

Chapter 7

Insecticide Basics

We have already learned the importance of reducing water, food, and eliminating harborage (cracks, crevices, clutter) for cockroaches. These primary control strategies should be done *before* doing any insecticide applications. Figure 7-1 shows a graph of how sanitation (food and water) and habitat modification can potentially reduce a cockroach population. It doesn't take a rocket scientist to understand it is easier to deal with a small population than a large one.

Before using chemicals, don't forget about the low risk controls discussed in Chapter 6. A multiple tactics approach will give best control.

Studies have shown poor long term control when insecticide sprays are used as the only method of control compared with a more integrated, multi-tactics approach. Reliance on sprays provides only temporary relief and repeated applications may become necessary to control the rebounding cockroach populations. Scientists call this situation the *insecticide treadmill*.

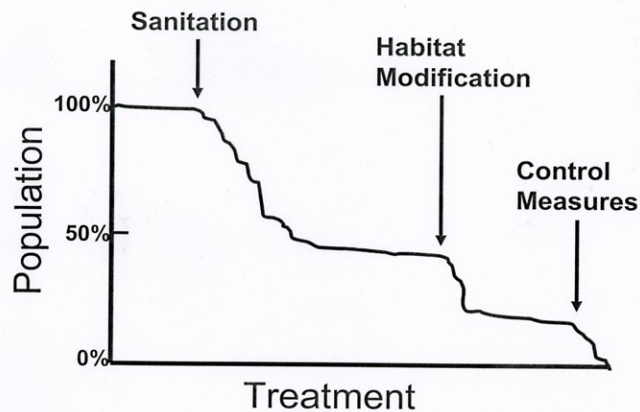
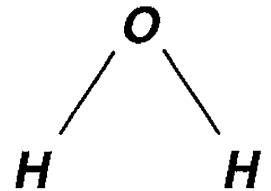


Figure 7-1. Cockroach populations can often be drastically reduced by sanitation (eliminating food and water) and eliminating harborage (cracks, crevices and clutter). Reducing the population makes control easier.

When used in conjunction with primary controls, properly chosen and placed insecticides can be very helpful in controlling cockroach populations. Using insecticides may require special equipment and protective clothing. This details will be discussed in the next three chapters.

What is a Chemical?

Everything around us, the earth, air, even our bodies are composed of chemicals. The smallest part of a chemical is called an atom. When atoms exist in a pure state, the substance is called an element. Oxygen, hydrogen, nitrogen, and carbon are some of the most common elements. When two or more elements are combined chemically, they are called compounds. Water, a common compound, has two hydrogen atoms and one oxygen atom (hence, H_2O).



Water is an example of a compound.

Animals and plants are composed of chemicals, most of which are very complicated chemical compounds. The chemistry of living things is known as organic chemistry, because they are composed primarily of the organic elements carbon, hydrogen, and oxygen. To some people, the word *organic* means something is *natural*, or grown in the absence of synthetic fertilizers and pesticides. For our purposes, organic refers to a chemical compound containing the organic elements.

Pesticides are chemicals that kill pests. If the pest is a weed, we use a herbicide; if it kills rodents, it is a rodenticide. Fungicides kill fungi, insecticides kill insects, and so on. Most insecticides are organic compounds, synthesized by chemists and manufactured by chemical companies. There are a few insecticides derived from plants, minerals, or non-organic elements with insecticidal properties.

Formulations

An *active ingredient* is the specific chemical in a pesticide product which “does the dirty work.” An active ingredient is mixed with less toxic *inert ingredients* and are listed on the label. The mixture of active and inert ingredients is called a *pesticide formulation*. Many insecticides, especially those made for in-home applications for homeowners, are Ready-To-Use (RTU) products. Others must be diluted with water to a correct concentration before application. The directions on the label will tell you how to use a pesticide formulation.

There are hundreds of insecticide products labeled for cockroach control inside homes, apartments, and dwellings. In this section, we will describe the formulations used for cockroach control and give advantages and disadvantages of the different formulations.

Some active ingredients are formulated in more than one way. For instance, permethrin, a commonly used pyrethroid insecticide, can be formulated as a dust, in granules, RTU, a wettable powder, an emulsifiable concentrate, an aerosol, and a total-release fogger.

Baits

A bait formulation is an edible or attractive substance mixed with an active ingredient. The best active ingredients act slowly which insures enough bait will be eaten by the cockroach to kill it. Baits are marketed over-the-counter at discount stores, hardware stores and even supermarkets and pharmacies. Baits are sold in bait stations and gel formulations in syringe-style applicators. They are easy to use and reasonably safe to humans. They are also marketed to pest management professionals under different product names and active ingredients than may be available to the general public.

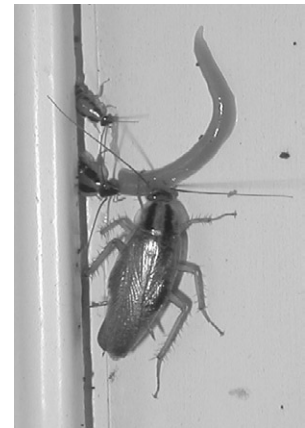
Some baits are formulated as granules for both indoor and outdoor use. Baits should be placed near where cockroaches live, in locations where they cannot fall into human food or be reached by children or pets. Bait can be squeezed into cracks and crevices or near locations where cockroaches live (Figure 7-2). Baits are an ideal companion



(V. Jedlicka)

Figure 7-2. (above) Gel bait is applied to areas where cockroach are found, near food, water and harborage.

(right) Most German cockroaches find gel baits very palatable, although resistance has occurred in populations where these baits have been used repeatedly.



(V. Jedlicka)

to other types of control and work best when sanitation—limiting water and food sources—is good.

Advantages: Most baits are toxic to cockroaches but have low toxicity to mammals. Some baits remain active in cockroach droppings and will kill the immature roaches after they eat their parent’s droppings. Most baits work fairly quickly to reduce cockroach populations. Baits are easily applied and can be removed when control is completed.

Disadvantages: Scientists have noticed behavioral resistance, chemical resistance, bait aversion, bait avoidance, and repellency among some cockroach populations. To overcome these factors, it is best to alternate between active ingredients and manufacturers over time. Baits can present a hazard to children and pets. Avoid this problem by carefully placing bait in inaccessible areas and by using tamper-proof stations. Dried up gel bait and empty stations won’t kill cockroaches because they won’t eat it. Baits require attention—check them at least monthly for best results.

There are quite a few active ingredients used in cockroach control baits. Because baits have been so successful in controlling roaches, manufacturers are busily developing new baits and formulations. Some active ingredients include:

Boric acid: Boric acid is an inorganic white powder formulated as both a granular and a gel bait. It has very low mammalian toxicity; however, caution must be taken to avoid accidental ingestion. Chapter 6 contains more information about boric acid.

Hydramethylnon: Hydramethylnon is a slow-acting stomach poison. It is low in toxicity to mammals and birds. It is available in tamper-proof stations, as a granular bait, and as gel in syringe applicators.

Fipronil: Fipronil may be the fastest acting bait on the market and readily transfers to other roaches. Fipronil is effective at very low concentrations. It is available in tamper-proof bait stations, as granular bait, and as a gel in syringe applicators.

Acetamiprid: Acetamiprid is readily eaten by cockroaches and transfers from one to another when feces or cockroach corpses are eaten. It is available as a gel formulation in syringe applicators.

Indoxacarb: Indoxacarb is considered a reduced risk insecticide by EPA because of its low toxicity to animals. Once eaten by the cockroach, it is converted into a chemical toxic to cockroaches. It readily transfers from one cockroach to the next, increasing its effectiveness. It is available as a gel bait and in a tamper-proof bait station.

Abamectin: Abamectin is a toxic extract from a soil microorganism with low toxicity to mammals. It comes in tamper-proof bait stations, a gel bait formulation, or as a flowable dust applied in cracks and crevices. (Chapter 6).

Imidacloprid: Imidacloprid is readily soluble in water and has a very low odor. The toxic effects are highly specific against cockroaches and extremely low toward vertebrates. It is available as a gel bait for cockroaches in a syringe applicator.

Noviflumuron: Noviflumuron is a low toxic IGR formulated as a bait and has been shown to be effective against German cockroaches. (Chapter 6)

Oxypurinol and xanthine: Oxypurinol is a metabolite of a drug used to treat gout in humans and xanthine is a natural substance found in all living things. Combined, these two ingredients work to block the formation and absorption of uric acid. Cockroaches need large amounts of uric acid for metabolism and reproduction. As existing uric acid stores are used up, the cockroach population is gradually controlled within five to nine weeks. These active ingredients are found in a tamper-proof bait station formulation.

Sulfluramid: Sulfluramid is another delayed action active ingredient formulated as a cockroach bait. It exhibits low toxicity to mammals, but is slightly toxic to fish and aquatic arthropods. It is available as a tamper-proof bait station.

Propoxur: Baygon® 2% Bait. Propoxur is a residual insecticide formulated as a bait. This bait would tend to act more quickly than others, but bait shyness may occur with its use. It is formulated as a granular bait formulation.

Dusts

Dust formulations contain an active ingredient plus a powdered dry inert substance like talc, clay, nut hulls, or volcanic ash. The inert ingredients allow the dust formulation to store and handle well. In households, dusts should be used only in locations where the inhabitants will not stir the dust, move it around, or inhale it. Appropriate places for dust

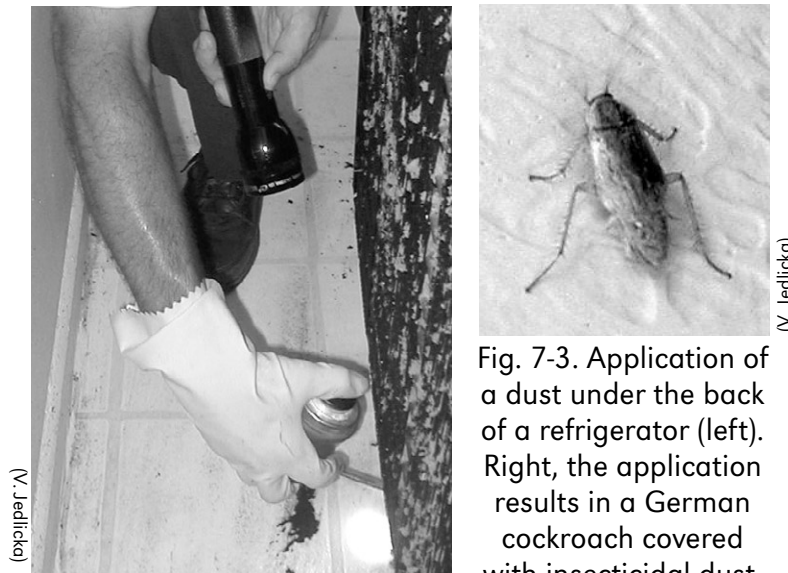


Fig. 7-3. Application of a dust under the back of a refrigerator (left). Right, the application results in a German cockroach covered with insecticidal dust.

applications are wall voids, behind baseboards, in enclosed spaces under kitchen counters, above dropped ceilings, behind appliances (Figure 7-3) and in unused attics. Dusts must be used dry and stored in a dry place.

Advantages: Most appropriate of all formulations for application in hard to reach areas such as wall voids. Dusts are easily picked up and transported by cockroaches.

Disadvantages: Cockroaches can move dusts before they die. Dusts can be unsightly if applied to visible areas. If applied to excess, it can act as a repellent to cockroaches. If dusts become damp or wet, they may be less effective.

Ready-To-Use (RTU) Sprays

Ready-to-use liquid spray formulations have already been diluted by the manufacturer and are applied without further dilution. RTU products (Figure 7-4) are often equipped with a pistol grip sprayer, attached to the container with a plastic tube. Nearly all active ingredients currently registered for cockroach control are available in RTU formulations.

Advantages: Easy to apply and ready to use



(B. O'g)

Figure 7-4. Ready-to-use sprays are readily available and convenient because no mixing is needed. However, they are not designed for crack and crevice applications.

immediately after purchase. They are safer because you don't need to mix concentrated insecticides.

Disadvantages: Application equipment can be awkward to use, and the sprayers sometime don't work properly. Sprayers may leak or dribble, creating a possible hazard. RTU equipment are rarely designed for crack and crevice applications.

Wettable Powders (WP)

These are dry, finely ground, powdery formulations added to water. They look like dusts, but a wetting agent has been added to the other ingredients to help them mix with water.

Advantages: When a wettable powder formulation is sprayed on a porous surface, like wood, the water will penetrate the wood, but the powder stays on the wood surface. This gives the greatest possible residue and residual activity (see How do Insecticides Work? section later in this chapter). They are less likely to stain surfaces.

Disadvantages: Constant agitation is needed to prevent settling of the insecticide on the bottom of the spray tank. The dried powder residue is sometimes visible and unsightly. This may limit the use of wettable powder formulations in cockroach control, unless there are areas where the presence of powder on the treated surface is not objectionable.

Emulsifiable Concentrates (EC)

Water is added to an emulsifiable concentrate, which forms a smooth mixture of the insecticide, solvent, and the water carrier. The inert ingredients are often highly refined oils and other solvents.

ECs are important formulations used for cockroach control, and some can be purchased from discount, drug, grocery, and hardware stores. Professional-use EC formulations can sometimes be purchased from local pest control companies or Internet sites advertising sale of pest control supplies to the public.

Advantages: Emulsifiable concentrates formulated for household pests usually have lower concentrations of active ingredients. They are easy to mix and require very little agitation.

Disadvantages: EC formulations will be in a concentrated form and need to be mixed in a spray tank with water before use. The petroleum solvents in EC formulations may stain carpets, fabrics, and wallpapers. You need to carefully consider the placement of these insecticides before you use them. EC formulations readily absorb into the skin, thereby exposing the applicator to the insecticide.

Aerosols

The active ingredient in an aerosol formulation is dissolved in a solvent with pressure from a gas propellant. Common, over-the-counter aerosol formulations have a low percentage of active ingredient. These aerosols are most effect when the liquid contacts the insect directly, and are not very effective when used against cockroaches hiding in cracks and crevices. There are some crack and crevice aerosol formulations, primarily marketed for pest management professionals, containing a higher percentage of the active ingredient. These can be quite effective when used as crack and crevice treatments.

Advantages: The main advantage of aerosols is they are easy to use and readily available.

Disadvantages: Aerosol container must be held upright during operation, the residual control is very poor, they are relatively expensive for the amount of insecticide they contain. The solvent vapors are readily airborne and can be harmful to the applicator and household residents.

Foggers: Total-Release Aerosols

An insecticide fogger is a total-release aerosol which discharges its entire contents in a single application. During fogging, the occupants and pets should leave and remain away for a few hours. Consult the label for the re-entry time and follow

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19 bug bomb foggers blast a house apart

SAVE THIS EMAIL THIS PRINT THIS MOST POPULAR

Pilot light on a wall heater may have ignited them; no one hurt in explosion

By Joe Hughes
UNION-TRIBUNE STAFF WRITER

December 18, 2003

It seemed like a good idea at the time.

A family living in a house infested with cockroaches and rats set off 19 "bug bomb" foggers in their 470-square-foot City Heights home yesterday, causing an explosion that virtually blew the building apart and sent Christmas decorations into the street, police said.

JOHN GIBBINS / Union-Tribune

A family living in a house infested with cockroaches and rats set off 19 "bug bomb" foggers in their 470-square-foot City Heights home Wednesday, causing an explosion that blew the building apart.

(Photo: John Gibbins)

Figure 7-5 shows what can happen if someone uses more foggers than is recommended on the label and neglects to turn off the pilot light. Fortunately no one was hurt in this explosion.

(San Diego Union Tribune, Joe Hughes, reporter).

all precautions before using a fogger. Aerosols and foggers produce very small droplets which settle on furniture, the floors, and countertops. These small droplets are easily inhaled by humans and pets. Fogging is **NOT** the same as fumigation. Fumigation uses deadly insecticidal gases and can only be done by professional, certified applicators.

Advantages: Foggers are easy to use and readily available.

Disadvantages: Foggers can be dangerous. You *must* extinguish all flames before using. Do not use more foggers than is recommended on the label. Foggers will only kill exposed cockroaches and will not penetrate cracks and crevices where cockroaches are hiding. After using foggers, cockroaches may retreat deep into walls and ceilings to avoid the insecticides. **We do not recommend the use of foggers for cockroach control.**

Insecticide Classes

The classes of insecticides listed here are grouped based on their chemical structures and the way they kill cockroaches.

Chlorinated Hydrocarbons—Banned: A few chlorinated hydrocarbons are DDT, aldrin, endrin, and chlordane. Throughout the 1970's and 80's, the EPA banned most chlorinated hydrocarbons from sale and use in the United States because these insecticides persisted in the environment and increased in the fatty tissues of animals. **None of these insecticides should be used in cockroach control.**

Organophosphates (OPs)—Old Standards, no longer used: The OPs were discovered in Germany during World War II research on nerve gas poisons. Some of the more common OPs used in cockroach control until recently were chlorpyrifos (Dursban®), diazinon, and acephate (Orthene®). Changes in environmental laws have resulted in the elimination of most indoor uses of these insecticides. **We do not recommend the use of these insecticides for cockroach control.**

Carbamates—Early Alternatives, much reduced use: In 1951, carbamate insecticides were introduced into the world market. There are two carbamates labeled for cockroach control in and around the home: propoxur (Baygon®) and carbaryl (Sevin®). Most indoor uses of these insecticides have been eliminated. **We do not recommend the use of these insecticides for cockroach control.**

Botanicals—Naturally Occurring: Botanicals are natural insecticides, made from plant extracts. When processed and concentrated, these botanical insecticides are similar to synthetic insecticides. Some people believe natural-occurring botanicals are safer to use than synthetic insecticides. *This is not necessarily the case.* Nicotine sulfate, a botanical derived from tobacco plants, is more toxic to mammals than many synthetic insecticides.

Oil extracts of the neem tree seeds, the herb thyme, mint, citrus peels (limonene), cloves (eugenol), and phenethyl propionate are sometimes used for cockroach control. Studies have shown these extracted oils have limited toxic activity on cockroaches and are virtually nontoxic to

mammals. They are useful as contact sprays only (kill on contact), with little or no residual activity. These oil extract botanicals were developed in response to public demand for more “natural” and safer products.

Another, older, botanical insecticide used for cockroach control is pyrethrum. Pyrethrum is a mixture of several compounds, including pyrethrins and cinerin. Pyrethrum has low mammalian toxicity but very fast knock-down activity, causing rapid paralysis in the target insects. However, the paralysis may only be temporary unless a synergist (such as piperonyl butoxide or MGK 264) is added. The synergist may have no insecticidal property, but enhances the activity of an insecticide.

To improve on the effectiveness of pyrethrum, chemists have synthesized similar, more stable compounds in the laboratory. These laboratory-created insecticides are known as the synthetic pyrethroids or simply *pyrethroids*.

Pyrethroids—New Age Insecticides: There have been dozens of pyrethroids identified and synthesized. A few include esfenvalerate, permethrin, tetramethrin, deltamethrin, cypermethrin and cyfluthrin. Notice nearly all pyrethroid insecticides end with ‘thrin’. This is because these newly synthesized chemicals were modeled after pyrethrins. Chemists have made these compounds more stable and more persistent than natural pyrethrum. A synergist is usually added to the pyrethroid formulation to further increase its effectiveness. One characteristic of pyrethroids is when a cockroach encounters the insecticide, it becomes more excited and active. Because of this, after an application of a pyrethroid you may see cockroaches during the day when previously you have only seen them at night. This change in behavior means the insect is being affected by the insecticide.

Like the botanical pyrethrum, pyrethroids have fast knock-down activity especially against flying insects and low mammalian toxicity. Pyrethroids are very toxic against fish so precautions must be taken to cover fish tanks and disconnect filters when using , at the very least. Pyrethroids are the active ingredients in most of the in-home aerosols you can buy (Raid®, Black Flag®, etc) and in the RTU

formulated products. They are also formulated as dusts, granules, wettable powders, and emulsifiable concentrates.

Exposure to pyrethroids may trigger asthmatic attacks in persons who have allergies or respiratory problems. This problem may limit their use in sensitive areas.

Novel Chemistries—Specific, Low-Toxic, Environmentally Friendly Insecticides: As mentioned in Chapter 6, there has been a movement toward “green” insecticides. The plant oil extracts, discussed earlier, are one example. These new products are often only toxic to a specific group of insects. Green insecticide products are usually less toxic to people, other animals and pets, and are much safer to the environment than nearly all insecticides developed previously.

Because of the specific nature of these products, they are also sometimes the only member of their insecticide class. This fact makes it difficult to organize them as has been done previously. Instead, they will be discussed as individual active ingredients in the upcoming paragraphs.

Several of these active ingredients, including imidacloprid, fipronil, noviflumuron, hexaflumuron, diflubenzuron, indoxacarb, acetamiprid, and hydramethylnon were discussed in the earlier section on baits. At the time of this writing, these active ingredients are only available in bait formulations for indoor control of cockroaches.

Chlorfenapyr affects cockroaches either when they contact it or ingest it. Cockroaches die because they are unable to produce energy for cellular activity. It has low mammalian toxicity and low irritation to people. This is the only non-repellent liquid insecticide registered for indoor spray treatments of cockroaches.

Inorganics—Borates and Diatoms: Inorganics are insecticides made from elements, compounds, and minerals which do not contain carbon. Sulfur and arsenicals are inorganic insecticides which were in common use from about 1930 until 1960. They are very toxic and should not be used. Boric acid, silica aerogel, and diatomaceous earth are the inorganics currently in use (Chapter 6).

How Do Insecticides Work?

Insecticides control pests in specific ways. The effectiveness of the treatment increases when the insecticide is used in a manner consistent with the way it works. This information is found on the label.

Residual insecticides (persistent) remain active in amounts sufficient to kill pests for at least a week, several weeks, or even years after application. These residual insecticides act by keeping a toxic insecticide residue on a surface the insect will contact. Conversely, non-residual insecticides (non-persistent) break down rapidly after application. Residual insecticides are useful when insects are a continual problem, such as cockroaches in your home.

Contact insecticides control the pest on contact and must be applied directly on the insect. Very little toxic residue remains on a surface after spraying a contact insecticide. Most aerosols and foggers contain contact insecticides.

Stomach poisons are insecticides eaten by an insect so the poison enters the stomach and then is absorbed into the body. Many baits are stomach poisons.

Insect Growth Regulators (IGRs) are insecticides which alter the growth and development of insects (Chapter 6).

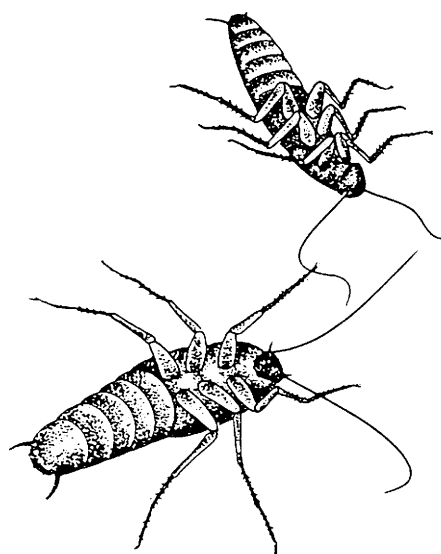


Figure 7-6. Dead Cockroaches

(J. Kalisch)