CHAPTER 3

PESTICIDES

LEARNING OBJECTIVES:

After you complete your study of this chapter, you should be able to:

- Explain four methods for classifying pesticides.
- Understand the difference between contact and systemic pesticides and how they control pests.
- Explain what organic and inorganic pesticides are.
- Differentiate between several pesticide chemistries registered for use on animals and the precautions necessary when handling or using them.
- Distinguish between active and inert ingredients.
- Identify the factors to consider when choosing a formulation.
- Explain the various methods of pesticide applications appropriate for small animals and their environment.
- Perform the precautions necessary for safe pesticide applications on an animal or in its environment.
- Recognize symptoms associated with small animal pesticide poisoning.
- Explain how and when pesticides may be incompatible.
- Understand how pesticides can harm nontarget organisms.

Pesticides are substances or mixtures of substances intended to prevent, destroy, repel or manage pests. In addition, the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) has extended the legal definition of a "pesticide" to include compounds intended for use as plant growth regulators, defoliants or desiccants, even though they are not normally used as pest management agents, and are usually not effective as such.

More specifically a **pesticide** may be defined as any chemical used to control pest populations directly or to prevent or reduce pest damage. Though the ending "cide" is derived from the Latin word cida, meaning "to kill," not all pesticides actually kill the target organism. For example, some fungicides may simply inhibit the growth of a fungus without killing it; attractants and repellents lure a pest to or divert it from a particular site.

The following chapters discuss a wide variety of insects, mites and ticks that afflict companion animals. Activities or infestations by these pests can, in many cases, severely compromise the health and well-being of individual animals. Though insecticides (control insects) and acaricides (control arachnids) are not the only means for controlling or preventing these pests from becoming problems, they often play an important or even a key role. Sometimes, one must choose between insecticide applications and drug treatments to deal with insect pests that are true parasites.

Pesticides are a mixed blessing. For example, they contribute significantly to agricultural productivity and to improved public health by managing disease-carrying pests, but they can adversely affect people, nontarget organisms such as fish and wildlife, and the environment.

Before using insecticides, one should think about the components of an integrated pest management program (see Chapter 2). For insect, mite or tick pests of animals, this means developing management systems that employ the full range of physical and cultural methods available to manage the pests before insecticides are used. For example, in the case of filth fly problems in kennels or pet exercise areas, insecticides should not be used until good sanitation practices have been

established. Also, purchasing pets from reputable breeders is a cultural preventive measure that may mean lice and mange mites can be avoided or kept in check.

In another example, flea control for pet dogs or cats must include sanitation and control around the home to eliminate larval fleas and flea eggs. Fleas do occur in very clean houses, but sanitation is essential for a successful flea management program. Attaching flea collars or medallions to pets during seasons of high flea pressure may help reduce the chance of new infestations. Check the animal frequently, especially after it has been at a boarding or grooming facility or veterinarian's office. Other animals at these locations may spread fleas to non-infested animals. Typically, only after an infestation occurs should you consider insecticide use in the home or on the pet, and then only in conjunction with good sanitation practices. The exception may be when a pet has flea bite sensitivity. Treatment after a flea population has become established would be too late to avoid the animal's discomfort. In this case, insect growth inhibitor products may be effectively used to prevent a problem from becoming established.

In this chapter, you will learn how pesticides are classified, the types of formulations, application methods, basic concepts of pest control on animals, and special concerns with pesticide use on and around animals. This knowledge will help you to use pesticides safely and effectively.

PESTICIDE CLASSIFICATIONS

Pesticides are classified according to a number of methods. Each method serves specific purposes. The four most common methods of classifying pesticides are based on (1) the group of pests managed by the pesticide, (2) how the pesticide works, (3) the chemical nature of the pesticide, and (4) the pesticide formulation.

Method 1: Types of Pests Managed

This pesticide grouping system is as follows:

Pesticide Classification	Pests Managed
Insecticide	Insects and other related animals
Acaricide	Mites, ticks and spiders
Miticide	Mites
Fungicide	Fungi
Herbicide	Weeds
Rodenticide	Rodents
Avicide	Birds
Piscicide	Fish
Ovicide	Eggs of organisms

Method 2: How Pesticides Work

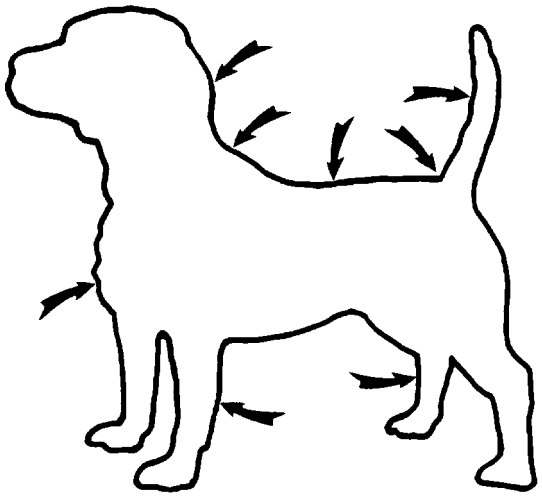
These common terms classify pesticides based on how they work:

Protectants – Pesticides applied to plants, animals, structures and products to prevent pest establishment. These may include repellents.

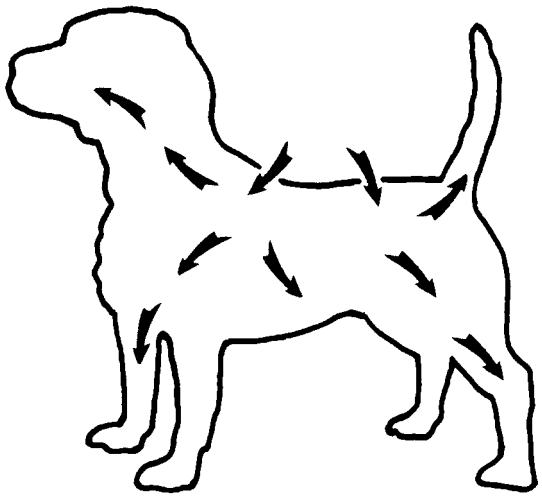
Sterilants – Pesticides that manage pests by rendering them incapable of normal reproduction.

Broad-spectrums – Pesticides that control two or more pests. They are sometimes labeled as multipurpose chemicals. A material capable of controlling fleas and ticks for, example, is broad spectrum. This category of pesticides is somewhat more general than the others because a broad spectrum pesticide may be a protectant, an eradicant or a systemic in its action.

Contacts – Pesticides that kill pests simply by coming into contacting with them.



Contact



Systemic

Systemics – Pesticides that are absorbed by one part of the animal or plant and distributed internally to other parts of the plant or animal. For example, some flea control agents are given orally to dogs. The flea is killed when it bites the dog and ingests the insecticide.

Many synthetic organic pesticides work in one or more of the ways listed above. Read the pesticide label to find out how the pesticide you are using works.

Method 3: Pesticide Chemistry

Pesticides can be divided into two chemical groups: inorganic and organic compounds.

Inorganic pesticides are of mineral origin and therefore do not contain carbon. They commonly contain either copper, boron, sulfur or zinc. Examples are lime-sulfur and Bordeaux mix. Inorganic pesticides are used primarily to manage plant diseases or for controlling certain pests on young, pregnant or stressed animals. Examples are given in later chapters.

Organic pesticides contain carbon. They also contain hydrogen and often oxygen, nitrogen, phosphorus, sulfur or other elements. Most pesticides in use today are organic compounds. Most are synthetic or manmade compounds. These compounds have been primarily responsible for the rapidly expanding use of pesticides since the 1940s. They are often extremely effective and easy to use, they have been relatively inexpensive, and some are quite specific in their activity. They have, however, been the principal focus of health and environmental concerns and have been primarily responsible for problems associated with pesticide use and misuse.

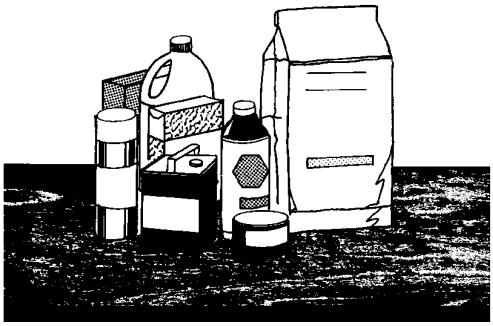
The **synthetic organic pesticides** (i.e., manmade, carbon-containing chemicals) include the chlorinated hydrocarbons, organophosphates, carbamates, synthetic pyrethroids, phenoxy herbicides and a number of other chemical classes.

Several types of insecticides and acaricides are used to control pests on or around animals. Classes of drugs used for pest control on animals are not reviewed in this manual. A drug is a treatment chemical approved and regulated by the Food and Drug Administration and is not classified by the EPA as a pesticide. Certain drugs and insecticides may control the same pest, however.

Under present regulations, pesticide labels must carry warnings against use of many compounds on certain animals or under certain circumstances. These warnings may pertain to acute or chronic toxicity or to residues in livestock animals. Label changes may arise from state or federal legislative action, changes in executive interpretation or changing ecological interests, so it is critical to read and follow current label directions every time a product is used.

Method 4: Pesticide Formulations

The component of a pesticide that controls the target pest is called the **active ingredient** (a.i.). Before a pesticide product is sold, active ingredients are mixed with liquid or dry **inert ingredients** (non-pesticidal). Though inert ingredients do not kill the target pest, they may be capable of causing adverse environmental and human health effects. Mixtures of active and inert ingredients are called **pesticide formulations.** Formulations make an active ingredient more convenient to handle; safer and easier to apply more accurately; and in some cases, more attractive to the pest.



Classes of Insecticides/acaricides Used in Animal Pest Management:

Eleven chemical classes of insecticides and acaricides are used to control pests on or around animals.

1. **Chlorinated hydrocarbons.** This class includes lindane and methoxychlor. Lindane has become a restricted use pesticide for mange mites and lice.

Chlorinated hydrocarbons are easily absorbed through the skin and accumulate in the body. Overexposure can occur from excessive use. These products are not recommended for cats and, several feline poisonings have occurred. Common symptoms of companion animal chlorinated hydrocarbon poisoning may include seizures, salivation, vomiting, tremors and death.

2. **Organophosphates (OP).** An organophosphate is a synthetic organic pesticide containing carbon, hydrogen and phosphorus. If the product label bears chemical names containing “phosphoro” and recommendations to use atropine plus

pralidoxime (2-PAM) as an antidote for poisoning, you can assume the product is an OP insecticide. Organophosphate compounds inhibit cholinesterase (see Chapter 5, Pesticides and Human Health). Cholinesterase is a chemical catalyst (enzyme) found in mammals that helps regulate the activity of nerve impulses.

This class of pesticides includes a broad range of insecticides/acaricides such as chlorpyrifos, malathion, DDVP, ronnel, stiriphos and others. Organophosphates are effective against a wide range of insects including fleas and ticks. OPs are commercially available as ready-to-use insecticidal solutions, emulsifiable concentrates, dips, dusts, baits and flea collars.

These products range from acutely to mildly toxic to animals. The body has the ability to break these compounds down, usually in the first 24 hours. Though they are less likely to accumulate in the body than chlorinated hydrocarbons, organophosphates cannot be used in conjunction with one another because they can accumulate during a short period of time immediately following exposure. Find out whether the animal has been administered an oral, systemic OP. If so, do not treat with a topically applied OP. The two products can have a combined effect on cholinesterase activity.

Overexposure to OPs commonly causes such symptoms as tremors, vomiting, salivation, **ataxia** (inability to coordinate voluntary muscular movements), loss of appetite, diarrhea, seizures, breathing difficulty (**dyspnea**), weakness and death.

A large percentage of serious OP poisonings have been related to the more toxic dip solutions dispensed by veterinarians. Major problems commonly result when canine products are used on cats. Deaths associated with chlorpyriphos poisonings have also been attributed to dip solutions. Cats topically exposed to chlorpyriphos may have delayed signs of poisoning, and these symptoms may persist for weeks. Abnormal behavior and loss of appetite may be most noticeable.

The third most commonly reported organophosphate insecticide-related poisoning among all animal types has been dichlorvos (DDVP). Many foggers contain DDVP in combination with other cholinesterase-inhibiting insecticides. DDVP-based flea collars have been involved with poisonings, especially in cats. Reading product labels and following all precautions and directions for use greatly reduces the chance of poisonings.

Onset of symptoms after excessive OP exposure usually occurs within hours but may be delayed up to two days. Severity and development of symptoms are influenced by the dosage and the route of exposure (dermal, oral, etc.). If poisoning from an OP is suspected, obtain immediate assistance from a veterinarian and take the label of the suspect insecticide with you.

3. **Carbamates.** Carbamates are similar to organophosphates in activity—they inhibit cholinesterase. Carbaryl, propoxur and methomyl are carbamates. Small animals have been the victims of carbamate poisoning by products labeled for use on sites other than on the animal. These include ant traps, products used for home insect control and agricultural products. Methomyl is particularly hazardous to dogs and cats because of its inherent toxicity (LD50 of 17 mg/kg) and the apparent palatability of the sugar baits in which it is often formulated.

Carbamate poisoning is characterized by excessive salivation, tremors, vomiting, seizures, diarrhea and loss of muscle control. If you suspect carbamate poisoning, obtain immediate assistance from a veterinarian and take the label of the suspect insecticide with you.

4. **Synthetic pyrethroids.** This class of insecticides/acaricides includes permethrin, resmethrin and allethrin. Often the formulations contain a **synergist** (something that enhances the effectiveness of the active ingredient) called piperonyl butoxide, or PBO. By itself, PBO is relatively nontoxic. The synthetic pyrethroids show properties of low mammalian toxicity but good activity against insects, ticks and mites. They do not appear to be readily absorbed through the skin.

Animals mildly affected by pyrethroids and those in the early stages of pyrethroid poisoning often display hypersalivation, vomiting, diarrhea, mild tremors, hyperexcitability or depression. These symptoms may be confused with symptoms of organophosphate or carbamate poisoning. More severely affected animals can have high fevers or lowered body temperature, difficulty breathing, severe tremors, disorientation and seizures. Death is due to respiratory failure. Generally, these signs begin within a few hours of exposure. In the case of excessive dermal exposure, the animal should be bathed using mild detergent and rinsed repeatedly. Initial assessment of the animal's respiratory and cardiovascular condition is important. Further treatment requires veterinarian assistance.

5. **Botanicals**. Rotenone and pyrethrin are derived from plants. They may be synergized in certain formulations with PBO. With the exception of nicotine, plant-derived insecticides have shown low mammalian toxicity.

6. **Repellents.** Repellents, though not strictly insecticides, help prevent animal pest establishment. Diethyl-meta-toluamide (DEET), butoxypolypropylene glycol and dipropyl isocinchomeronate are repellents with activity against certain arthropods. Some formulations containing synthetic pyrethroids are repellents. There have been reported deaths of both cats and dogs after excessive exposure to DEET. The most common signs of poisoning include vomiting, tremors, ataxia and incoordination, hyperactivity, hypersalivation, depression, loss of appetite, seizures and breathing difficulty.

7. **Lime sulfur** (calcium polysulfide). Sulfur and lime-sulfur are two of the oldest insecticides. Lime-sulfur is an inorganic chemical option for lice control. Lime-sulfur may cause the animal irritation, discomfort or blistering, but it rarely causes death. If overexposure is suspected, bathe the animal to remove any residues and rinse repeatedly with clean water.

8. **Mineral oil.** Mineral oil is useful as a barrier against biting flies in ears of horses. It is also a diluent in some ear mite treatments that contain carbaryl.

9. **Amitraz.** Amitraz is a formamidine chemical with insecticidal and acaricidal properties.

10. **Insect growth regulators and hormone mimics.** This class of insecticides prevents development of immature insects to the adult stage. Methoprene is formulated as a spray for flea control (eggs on animals, larvae in the environment). These chemicals simulate the activity of juvenile hormone, the hormone in insects that maintains immature characteristics in insects.

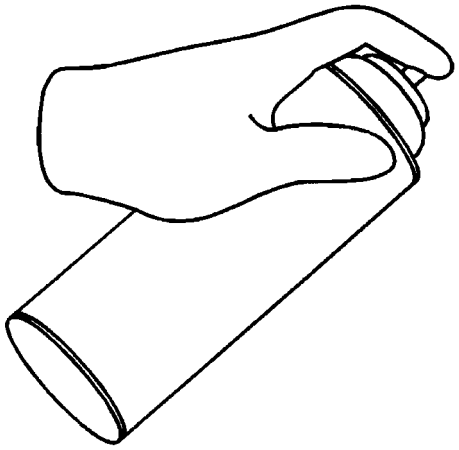
11. **Ivermectins.** The ivermectin/avermectin group of insecticides are labeled as drugs, and they often come into use for pest control on animals. Because they are drugs, they must be obtained and administered by a veterinarian for companion animal use.

FORMULATIONS USED IN MANAGING SMALL ANIMAL PESTS

It is important to choose the formulation that is best for a particular job based on its effectiveness, cost, practicality, and relative safety to you, the animal being treated and the environment.

Insecticide and acaricide formulations vary widely and must be chosen to fit the particular situation. A high-pressure hydraulic sprayer would be inappropriate for applying a flea shampoo to a puppy, to give one extreme example. Under certain conditions, the application method requires a particular formulation. Sometimes the formulation and application method are described by the same word (e.g., shampoo). Formulations used for small animal pest management include:

1. **Ready to use (RTU).** Ready-to-use formulations require no mixing or combining with other ingredients or diluents. They usually come in a container that serves as the application device, such as an aerosol can, pour-on bottle, roll-on, spot-on or spray bottle. These formulations tend to be the most expensive options because they are convenient and packaged for application. These may include ointments or gels that help prevent fly bites.



2. **Wettable powders.** Wettable powders must be mixed with water before application. They are concentrates in solid, powdered form. They can be sprayed after mixing.

3. **Emulsifiable concentrates.** Emulsifiable concentrates are liquids that must be mixed with water before application. They can be sprayed after mixing or sponged on the animal.

4. **Shampoo.** A shampoo is a formulation of insecticide and other ingredients that is applied to an animal's wet fur and worked into a lather. Label directions may indicate a length of time that the shampoo must remain on the animal to

achieve effective pest control before being thoroughly rinsed off. Shampoos should be pH balanced and labeled for use on the pet to be treated. Industrial shampoos and dish detergents are not acceptable products for use on small animals. Exercise all caution when applying pesticide products to debilitated animals (animals weakened by injury, illness or some other stress). These animals should be referred to a veterinarian for close observation during and after application.

Insecticides for treating pests on animals are often formulated as shampoos.

5. **Dust.** A dust is a ready-to-use dry formulation. Protect the animal's eyes from the dust. Applicators must wear appropriate personal protective equipment to protect exposed skin, the respiratory tract and eyes.

6. **Feed additive or bolus.** These formulations are mixed with feed or, in the case of a bolus, fed directly to an animal. Proban® is an FDA-regulated product available for companion animal use in a pill or liquid form. If a client is administering an oral formulation, be sure the shampoo or product you select to use is compatible.

7. **Collars and medallions.** Some insecticides and acaricides are formulated with plastics, such as collars and medallions that are fixed to an animal and left attached for a period of time. Collars and medallions are used on small animals to control fleas and ticks. Plastic straps containing an insecticide can be fixed to horse halters for biting fly control. In these formulations, the insecticide moves from the plastic to the hair or coat of the animal.

8. **Pastes, liquids, powders** and **tablets/pellets.** These formulations are given orally to animals to control internal parasites. Some products have restrictions, are regulated as drugs by the FDA, and may be purchased and administered only by licensed veterinarians.

9. **Baits.** Baits are either commercially prepared as dry granules or made as mixes of insecticides, sweeteners and water, as discussed in "Methods of Application" below.

METHODS OF APPLICATION

The methods of application of insecticides/acaricides to animals or the animals' environment depend on the target pest, the formulation chosen and the number of animals or size of area to be treated. Sometimes the limiting factor will be the availability of application equipment or suitable facilities and helpers. Applicators must wear all the protective equipment required on the pesticide label. Labels list minimum requirements. The applicator should use common sense and protect body areas that may be at risk of exposure. Waterproof aprons, gloves, boots and goggles are always a wise choice, especially when bathing animals.

Always wear the appropriate personal protection equipment when making a pesticide application.

A **premise spray** is an insecticide application that will persist on the surfaces in an animal's living area for a period of time. Pest insects, such as filth flies or fleas, will contact these surfaces, encounter the insecticide and die. The spray is intended to offer a few days to a few weeks of control.

An **area spray** or **space spray** does not involve an insecticide with long residual qualities. Instead, the spray, aerosol or fog kills the insects in the area at the time of the application. Thus, a space spray is much more temporary than a premise spray. A space spray may involve **ultra-low volume** equipment—small droplets of insecticide are sprayed at a low rate of application into the space.

An insecticidal **bait** can be purchased ready to use (generally dry, as granules) or can be mixed. Baits can be established at bait stations that lure the pest toward the insecticide source. Some fly baits contain attractants to draw flies in, such as muscamone. Some fly baits are made by mixing sugar, corn syrup or molasses with water and insecticide, and then applied as a slurry with a brush to surfaces in confined settings. Caution: Do not apply this sweet mixture where animals can lick it from treated surfaces.

Dips are another method of insecticide application to animals. "Dip" is often the term used to describe the shampoo procedure performed on companion pets in kennels, grooming salons and in veterinary clinics. These situations do not require that the animal be immersed, nor does the animal stand in treated water. Dips may also be pour-on products that do not require total immersion of the animal.

The person bathing or dipping the animal should wear a water- and chemicalproof apron and gloves. As noted in Chapter 5, Pesticides and Human Health, a human's groin area is the most absorptive part of the body and should be completely protected from pesticide exposure. Goggles will prevent splashing water from entering the eyes. **Always wear** the minimum amount of personal protective equipment required on the label. It's OK to wear more.

Pour-ons and **spot-ons** are high-concentrate, low-volume formulations applied directly to animals. The materials are applied with the container they are purchased in. Because of the toxicity of the products, spot-ons are typically applied by a veterinarian. These products may require that after being applied, the animal be completely dried before it contacts humans or other animals. Wipes are also used as direct applications to animals—cloths or sponges are saturated with the pesticide and used to wipe the animal. Wipes are not commonly used for small animal treatments.

Animals can be **dusted** with the use of the shaker in which the product is packaged. The eyes of the animal and the applicator should be protected from dusts.

Collars and **medallions,** though technically formulations as described above, are also methods of application. These formulations come ready to use and are applied by fastening them to the animal. They offer long-term release of insecticide or acaricide onto the animal.

Feeding insecticides to animals can be accomplished with drugs prescribed by or obtained from veterinarians. Of course, only those insecticides labeled for oral delivery can be provided in this manner. In other cases, every attempt should be made to avoid contaminating water and feed with insecticides.

PESTICIDE USE AROUND ANIMALS

Pesticide use on animals or in their environment must be done with the safety of the animals and the applicator in mind. Remember that insecticides and acaricides are toxic not only to the target pest but also to the animals at certain doses. Thus, the dose-response relationship of the insecticide and the targeted animal must be considered. Many insecticides are labeled with restrictions and are not to be used on animals of certain ages (especially young ones), in certain reproductive states (pregnancy, nursing), or on certain breeds. Also, use extreme caution or avoid

Protect the animal's eyes from pesticides by applying an ophthalmic ointment before the pesticide treatment.

using pesticides on animals just before or just after surgery. The product may interact with the anesthesia.Apply all insecticides with extreme care. Insecticides should never be applied to the eyes, nostrils or mouth. When treating dogs and cats for fleas using a spray, the applicator should wear appropriate protective gear and shield his/her eyes and those of the animal. It is standard practice to apply an ophthalmic (eye) ointment to protect a dog or cat's eyes before dipping, spraying or shampooing. Petroleum jellies are not an acceptable substitute for ophthalmic ointment. Be sure not to contaminate ointments. Handle carefully and wash your hands between animal treatments.

Ophthalmic ointment will help prevent pesticide irritation. Extra caution will be necessary when working with animals with flat profiles such as the one on the right.
Source: Canine Terminology

Insecticides must be applied at the rates and with the application methods described on the label. Labels also usually state to avoid testicle and vulva areas and mammary gland areas if the animal is nursing young.

Application of certain insecticides or acaricides on animals is done with the intent of creating a residual of systemic insecticide in the body tissues of the animal. These insecticides are used in ways that do not differ greatly from the way drugs are used for animal health. In such cases, there may be dose limits established in relation to the weight of the animal. Thus, only a certain amount of insecticide per unit of body weight can be applied at any one time.

Many kinds of pesticides are commercially available. Though different products may have the same active ingredient, the formulations can vary significantly. The result may be that one product is safe for animal applications and others are deadly. **Use only products specifically labeled for use on animals or in animal habitats.** Consult with experts such as veterinarians, licensed veterinary technicians, Extension specialists or product representatives for help in selecting the best product for your situation. These experts can provide verbal advice and specialized literature to help make your decision and support your action. When selecting an insecticide, the label is a primary source of information. If the label does not allow the use or method of application you intend to use on the animal, then that insecticide formulation cannot be used.

When several product choices are available, consider the type and percent of active ingredient, toxicity, formulation, equipment required to make the application and requirements for retreatment later.

In general, observe the following guidelines for insecticide use on or around animals:

1. Use only products labeled for use on animals or in animal environments.

2. Do not exceed label dosages; measure carefully.

3. Read labels before using and follow all instructions.

4. Provide adequate ventilation while using pesticides.

5. Prevent drift or drainage to adjacent cropland, yards, woodlots, lakes or ponds. (Some insecticides may severely harm fish and wildlife.)

6. Avoid treatment of animals that are sick, overheated or stressed (such as after shipping, surgery or heartworm treatment, or recently weaned).

7. If available, use a dust formulation instead of sprays on outdoor animals on cold winter days.

8. Avoid contaminating feed (feeders and/or feed in storage) and water (including waterers, wells and reservoirs). See Chapter 6, Pesticide Handling, Storage and Disposal.

9. Use all appropriate personal protective equipment during applications of any pesticide.

10. Do not add new insecticides to old, previously used dipping water. Start with fresh water.

11. Do not reuse towels used for drying animals without washing them. Launder towels on the hottest and longest wash cycle, using heavy detergent, between uses.

12. Avoid using pesticides when an animal has been, will be or is anesthetized.

13. Keep records of pesticide applications. See Chapter 1, Laws and Regulations.

14. Always store and dispose of pesticide containers according to label directions.

COMPATIBILITY of PESTICIDES

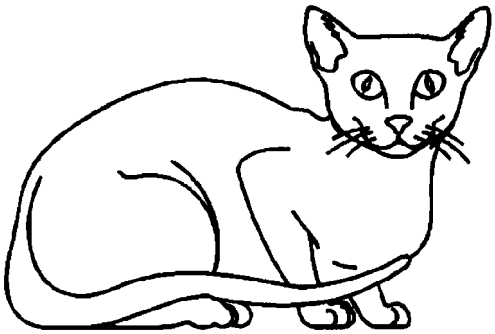
In some situations, applicators may attempt to manage more than one pest with a single application by combining pesticides. Such a practice can create problems, sometimes more serious and costly than applying the chemicals alone. There is no question that product mixing requires extensive knowledge of pesticide formulations, timing of application and application techniques.

The important issue is to determine the compatibility of the products involved. In simple terms, we are concerned about whether the mixtures can be used in combination without reducing the safety and effectiveness of the compounds. Before combining any pesticides, check labels, product information sheets, company representatives or Extension agents for information on compatibility of the products in question.

Below are important areas of incompatibility that you should consider before attempting to mix products.

Host Tolerance

As mentioned earlier, problems can arise when more than one organophosphate is applied to an animal at any one time, or when a residual is still present from a previously applied dose. Never use more than one OP insecticide on an animal. The combined effects of the OPs may cause irreversible damage to the animal or even kill it. Also, some animals are more sensitive to certain products than others. Always read the label before applying a pesticide on an animal.



Cats are more sensitive to pesticides than most dogs.

Physical Incompatibility

Physical incompatibility occurs when two or more pesticides are mixed together and the result is an unsprayable mixture because of excessive foaming, curdling or a gummy deposit. Hard water and cold water can also cause some physical incompatibilities.

Chemical Incompatibility

This type of incompatibility occurs when mixing pesticides reduces or destroys the effectiveness of one or all of the compounds. This happens frequently when materials with a high pH are added to the mixture. Chemical incompatibility is not evident in the spray tank but becomes apparent when the application fails to control the target pest adequately.

Timing Incompatibility

Pesticides must be applied when the pest is at a vulnerable stage of development. With many insects, diseases or weeds, this may be a relatively short period. It is of utmost importance when using two or more chemicals to manage more than one pest to apply the mixture at the correct time in the pests' life cycles to be effective.

This has been a brief summary of pesticide compatibility problems. Remember, you should never assume that pesticides can be mixed together unless the combination is specifically indicated on a product label. If recommendations for use are not given on the label, the products in the mix must be applied at a rate not to exceed the label directions for use of any component product applied alone for the same purpose. Many product labels have toll-free numbers. Call with any questions you may have before using a product.

SPECIAL CONCERNS ASSOCIATED WITH PESTICIDE USAGE

Careless pesticide use can create pest resistance and may harm nontarget species. The following sections explain precautions that applicators can take to avoid these problems.

Pest Resistance

Cross-resistance and multiple resistance to some pesticides (especially insecticides) are becoming common. Cross-resistance occurs when a pest develops resistance to two or more compounds that are usually chemically related with similar modes of action. (Mode of action refers to the chemical's means of exerting a toxic effect.) Multiple resistance occurs when a pest can tolerate pesticides from different classes of compounds with unlike modes of action. Some flea populations have shown resistance to various insecticides.

The possible solutions to a resistance problem may involve using new or altered pesticides,

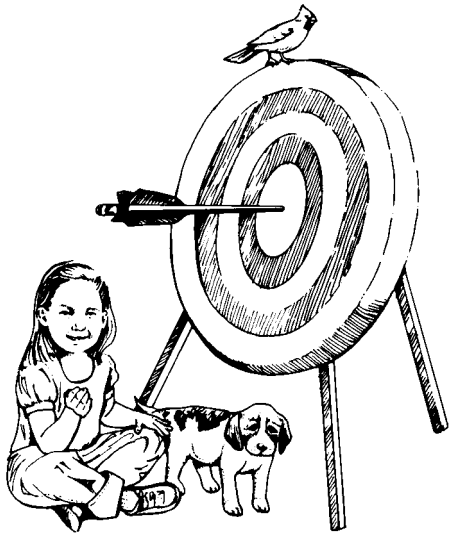
changing pesticide use patterns and, when treating an area repeatedly, alternating the type of insecticide used.

Hazard to Nontarget Organisms

Another problem associated with pesticide usage is potential injury to nontarget organisms. Most pesticide poisonings of humans and animals are caused by insecticides. Great care must be taken in selecting and using insecticides so as to minimize injury to pesticide handlers and others who may come in contact with pesticide residues. Explain to the pet owner precautions to be observed after a pet has been treated. Take care also to safeguard bees, birds, fish and other wildlife and nontarget plants. Bathe or dip pets so that drift, runoff or disposal options do not threaten nontarget organisms or water sources.

Information on pesticides and their uses is available on the label and from your county Extension office, the manufacturer's technical service representative and state regulatory agencies. These sources can provide the best information available on pesticides, their potential adverse effects and their place in a total pest management program.

Using new compounds with different modes of action will lessen the likelihood of resistance development. These include compounds that are very selective in which pests they kill and compounds that modify the pest's mating or feeding behavior.



Consider potential hazards to nontarget organism

Chapter 3 – Review Questions

Write the answers to the following questions and then check your answers with those in the back of this manual.

1. A pesticide is a chemical that:
   a. manages only insects and vertebrates
   b. directly controls pest populations
   c. prevents or reduces pest damage
   d. only a certified applicator may apply
   e. b and c

2. List the four classification methods of pesticides and give an example of each.
   1.
   2.
   3.
   4.

3. An insecticide is a pesticide used to manage _____.

4. Pesticide products labeled for use in controlling fleas are:
   a. potentially toxic to the host animals.
   b. formulated as shampoos and dusts.
   c. insecticides.
   d. available in collars.
   e. all of the above.

5. Pesticides with chlorinated hydrocarbon chemistry are not recommended for use on cats. True or False?

6. What are the symptoms that a small animal may exhibit as a result of overexposure to an organophosphate pesticide?

7. Which two types of pesticide chemistry inhibit cholinesterase? What types of pests of small animals do these pesticides control?

8. If an animal is overexposed, it can be killed by pesticide products even though the products are labeled for use on small animals. True or False?

9. Protectants are pesticides applied to manage pests by rendering them incapable of normal reproduction. True or False?

10. A pesticide that controls more than one pest is called:
    a. systemic.
    b. broad-spectrum.
    c. multipurpose.
    d. a and c
    e. b and c

11. What is the difference between a contact and a systemic pesticide?

12. Pesticides that contain carbon are called:
    a. organic pesticides.
    b. inorganic pesticides.
    c. synthetic pesticides.
    d. These don't exist.
    e. carbonic pesticides.

13. The component of the pesticide that controls the target pest is called the active ingredient. True or False?

14. List four types of synthetic organic pesticides.

15. Explain the difference between a premise spray and an area or space spray.

16. When choosing among several insecticide products, what are some of the things that must be considered?

17. What does the term "incompatibility" mean with reference to mixtures of pesticides?

18. List three types of pesticide incompatibility and give a brief definition of each.
    1.
    2.
    3.

19. Where can you find information on the compatibility of pesticide mixtures?

20. What are nontarget organisms?