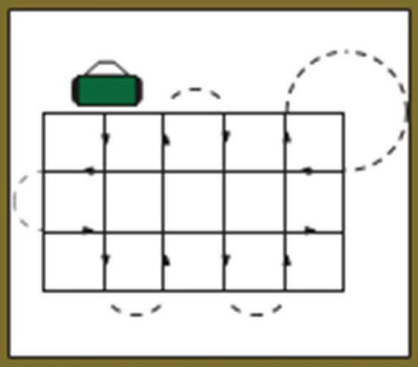

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EXTENSION

Pesticide Safety Education Program

Pesticide Safety in Landscapes

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Pesticide Safety in Landscapes

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Many people who care for landscapes and gardens use pesticides to manage pests. Pesticides are any chemical, whether synthetic or organic, used to manage a pest. This publication describes how to reduce the risk of harm to people, pets, and other animals, as well as the environment when using pesticides in landscapes.

Pesticide Laws and Regulations

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) is a federal law enacted in 1947 that covers the approval and registration of pesticides in the United States. FIFRA stipulates that the Environmental Protection Agency (EPA) has the authority to collect data to support regulations for requirements on pesticide use and handling. It is intended to protect both people and the environment by providing for the controlled use of pesticides. The law covers pesticide registration, risk assessments, classification, labeling, distribution, use, record keeping, certification of applicators, and penalties for violations. In addition to FIFRA, each state may have stricter regulations. The Nebraska Pesticide Act was enacted in 1993 and is administered by the Nebraska Department of Agriculture (NDA). Any pesticide sold in Nebraska must be registered with the NDA. The NDA has authority over pesticide use, certification and licensing of applicators, and enforcement of pesticide regulations in Nebraska.

Pesticide Labels

FIFRA clearly states that it is unlawful to use a pesticide in a manner inconsistent with its labeling. The pesticide label is a legal document recognized by courts of law. Anyone who applies a pesticide must follow all label requirements. Read label instructions every time a pesticide container is handled, including before purchasing, storing, mixing, or disposing of pesticides.

Even products considered relatively safe have labels with legal requirements. Purchasing or using a pesticide comes with legal obligations and potential consequences for misuse. Labels vary depending on the manufacturer of the product and whether it is for consumer (homeowner) or commercial (professional) use. FIFRA requires certain information to appear on virtually all pesticide labels. Some products also have supplementary labeling, which can include websites referenced on the main label. Supplementary labeling carries the same legal weight as a primary label.

This portion of the publication outlines the specific parts of every label. Once you become familiar with the label, you will be able to quickly find the information you need to make important decisions. Registrants update product labels frequently, often without warning, so it is good practice to read the label prior to every use.

The sample pesticide label on page four has numbers that correspond to the listing below (Figure 1).

1. **Use classification**. This box is only present on restricted-use pesticide labels, which require an applicator's license to purchase or apply due to elevated risk. General-use, or 'over-the-counter' product labels do not have this box. (In Nebraska, anyone making pesticide applications for hire or compensation in the Ornamental and Turf category must be licensed to apply restricted-use *and* general-use pesticides due to the sensitivity of these sites.)

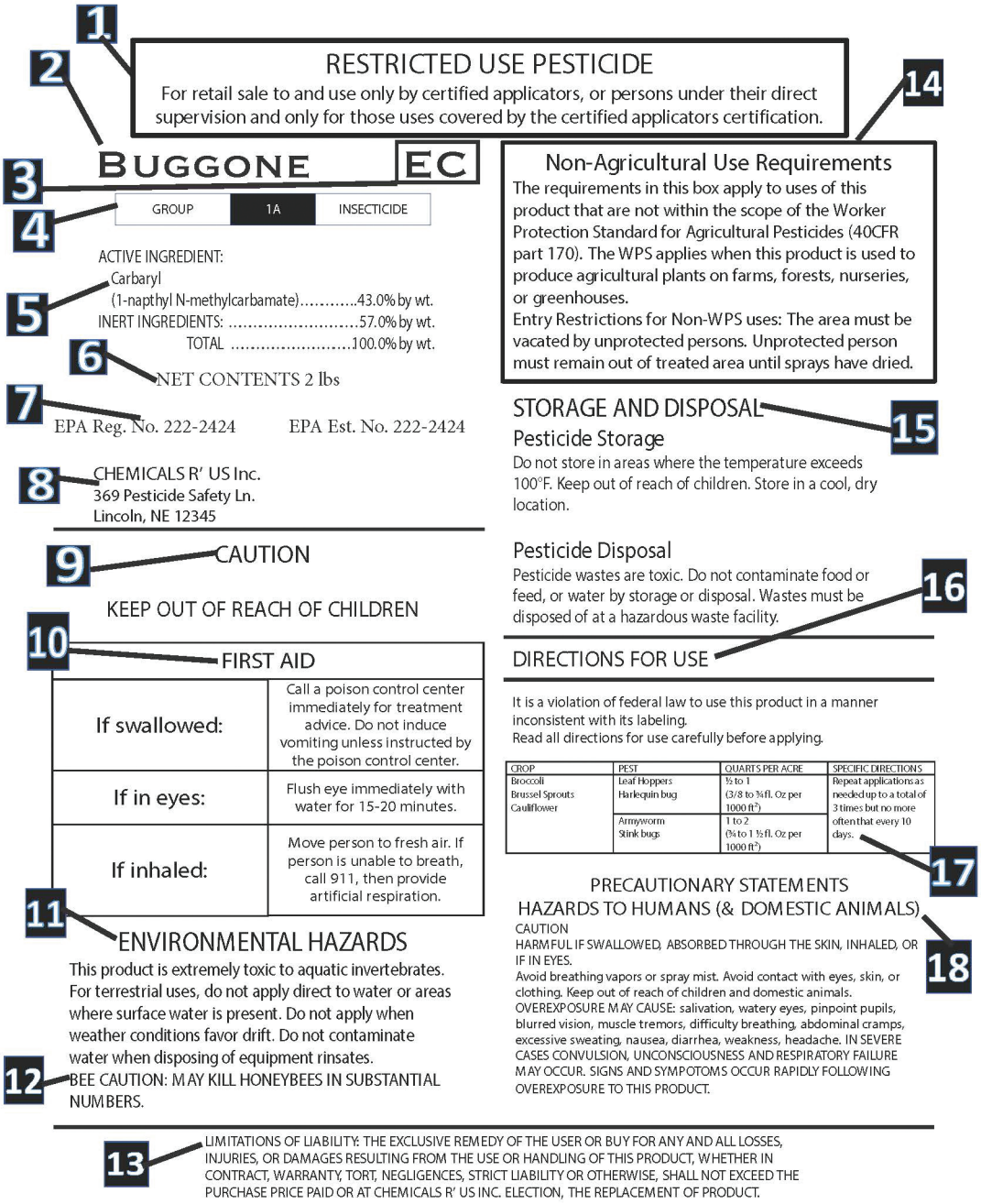

Fig. 1. Not all pesticide labels look exactly the same. Pesticide Manufacturers are required by law to furnish certain information on the label including the areas labeled on the sample label.

2. **Brand name or trade name of the product**. This name identifies the product and is used for marketing. Different companies have different brand or trade names for pesticides that have the same active ingredient (*Figure 1*).

3. **Formulation**. This identifies the products consistency such as granules, Ready-to-use, or Emulsifiable concentrate (EC). It may be present on the label but is not always in the same location.

4. **Mode of Action Classification Scheme**. This chart provides information about the specific mode of action and target site of insecticides. Insecticides are classified by the Insecticide Resistance Action Committee (IRAC) to help guide users so they can manage pesticide resistance and sustainable resistance management.

5. **Ingredient statement** The active ingredient is the chemical in the pesticide that kills, controls, or repels the pest. Inert ingredients are substances added to the pesticide product that help in the application of the product (i.e.,

Table 1. Signal words and toxicity ratings are listed on pesticide labels.

Group	Signal Word	Toxicity Rating	Oral Lethal Dose *(150-pound adult)
I	**Danger	Highly toxic	Few drops to 1 teaspoon
II	Warning	Moderately toxic	1 teaspoon to 1 tablespoon
III	Caution	Slightly toxic	1 tablespoon to a pint
IV	Caution (Optional)	Relatively nontoxic	More than a pint

*Lethal dose may be less than that listed for an adult under 150 lbs. or a child, and more for an adult over 150 lbs.
**Danger also may have skull and crossbones and "Poison."

solvents, carriers, and adjuvants). Every pesticide label must include all of the product's active ingredients, listed by chemical and/or common name, plus the percentage of each by weight. Inert ingredients, also called 'Other ingredients' on consumer pesticide labels, do not have to be listed by name but the percentages by weight must be shown.

6. **Net contents of the container**. This is the total amount of pesticide product in the container. It is expressed in fluid ounces, pints, quarts, or gallons for liquids and ounces or pounds for dry formulations.

7. **Registration and establishment numbers**. Each pesticide product has a unique registration number, which signifies EPA approval. The establishment number identifies the specific facility that manufactured the product.

8. **Name and address of the manufacturer**. This information must be available so that a user can contact the company for further information.

9. **Signal words**. These words identify the relative toxicity of a particular product (*Table 1*).

10. **First Aid**. This is a statement of practical treatment, providing users and first responders the appropriate response in case the product is accidentally inhaled, swallowed, splashed into eyes, or comes in direct contact with skin or clothing

11. **Environmental hazard statements**. These statements indicate possible hazards to non-targets. Non-targets are sites and organisms not labeled for application which are unintentionally impacted by the use of the pesticide. Non-targets include soil, water, air, plants, wildlife, fish, and invertebrates. "

12. **Pollinator Hazard** Pesticides may be evaluated for the risk they may cause to pollinators. Refer to Figure 2 to learn more about pollinator warnings on labels.

13. **Liability** . This legal statement releases the manufacturer from damages due to misuse of the product or failure to follow label directions.

14. **Precautionary statements**. These statements indicate proper precautions to take to protect humans or animals that could be exposed to the pesticide. Examples of precautionary statements include "Harmful if inhaled," or "Remove contaminated clothing and wash before use." Among other things, this section specifies the protective clothing and equipment that must be worn to protect the applicator from exposure. These items might include a specific type of gloves, a face shield, a chemical-resistant hat or plastic hardhat with a plastic sweatband, or a chemical-resistant apron. If no protective clothing is listed, Nebraska Extension recommends the applicator wear a long-sleeved shirt, long pants, socks, and chemical-resistant shoes and gloves. Eye protection and a wide-brimmed hat that is water repellant and easy to clean are additional items to consider.

15. **Storage and disposal statements** . Requirements for storage, including temperature ranges, ventilation, fire precautions, distance to surface water (ponds, lakes, or streams), and exposure to sunlight are listed in this section.

16. **Directions for use**. This section explains how to apply the pesticide for best results. It provides information on the rate of application, the sites the product is intended to protect, pests controlled, and mixing directions. It may include information on timing of application, such as the stage when the pest is most vulnerable.

17. **Re-entry statement, if necessary**. This indicates how long people and pets must wait after an application to enter the treated area. If no interval is given, sound advice includes waiting until the product has dried or dust has settled on the use site before allowing re-entry.

18. **Harvesting and/or grazing restrictions**. Also called the pre-harvest interval (PHI), this information identifies how much time must pass between the pesticide application and harvest to avoid pesticide residues that might cause harm to people or animals. Pre-harvest intervals may vary based on the type of plant to which the pesticide is applied. Although no pre-harvest interval is given for this label, harvesting and/or grazing restrictions are typically found in the label's Directions for Use section.

19. **Precautionary statements**. These statements indicate proper precautions to take to protect humans or animals that could be exposed to the pesticide. Examples of precautionary statements include "Harmful if inhaled," or "Remove contaminated clothing and wash before use." Among other things, this section specifies the protective clothing and equipment that must be worn to protect the applicator from exposure. These items might include a specific type of gloves, a face shield, a chemical-resistant hat or plastic hardhat with a plastic sweatband, or a chemical-resistant apron. If no protective clothing is listed, Nebraska Extension recommends the applicator wear a long-sleeved shirt, long pants, socks, and chemical-resistant shoes and gloves. Eye protection and a wide-brimmed hat that is water repellant and easy to clean are additional items to consider.

Additional Sections

Labels have other important information on them. They may include links to additional information about the product and it's use. Safety Data Sheets (SDS) are available for all pesticides and can be accessed for more information regarding safety and risk management. A few other sections to take note of as you read the label include:

1. **First Aid for Toxicity Category I**. Products classified in EPA's highest toxicity category typically must have first aid statements on the label's front panel.

Table 2. Relative oral toxicity of specific materials to rats, along with the corresponding signal word listed on the pesticide label.

Material	Oral LD_{50} in mg/kg	Pesticide signal word
Sugar	29,700	
Grain alcohol (Ethanol)	14,500	
Glyphosate — herbicide	5,600	Caution
Table salt	3,000	
Malathion — insecticide	1,375	Caution
Aspirin	1,000	
Metalaxyl — fungicide	633	Warning
Ammonia	350	
Caffeine	192	
Arsenic acid	48	
Nicotine	1	
Aldicarb — insecticide	0.93	Danger — Poison
Dioxin	0.001	
Botulinum toxin	0.00001	

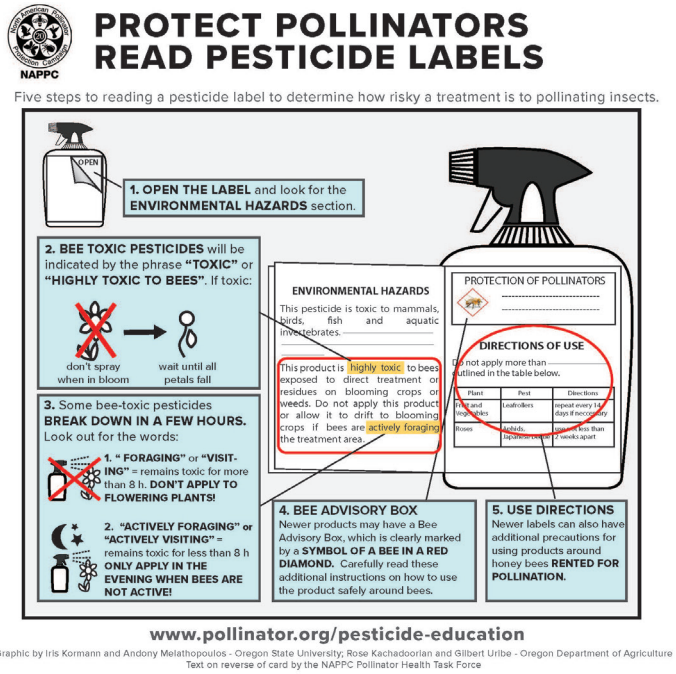

Fig. 2a. Labels may identify risk to pollinators and provide safety instructions to reduce exposure risks to them.

Figure 2. Product selection should not be based solely on brand or trade names. The brand names of many products are only slightly different — Roundup Weed and Grass Killer Plus®, Roundup Poison Ivy Plus Tough Brush Killer®, Roundup Weed & Grass Killer Super Concentrate®, Roundup Extended Control®, and Roundup Weed & Grass Killer®, but the active ingredients may affect the target area in significantly different ways. These Roundup® products have five different labels and each contains slightly different combinations of the active ingredients. In addition to glyphosate, which is the active ingredient of the original Roundup®, other active ingredients found in these Roundup® products include triclopyr, diquat, pelargonic acid, and imazapic. Use of a Roundup® with imazapic delays the ability to seed or plant into the sprayed area for 4 months. Roundup® products with the broadleaf herbicide triclopyr added will delay seeding or planting up to 30 days, depending on the type of plant being seeded or transplanted. The use of Roundup® products with diquat or pelargonic acid does not significantly delay seeding or transplanting; seeding or transplanting can occur one day after application.

MINIMIZING PESTICIDE EXPOSURE RISK TO BEES

Understanding pesticide label information on the hazard and risks of bees is an important first step to protecting bees. Insecticides and some fungicides are of concern for bees. Here are a few actions to help minimize pesticide exposure to bees while managing pests and diseases.

1. Avoid sprays during bloom. Bees face the highest exposure to pesticides when they are applied to the bloom of bee-attractive crops and weeds. When possible, use clean-up sprays before bloom to knock pests and diseases down to reduce the need for bloom treatments.

2. If you must treat during bloom, choose products carefully and apply in the evening. Choose insecticides that are not labeled as 'Toxic' or 'Highly Toxic' to bees (front of card, Point 2). Avoid insecticides with residual acute toxicity to bees (front of card, Point 3). Treat in the evening or not more than 2 hours before sunset.

3. Communicate with beekeepers. Contact beekeepers at least 48 hours prior to applying insecticides or fungicides to blooming bee-attractive crops. Communicate with local beekeepers during the off-season to help reduce conflict during the busy season. Your state may have a program that maps bee colonies; contact your state Department of Agriculture to learn how to access it.

4. Maintain a buffer around bee colonies and into bee habitat. Avoid placing bees in a crop, set them outside the spray drift zone (20-100 feet, depending on sprayer technology). Avoid pesticide drift onto bee habitat bordering the crop. Reduce drift by using coarser droplet sizes, drift reducing agent, or intelligent sprayer technology.

5. Mow blooming weeds. If there are bee-attractive blooming weeds (e.g., mustard, clover or dandelion), mow them before spraying.

6. Review State Pollinator Protection Plans and use IPM. Many states provide information on how to protect bees and other pollinators. Contact your Department of Agriculture to obtain this plan. Integrated Pest Management (IPM) can also help reduce bee pesticide exposure. IPM starts with proactive pest or disease management: scouting the crop for pest levels, plant disease resistant cultivars; when damage occurs, determine the cause and decide if you can accept low levels of damage, consider all the control measures, choose the best-suited tool for the pest or disease.

HELPFUL LINKS

The **North American Pollinator Protection Campaign (NAPPC)** is a growing collaborative body of more than 170 diverse partners, including respected scientists, researchers, conservationists, government officials and dedicated volunteers. NAPPC's mission is to encourage the health of resident and migratory pollinating Animals in North America.

The infographic was funded by: SARE, FFAR, North Central IPM Center, USDA National Institute of Food and Agriculture

Figure 3. There are three main routes of pesticide exposure. (Graphic courtesy of National Pesticide Information Center)

2. **Keep Out of Reach of Children Statement.** This statement must appear on all labels near the signal word to indicate the hazard of the product to children.

3. **Pollinator Statement**. This statement appears on a label if the EPA has determined that the product may cause off-target effects on pollinators (Figure 3).

Pesticide Safety

All pesticides pose some risk. An "organic" or "natural" pesticide is not necessarily safe, nor is a synthetic or human-made pesticide automatically highly toxic. Mercury, nicotine, and arsenic, all naturally occurring materials, were used as pesticides in the U.S. until people realized that they were extremely dangerous. Some synthetic pesticides are based on naturally occurring substances; often, the synthetic material is actually less toxic than its natural inspiration. Risk, defined as the possibility of harm or danger, depends upon the combination of the pesticide's toxicity (the signal word) and your exposure to the pesticide. One way of expressing risk is through the risk formula:

Risk = Toxicity X Exposure

Toxicity is an adverse biological effect elicited by a chemical, physical, or biological agent. Acute toxicity reveals itself relatively quickly after a single exposure (or several within a short time). A pesticide product's acute toxicity level is defined on the label through the use of a signal word (caution, warning, danger). Sometimes, closely-related chemicals have vastly different acute toxicity levels. For example, nicotine, a naturally-occurring chemical derived from tobacco plants, is over 1000 times more toxic to humans than malathion, a synthetic insecticide based on nicotine. Chronic toxicity may take years or decades to reveal itself, and is a result of long-term or repeated low-level exposures.

To reduce risk, select pesticides that are lower toxicity and highly selective. Choose products with a signal word like caution over something with the word warning or danger when possible. Selecting pesticides that are selective for specific pests can also reduce the potential for harm to non-target organisms.

Exposure describes how pesticides come into contact with human bodies. Skin or eye contact (dermal exposure), in- halation (respiratory exposure), and ingestion (oral exposure) are the main routes of human exposure to pesticides (*Figure 3*). Each area of the human body absorbs pesticides at a different rate (*Figure 4*). If the forearm is given an absorption rate of 1, the forehead (with an absorption rate of 4.2) will absorb pesticides about 4 times faster than the forearm. The groin area (with an absorption rate of 11.8) will absorb almost 12 times faster, about the same rate as a direct injection into the blood-stream. Pesticide applicators are more apt to receive dermal exposure, while oral exposure is often a concern for children. Anyone that spends time in the landscape area, lawn, garden, or neighboring area has potential to come into contact with pesticides and should be careful during and after a pesticide application. There are a number of ways to manage exposure to pesticides and thus reduce risk. They include:

- **Select formulations less likely to cause excessive exposure**. The fine particles in dusts pose a greater inhalation hazard than granules. Emulsifiable concentrates contain solvents that are more easily absorbed through the skin than liquids that have already been diluted, such as ready-to-use (RTU) products.

- **Wear the appropriate clothing**. The label tells what type of clothing and personal protective equipment (PPE), such as specific types of gloves, goggles, or face shields, to wear.

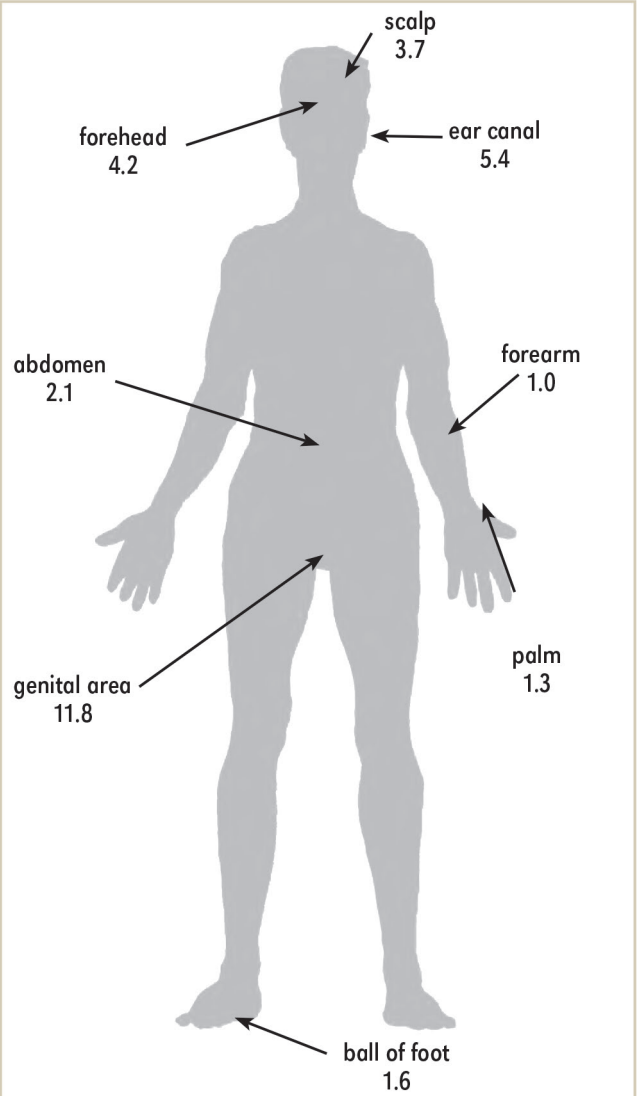

Figure 4. The relative absorption rate of pesticides is different for different parts of the body. The relative rate is based on the absorption rate of the forearm.

- **Wash hands immediately after handling or applying pesticides**.
- **Remove and launder clothing**. Wash clothing worn while working around pesticides separately from the family laundry, with hot water and detergent. Rather than using A clothes dryer, line dry clothing to allow any pesticide residues to dissipate and break down in sunlight. Remove footwear that could carry pesticide residues before entering the home to reduce exposure to family members.
- **Store pesticides safely**. Read the label to determine if the pesticide will be affected by high or low temperatures, or by exposure to sunlight. Store pesticides away from food and animal feed products, in an area that can be secured. By law, the pesticide must be kept in its original container with the original label. Do not be tempted to store a pesticide in another container or share a pesticide with someone by pouring some into an empty food or beverage container; someone could mistake it for a beverage or food product. Purchase only what is needed for a growing season to avoid having to store pesticides through the winter.
- **Mix and apply pesticides correctly**. Reread the label and wear the appropriate clothing when mixing and applying pesticides. Check equipment for leaking hoses or connections, and plugged, worn, or dripping nozzles before adding the pesticide. Have all pets and people leave the area before applying the pesticide, and abide by the label's re-entry interval.
- **Properly dispose of pesticides, rinsewater (rinsate), and containers**. Some communities have special collection sites or events for pesticides or empty containers. Otherwise, use all the pesticide according to label directions. Rinsate can only be applied to a use site listed on the label and should never be poured down a household drain or storm drain as it could contaminate groundwater or surface water. Follow label directions and do not exceed the maximum pesticide application rate. Follow label directions for disposing of containers, which usually includes triple-rinsing the container, puncturing it so it cannot be reused, and disposing of it with solid waste.

Understanding the toxicity of a product and the potential for personal exposure helps to lower risk. No matter how toxic the pesticide, if the amount of exposure is kept low, risk can be held at an acceptably low level. People manage and reduce risk every day in the choices they make. For example, gasoline is highly toxic, causes cancer, and is extremely flammable, but people use it without hesitation. Why? Precautions are taken to minimize exposure. Typically, gasoline is used in areas with good ventilation and kept in sealed containers, and users avoid smoking when handling it. A pesticide applicator can reduce risk by selecting less toxic pesticides and minimizing exposure.

Signs and Symptoms of Poisoning

Anyone who may be exposed to pesticides or is working with someone who may be exposed should be aware of the signs and symptoms of pesticide poisoning.

- **Signs**. These effects can be seen by others. Vomiting, sweating, and pinpoint pupils are signs of pesticide poisoning.
- **Symptoms**. These are any changes in normal condition that can be described by the victim of poisoning, including nausea, headache, weakness, and dizziness.

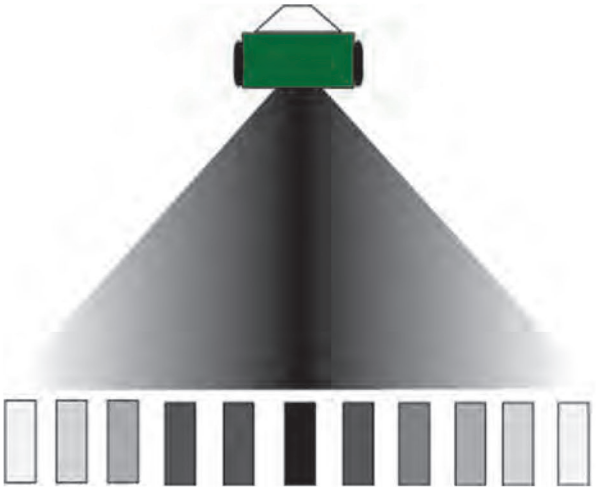

Figure 5. Rotary spreaders do not distribute products uniformly. The amount applied is heavier near the spreader and lessens as the product is thrown to the left and right of the spreader. As a result, it is important to have significant swath overlap, generally 30-50 percent. The distance the product is thrown depends on its weight and density, so swath width will vary depending on the product used.

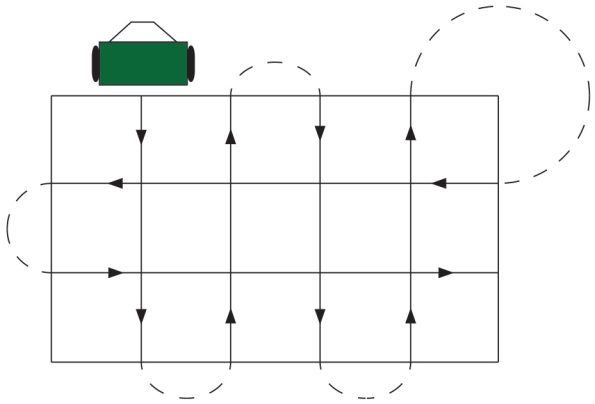

Figure 6. Skipping or overlapping can easily occur with drop spreaders, so consider using a split-rate application in two directions. Apply half the amount of product needed in the first direction. Apply over the lawn back and forth. Add the second half of the product to the spreader and apply at a 45- to 90-degree angle to the first application.

Knowledge of these signs and symptoms will allow for prompt treatment and may help prevent serious injury. Each pesticide may exhibit differently based on the person exposed as well as the dose to which they are exposed. Follow these steps:

1. **Recognize the signs and symptoms**. Know the effects of exposure to humans for the pesticide in use. Poisoning may be similar to flu symptoms and can occur from minutes to days after exposure. Find information on this topic in Extension Circular EC2505, Managing the Risk of Pesticide Poisoning and Understanding the Signs and Symptoms. The National Pesticide Information Center has additional information on pesticide poisoning at *https://npic.orst.edu/*.
2. **Get help**. If you suspect poisoning is due to a pesticide, get immediate help from a local hospital, physician, or the nearest Poison Control Center (1-800-222-1222).
3. **Identify the poisoning source**. Identify the pesticide to which the victim was exposed, giving the chemical name and the EPA registration number found on the label to the medical providers, if possible.
4. **Provide the pesticide label**. Have a copy of the pesticide label and/or SDS available for medical professionals.
5. **Provide early treatment**. Assist the victim until help arrives or the victim can be taken to the hospital. Both first aid and medical treatment procedures are listed on the product label. If a pesticide is spilled on skin, wash the area with soapy water immediately. If a pesticide is spilled on clothing, remove the clothing.

Pesticide Equipment and Use

The type of application equipment used will depend on the formulation or form (dust, granule, wettable powder, or liquid) of the pesticide. The size of the area to be treated also influences the type of equipment used, ranging from hand-held sprayers for small areas to spray tanks mounted on utility vehicles for very large areas. Purchase equipment that is easy to use and easy to clean.

- **Rotary spreader**. These spreaders are used for applying granules, such as fertilizers or mixtures of granular fertilizers and pesticides. Rotary applicators use a spinning plate to distribute granules. The pattern is not uniform (*Figure 5*). Rotary spreaders work well for large turf areas, uneven terrain, or where clearance could be a problem, such as tall grass. The application rate is based on the applicator's walking speed and the amount of granules allowed to fall through holes onto the spinning plate. The larger the holes, the greater quantity of product that is distributed. The faster a person walks, the smaller the amount of product that is distributed.

Figure 7. Many homeowner products come in concentrated forms. When diluting these products for use in an empty trigger pump sprayer, be sure to clearly mark the sprayer so others know it is dedicated to pesticide use. Some people use trigger pump sprayers for misting plants with water and could accidentally spray a desirable plant with an herbicide mixture or water with herbicide residue from the sprayer.

- **Drop spreaders**. Drop spreaders have small adjustable holes at the bottom of the spreader where granules drop through to the ground. The larger the opening, the more product the spreader will dispense. Drop spreaders are used for turf areas and are very effective when applying light materials, in windy conditions, small areas, or when precise placement of the product is needed, such as near sidewalks and drives. Drop spreaders can sometimes skip or overlap, so split-rate applications in two directions are recommended (*Figure 6*).
- **Hand dusters**. Various forms of dusters exist, but the most commonly used by gardeners is the shaker. With any duster, uniform coverage of foliage is difficult to achieve. Dusts are commonly used for pests on vegetables.
- **Trigger pump or pistol grip sprayers**. Ready-to-use (RTU) formulations require no further dilution. They are purchased in plastic jugs or containers with triggers to build pressure and pump the pesticide. These are a good choice for spot applications of pests. A disadvantage of RTU products is increased cost per area covered when compared with pesticides sold as concentrates. Empty trigger pump sprayers are available for purchase as well, but should be labeled so they are not used for other purposes (*Figure 7*).
- **Compressed air sprayers (tank or backpack)**. These sprayers are filled with the correct amount of water and concentrated pesticide. Common sizes range from 1 to 5 gallons. They are carried over the shoulders or by hand. The tank is pressurized with a hand-operated pump. This can make it difficult to maintain a consistent pressure level. Uniform concentration of spray can be maintained since the pesticide is mixed with a known quantity of water. Agitation is required for some formulations to avoid pesticide settling. This information is available on the pesticide label. This type of sprayer works well when treating dwarf fruit trees, vegetables, ornamentals, and spot spraying weeds.
- **Small power sprayers**. These sprayers also are filled with water and concentrated pesticide. The pumps are motor-driven so applicators do not have to pump the tank by hand. Power sprayers provide uniform pressure but are generally too expensive for home garden use. An acreage owner may mount one on a utility vehicle to treat larger areas.
- **Proportioner or hose-end sprayers**. These small sprayers are designed to attach to garden hoses. A small amount of pesticide is mixed with usually no more than a pint of water, and placed in the receptacle attached to the hose. Some pesticides may be purchased in diluted form, so no additional water is needed before attaching the canister to the hose. A tube connects the canister filled with the pesticide solution to the opening of the hose. When the water is turned on, the suction created by the water passing over the top of the tube pulls the pesticide solution up and into the stream of hose water. While initially inexpensive, this application method has poor spray distribution, which makes it difficult to apply pesticides at accurate rates. All hose-end proportioners should have anti-siphon devices to prevent back siphoning of pesticides into the water system. The stream of a hose-end sprayer can reach into medium-tall trees if the water pressure is high enough.

Mixing and Applying Pesticides

The correct amount of pesticide must be applied to be safe, effective, economical, and reduce the chance of the target pest developing resistance. Using more chemical than is needed is wasteful, may pollute the environment, and injure desirable plants. Applying less than the recommended rate may not be economical because the treatment is less effective and may need to be repeated.

- **Applying Granular Pesticides**. Almost all granular products available for homeowners have bag sizes based on the amount of product needed to cover 5,000, 10,000, or 15,000 square feet. Calculate the total square footage of the yard and then purchase and apply only the amount of pesticide needed to cover that area (*Figure 8*). Store leftover materials according to the label so they remain effective.

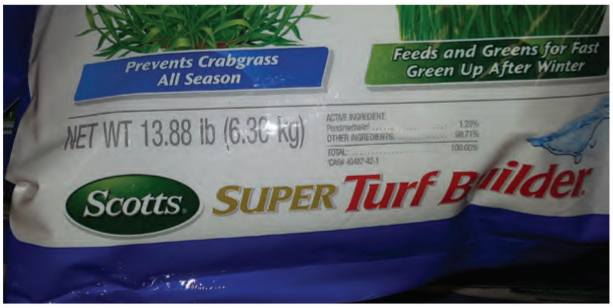

Figure 8. This 13.88-pound bag of herbicide will cover 5,000 ft² of turf. The applicator must calculate how much of the product to treat an area 4,500 ft². This can be set up as

13.88 pound bag/5,000 ft² covered = ? pounds needed/4,500 ft² lawn to treat

And written as a ratio for cross-multiplication:

$$\frac{\text{13.88-pound bag}}{\text{5,000 ft}^2} = \frac{\text{? pounds needed}}{\text{4,500 ft}^2}$$

13.88 pounds x 4,500 ft² = 5,000 ft² x ? pounds

62,460=5,000 x ? pounds so 62,460/5,000 ft² = ? pounds

? =12.5 pounds

Based on the sample herbicide label, a homeowner will need to apply 12.5 lbs. of product to 4,500 ft² of lawn to supply the correct amount of active ingredient for preemergence control of weeds. Many products will have spreader setting recommendations. While those settings can provide a good starting point, they should not be considered 100 percent accurate. It is best to apply all products, whether using a drop or rotary spreader, in two directions using half rates for each direction.

- **Applying Liquid Pesticides**. For concentrated liquid products, label instructions state the specific number of fluid ounces, teaspoons, or tablespoons of the product that must be mixed with a specific volume of water before applying to the treatment area. Additional directions include whether to spray lightly, spray until drops run off the target, or spray the undersides of the leaves. The spray pattern should give uniform coverage with little spray overlap. Overlap can be a problem because it results in greater amounts of pesticides in some areas. Use a continuous, uninterrupted spray pattern to apply the pesticide. When applying a broadcast herbicide to turf, do not stop or slow down at each weed; maintain a constant speed.

Cleaning Equipment

Thoroughly clean all equipment immediately after use. Do not store pesticides that have already been mixed for application. If any diluted pesticide is left after completing an application, apply the excess on a labeled use site, being careful not to exceed the maximum application rate. Thoroughly clean all spray equipment inside and out with clean water. Flush hoses and nozzles and apply the rinsate to a labeled site.

****Never rinse pesticides or rinsate down a drain or into a storm drain—this could contaminate groundwater or surface water (Figure 9).****

Figure 9. Storm drains carry untreated runoff from yards and streets directly to streams. Never dump pesticides or rinsate from application equipment down a storm drain. Be careful that granular pesticides do not fall on sidewalks, streets, or drives, as rain or irrigation will carry them down storm drains.

Protecting the Environment from Pesticides

The label provides information on how to reduce pesticide risks to the environment. Pesticide drift, run-off, volatility, infiltration to groundwater, and toxicity to bees are some situations that may be addressed.

Pesticide drift and volatilization occurs when a pesticide moves through the air away from where it was applied the target site. It can move as a vapor (volatilization) or as a liquid in very small droplets (drift). Both situations can injure non-target plants or animals (*Figure 10*). The person applying the pesticide is responsible for preventing drift. Several factors affect the ability of a pesticide to drift or volatize from the target site to a non-target site. These include pesticide formulation, application method, temperature, relative humidity, wind, and soil factors.

- **Formulation**. The formulation of a pesticide determines how that pesticide should be applied and the possibility of injuring non-targets. Consumers generally can choose from granular, liquid, or dust formulations. Granular formulations rarely move far from the use site. Liquid pesticides have the greatest opportunity for drift. Wind can blow small droplets away from the target area and affect sensitive plants nearby. Some liquid formulations volatilize or change to a gas at temperatures above 85°F. Depending on the type and concentration of pesticide and weather conditions, gas vapors may affect sensitive plants throughout the neighborhood. Dusts are subject to drift due to their light weight and poor sticking qualities.
- **Method of application**. Fine spray droplets have a greater possibility of drifting from the use site. Use application

Figure 10. Spring applications of post-emergence herbicides to control broadleaf weeds can result in herbicide damage to non-target plants due to drift or volatilization. Sensitive plants include grapes, tomatoes, and redbud trees (above).

Figure 11. Apply pesticides as close to the target as possible. Pesticides will not be suspended in the air as long, which may reduce the possibility of drift.

methods that produce larger droplets, as they are less likely to drift. Apply with lower pressures or use sprayers with large-orifice nozzles, which increase the average droplet size and therefore reduce potential pesticide drift problems. The pesticide label may list required or suggested spray pressures or nozzle sizes. In addition, try to apply the pesticide as close to the target as possible (*Figure 11*).

- **Temperature and relative humidity**. High temperatures, such as above 85°F, and low relative humidity during or immediately after application may cause some pesticides to vaporize and move away from the use site. Spray during the cool part of the day to reduce vaporization. The pesticide label will list any application restrictions due to temperature.
- **Wind**. Wind, even small gusts, can move pesticide spray droplets away from the use site and injure non-target plants or animals. Check the label for wind restrictions. Generally, winds between 3 to 10 mph are ideal. If there is no wind, pesticide particles may hang in the air and move long distances. These particles may cause plant damage and reduce insect populations. Typically, wind speeds are lower in mornings and evenings. If the pesticide application is near an area containing sensitive plants or animals (called a sensitive site), make sure there is a slight wind blowing away from the sensitive site.

Runoff and infiltration to groundwater are potential environmental hazards that may contaminate water resources. Runoff from irrigation or rain can carry pesticides away from the target site to surface water such as ponds, streams, or lakes. In addition, pesticides can travel through the soil to groundwater. Several factors affect the ability of a pesticide to be carried as runoff or to leach into groundwater. These include site characteristics, soil characteristics, pesticide characteristics, and weather conditions.

- **Site characteristics**. This includes features of the area where the pesticide will be applied, such as the slope, type or amount of vegetation, depth to groundwater, and distance to surface water. The slope of the area will affect runoff. The greater the slope, the greater the risk that pesticides will be carried off the site with irrigation or stormwater runoff. In addition, a slope with little vegetation or ground cover will have greater potential for runoff. The depth to groundwater and the distance to a storm drain, pond, or stream will influence the risk of pesticides reaching groundwater or surface water.
- **Soil characteristics**. The texture of the soil, whether it is sand, silt, clay, or loam, will affect the potential for a pesticide to be carried away through runoff or leach through the soil to groundwater. Contaminants are more likely to leach into groundwater in sandy soils with little organic matter. Compacted clay soils have greater potential for runoff because of decreased water infiltration. Soil moisture also influences runoff; saturated soil cannot soak up additional water so any moisture added will run off, carrying pesticides with it.
- **Pesticide characteristics**. The pesticide's formulation, water solubility, adsorption, and persistence will affect runoff. Granular pesticides that land on sidewalks, streets, or driveways are easily carried to storm drains by rainwater runoff. A pesticide with high water solubility dissolves easily in water and can leach through soil into groundwater or travel with runoff water to non-target sites such as

Figure 12. Reduce risk of harm to bees and other pollinators by applying pesticides when these insects are least likely to be foraging. If possible, control pests before bloom or after bloom is complete. If you need to apply pesticides to flowering plants, apply in evenings using an insecticide with a short residual.

surface water. Adsorption is the ability to bind with soil and plant surfaces. A pesticide with low adsorption will be transported through leaching or runoff. Also, a pesticide with higher adsorption could adhere to soil particles and be transported through soil erosion. Persistent pesticides are those that do not break down readily and therefore are active longer, increasing the risk of transport.

- **Weather conditions**. Many pesticides should not be applied if rain is expected because stormwater runoff can carry them away from the target site. For example, pyrethroid pesticide labels indicate that because of the risk to aquatic invertebrates and fish, applications should not be made if rain or irrigation is expected within 24 hours. Application of pre-emergent herbicides, however, should be timed so that irrigation or rainfalls occur shortly after application.

Toxicity of pesticides to bees and other beneficial pollinators. Protecting beneficial insects such as bees is a growing concern. Because pollinators may fly great distances when foraging for pollen, they may be exposed to pesticides even when a homeowner has taken precautions to limit exposure. Avoid broad spectrum pesticides, avoid treating any blooms, and apply when bees and other pollinators are least likely to be foraging (Figure 12), such as early morning or late evening. For more information, see Extension Circular 301, Bee Aware: Protecting Pollinators from Pesticides.

Summary

Careful selection and use of pesticides will reduce the risk of harm to people, pets, other non-targets, and the environment. Keep risk low by using the least toxic pesticide suitable for the job, and by following all label precautions. Read the label before purchasing and using a pesticide.

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