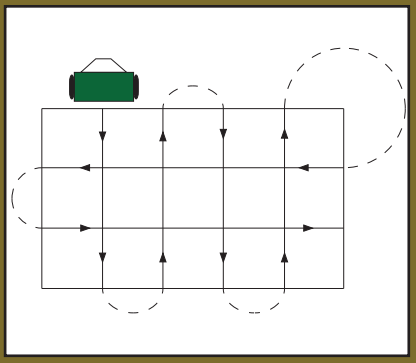

University of Nebraska Lincoln EXTENSION

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EC1271

Pesticide Safety in Landscapes

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Clyde L. Ogg, Extension Educator
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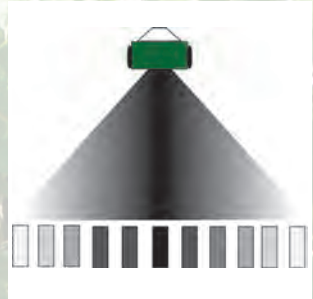

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Pesticide Safety in Landscapes

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Many people who care for landscapes and gardens use pesticides to manage pests. This publication explains how to reduce the risk of harm to people, pets, and other animals, as well as the environment through careful use of pesticides.

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 is intended to protect both people and the environment by providing for the controlled use of pesticides. The law covers pesticide registration, 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.

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, and anyone who applies a pesticide must follow all requirements. Always read label instructions before purchasing, storing, mixing, or disposing of pesticides.

Pesticide Labels

The pesticide label is more than just a piece of paper; it is a legal document recognized by courts of law. People have certain responsibilities when they purchase pesticide products, so it is important to understand the information on the labels. The format of pesticide labels varies depending on the manufacturer of the product and whether it is for consumer (homeowner) or commercial (professional) use. All pesticide manufacturers are required by law to provide certain information on the label, which follows. The pesticide label in this publication has numbers that correspond to the listing below (*Figure 1*).

1. **The brand name or trade name of the product.** This name identifies the product and is used for marketing. Different companies will have different brand or trade names for pesticides that have the same active ingredient (*Figure 2*).
2. **The ingredient statement and the percentage or amount of active ingredient by weight**. The active ingredient is the chemical in the pesticide that kills, controls, or repels the pest. Every pesticide label must include the product's active and inert ingredients with the percentage of each by weight. Inert ingredients are substances added to the pesticide product that help in the application of the product. For example, solvents dissolve the active ingredient, carriers help deliver the active ingredient, and adjuvants help pesticides spread out on a surface or stick to a leaf. Only the active ingredients must be listed by chemical and/or common name. 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.
3. **The net contents of the container.** This number is the total amount of pesticide product in the container. Net content is expressed in fluid ounces, pints, quarts, or gallons for liquids and ounces or pounds for dry formulations.
4. **The name and address of the manufacturer.** This information must be available so that a user can contact the company.
5. **The registration and establishment numbers.** The U.S. Environmental Protection Agency (EPA) registration number is proof that EPA approved the product and label. The establishment number identifies the specific facility that manufactured the product.
6. **Signal words**. These identify the relative toxicity of a particular product (*Table 1*).
7. **Statement of practical treatment.** Also called first aid on some labels, this statement tells users and first responders what to do in case of accidental exposure to the pesticide. Read this prior to using a pesticide to react quickly if the product is inhaled, swallowed, or comes in direct contact with skin.
8. **Precautionary statements.** These statements indicate proper

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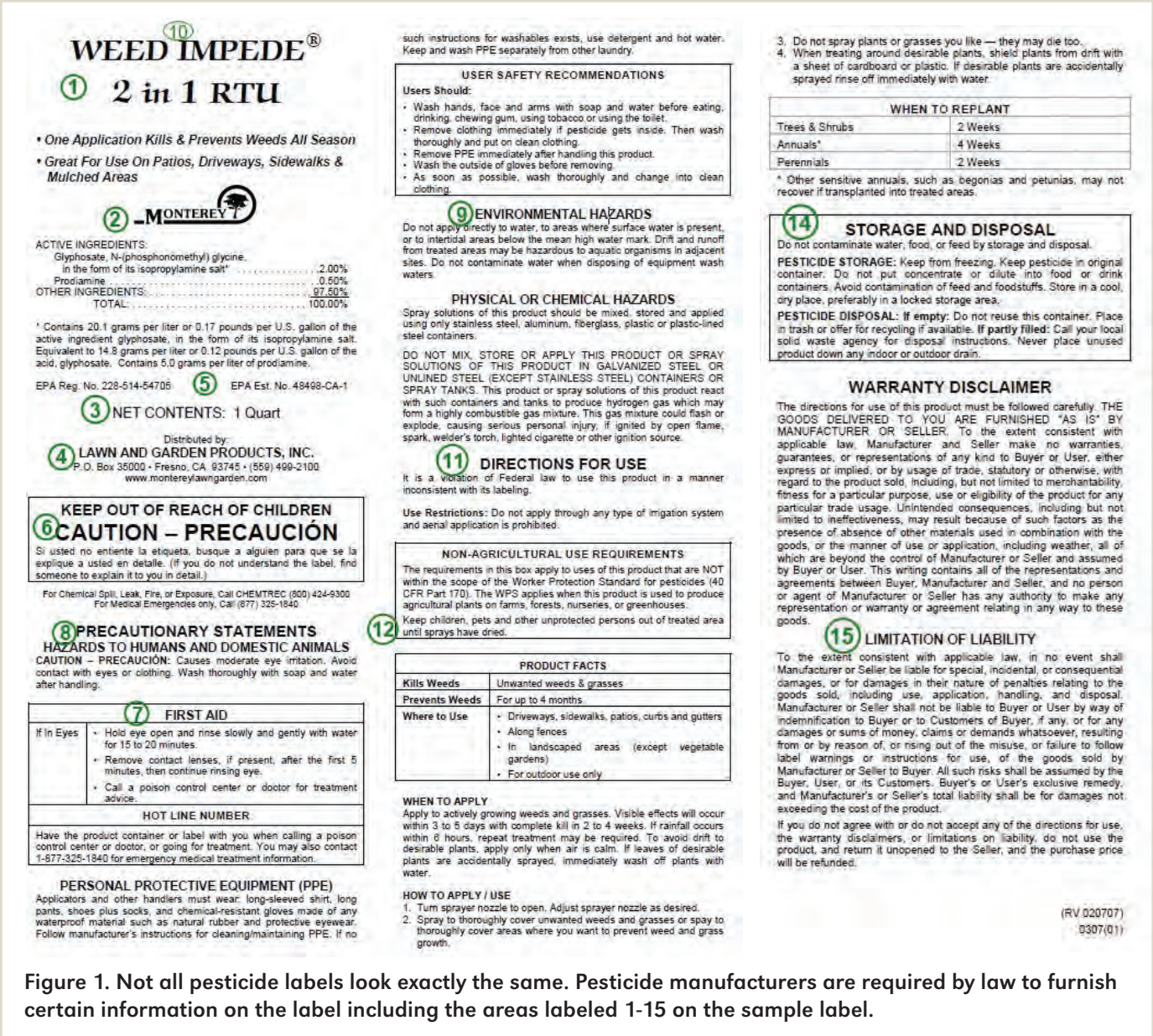

10 WEED IMPEDE®

1 2 in 1 RTU

• One Application Kills & Prevents Weeds All Season

• Great For Use On Patios, Driveways, Sidewalks & Mulched Areas

2 MONTEREY

ACTIVE INGREDIENTS:
Glyphosate, N-(phosphonomethyl) glycine, in the form of its isopropylamine salt* 2.00%
Prodiamine 0.50%
OTHER INGREDIENTS: 97.50%
TOTAL: 100.00%

* Contains 20.1 grams per liter or 0.17 pounds per U.S. gallon of the active ingredient glyphosate, in the form of its isopropylamine salt. Equivalent to 14.8 grams per liter or 0.12 pounds per U.S. gallon of the acid, glyphosate. Contains 5.0 grams per liter of prodiamine.

EPA Reg. No. 228-514-54705 5 EPA Est. No. 48498-CA-1

3 NET CONTENTS: 1 Quart

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KEEP OUT OF REACH OF CHILDREN
6 CAUTION – PRECAUCIÓN
Si usted no entiente la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

For Chemical Spill, Leak, Fire, or Exposure, Call CHEMTREC (800) 424-9300
For Medical Emergencies only, Call (877) 325-1840

8 PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS
CAUTION – PRECAUCIÓN: Causes moderate eye irritation. Avoid contact with eyes or clothing. Wash thoroughly with soap and water after handling.

7 FIRST AID

If In Eyes	• Hold eye open and rinse slowly and gently with water for 15 to 20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.

HOT LINE NUMBER
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-877-325-1840 for emergency medical treatment information.

PERSONAL PROTECTIVE EQUIPMENT (PPE)
Applicators and other handlers must wear: long-sleeved shirt, long pants, shoes plus socks, and chemical-resistant gloves made of any waterproof material such as natural rubber and protective eyewear. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exists, use detergent and hot water. Keep and wash PPE separately from other laundry.

USER SAFETY RECOMMENDATIONS
Users Should:
• Wash hands, face and arms with soap and water before eating, drinking, chewing gum, using tobacco or using the toilet.
• Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
• Remove PPE immediately after handling this product.
• Wash the outside of gloves before removing.
• As soon as possible, wash thoroughly and change into clean clothing.

9 ENVIRONMENTAL HAZARDS
Do not apply directly to water, to areas where surface water is present, or to intertidal areas below the mean high water mark. Drift and runoff from treated areas may be hazardous to aquatic organisms in adjacent sites. Do not contaminate water when disposing of equipment wash waters.

PHYSICAL OR CHEMICAL HAZARDS
Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic or plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED STEEL OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

11 DIRECTIONS FOR USE
It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Use Restrictions: Do not apply through any type of irrigation system and aerial application is prohibited.

NON-AGRICULTURAL USE REQUIREMENTS
The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.
12 Keep children, pets and other unprotected persons out of treated area until sprays have dried.

PRODUCT FACTS	
Kills Weeds	Unwanted weeds & grasses
Prevents Weeds	For up to 4 months
Where to Use	• Driveways, sidewalks, patios, curbs and gutters • Along fences • In landscaped areas (except vegetable gardens) • For outdoor use only

WHEN TO APPLY
Apply to actively growing weeds and grasses. Visible effects will occur within 3 to 5 days with complete kill in 2 to 4 weeks. If rainfall occurs within 6 hours, repeat treatment may be required. To avoid drift to desirable plants, apply only when air is calm. If leaves of desirable plants are accidentally sprayed, immediately wash off plants with water.

HOW TO APPLY / USE
1. Turn sprayer nozzle to open. Adjust sprayer nozzle as desired.
2. Spray to thoroughly cover unwanted weeds and grasses or spay to thoroughly cover areas where you want to prevent weed and grass growth.
3. Do not spray plants or grasses you like — they may die too.
4. When treating around desirable plants, shield plants from drift with a sheet of cardboard or plastic. If desirable plants are accidentally sprayed rinse off immediately with water.

WHEN TO REPLANT	
Trees & Shrubs	2 Weeks
Annuals*	4 Weeks
Perennials	2 Weeks

* Other sensitive annuals, such as begonias and petunias, may not recover if transplanted into treated areas.

14 STORAGE AND DISPOSAL
Do not contaminate water, food, or feed by storage and disposal.
PESTICIDE STORAGE: Keep from freezing. Keep pesticide in original container. Do not put concentrate or dilute into food or drink containers. Avoid contamination of feed and foodstuffs. Store in a cool, dry place, preferably in a locked storage area.
PESTICIDE DISPOSAL: If empty: Do not reuse this container. Place in trash or offer for recycling if available. If partly filled: Call your local solid waste agency for disposal instructions. Never place unused product down any indoor or outdoor drain.

WARRANTY DISCLAIMER
The directions for use of this product must be followed carefully. THE GOODS DELIVERED TO YOU ARE FURNISHED "AS IS" BY MANUFACTURER OR SELLER. To the extent consistent with applicable law, Manufacturer and Seller make no warranties, guarantees, or representations of any kind to Buyer or User, either express or implied, or by usage of trade, statutory or otherwise, with regard to the product sold, including, but not limited to merchantability, fitness for a particular purpose, use or eligibility of the product for any particular trade usage. Unintended consequences, including but not limited to ineffectiveness, may result because of such factors as the presence of absence of other materials used in combination with the goods, or the manner of use or application, including weather, all of which are beyond the control of Manufacturer or Seller and assumed by Buyer or User. This writing contains all of the representations and agreements between Buyer, Manufacturer and Seller, and no person or agent of Manufacturer or Seller has any authority to make any representation or warranty or agreement relating in any way to these goods.

15 LIMITATION OF LIABILITY
To the extent consistent with applicable law, in no event shall Manufacturer or Seller be liable for special, incidental, or consequential damages, or for damages in their nature of penalties relating to the goods sold, including use, application, handling, and disposal. Manufacturer or Seller shall not be liable to Buyer or User by way of indemnification to Buyer or to Customers of Buyer, if any, or for any damages or sums of money, claims or demands whatsoever, resulting from or by reason of, or rising out of the misuse, or failure to follow label warnings or instructions for use, of the goods sold by Manufacturer or Seller to Buyer. All such risks shall be assumed by the Buyer, User, or its Customers. Buyer's or User's exclusive remedy, and Manufacturer's or Seller's total liability shall be for damages not exceeding the cost of the product.

If you do not agree with or do not accept any of the directions for use, the warranty disclaimers, or limitations on liability, do not use the product, and return it unopened to the Seller, and the purchase price will be refunded.

(RV 020707)
0307(01)

Figure 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 1-15 on the sample label.

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."

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precautions to take to protect humans or animals that could be exposed to the pesticide. Every pesticide label must contain the statement "Keep Out of Reach of Children." Examples of other precautionary statements include "Harmful if inhaled," or "Remove contaminated clothing and wash before use." This section also will specify 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, UNL Extension recommends that 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.

9. **Environmental hazard statement**. This statement indicates possible hazards to non-target sites or locations and organisms, including soil, water, air, wildlife, fish, and plants. Non-targets are locations or organisms not labeled for application of a particular pesticide, or are unintentionally impacted by the use of the pesticide. The environmental hazard statement may include additional warning statements such as "This product is highly toxic to bees," "Do not contaminate water when disposing of equipment rinse waters," and "Do not allow drift to contact non-target plants or trees."

10. **Classification statement.** This section describes the pesticide's risk. Pesticides that pose more risk to people, pets, wildlife, and the environment are classified as Restricted Use Pesticides (RUPs). Those that are not classified as RUPs are considered General Use Pesticides (GUPs), which is the type used by households. An applicator must be trained and certified to purchase, apply, or supervise the use of RUPs.

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.

In Nebraska, anyone making pesticide applications for hire or compensation in the Ornamentals and Turf Category must be certified and licensed to apply restricted use *and* general use pesticides. According to the EPA, about 25 percent of the pesticides used in the U.S. are classified as RUPs. A RUP must state the classification on the label; a GUP will not state the classification. The example pesticide label is a GUP and does not contain a classification statement. However, the number 10 has been placed on the label to show the required location of the RUP statement, at the very top of the front panel of the label.

11. **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.

12. **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.

13. **Harvesting and/or grazing restrictions.** Also called the pre-harvest interval, this information identifies how much time must pass between the pesticide application and harvest to avoid pesticide residues that might cause toxicity to people or animals. Pre-harvest intervals may be different for each type of plant to which the pesticide is applied. Although no pre-harvest interval is given for this label,

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harvesting and/or grazing restrictions typically would be in the Directions for Use section.

14. **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. Store pesticides in original containers with the label intact in a secure location, away from food and feed supplies. Use all the pesticide according to label instructions, and triple rinse and puncture containers prior to disposal. Purchase only what is needed for a growing season to avoid having to store pesticides through the winter. Pesticides subjected to freezing temperatures may lose effectiveness. Some communities and counties have household hazardous waste disposal drop-off sites or events that may accept unused pesticides and empty rinsed containers.

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

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. Risk, defined as the possibility that something will happen, depends upon the choices made. One way of expressing risk is through the risk formula:

Risk = Toxicity X Exposure

Toxicity identifies how dangerous a pesticide is. Toxicity is classified as acute (resulting from a single exposure or repeated exposures over a short period of time) or chronic (resulting from long-term or repeated low-level exposures). It is measured in terms of Lethal Dose 50 (LD_{50}), the amount of a substance that will kill 50 percent of a test population, often lab rats. The LD_{50} is measured in milligrams of pesticide per kilogram of body weight (mg/kg). The lower the LD_{50}, the less needed to kill a test animal, so it is more toxic. For example, nicotine, with an oral LD_{50} of 1 mg/kg for lab rats is much more toxic than malathion, a common insecticide, with an oral LD_{50} of 1,375 mg/kg (*Table 2*). The LD_{50} will vary according to the concentration and formulation of the material.

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	

Exposure describes how pesticides might get into human bodies. Skin or eye contact (dermal exposure), inhalation (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-

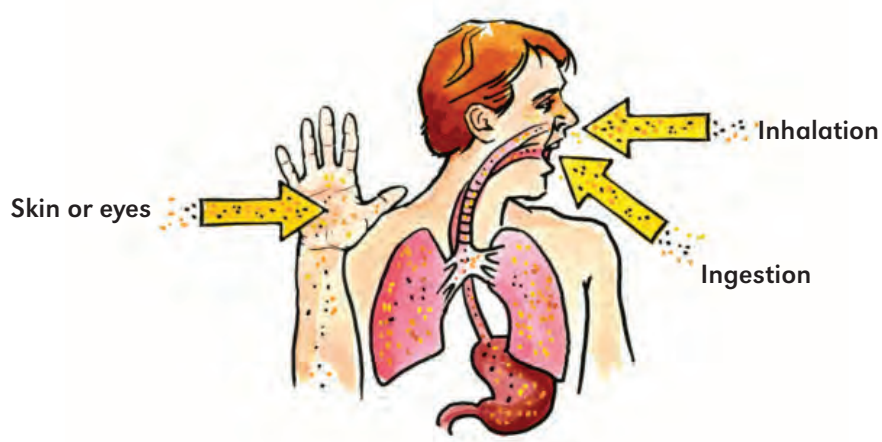

Figure 3. There are three main routes of pesticide exposure. (Graphic courtesy of National Pesticide Information Center)

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stream. Pesticide applicators are more apt to receive dermal exposure, while children are more apt to suffer from oral exposure. There are a number of ways to manage exposure to pesticides. They include the following.

- **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 already have 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.
- **Wash 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 the sunlight to break them down. Consider other potential sources of exposure to family members. For example, remove footwear that could carry pesticide residues before entering the home.
- **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 from children. By law, the pesticide must be kept in the 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.
- **Mix and apply pesticides correctly.** Reread the label and wear the appropriate clothing when mixing and applying pesticides. Put water in the application equipment and check 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 do not allow them to return until the appropriate re-entry interval has passed. If no re-entry interval is listed on the label, wait until dust has settled or liquids have dried.
- **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. 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. Apply the rinsate to a use site, making sure not to exceed the pesticide application rate. Do not pour rinsate or pesticides down a household drain or storm drain as this could contaminate groundwater or surface water.

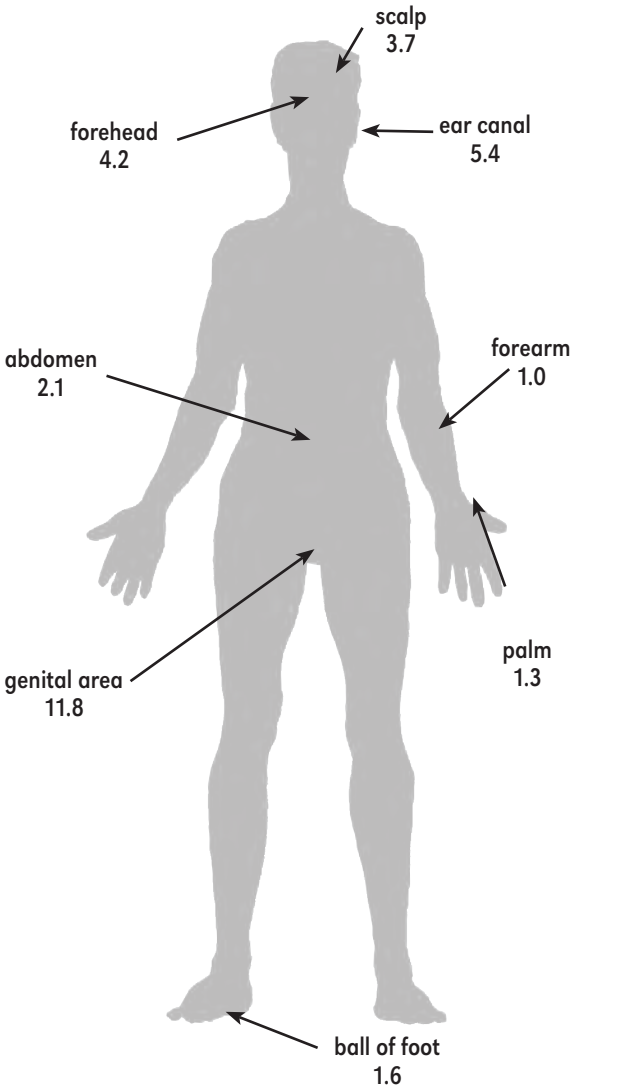

Figure 4. The relative absorption rate of pesticides is different for different parts of the body. The relative rate is based on the absorption rate of the forearm.

Understanding the toxicity of a product and the potential for personal exposure will help to lower risk. No matter how toxic a pesticide is, 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 manage and reduce risk by selecting less toxic pesticides, carefully following the label instructions, and wearing the required PPE.

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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.

Knowledge of these signs and symptoms will allow for prompt treatment and may help prevent serious injury. Signs and symptoms of pesticide poisoning will vary, depending on the pesticide, the amount of exposure, and the age and health of the victim. People who work with pesticides should become familiar with the following steps.

1. **Recognize the signs and symptoms.** Know the poisoning signs and symptoms for those pesticides commonly used or to which people may be exposed. Often, pesticide poisoning resembles flu symptoms. Reactions may 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* at *http://www.ianrpubs.unl.edu/sendIt/ec2505.pdf*. The National Pesticide Information Center has additional information on pesticide poisoning at *http://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 available when medical attention begins. The label provides information that will be useful to those assisting a victim of pesticide poisoning.
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.

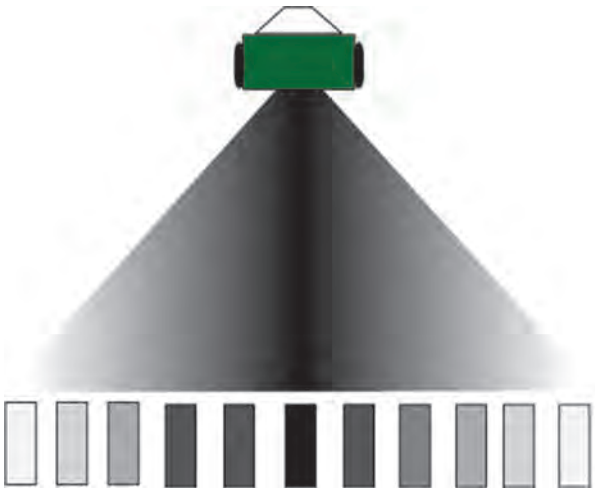

Figure 5. Rotary spreaders do not distribute products uniformly. The amount applied is heavier near the spreader and lessens as the product is thrown to the left and right of the spreader. As a result, it is important to have significant swath overlap, generally 30-50 percent. The distance the product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

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 affects the type of equipment, 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.
- **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 one most

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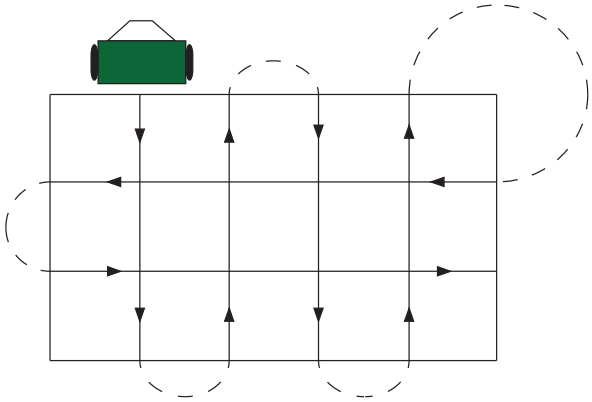

Figure 6. Skipping or overlapping can easily occur with drop spreaders, so consider using a split-rate application in two directions. Apply half the amount of product needed in the first direction. Apply over the lawn back and forth. Add the second half of the product to the spreader and apply at a 45-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

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.

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 versus pesticides that are 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. 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, and 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

For best results and the least risk of harming people, pets and other non-targets, or the environment, mix chemicals at the rate given on the label. 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 and may pollute the environment. In addition, applying more than the recommended rate of some pesticides could 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 Liquid Pesticides.** The labels of concentrated pesticides direct the applicator to mix a

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specific number of fluid ounces, teaspoons, or tablespoons of the product with a specific amount of water in a sprayer and apply it 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.

- **Applying Granular Pesticides.** Almost all pesticide 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 or dispose of leftover materials properly.

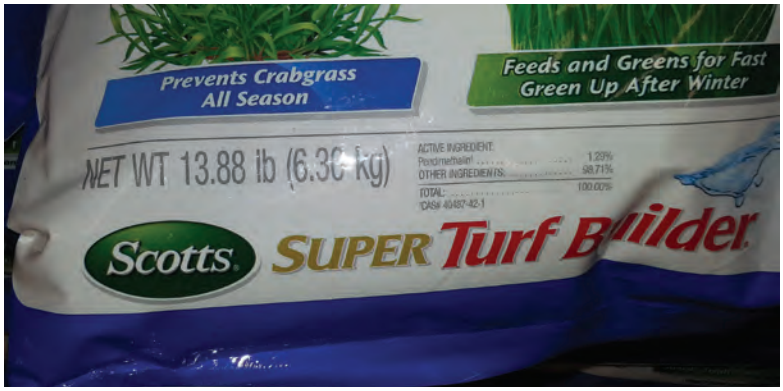

Figure 8. This 13.88-pound bag of herbicide will cover 5,000 ft² of turf. The applicator must calculate how much of the product to treat an area 4,500 ft². This can be set up as

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

And written as a ratio for cross-multiplication:

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

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.

Cleaning Equipment

Thoroughly clean all equipment immediately after use. Do not store pesticides that have been diluted for application. If any diluted pesticide is left after completing an application, spray the excess on a labeled use site, being careful not to exceed the label directions. 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*).******

Protecting the Environment from Pesticides

The label tells how to handle a pesticide to reduce hazards to the environment. Pesticide drift, runoff, infiltration to groundwater, and toxicity to bees are some situations that may be addressed.

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.

Pesticide drift occurs when a pesticide moves through the air away from where it was applied — the target site. It can move as a vapor (gas) or as a liquid in very small droplets. Drift can injure non-target plants or animals (*Figure 10*). The person applying the pesticide is responsible for preventing drift. Several factors affect the ability

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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.

of a pesticide to drift from the use site targeted for application to a non-target site. These include pesticide formulation, application method, temperature and 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 methods that produce larger droplets, as they are less apt to drift. Use lower pressures or use sprayers with large orifice nozzles that will increase the average droplet size and reduce potential pesticide drift problems. The pesticide label may list required or suggested 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. Pesticide vapors may cause damage to neighboring areas. 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. Mix and apply pesticides only when winds are calm (from 3 to 10 mph or whatever the label says). If there is no wind, pesticide vapors may hang in the air and not spread out. The concentrated pesticide vapors may cause plant damage and reduce insect populations. Typically, wind speeds are lower in mornings and evenings. If the pesticide application will be near an area containing plants or animals that are sensitive to the pesticide (called a sensitive site), make sure that any slight wind is blowing away from that sensitive site. As mentioned before, larger droplets and spraying closer to the target can reduce the chance of drift.
- **Soil.** The amount of pesticide applied in the soil or to the soil surface that a plant's roots can take up depends on the pesticide, the location of the roots in the soil, soil type, and soil moisture. Some pesticides will move readily in sandy or porous soils, especially after a rain or irrigation. Other pesticides may not stay active in the soil for very long. The pesticide label specifies if the product has the potential to move in the soil and injure adjacent plants due to root uptake.

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 use 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.

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- **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 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 will affect runoff; saturated soil cannot take additional water so any moisture added will run off, carrying pesticides with it.
- **Pesticide characteristics**. The pesticide 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 a high water solubility means that it dissolves easily in water and can leach through soil into groundwater or travel with runoff water to non-target sites such as 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 within 24 hours because stormwater runoff can carry them away from the use 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.

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.

Toxicity of pesticides to bees and other beneficial pollinators 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 pesticides with the greatest potential toxicity, and apply them when bees and pollinators are least likely to be foraging (*Figure 12*), such as early morning or late evening.

Summary

Careful selection and use of pesticides will reduce the risk of harm to people, pets and other non-targets, and the environment. Read the label before purchasing and using a pesticide. The label contains information that will help the pesticide applicator keep risk to the lowest possible levels. Use the risk formula and keep risk low by using the least toxic pesticides that will be effective. Pesticides with higher toxicity have labels listing the necessary personal protective equipment. This helps manage the risk of increased toxicity by reducing exposure.

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