposure to the active ingredient.

Some of the suspected chronic effects from exposure to certain pesticides include birth defects (teratogenesis); fetal toxicity (fetotoxic effects); production of tumors (oncogenesis), either benign (noncancerous) or malignant (cancerous/carcinogenesis); genetic changes (mutagenesis); blood disorders (hemotoxic effects); nerve disorders (neurotoxic effects); and reproductive effects. The chronic toxicity of a pesticide is more difficult to determine through laboratory analysis than is acute toxicity. The

product's MSDS also contains information regarding chronic symptoms of pesticide exposure.

SYMPTOMS OF PESTICIDE POISONING

The symptoms of pesticide poisoning can range from a mild skin irritation to coma or even death. Different classes or families of chemicals cause different types of symptoms. Individuals also vary in their sensitivity to different levels of these chemicals. Some people may show no reaction to an exposure that may cause severe illness in others. Because of potential health concerns, pesticide users and handlers must recognize the common signs and symptoms of pesticide poisoning.

The effects, or symptoms, of pesticide poisoning can be broadly defined as either topical or systemic. Topical effects generally develop at the site of pesticide contact and are a result of either the pesticide's irritant properties (either the active and/or inert ingredient) or an allergic response by the victim. Dermatitis, or inflammation of the skin, is accepted as the most commonly reported topical effect associated with pesticide exposure. Symptoms of dermatitis range from reddening of the skin to blisters or rashes. Some individuals exhibit allergic reactions when using pesticides or when these materials are applied in or around their homes or places of work. Symptoms of allergic reactions range from reddening and itching of the skin and eyes to respiratory discomfort often resembling an asthmatic condition.

Systemic effects are quite different from topical effects. They often occur away from the original point of contact, as a result of the pesticide being absorbed into and distributed throughout the body. Systemic effects often include nausea, vomiting, fatigue, headache, and intestinal disorders.

Seeking prompt medical attention is important; however, the development of certain symptoms is not always the result of exposure to a pesticide. Common illnesses such as the flu, heat exhaustion or heat stroke, pneumonia, asthma, respiratory and intestinal infections, and even a hangover can cause symptoms similar to pesticide exposure. Carefully consider all possible causes of your symptoms.

Responding to pesticide poisoning symptoms

Be alert for the early symptoms of pesticide poisoning. Responding immediately and appropriately when pesticide exposure is suspected will help minimize the effects of exposure and, in extreme cases, may save a life. If you are having symptoms but are unsure if they are pesticide related, at least notify someone in case your symptoms become worse. At this time, call the National Poison Center at 1-800-222-1222 for guidance on the proper response to your symptoms. This number will direct your call to the nearest poison center, which is staffed on a 24-hour basis.

If safe to do so, take the pesticide container to the telephone. (However, if the pesticide container is contaminated, write down the product name and percentage of active ingredients, and take that to the phone.) The product label provides medical personnel information such as active ingredients, an antidote, and an emergency contact number for the manufacturer of the product. If you must go to the hospital or doctor's office, take the entire container, including the label, with you. In order to avoid inhaling fumes or spilling the contents, make sure the container is tightly sealed and never put it in the enclosed passenger section of a vehicle.

If the Material Safety Data Sheet (MSDS) is available, take this with you also because it frequently contains additional information for medical personnel. In addition to posting emergency numbers or having them readily available by a telephone, keep these numbers in all service vehicles involved in transporting pesticides. Additional pesticide information can also be obtained by contacting the National Pesticide Information Center (NPIC) located at Oregon State University at 1-800-858-7378. The NPIC provides a variety of unbiased information about pesticides to anyone in the United States. (Medical professionals and government agencies can call NPIC at 1-800-858-7377.)

FIRST AID FOR PESTICIDE POISONING

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Immediate and appropriate action, such as providing first aid, may be necessary to prevent serious injury to a victim of pesticide poisoning. The situation can be a life-or-death matter. The product label should be one of the first sources of information in a pesticide exposure emergency, in addition to calling the National Poison Center (1-800-222-1222) and 911. First aid is only the “first response” and is not a substitute for professional medical help.

General first aid instructions

- Most important, be sure to protect yourself by wearing appropriate protective clothing and equipment if there is a likelihood of being directly exposed to a pesticide while administering first aid or removing the victim from an enclosed area.
- Have current labels and Material Safety Data Sheets (MSDS) available.
- Have emergency response telephone numbers readily available.
- Assemble a first aid kit with necessary supplies.
- Always have a source of clean water available. In an extreme emergency, even water from a farm pond, irrigation system, or watering trough could be used to dilute the pesticide.
- If oral or dermal exposure has occurred, the first objective is usually to dilute the pesticide and prevent absorption.
- If inhalation exposure occurs, first protect yourself, then get the victim to fresh air immediately.
- Never give anything orally to an unconscious person.
- Become familiar with the proper techniques of artificial respiration; it may be necessary if a person’s breathing has stopped or become impaired.

Specific first aid instructions

If the victim **IS NOT** breathing:

FIRST—Evaluate the surroundings of the victim. Protect yourself from pesticide exposure prior to and while giving assistance.

SECOND—Administer artificial respiration and call 911.

THIRD—Call National Poison Center (1-800-222-1222).

FOURTH—Decontaminate the victim immediately; wash thoroughly and quickly. Speed is essential.

If the victim **IS** breathing:

FIRST—Evaluate the surroundings of the victim. Protect yourself from pesticide exposure prior to and while giving assistance.

SECOND—Decontaminate the victim immediately; wash thoroughly and quickly. Speed is essential.

THIRD—Call 911 if the victim has ill effects from the exposure.

FOURTH—Call the National Poison Center (1-800-222-1222).

If the pesticide has been spilled on the skin or clothing, remove any contaminated clothing immediately and thoroughly wash the skin with soap and water. Avoid harsh scrubbing, as this enhances pesticide absorption. Rinse the affected area with water, wash again, and rinse. Gently dry the affected area and wrap it in a loose cloth or blanket, if necessary. If chemical burns of the skin have occurred, cover the area loosely with a clean, soft cloth. Avoid the use of ointments, greases, powders, and other medications unless instructed by medical personnel.

Heavily contaminated clothing should be disposed of properly. If clothing is not heavily soiled, wash all contaminated clothing separately from any other laundry in hot water, at a high water level, and with a heavy duty liquid detergent. Run the washer through a complete cycle with detergent and no clothes to remove pesticide residue before another wash. Store washed protective clothing separately from other clothes. Also, do not store protective clothing and equipment in pesticide storage areas.

If the pesticide has entered into the eyes, hold the eyelid open and immediately begin gently washing the eye with clean running water. Do not use chemicals or drugs in the eye wash water. Continue washing for 15 minutes. If only one eye is involved, avoid contaminating the other one. Flush under the eyelids with water to remove debris. Cover the eye with a clean piece of cloth and seek medical attention immediately. If contact lenses are worn, remove and discard the contacts, then wash the eyes as described above.

If the pesticide has been inhaled, get the victim to fresh air immediately. However, do not attempt to rescue someone who is in an enclosed area unless you are wearing appropriate protective equipment. Have the victim lie down and loosen their clothing. Keep the victim warm and quiet. If the victim is convulsing, watch their breathing and protect their head. Keep the chin up to keep air passages free for breathing. If breathing stops, administer artificial respiration and call 911. Call the National Poison Center (1-800-222-1222) after the victim is stabilized for further advice.

If the pesticide has been swallowed, contact the National Poison Center (1-800-222-1222) and provide them with the name and approximate amount of material that was ingested. Call 911 immediately if the victim has symptoms from the exposure. If the pesticide has entered the mouth but has not been swallowed, rinse the mouth with large amounts of water.

Inducing vomiting is rarely advised for any poisoning, including pesticide poisonings.

If a petroleum product (kerosene, gasoline, oil, lighter fluid, EC pesticides) **has been swallowed**, call the National Poison Center (1-800-222-1222) and 911 immediately for further instruction.

If a corrosive poison (a strong acid or alkali) **has been swallowed**, dilute with water or milk immediately. Consult the National Poison Center (1-800-222-1222) and 911 immediately. The victim may experience severe pain and have extensive mouth and throat burns. Fortunately, most commonly used pesticides are not corrosive, but some household disinfectants and germicides fall into this category.

Safe storage of pesticides

- Read the label for specific storage instructions and precautions.
- Store pesticides in a clean, cool, dry, and well-ventilated building. Always lock the area to prevent entry by children and untrained persons. Mark the storage facility with an appropriate warning sign.
- Maintain proper temperature control. For example, if emulsion-type materials freeze, the emulsion may be destroyed, resulting in loss of effectiveness and possible serious plant injury.
- To avoid the danger of cross-contamination, do not store herbicides with other pesticides.
- Keep dry materials above liquid materials.
- Do not store pesticides where food, water, feed, seeds, fertilizers, or personal protective clothing and equipment (such as respirators) can become contaminated.
- Store pesticides in their original containers. Never store pesticides in any food or drink containers.
- Do not remove the labels. Keep lids tightly closed.
- Check containers frequently for leaks.
- Clean up spilled chemicals promptly and properly. Dispose of broken or damaged containers and any pesticide waste in an approved and safe manner as directed on the product label.
- Keep an inventory of all chemicals. Mark each container with the year of purchase.
- Inform your local fire department of any chemicals (including fertilizers) stored in large quantity.

Safe disposal of pesticides

- Read the pesticide label for specific disposal instructions.
- Avoid disposal problems by purchasing only the amount of material needed for one growing season. Do not stockpile.
- Use proper personal protective clothing and equipment when you dispose of pesticide wastes and containers.
- Mix only the amount of pesticide required for a particular application. If you mix too much, use the surplus by applying the material at the recommended rate to one of the crops listed on the label.
- Do not dump pesticides or pesticide rinsates on the ground or pour them down sinks, toilets, or other drains, including storm sewers.
- Pressure rinse or triple rinse empty pesticide containers with water and pour the rinse water into the spray tank. Drain 30 seconds each time.
- After rinsing metal, plastic, or glass containers, puncture,

break, crush, or in some way render unusable. Recycle plastic containers through the Plastic Pesticide Container Recycling Program sponsored by the Pennsylvania Department of Agriculture (PDA). Contact your regional PDA office for further information. Disposal in a sanitary landfill is desirable if conducted in accordance with local regulations.

- If stated on the label and permitted by local ordinances, combustible containers can be burned. However, do not burn pesticide containers near residential areas or where the smoke can contact humans. Avoid exposure to the smoke; it may contain toxic vapors. Bury the ashes since they also may be toxic.
- Send large metal drums to a reconditioning company.
- Before disposing of pesticide concentrates, check with PDA's CHEMSWEEP Program, which provides disposal options for unwanted and outdated pesticide concentrates free of charge.
- Do not reuse empty pesticide containers for any purpose.
- Clean up thoroughly after handling and disposing of pesticides.

Current status of restricted-use pesticides in Pennsylvania

Under the authority of the amended Pennsylvania Pesticide Control Act of 1973 and the amended Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), applicators who apply restricted-use pesticides (RUP) in the production of an agricultural crop must be certified as a private applicator or must work under the direct supervision of a certified applicator. Furthermore, only certified applicators can purchase restricted-use pesticides. The pesticide dealer is required by law to record the name, address, and certification number of the purchaser of RUPs, as well as the identity of the product, amount sold, and date of purchase. Commercial and public pesticide applicators must be certified to use any pesticide, not just restricted-use pesticide products.

The official list of Pennsylvania's RUPs includes all pesticide products designated as restricted-use by the U.S. Environmental Protection Agency, and, in the interest of the public health and welfare of the citizens of the Commonwealth, any other product designated for restricted-use by the Secretary of Agriculture, Commonwealth of Pennsylvania. If a pesticide is restricted-use it will be clearly marked on the label.

Worker Protection Standard for agricultural pesticides

In 1992, the U.S. Environmental Protection Agency (EPA) revised its Worker Protection Standard (WPS), which addresses the protection of agricultural workers from pesticide exposure (40 CFR Part 170). The WPS includes requirements designed to reduce the risks of illness or injury to agricultural workers and pesticide handlers from occupational or accidental exposure to pesticides in the production of agricultural plants on farms and in nurseries, greenhouses, and forests.

The WPS expands the scope of prior worker protection regulations to identify two types of agricultural employees:

pesticide handlers—those who handle agricultural pesticides (mix, load, apply, clean or repair contaminated equipment, act as flaggers, etc.), and

agricultural workers—those who perform tasks related to the cultivation and harvesting of plants on farms or in greenhouses, nurseries, or forests where pesticides are used.

The WPS holds growers/employers responsible for compliance. The regulations expand requirements for the employer to make sure that employees are provided with the following:

- Warnings about pesticide applications
- Clean and properly maintained personal protective equipment (PPE), which employers must ensure is used
- Restrictions on reentry by personnel to treated areas (all pesticides used on farms and in forests, nurseries, and greenhouses have specific restricted entry intervals (REI's) that are listed on the label under the "Agricultural Use Requirements" section)
- Decontamination facilities
- Pesticide safety training and information
- Notification of pesticide applications and information about the pesticide(s) used
- Maintained contact with handlers when applying highly toxic pesticides
- Emergency assistance when required
- A pesticide safety poster placed in an area where it can be seen easily by all workers
- Information about pesticide label safety for pesticide handlers and early entry workers
- A centrally located listing of recent pesticide applications on the premises

Under WPS, labels now include statements specifying personal protective equipment, restricted-entry intervals (REIs), and (on some pesticide labels) a requirement to provide both oral warnings and posting of treated areas.

EPA developed these regulations with the non-English-speaking worker specifically in mind. Safety warnings, information, and training must be given in "a manner the worker can understand."

The Pesticide Safety Fact Sheet EPA Worker Protection Standard for Agricultural Pesticides describes these requirements in some detail. It is available from the Publications Distribution Center, The Pennsylvania State University, 112 Agricultural Administration Building, University Park, PA 16802; phone 814-865-6713, or online at <http://www.pested.psu.edu/resources/facts/>.

ORCHARD SPRAYING

Orchard spraying falls into two classes: (1) tree spraying for disease and pest control, nutrition, growth regulation, and chemical thinning, and (2) ground spraying for weed control. Each class requires different equipment. Air-blast sprayers are generally used for tree application, and hydraulic sprayers and granular applicators are used for ground application. Air-blast sprayers use water and air as diluents and carriers for the chemical, while hydraulic sprayers use water and pressure. Growers with very small orchards may want to consider using a handgun (for dilute spraying only).

Tree Spraying

The air-blast sprayer plays an important role in achieving the level of pest control obtained with a specific amount of pesticide. Best results are obtained when the sprayer has enough fan capacity to blow the spray through the trees and at least 10 feet beyond, even when operating against a 5-mph wind. Maximum spray deposit requires that the droplets be forced against the object to be covered. Spray that drifts at slow speeds past tree tops is not sufficient.

Many sprayers are unable to achieve adequate deposit on trees over 20 feet high. Most sprayers should be operated at 2.5 mph or less on mature trees. When low air volume sprayers are being used, the ground speed usually must be limited to 2 mph or less, even on trees of small to moderate size. Sprays should be applied only when there is little or no wind. Large trees require sprayers with large air volume capacities. Match the sprayer capability to the tree size. Air capacity and air speed are not the same. Use water-sensitive paper targets in the trees to evaluate coverage.

Low-volume (concentrate) spraying involves reduced amounts of water per acre, generally a reduction from 350 to 400 gallons per acre for dilute sprays to 20 to 100 gallons. The term "low volume" is derived from the fact that a smaller volume of water, not air, is used to carry the chemical. Runoff is eliminated with low-volume spraying. Individual sprayers are designed to operate most efficiently at certain gallonages per acre, and best spray coverage and deposit are obtained within the manufacturer's recommended range. Tree size and number of trees per acre as well as spray droplet size influence the gallonage needed for adequate coverage.

Choose the gallonage per acre best suited to your equipment, tree size, and orchard problems. Then add the amount of chemical needed per acre to that amount of water. Spraying less than 40 gallons of water per acre onto trees over 18 feet high usually results in unsatisfactory coverage. See "Tree Row Volume" in this section.

The amount of pesticide per acre in low-volume spray is reduced in comparison with the amount needed in a standard 400 gallons of dilute spray per acre. For example, a fungicide might be suggested at 8 pounds in 400 gallons of water per acre. With low-volume sprays on apples and sweet cherries, the 8 pounds can be reduced about 20 percent. In low-volume sprays for peaches, pears, nectarines, plums, and tart cherries, the rate can be reduced by about 25 percent or to 5.25 pounds per acre. For lower rates to be effective, the entire tree must be covered without runoff.

The advantages of low-volume spraying are: less pesticide, water, labor, and time, with fewer refills. The disadvantages are in the increased care required to calibrate the sprayer, maintain a constant ground speed, select good spraying conditions, and train a skilled operator. As gallonage is reduced, errors become more critical. In addition, some materials such as dormant oil and growth regulators need to be applied at higher water gallonage per acre to be effective. Rates of water of 100 to 300 gallons per acre may be required. Fire blight sprays should be applied at full dilute rate. Dual "flop over" nozzles, multiple-orifice nozzles, or adjustable flow to air-shear nozzles are convenient time savers.

Application costs decrease most rapidly when changing from 400 gallons to 50 gallons of spray solution per acre. Below 50