

Chapter 9

USING PESTICIDES SAFELY



Introduction	2
Pesticide Use	2
Law and Regulation	2
Pest Management	3
Pesticide Types	3
Active Ingredients	4
Resistance	4
Formulations	5
Biopesticides	5
Pest Control for Organic Systems	5
Safety	6
Pesticide Labels	6
Hazards and Health	9
Pesticide Exposure Guidelines	9
Stewardship	9
Handling	10
Handling PPE	10
Pesticide Properties and Movement	10
Water Quality Impacts on Pesticide Performance	11
Pesticide Application Math	12
Setting Up the Application Equipment	13
Calibration	13
Storage	13
Disposal	14
How to Hire a Professional	14
Important Numbers and Information	15
Resources	15
Further Reading	15
Acronyms	16
Glossary	17
Important Numbers and Information Poster	18

Chapter 9

Using Pesticides Safely

Kimberly Tate, Associate Extension Instructor, University of Idaho Boise, Pest Management Program
Ronda Hirnyck, Extension Pesticide Specialist and Professor, University of Idaho Boise
Edward Bechinski, Professor Emeritus, Entomology, Plant Pathology, and Nematology, College of Agricultural and Life Sciences, University of Idaho

LEARNING OBJECTIVES

- ✓ Understand the definition of a pesticide.
- ✓ Understand how to read a pesticide label.
- ✓ Understand how to prevent pest resistance.
- ✓ Understand personal protective equipment.
- ✓ Understand the spray zone and when to keep out.
- ✓ Understand sanitation and decontamination practices.
- ✓ Understand pesticide storage.
- ✓ Understand product disposal and container recycling.
- ✓ Understand good record-keeping practices for pesticide use.
- ✓ Understand how to hire a professional applicator.

INTRODUCTION

Pesticides are used to destroy, repel, suppress, mitigate, or otherwise control an unwanted organism in our environment, one that is in the wrong place at the wrong time. To some gardeners, this may include powdery mildew in an orchard, a dandelion in a lawn, or an aphid colony eating through a kale patch. This chapter by no means enables you to be a pesticide specialist, but it will help you to understand the best practices for pesticide use, safety, and stewardship.

PESTICIDE USE

Law and Regulation

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) establishes federal regulatory authority for the use, sale, and distribution of pesticides. In 1970 the United States Environmental Protection Agency (US EPA) was created to protect and treat

air, water, and land as an interrelated system. That same year, the US EPA was charged with the enforcement of FIFRA. Under the authority of the US EPA, the Idaho State Department of Agriculture (ISDA) oversees the enforcement of pesticide use and regulations within the state of Idaho.

As citizens purchasing a pesticide product, we enter into a legal binding contract with a pesticide company to follow the labeled instructions. The label is the law! Master Gardeners (MGs) should thus be able to explain label subjects to a homeowner and know how to recommend pesticides to the public.

Master Gardener Tip

You may need to invest in a small magnifier because pesticide labels are printed in very small fonts.

Researchers conduct extensive studies that often cost millions of dollars to ensure the efficacy and safety of each pesticide product. Indeed, every product that is registered as a pesticide with the US EPA must comply with FIFRA regulations and Idaho's pesticide law, regardless of whether it is an **organic** or a conventional pesticide. Pesticide producers can register two types of pesticides, those for general use and those for restricted use.

Anyone over the age of 18 can purchase and apply general-use pesticides. In order to purchase and apply restricted-use pesticides, however, an individual must possess a pesticide license. This requires passing a strict test and undergoing a certification process conducted by the ISDA. MGs, who help communities and homeowners to recognize pest damage, pest identification, and the

stages of a pest’s life cycle (and the best pest control method to choose), can only recommend general-use pesticides; also, they must be University of Idaho MG–certified, meaning they have successfully completed MG pesticide policy training.

Master Gardener Tip

Pesticides are tools that help gardeners to manage pests that have become a problem. If you are using the wrong tool (or wrong pesticide), your efforts will prove ineffective.

Pest Management

Bactericides kill bacteria, fungicides kill or prevent fungus and mildews, herbicides control weeds and other plant materials, insecticides kill insects, and so forth. Choosing and using the best one as part of an Integrated Pest Management (IPM) program gets you one step closer to gaining the upper hand on any pest. Refer to Table 1 for the appropriate pesticide to use to improve the health of your garden and landscape setting.

Table 1. Types of pesticides and the pest they control.

Pesticide	Targeted Pest
bactericide	bacteria
fungicide	mildew and other fungi
herbicide	weeds
insecticide	insects
miticide	mites
molluscicide	slugs and snails
nematicide	nematodes (roundworms)
piscicide	fish
rodenticide	rodents (mice, rats, etc.)

Other good reference sources for pest management control methods to add to your library are the Pacific Northwest (PNW) Handbooks published by University of Idaho, Oregon State University, and Washington State University. The product of a collaboration between the Agriculture Experiment Station and Extension Service’s research of plant disease and insect and weed control, these publications provide useful information about both agricultural and horticultural pest management practices.

Pesticide Types

Pesticides are either selective in targeting a specific pest or nonselective (sometimes called broad spectrum). Broad spectrum insecticides can eliminate all insects, including beneficial ones, so

apply them carefully in order to prevent further insect pest outbreaks. You do not want to inherit the work of beneficial insects! The most common pesticide types homeowners use include the following:

Bactericides

Bactericides are commonly found in household products such as disinfectants. These products are labeled as a pesticide and are registered through the US EPA.

Master Gardener Tip

Use these products to keep your garden tools clean and sanitized (follow the label’s instructions and wear required protective equipment). Routine sanitation practices will reduce plant diseases from spreading in your garden or landscape.

Fungicides

Fungicides are used to prevent and control fungal infestations. Some fungicides are systemic, working from the inside of the plant to control an infection that has already occurred. This will prevent further spread of the disease. Other common fungicides are protectants that prevent the infection and establishment of a fungal disease. They must be reapplied on new plant growth or after rainfall and overhead irrigation. Many fungicide products are available as premixes that contain both a systemic and a protectant. These products protect the plant with the two types of fungicides and help to prevent fungicide resistance.

Master Gardener Tip

If a gardener has a problem with fungus in their landscape, investigate their watering and planting practices. They may be creating their fungal problem.

Herbicides

Herbicides affect plants differently depending on the chemical properties and how the herbicide attacks the weed, qualities collectively called the mode of action (MoA) of a herbicide. Herbicides generally control weeds as a preemergent, attacking underground weed growth when germination occurs, or as a postemergent, after the weed has begun growing. Preemergent herbicides are applied to the soil before weeds emerge. Postemergent herbicides are applied

directly to the weeds after they have emerged. Proper spray coverage is important for good weed control. Some herbicides may be persistent in the soil and will not break down quickly. They can remain active in the soil for several weeks. Be sure to check the herbicide label to determine what plants can be sown into the treated area. Otherwise, plant/crop damage can occur.

Master Gardener Tip

When a homeowner client wants to control a weed, be sure to identify the weed species accurately and understand its life stage. Consult the PNW Weed Management Handbook for a list of management options and herbicides recommended for the weed species and life stage.

Insecticides

Insecticides enter insects in several ways. Stomach-poison insecticides must be ingested as an insect feeds. These products are used to eliminate insects with chewing mouth parts.

Other insecticides, classified as contact poisons, penetrate an insect's outer membrane or enter through its respiratory tubes or spiracles. These products must be sprayed directly on an insect.

When insecticides are absorbed and translocated throughout a plant you are protecting, they are called systemic insecticides. They are especially effective against insects with piercing-sucking mouthparts.

Broad-spectrum insecticides kill many insects or other arthropods; however, they also destroy predator insects, the bugs a smart gardener tries to retain. Alternatives include selective insecticides that control fewer but more biologically similar insects, repellent products that discourage insects from eating plant materials, and pheromone products whose chemical makeup confuses insects from mating properly.

Because there are many types of insecticides on the market, we recommend you seek advice from a county educator or consult the PNW Insect Management Handbook. Insecticides are crucial to pest management because insects can take down any untreated single plant or tree.

Master Gardener Tip

When a homeowner wants to control any insect, identify the insect species and understand the life stage of the insect. Consult the PNW Insect Management Handbook for a list of management options and insecticides recommended for the insect species and information on proper insecticide timing and coverage.

Active Ingredients

Pesticide concentrates are formulated products that contain different combinations of ingredients. The **active ingredient** is the working portion of the product that controls the pest problem. Other ingredients, called inert ingredients, are added to the active ingredient to enhance its performance. For instance, surfactants help pesticides to adhere to plant surfaces. For science-based pesticide information, contact the National Pesticide Information Center (NPIC).

Because homemade remedies and concoctions are not labeled for pesticide use, Idaho MGs cannot recommend these products. Be sure to complete the Idaho MG Pesticide Policy module and sign the MG Pest Management Agreement prior to making any pesticide recommendation.

Master Gardener Tip

All recommendations must follow the pesticide label to ensure the host plant or application site and the pest is listed on the manufacturer's label.

Resistance

Most pests can rapidly reproduce in favorable environmental conditions. Pests that produce multiple generations in a season have a better chance of developing **pesticide resistance** if repeatedly exposed to the same group of pesticide. Some individual pests have the natural ability to survive a pesticide application. Those that do may produce offspring or seeds with the same genetic traits, thus hastening the development of a pesticide-resistant population. Rotating pesticide products with a different MoA will play a role in thwarting resistance. In agricultural settings, it's a particularly vital strategy, so rotate the pesticides every two years to keep exposure to the same MoA at a reasonable mini-

mum. When you notice poor results from a pesticide application, pest resistance may be developing, or it may be an application problem. Investigate it to rule out one or the other. It is very important to identify potential pesticide resistance early!

Understanding Pesticide Mode of Action

MoA influences the development of resistance in a pest, because it describes the way that a pesticide interferes with pest metabolism, growth, and development in order to kill the pest. The MoA refers to cellular interruption of a particular plant process or function. It involves how a pest ingests or absorbs the toxin, how it metabolizes it, and how it physiologically responds to the poison.

Site of Action (SoA) is another resistance-related term, used by weed scientists to describe the specific “site” or area in a weed where the herbicide interferes with the plant’s growth and development.

It is important to become familiar with the term MoA so you can manage your pesticide choices based on the MoA. This will help discourage resistance development. Pesticides are grouped by the MoA codes. These codes are numbers (sometimes including an alpha character) that are determined by three international bodies of scientists and pesticide manufacturers based on the pesticide’s “mode of action” and the specific site or target on the pest. The international MoA codes are located on the front panel of all pesticide product labels. Pesticide applicators use the designations to help them avoid purchasing and using pesticides from the same group. Rotating MoA groups is one of the best tactics to prevent pesticide resistance. MoA and SoA codes are available online through the PNW Handbooks or Resistance Action Committees (see “Resources”).

Formulations

Pesticides are sold in many different formulations to make the products easier to measure and use. Most liquids are concentrated and require dilution in your spray tank before application. Those that are ready to use, however, do not require dilution. The “ready to use” products have a very low percentage of active ingredient, making them much more expensive than the concentrates. These products are convenient for some homeowners who may have small areas to spray and who do not like to mix pesticides or clean out the sprayers.

Dry pesticide products include dusts, powders, granules, and baits; some require mixing with water to apply as a spray mixture and some are ready to use. Weed and feed products are a common example of a ready-to-use granule. Whichever type you choose, look for one that will control your problem pest but is the least toxic to humans, pets, bees, other beneficial organisms, and the environment. See Table 2 for the advantages and disadvantages of formulations. Ready-to-use products reduce the need to purchase specialized equipment and eliminate mixing errors.

Master Gardener Tip

If you purchase only what you need, you will save money, reduce storage issues, and more easily rotate through the products.

Biopesticides

A newer type of pesticide that is gaining popularity in the marketplace, the biopesticide, is a registered pesticide whose active ingredient derives from some type of biological organism. Although naturally occurring, the biologically based ingredients require research data similar to conventional pesticides before they become commercially available as a pesticide product. The US EPA still evaluates and registers them in a similar manner as conventional pesticides. An example of a biopesticide is *Bacillus thuringiensis* (Bt), a microbe that is toxic to certain insects.

Master Gardener Tip

There are many subspecies of Bt, so understand each type, particularly the different pests it treats or targets.

Pest Control for Organic Systems

All products used in organic systems for pest control are considered pesticides and must be registered with the US EPA and ISDA as a pesticide (plus, all pest control claims are reviewed by the ISDA). The US EPA, however, may determine that a product is exempt from the federal registration requirement. Furthermore, all products used in a certified organic production system must be approved through the United States Department of Agriculture (USDA) and ISDA-certified organic programs. These exempt products must still be registered by the ISDA and are considered pesticides. Organic Materials Review

Table 2. The advantages and disadvantages of different pesticide formulations.

	Formulation	Definition	Advantages	Disadvantages
Ready-to-use formulations	Dusts	Pesticide + finely ground dry carrier	Ready to use	Drift hazard
	Granules	Like dusts but larger particles; organic or mineral particles impregnated with pesticide	Reduced drift hazard vs dust	Calibration
	Aerosols	Pesticide + volatile petroleum solvent + pressurized propellant	Ready-to-use convenience	Fine droplets, extreme low-percent active ingredient = inhalation hazard and high relative cost; plus drift hazard!
	Ready-to-use sprays	Liquid in a trigger hand pump	Convenience (no mixing nor spray equipment)	Low-percent active ingredient = high relative cost
	Baits	Pesticide + food source	Ready to use	Must be in a bait station to reduce access to children and pets
Concentrated formulations	Emulsifiable concentrates	Petroleum-soluble pesticide + solvent + emulsifier	Very little agitation needed	More readily absorbed through the skin than dry or water-based formulations; may cause plant injury
	Flowables (liquids)	Water-soluble pesticide mixed with water	No agitation needed	None
	Wettable powders	Water-insoluble pesticide impregnated on a finely ground organic or mineral particle +/- a wetting agent	Easy to store, handle, and transport.	Requires agitation, may leave visible residues. Sometimes difficult to mix in cold water.
	Water-dispersible granules	Water-insoluble pesticide impregnated on finely ground organic or mineral-aggregated granular	Reduced inhalation hazard from the powders	Requires agitation, may leave visible residues

Master Gardener Tip

Certified organic produce is a regulated food production system.

Master Gardener Tip

When assisting homeowners with pesticide label questions, be sure you are looking at the same product label. The best way to ensure consistency is verify the US EPA registration number found on the front panel of the label.

Institute (OMRI), a national program, reviews and approves all US EPA-registered pesticides and exempt products used for certified organic pest control. Those approved by OMRI have the OMRI logo on an organic pesticide’s label on the front panel.

SAFETY

Pesticide Labels

It is important for you to understand the directions on the pesticide label so that you may assist homeowners with questions they may have. Indeed, the pesticide product label is the law. It is a binding

contract between the pesticide registrant and the user. By purchasing and using the product you agree to follow the label directions. This means the application site or crop must be stated on the label. For instance, if you are treating aphids on your kale patch, then the label must list kale as a crop.

Here are some guidelines to understanding a label (see Figure 1A for numerical correspondence of sections 1–8):

1 | Product or brand name

The name given by the pesticide registrant. Several products may have the same active ingredient but are sold and distributed by different companies—thus they will have different product or brand names.

2 | Product type

The pesticide type (for example, an insecticide to control aphids on ornamental plantings; a herbicide to control broadleaf weeds in lawns).

3 | Active ingredient(s)

The pesticide ingredient that provides the controlling action in the product. The chemical and common names are stated as a percentage of the total product.

4 | Other ingredients

The other constituents that make up a formulated, commercial product. They are also listed as a percentage of the total product. Ingredients include solvents, surfactants, dyes, etc. that make the product easier to handle. They are usually “trade secrets” that make the product better and are thus just listed as other or inert ingredients.

5 | US EPA registration number (EPA Reg. No.)

Each product has a unique registration number, somewhat comparable to a person’s Social Security number. This number makes it easy to inquire about a specific product. Look for the US EPA Reg. No. on the front panel of the label.

6 | Signal word

The **signal word** indicates the acute toxicity (toxicity that occurs 24–48 hrs after exposure) and hazards of skin and eye injury from the pesticide. It provides a quick way to determine the toxicity of the product to humans and animals. Signal words include

- *Caution*: Indicates slight toxicity. Found in labels of common homeowner and ornamental products.
- *Warning*: Indicates moderate toxicity and acute eye hazards.
- *Danger-Poison*: Indicative of highly dangerous toxicity, including the risk of severe eye damage or skin irritation. These products are NOT registered for use by MGs and/or homeowners.

1 Bugz-b-Gone
Net Contents: 3 lbs

2 Reliocard Insecticide
For Control of Beetles and Weevils

3 Active Ingredients: Reliocard..... 20%

4 Inert Ingredients: 80%

100%

5 EPA Reg#: G312-150

Keep Out of Reach of Children!

6 CAUTION

Bugz-b-Gone Reliocard Insecticide kills blister beetles, black vine weevils, elm leaf beetles, flea beetles, ground beetles, hollyhock weevils, Japanese beetles, nitidulid beetles, pea leaf weevils, root weevils, and western spotted cucumber beetles. Bugz-b-Gone Reliocard Insecticide liquid formulation is ready to use on ornamental plants, trees, shrubs, flowers, and vegetables.

**7 PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS**
Danger. Corrosive. Causes irreversible eye damage. Harmful if swallowed. Avoid breathing vapors or spray mist. Do not get in eyes, on skin, or on clothing. Wash hands with soap and water after handling and prior to eating, drinking, or using the restroom.

Applicators must wear long-sleeved shirt, long pants, shoes, and socks. Wear eye protection—safety goggles or safety glasses.

8 FIRST AID
IN EYE: Flush eye(s) with water for 15 minutes.
ON SKIN: Wash skin with plenty of soap and water. Remove contaminated clothing.
IF SWALLOWED: To a conscious and alert patient, give 2–3 glasses of water, milk or if available, give 1 tbsp of ipecac syrup to induce vomiting. Do not make an unconscious person vomit. Seek medical attention.

BEE HAZARDS
This product is highly toxic to bees exposed to treatment on blooming crops. Apply from late evening to early morning or when bees are not foraging.

ENVIRONMENTAL HAZARDS
This product is toxic to aquatic invertebrates. Drift or runoff may adversely affect aquatic invertebrates and nontarget plants. Do not apply directly to water or to areas where surface water is present.

Figure 1A. The front panel of a fictitious pesticide label for the purpose of understanding how to read the statements and directions. Credit: Stacy Springer, University of Idaho Extension.

- Some pesticide labels do not list a signal word because the product's acute effects on humans and animals are nontoxic. You can find pesticides like these in the home and garden market. "Generally regarded as safe" by the US EPA, they are "minimum risk pesticides," products that do not require registration by the federal agency. Nevertheless, the ISDA requires their registration as a pesticide. Thus, follow all label directions.

7 | *Precautionary statements*

Declarations about the hazards a pesticide presents to humans, pets, wildlife, beneficial insects, and the environment. One of the larger sections in a label, it contains instructions on personal protective equipment (PPE) to protect the user plus instructions on protecting pollinators, endangered species, water resources, and avoiding drift, etc.

Master Gardener Tip

If not explicitly stated on the product label, PPE refers to, at a minimum, long pants, long-sleeved shirt, shoes, and socks. It is always a good practice to wear chemical-resistant gloves and protective eyewear too!

If you have a choice, compare products and avoid using those that may be harmful to bees and other environmental resources. Be sure to follow the instructions in this section to avoid any problems with off-site movement and unwanted pesticide residues.

8 | *First aid statement*

Provides instruction on what to do in case of exposure. It is thus a good practice to read this section before purchasing and using a pesticide product. When seeking emergency medical help, bring the product label with you. Also, contact the pesticide company or the NPIC for any questions.

See Figure 1B for numerical correspondence of sections 9–10.

9 | *Directions for use*

This information indicates where, how, and when to apply the product. Be sure the site or crop for application is clearly stated on the label and preferably the pest too. You will also find the application rates, allowable by law, in this section.

9 DIRECTIONS FOR USE

It is a violation of federal law to use this product in a manner inconsistent with its labeling. Read entire label before using this product. Do not use Bugz-b-Gone on new transplants.

Spray on infected areas when a large population is present. Product is best sprayed early morning or late afternoon when temperature is between 50°F and 80°F. Do not apply if wind speed is above 10 MPH to reduce spray drift. APPLICATION RATE: Mix 3 oz per 4 gal water every 1,000 ft².

10 STORAGE AND DISPOSAL

DO NOT CONTAMINATE WATER, FOOD, OR FEED.

Do not store with fertilizer, food, or feed. Keep away from children and pets. Store in original container in a dry, secure storage area. Keep container tightly closed when not in use with label secured. If using measuring utensils, mark "Pesticides Only!" and keep in storage.

Pesticide Disposal: Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide or spray mixture is a violation of federal law and may contaminate groundwater. Do not pour down kitchen or sewer drains.

Container Disposal: Triple rinse pesticide container and use as directed. Then offer for recycling or puncture and dispose of in a sanitary landfill.

Figure 1B. The back panel of a fictitious pesticide label for the purpose of understanding how to read the statements and directions. Credit: Stacy Springer, University of Idaho Extension.

Both the restricted-entry interval (REI)—the time to remain out of the treated area after treatment—and the preharvest interval (PHI)—how long to wait before you harvest the plants—are found in this label section. It may also include other directions regarding restrictions, such as how to apply the product, how many times it can be applied per year, etc.

10 | *Storage and disposal*

Provides information about the proper storage and disposal of the product. Read each product label section carefully, but some rules of thumb include the following:

- Keep the product in its original container with the label attached.

- Store it out of the reach of children and in a temperature-maintained, well-ventilated box/ cupboard.
- Mark all measuring utensils “Pesticides Only!” Do not store with food, feed, or seed.
- Rinse an empty container three times and use the rinsate (the mixture produced from cleaning pesticide containers or application equipment) as directed by the label. Place the clean, empty container in a waste bin. If extra product needs to be disposed, contact your city or county government or the ISDA Pesticide Disposal Program for dates and times of hazardous materials collection.

Hazards and Health

Toxicity

Chronic toxicity is long-term toxicity and usually occurs from exposure over an extended period of time. Acute toxicity ensues within 24–48 hrs of exposure. Reference the signal word on the pesticide label—it identifies a product’s acute toxicity. For example, the signal word “CAUTION” indicates low toxicity of 5000+ mg/kg, meaning that 5000+ milligrams (mg) of pesticide [per kilogram (kg) of body weight] kill 50% of the tested population of animals. The research data for toxicity is complex, however, so you won’t find it on a product label.

To better understand the science behind the rating system, the signal word is determined by a pesticide’s LD50. LD stands for lethal dose and 50 represents 50% of the animals tested, meaning that in the tested population of animals, 50% die when exposed to a dose of pesticide through oral ingestion. Consequently, the higher the LD50, expressed in milligrams of chemical per kilogram of animal body weight (mg/kg), the less toxic the pesticide. Minimize hazards by choosing an effective product that is least toxic to users, children, pets, and the environment.

Master Gardener Tip

Signal words = acute toxicity.

Pesticide Exposure Guidelines

Do not eat, drink, or smoke while handling pesticides. Wash your hands with soap and water after each use. Stay clean and free of spills. Just in case,

place decontamination supplies nearby, including jugs of water, soap, and towels.

There are four ways you can be exposed to pesticides: through the eyes, airways (inhalation), mouth (ingestion), and skin (dermal absorption). Be mindful that the risk of a pesticide is equal to the toxicity of a pesticide times the exposure. Always follow pesticide label directions. See Figure 2 for the different routes of pesticide exposure.

In the eye

Flush eye(s) with water for at least 15 min.

In an airway

Immediately leave the area.

In the mouth

Flush mouth out with water for at least 15 min.

If swallowed

Follow label directions; if no first aid applied, take victim to the nearest medical facility.

On clothes

Remove clothes and wash skin with soap and water.

When seeking medical attention, always take the product label with you so you can provide health-care specialists with the proper treatment instructions. However, do not transport the pesticide product to the medical facility; remove its label and take that along instead.

STEWARDSHIP

It is the responsibility of the product user to maintain personal and environmental protection practices. Uphold all restrictions and requirements listed on the product label. Keep a good attitude while

Routes of Exposure

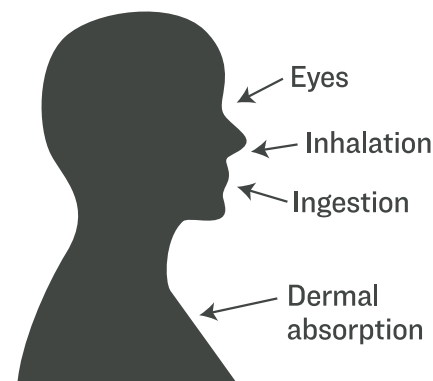


Figure 2. Pesticide routes of exposure to an individual. Graphic credit: Lynna Stewart, University of Idaho Extension.

handling and applying a pesticide—it is essential. For example, always read a product label prior to purchase. The habit will ensure that you have the correct product for the job at hand and will indicate the time you need to wait before it's safe to harvest any edible garden or landscape (the PHI).

Handling

Always use the recommended or mandated PPE listed on the pesticide label. Calculate the correct amount of pesticide for one application. Only mix the amount of pesticide and spray mixture needed for the job to eliminate the need for disposing of unused spray mixture.

In preparation for a pesticide application, evaluate the treatment area to be sure you are aware of ponds and other water features before spraying. Check that bees are not visiting the plants during the application times. It is a good idea to close windows, doors, and household air intakes and to remove objects and pets from the area to avoid creating unwanted exposures.

Follow reentry interval (REI) requirements on the label for each product, listed in hours or days. This time-period calculation keeps humans and pets safe from accidental exposure to any pesticide that may still be on the plants. Some pesticide labels may only require you to wait until the applied sprays are dry. But be sure by reading and following the specific pesticide label instructions.

Master Gardener Tip

If pets have access to the area, barricade half of the area before application. This allows pets to traffic an untreated area. Once the REI has passed, relocate the pets and repeat the procedure in the other half of the area.

When handling edible landscaping, know the PHI for the pesticide that you have used. This is the actual timeline you **MUST** wait before picking the fruits and vegetables. The PHI provides enough time for the pesticide residues to break down under natural conditions, ensuring that residues are at or below the regulated pesticide tolerance level set by the US EPA. After this time lapse, if any pesticide residue remains, there are levels that are considered safe for consumption. Remember, the PHI is always listed on the pesticide label!

Handling PPE

Removing protective clothing should be practiced in a certain order to reduce exposure.

1. Keep your gloves on (they are the last thing you remove!).
2. Find an area where you can safely gather your clothing (e.g., garage or mud room).
3. Wash gloves with soap and water.
4. Remove shoes or boots. Use one shoe to push the heel from the second shoe, while keeping the shoe on the second foot. Use the same procedure with the second foot to release the heel from the first shoe. Step out of both shoes.
5. Remove mask (if applicable).
6. Remove goggles.
7. Remove long pants.
8. Remove socks.
9. Remove long-sleeved shirt.
10. Remove gloves.
11. Using a washing machine, launder only the exposed clothes. Use heavy-duty detergent and hot water. If a clothesline is available, hang the clothes in the sun to further the pesticide breakdown process. Be sure to run a rinse cycle again after the wash-rinse cycle has completed.

Pesticide Properties and Movement

The Idaho Pesticides and Chemigation Law maintains that pesticide applications must not damage or endanger humans, animals, property, or the environment. To uphold this law, it's important to understand how to recognize the fate of a pesticide—how it travels and how it degrades.

Master Gardener Tip

Remember to apply pesticides with accuracy and responsibility and to always follow label directions.

Absorption

Pesticides are generally absorbed by plants or the pests themselves. The organisms' metabolism over time helps break them down.

Adsorption

Pesticide molecules can be adsorbed to soil particles and/or minerals in the soil or water. This depends upon the chemical properties of the pesticide. To adsorb means to adhere tightly to the soil or minerals, like nails attracted to a strong magnet. When pesticides are tightly adsorbed to soil or minerals in the water in your spray mixture, they become “tied up” or unavailable for pest control. If adsorbed to soil particles, the pesticide will not be available to the pest, and may travel away from the site through wind or rain.

Drift

According to the US EPA, “Pesticide spray **drift** is the movement of pesticide dust or droplets through the air at the time of application . . . to any site other than the area intended.” To reduce drift, understand these factors: weather, application equipment, and applicator skills.

Weather

Temperature inversion, wind, and humidity are negative weather conditions. An inversion develops when the trapping of cool air at ground level by the warm air above it creates a horizontal airflow. The atmospheric phenomenon may cause pesticides to move horizontally with the layers of air, casting the toxins off-site and possibly endangering the surrounding environment.

High wind is the perfect conduit for carrying a pesticide away from its target. Idaho state law prohibits any pesticide application when wind speeds are 10 mph or higher. Desirable plants, beneficial insects, domestic animals, and other desirable natural features can be damaged by drifting pesticide or other movement caused by inversions. Check your local weather conditions prior to any application to reduce drift and off-target pesticide applications.

Volatilization occurs when either a solid or liquid pesticide product changes into a gas. This can happen with high temperatures and low humidity. These weather factors can cause your pesticide product to change form and either be lost or vaporized into the

Master Gardener Tip

Consider the environment of your spray zone. It may include a neighboring garden or landscape border.

air and drift off-site, potentially causing unwanted pesticide contamination.

Runoff

Many pesticides are water-soluble, meaning that any water that courses through a treated area may carry off these pesticides. The term runoff refers to the movement of pesticides with water over surfaces. Thus, the degree of water solubility may be a factor for off-site movement of the pesticide and unwanted pesticide residues in surface waters (ponds, streams, lakes, etc.).

Leaching

Highly soluble pesticides may move downward through the soil profile, especially in sandy soils. This downward movement of pesticides with soil water is called leaching. Along with possibly compromising groundwater sources, leaching also removes effective pesticides from their intended site.

Plant Removal

When a treated crop, such as grass clippings, is removed and taken to another location, the pesticide residues may still be present on that plant material. This is considered an off-site movement of pesticide, wherein residue on the clippings risks causing unwanted pesticide contamination at the new location.

Master Gardener Tip

Composting is an example of plant removal. If you hired an applicator to manage the pesticide applications in your landscape, know what they are spraying, especially if you are composting or mulching your grass clippings.

Water Quality Impacts on Pesticide Performance

Our beautiful Idaho rivers and streams are fed through local watersheds. As the water travels, minerals are weathered and transported into our water supplies. Quite often these minerals are in our wells and irrigation canals, impacting the water hardness and pH (acidity and alkalinity). Are you irrigating from a well or are you using city water? Let us address how this influences pesticide applications.

Master Gardener Tip

If mixing pesticides, test your water source for hardness and pH.

Hardness

The amount of minerals in a water sample are called total dissolved solids (TDS). These minerals are not visible in the water but can bind to a pesticide in the spray mixture, causing it to become unavailable and ineffective for pest control. Water with a high level of minerals or TDS may need a buffering agent before mixing with pesticides.

pH

Many pesticides perform best when the water pH is in the 4–6.5 range. Test your water source to determine the pH of the water you plan to use for the spray mix. You can easily test your own water by using do-it-yourself water-testing strips purchased at your favorite garden or hardware store.

If the pH is above 7, use an adjuvant or buffering agent to adjust the water's pH (though the pesticide label will also let you know if one needs to be added). If the water is too alkaline or too acidic, the pesticide will begin degrading or hydrolyzing, neutralizing the pesticide in a short period of time. Remember, adjust the water's pH before adding the pesticide product to the spray mixture.

Pesticide Application Math

Once you know the best pesticide to use to control your pest, you need to calculate how much to apply. Purchase only what you will need for one growing season.

Before each application you need to determine how much area you will be treating, how much product you will use, and how to set up your equipment. Gather your measuring tools, the product label, and specific calculations to perform your investigation. Prior to any application of a pesticide, consult the label to determine the amount of product to use and what protective clothing you should wear.

To help you do the calculations properly, use the following hypotheticals to guide you:

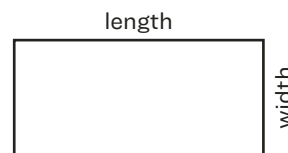
Determine the size of the treatment area

Rectangular

$$\text{length} \times \text{width} = \text{area}$$

For an area that is 20 ft by 40 ft,

$$20 \text{ ft} \times 40 \text{ ft} = 800 \text{ ft}^2$$

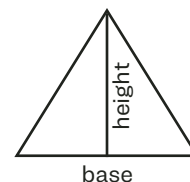


Triangular

$$(\text{base} \times \text{height}) / 2 = \text{area}$$

For a triangle with a base of 30 ft and height of 50 ft,

$$(30 \text{ ft} \times 50 \text{ ft}) / 2 = 750 \text{ ft}^2$$

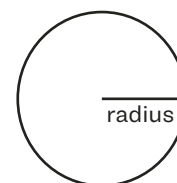


Circular

$$\pi (\text{pi} = 3.14) \times \text{radius}^2 = \text{area}$$

For a circle with a 15 ft radius,

$$3.14 \times 15 \text{ ft}^2 = 706.5 \text{ ft}^2$$



Determine the amount of product needed

Reading the product label, you learn that you need to dilute 2 fl oz of product into 1 gal of water and apply the resultant mixture at the rate of 5 gal per 2000 ft² (5 gal/2000 ft²). Your treatment area is 490 ft², so calculate how much water you need for this application in the following way:

- 5 gal/2000 ft² = x/490 ft². Solve for x.
Cross multiply and divide.
- 2000 ft²x = (490 ft² × 5 gal)
- 2000 ft²x = 2450 ft²/gal
- x = 2450 ft²/gal ÷ 2000 ft²
(note that square-foot units cancel out)
- x = 1.225 gal

For the 490 ft² treatment area you will use 1.225 gal of water.

Now you can calculate how much product is needed to add to the 1.225 gal of water.

- With x the amount of pesticide you will dilute into water, solve for x: 2 fl oz/1 gal = x/1.225 gal. Cross multiply and divide.
- 1 gal x = (1.225 gal × 2 fl oz)

3. $x = 2.45 \text{ gal/fl oz} \div 1 \text{ gal}$
(note that gallon units cancel out)

4. $x = 2.45 \text{ fl oz}$ or 2.5 fl oz

Answer: You will need to add 2.5 fl oz of product to 1.225 gal of water and apply the result to your 490 ft² treatment area.

Setting Up the Application Equipment

Hose-End Sprayers

Hose-end sprayers attach to the end of a garden hose. Some come preloaded with pesticide; others you'll need to add to the sprayer tank yourself after measuring the pesticide. Either kind is problematic. A decrease in water pressure creates uneven or inaccurate spray; or they may apply excessive pesticide due to incomplete rate calculation and/or area measurements.

Hand-Held Sprayers

A small, hand-operated spray tank (generally 1–3 gal) used for formulations that require dilution. Calculate and measure the pesticide product, add to the tank, and top off with water. Mix the solution by shaking; maintain sprayer pressure by hand pumping. For uniform coverage, mix concentration thoroughly and apply consistent pressure. If using a dry formulation, frequent agitation is necessary to avoid separation and sedimentation. These sprayers are best for applications on lawns, vegetables, bushes, and dwarf trees. It is difficult for them to generate sufficient pressure to reach the limbs of tall trees and get good pesticide coverage.

Broadcast Spreaders

These are hand-held devices or walk-behind hoppers on wheels that generally use fertilizer and pesticide granular mixtures. They need to be calibrated so that you can determine how much product to apply. These spreaders conveniently allow for a certain amount of adjustment that you can execute by changing the opening size on the bottom of the spreader.

Calibration

As you prepare for spring and the garden season, calibrating your equipment is like tuning up your tools. It should be done every year. So, gather your measuring tools, a stopwatch, a calculator, your notebook, and flags for marking certain distances.

Next, fill up your tank with a measured amount of water, then pressurize the tank. When you begin spraying, use a stopwatch to time how long it takes to spray this specific amount of water. If you are timing a hose-end sprayer, completely turn on your faucet so that you can time how long it takes to collect a fixed amount of water into a bucket.

Lastly, stage a section of your driveway or someplace similar (approximately 10 ft x 10 ft). Using a sprayer with a water-filled tank, record the time it takes to cover the section. Now that you know the flow rate at that traveling speed, calculate whether you will need to move faster or slower to affect the application rate. Practice this stride.

Master Gardener Tip

Calibration should be figured for each person using the application equipment.

Maintenance

Frequently check your equipment for leaks or holes. Keep equipment clean.

Record Keeping

What was your biggest pest last year? Logging your experiences and planning ahead will help you to prevent the same infestation or outbreak. Evaluate the pesticide you used—was it effective? Be sure to document the pesticide name and EPA registration number to help you keep track of proper pesticide rotation.

Master Gardener Tip

Capture your landscape issues, follow plant/insect life cycles, and allow patterns to unfold.

Storage

Always store pesticides in their original containers, and always with its label attached. Indicate on your equipment and measuring tools that they are “Pesticide Only!” This includes measuring cups and spoons. Stow these items with your pesticides in a locked container.

Make sure the locked container or box is in a cool, well-ventilated environment. Keep it out of the reach of children and store it separately from feed,

Master Gardener Tip

Buy small quantities for the season (or only what you need) to eliminate storage problems altogether.

seed, food, and fertilizers. If shelving it, place dusts above liquids (in case of leaks) and secure tightly.

Disposal

If you've mixed more product than you need, apply the extra mixture to another area that is listed on the label. For expired pesticides, discard them at designated pesticide collections (sponsored by your county or the ISDA). **Do not dump pesticides!**

After disposal, triple rinse the empty containers. Begin by adding water to the pesticide container, sealing the lid tight, and shaking it (to ensure that the water "rinses" the container's side walls). Handle its byproduct (rinsate) as you would the product. Repeat three times (hence triple rinsing). Remember, by triple rinsing you are using the rinsate as you would the product. Be sure to triple rinse the equipment too.

Master Gardener Tip

For any question about where to find your local pesticide collection sites, contact the ISDA.

Pesticide Spills

When a pesticide spill occurs, apply the 3 Cs: control, contain, and clean up. Control the spill by simply picking up the pesticide container and placing it upright to stop further spillage. Contain it by installing a small dike around the spilled area (the dike can be a small barrier of soil or other absorbent material). Clean up the spill by using the following recommendations:

Liquid product spillage

- These types of spills can be more difficult to clean up, so begin by absorbing the pesticide with sorbent granulars (e.g., Floor-Dry brand) or cat litter. Then sweep it up and dispose in a plastic bag.
- Wash the area with an appropriate cleaner, such as household bleach.

Table 3. Professional urban pesticide–licensing categories in Idaho.

AP	Aquatic Pest Control
GP	General Pest Control Operator
OH	Ornamental Herbicide
OI	Ornamental Insecticide and Fungicide
SP	Structural-Destroying Pests
WP	Wood Preservative

- If the spill has contaminated other materials that you may have used to contain or soak up the pesticide, discard that material.

Dry product spillage (these spills can be simpler)

- Sweep up the product and use it.
- Or place it in a heavy plastic bag for disposal.

In either case, if you have any questions be sure to read the product label's disposal instructions or contact Poison Control.

How to Hire a Professional

Professional pesticide applicators are licensed, certified in technical training, and use specialized equipment. So there are many advantages to relying on them. They are convenient and quick, skilled at reducing pesticide exposure, and knowledgeable about decontamination techniques. Indeed, they are required to uphold the state's regulations by following pesticide product label directions and safety precautions.

Before deciding to call a professional, gather information from your local Extension office on the pest's identification, life cycle, treatment, and environmental effects. Determine whether or not your client has the time, knowledge, and equipment to complete a pesticide application. If not, solicit a licensed pesticide applicator to do the work.

The ISDA provides a searchable database of certified applicators (see Table 3 for the licensing categories). To find a licensed professional applicator in your area, search the database by your county of residence. Below are suggested questions to ask a potential professional applicator.

1. What is your reputation and business rating?
2. What is the name of your insurance or bond company?
3. Will you provide a copy of the pesticide application paperwork, including

- a. the pesticides name(s)
- b. the rate applied
- c. application weather conditions
- d. the reentry interval (when you can reenter the area)
- e. the preharvest interval
- f. the applicator's name
- g. the applicator's license number
- h. the company's name

Master Gardener Tip

If a client comes into your plant diagnostic lab looking for a professional applicator, suggest they contact their favorite garden store for references or consult the ISDA website. It is recommended that they collect more than one bid for a competitive market price.

Important Numbers and Information

Be prepared for accidents or unintended circumstances that puts you in harm's way. For your convenience and safety, we have included a poster on which you can enter your emergency contact information (see end of chapter). Post the completed poster for easy access. If you have an emergency, it will give you a head start on finding assistance.

RESOURCES

American Association of Poison Control Centers
<http://www.aapcc.org/> or (800) 222-1222

Extension Toxicology Network
<http://extoxnet.orst.edu/>

Fungicide Resistance Action Committee (FRAC)
<http://www.frac.info/>

Herbicide Resistance Action Committee (HRAC)
<http://www.hracglobal.com/>

Idaho State Department of Agriculture (ISDA),
Organic Certification Program <https://agri.idaho.gov/main/about/about-isda/ag-inspections/organic-certification-program/>

ISDA Pesticide Disposal Program (PDP)
<https://agri.idaho.gov/main/56-2/pesticides/pesticide-disposal/>

ISDA, "Pesticides,"
<https://agri.idaho.gov/main/56-2/pesticides/>

Insecticide Resistance Action Committee (IRAC)
<http://www.iraconline.org/>

National Pesticide Information Center
<http://npic.orst.edu/> or 1-800-858-7378

Organic Materials Review Institute (OMRI)
<https://www.omri.org/>

Pacific Northwest Insect Management Handbook
<https://pnwhandbooks.org/insect>

Pacific Northwest Plant Disease Management Handbook
<https://pnwhandbooks.org/plantdisease>

Pacific Northwest Weed Management Handbook
<https://pnwhandbooks.org/weed>

US Environmental Protection Agency (US EPA),
"Pesticides," <https://www.epa.gov/pesticides>

FURTHER READING

Bauder, T., R. Waskom, and C. Arrieta. "Best Management Practices for Pesticide and Fertilizer Storage and Handling." Colorado State University Extension, Fact Sheet 178.

"Chemically-Related Groups of Active Ingredients." 2016. *Environmental Protection Agency*. <https://www.epa.gov/ingredients-used-pesticide-products/chemically-related-groups-active-ingredients>. Accessed 11 August 2017.

Church, C.S., W. Buhler, L. Bradley, and R. E. Stinner. 2012. "Assessing Extension Educators' Needs for Homeowner Pesticide Use and Safety Information." *Journal of Extension* 50(5), Article 5RIB7. <https://joe.org/joe/2012october/rb7.php?pdf=1>.

Coleman, P. 2012. *Guide for Organic Crop Producers*. US Department of Agriculture (USDA). 64 p. <https://www.ams.usda.gov/sites/default/files/media/GuideForOrganicCropProducers.pdf>.

Fischel, F. 1997 (revision). "Agricultural MU Guide: Pesticides and the Environment." University of Missouri-Columbia Extension, G7520. 6 p.

Fischel, F. M. 2016. *Pest Management and Pesticides: A Historical Perspective*. University

- of Florida IFAS Extension/EDIS, Publication PI219. 5 p. <https://edis.ifas.ufl.edu/pi219>. Accessed 11 August 2017.
- Jervais, G., B. Luukinen, K. Buhl, and D. Stone. 2008. "2,4-D General Fact Sheet." *National Pesticide Information Center*. Oregon State University Extension Services. <http://npic.orst.edu/factsheets/24Dgen.html>. Accessed 11 August 2017.
- Martin, A., F. Whitford, and T. Jordan. 2011 (revised). *Pesticides and Formulation Technology*. Purdue University Cooperative Extension Service, PPP-31. 16 p. <https://www.extension.purdue.edu/extmedia/PPP/PPP-31.pdf>
- Master Gardener Foundation of Grays Harbor and Pacific Counties. n.d. "Pesticides." <http://pnwmg.org/garden-info/organic-gardening/>.
- Oregon Occupational Safety and Health Administration, Consumer and Business Services. *Personal Protective Equipment: Selecting the Right PPE for Pesticide Use*. 2018. Oregon Occupational Safety and Health Administration, 440-1018. 16 p. <http://osha.oregon.gov/OSHAPubs/1018.pdf>.
- Oyler, T.O. Jr., S.I. Gripp, K.M. Richards, W.K. Hock. 2000. *Safe Use of Pesticides Around the Home*. Pennsylvania State University, Agricultural Research and Cooperative Extension, Agrichemical Fact Sheet 3. 12 p. <http://www.accuracyinspections.com/uo190.pdf>.
- Penn State Cooperative Extension. 2013. *Introduction to Weeds and Herbicides*. Penn State Cooperative Extension, UC175. 28 p. <https://extension.psu.edu/introduction-to-weeds-and-herbicides>. Accessed 11 August 2017.
- Penn State Pesticide Education Program (PSU PestEd). 2015 (14 December). "History of Pesticides." YouTube video, 8:05, https://www.youtube.com/watch?v=gyZPDcr5_dw. Accessed 11 August 2017.
- Tharp, C., and A. Sigler. 2013. *Pesticide Performance and Water Quality*. Montana State University Extension, 1213SA. 4 p. http://msuextension.org/lewisclark/documents/MSU_Pesticide_Performance_and_Water_Qual.pdf.
- Trinklein, D. 2016 (revised). *Using Pesticides Safely in the Home and Garden*. University of Missouri Extension, MG14. <http://extension.missouri.edu/p/MG14>.
- United States Environmental Protection Agency. 2005. *Citizen's Guide to Pest Control and Pesticide Safety*. Prevention, Pesticides, and Toxic Substances (7506C), EPA 735-K-04-002. 53 p. https://www.epa.gov/sites/production/files/2017-08/documents/citizens_guide_to_pest_control_and_pesticide_safety.pdf. Accessed 11 August 2017.
- University of California Agriculture and Natural Resources. 2006. *Hiring a Pest Control Company*. University of California Agriculture and Natural Resources, Pest Notes Publication 74125. 4 p. <http://ipm.ucanr.edu/PDF/PESTNOTES/pnhirepestcontrol.pdf>.
- Whitford, F., A. Martin, and R. Ballard. 2003. "Pesticide Safety and Calibration Math for the Homeowner." *Purdue Pesticide Programs*, PPP-39. Purdue University Cooperative Extension Service. 11 p. <https://www.extension.purdue.edu/extmedia/ppp/ppp-39.pdf>.
- Whitford, F., G. Ruhl, S. Mayer, J. Orick, R. Lerner, and K.L. Smith. 2015. *What Gardeners Should Know about Pesticides: A Practical Guide for Home Use*. Purdue University Extension, PPP-109. 64 p. <https://ppp.purdue.edu/wp-content/uploads/2016/08/PPP-109.pdf>.

ACRONYMS

FIFRA – Federal Insecticide, Fungicide, and Rodenticide Act

IPM – Integrated Pest Management

ISDA – Idaho State Department of Agriculture

MG – Master Gardener

MoA – mode of action

NPIC – National Pesticide Information Center

OMRI – Organic Materials Review Institute

PHI – preharvest interval

PNW Handbook – Pacific Northwest Handbook

PPE – personal protective equipment

REI – reentry interval

SoA – site of action

TDS – total dissolved solids

USDA – United States Department of Agriculture

US EPA – United States Environmental Protection Agency

GLOSSARY

active ingredient—The chemical in a pesticide product that controls the organism.

drift—The movement, through the air, of a pesticide application.

organic—A regulated standard of food production that can involve the use of pesticides derived from naturally occurring substances.

pesticide—A product whose application intends to prevent, destroy, repel, or mitigate an unwanted organism.

pesticide resistance—The decreased susceptibility of a pest population to a pesticide that develops from repeated exposure; the offspring, in turn, inherit the tolerance.

signal word—Terminology on a pesticide label that indicates the level of acute toxicity to pesticide exposure. Identifies the product's degree of toxicity to humans.

ALWAYS read and follow the instructions printed on the pesticide label. The pesticide recommendations in this UI publication do not substitute for instructions on the label. Pesticide laws and labels change frequently and may have changed since this publication was written. Some pesticides may have been withdrawn or had certain uses prohibited. Use pesticides with care. Do not use a pesticide unless the specific plant, animal, or other application site is specifically listed on the label. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

Trade Names—To simplify information, trade names have been used. No endorsement of named products is intended nor is criticism implied of similar products not mentioned.

Groundwater—To protect groundwater, when there is a choice of pesticides, the applicator should use the product least likely to leach.

Revised December 2019

IMPORTANT NUMBERS & INFORMATION

EMERGENCIES

Primary Emergency Contact: _____

Poison Control Center: _____

Fire: _____

Police: _____

UI EXTENSION

Find information about the University of Idaho Extension Pest Integrated Management Program at uidaho.edu/extension/ipm

PERSONAL DOCTOR

Name: _____

Phone: _____

Office Address: _____

EXTENSION HEADQUARTERS:

(208) 885-5883
extension@uidaho.edu

HOSPITAL

Name: _____

Phone: _____

Physical Address: _____

COUNTY OFFICE

Phone: _____

Address: _____

MEDICAL HISTORY

Name: _____

Allergies: _____

Medications: _____

Other: _____

IDAHO DEPT. OF AGRICULTURE

(208) 332-8500
www.agri.idaho.gov/main

VETERINARIAN

Name: _____

Phone: _____

Office Address: _____

MARK UTILITY LINES

Before you dig, have utility lines marked. Call 811 or visit www.call811.com

ADDITIONAL NOTES:

NATIONAL PESTICIDE INFORMATION CENTER

(800) 858-7378
<http://npic.orst.edu/>