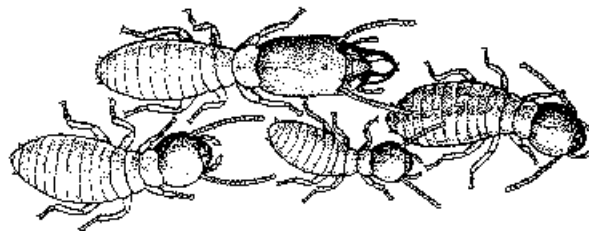


Chapter 5



Termiticides: Termite Control Chemicals

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, H₂O).

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 that 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 either control pests or prevent the pests from causing damage or infesting an area. If the pest is a weed, we use a *herbicide*; if it controls rodents, it is called a *rodenticide*. *Fungicides* control fungi, *insecticides* control insects, and *termiticides* control termites. Most termiticides are organic compounds that are synthesized by chemists and manufactured by chemical companies. There are a few, however, that are made from plants, minerals or non-organic elements that have the ability to control termites.

Termiticide Formulations

An *active ingredient* is the specific chemical in a pesticide product that “does the dirty work”. An active ingredient is mixed with less toxic *inert ingredients*. The mixture of active and inert ingredients is called a *pesticide formulation*. The directions on the label tell the applicator how to use a pesticide formulation. Since control is often based on how the termiticide is used, a homeowner who is interested in having an effective treatment should read and understand the label directions.

There are a number of termiticide products that are labeled for termite control in and around homes, apartments, and dwellings. In this section, we will describe the formulations that are used for termite control.

Liquid Formulations

Emulsifiable Concentrates (EC). Emulsifiable concentrates are uniform mixtures of the concentrated active ingredient, oil-based ingredients and other ingredients. When the EC is diluted in water, the active ingredient and oil droplets are suspended uniformly throughout the water. EC's are normally opaque or milky in appearance. Emulsifiable concentrates can be toxic to plants and are easily absorbed through the skin. Certain oil-based ingredients that are used with EC formulations cause the strong smell that we often associate with pesticides.

Many of the termiticides labeled for chemical barrier treatments are emulsifiable concentrates. They are usually either organophosphates or synthetic pyrethroids. See the relevant sections in this chapter and Appendix A for more details.

These termiticides are also labeled for surface applications to wood for controlling termites and other wood destroying insects. Soil barrier treatments and wood treatments are discussed in detail in Chapter 6.

Water Miscible Liquids. Liquid miscible liquids are mixable in water. The concentrated active ingredient is able to dissolve in water or alcohol. These formulations resemble EC's but do not become milky when diluted with water. Water-miscible liquids are labeled as water-soluble concentrates (WSC), liquids (L), soluble concentrates (SC) or solutions (S). An example of a termite control product that is a water miscible liquid is Bora-Care™, a boric acid product used to treat wood.

Dry Formulations

Dusts (D). 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 the home, dusts should be used only in locations where the inhabitants will not stir the dust, move it around, or inhale it.

Wettable Powders (WP or W). These are dry, finely ground, powdery formulations. They look like dusts, but a wetting agent has been added to the other ingredients to help them to mix with water. Wettable powders form a uniform mixture of particles rather than becoming dissolved when added to water. A wettable powder formulation registered for termite control as a barrier treatment is Premise® 75 (*imidacloprid*).

Baits (B). A bait formulation is an edible or attractive substance mixed with a toxicant. When baits are used against termites and other social insects, the most effective baits will contain active ingredients that have low toxicity and cannot be detected by the foraging insects. It is important that a lethal dosage of the bait toxicant is passed throughout the colony to affect all the colony members. Since termites eat cellulose, paper is often used as the carrier for termite baits.

In 1994, Dow AgroSciences received EPA registration for *hexaflumuron*, an insect growth regulator. Since then, there have been several additional bait products that have been registered for termite control. In 1996, FMC introduced FirstLine®, a bait that uses *sulfluramid* as its active ingredient. In 1998, Exterra Termite Interception and Baiting System® was registered by Ensysstex, Inc. The bait ingredient of this system is *diflubenzuron* (commonly called Labyrinth), another insect growth regulator. The most recent ingredient to be registered is *noviflumuron*, also by Dow Agro-

Sciences. You can be sure that there will be many more baits appearing on the market over the next several years. Bait products will be discussed in detail in Chapter 7.

Miscellaneous Formulations. There is another termite product that has an unusual formulation. Jecta® is a borate that is formulated as a gel to be applied with a syringe into cracks of wood. More information about borates is found later in this chapter.

Foaming Agents. Foams may be used as part of a chemical barrier treatment to help distribute the termiticide in areas that might be difficult to treat. Foam results when air is forced into the termiticide along with a foaming agent.

The use of foaming agents is a developing technology in termite control. The foam is a compact mass of air bubbles separated from each other by a liquid film; air makes up about 85 percent to 95 percent of the foam. There are “wet” and “dry” foams depending on how much water is used in the mix. After a few minutes to hours after application, the foam breaks down into a liquid as the bubbles collapse.

The foam helps distribute insecticide in areas that are difficult to treat, such as under slabs and outside steps, around rubble foundations, behind veneers, and in voids found in walls, chimneys, and masonry. Most of these sites are treated blindly. Foams will disperse around obstructions and will better fill a void. Once the foam has spread into the desired area, the solution drains from the mass of bubbles downward into the fill. This can result in a more complete, uninterrupted treatment barrier.

Termiticide Classes

Chlorinated Hydrocarbons: *Banned*

A few of the better known chlorinated hydrocarbons are *DDT*, *aldrin*, *dieldrin*, *heptachlor*, and *chlordane*. Throughout the 1970s and 80s, the EPA banned most chlorinated hydrocarbons in the United States because these insecticides persisted in the environment and accumulated in the fatty tissues of animals. The last chlorinated hydrocarbon to be used for termite control was Chlordane. Chlordane was withdrawn from the market by its manufacturer in 1988. It persists in the soil so long that there still may be houses protected from termites by a chlordane treatment that was done before 1988. These insecticides should not be used in termite control.

Organophosphates (OPs):

OP's are generally more toxic to vertebrates (including humans) than the chlorinated hydrocarbons, but they are much less persistent in the environment. Currently, the only OP used in termite control is *chlorpyrifos*. Chlorpyrifos barriers are non-repellent to termites and kill termites quickly on contact. This action results in many dead termites near the point of contact with the barrier. It is thought that the dead termites deter other termites from the treatment zone.

The Environmental Protection Agency recently revised the risk assessment for chlorpyrifos and reached an agreement with the registrants to eliminate and phase out certain uses of chlorpyrifos. All uses of termiticide formulations containing chlorpyrifos will be phased out. Post-construction uses have stopped, and preconstruction uses must end by 12-31-05.

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 that 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 other synthetic insecticides.

A botanical insecticide used to control some insects is *pyrethrum*, a natural compound that comes from the chrysanthemum plant. Pyrethrum has low toxicity to mammals but causes very fast knockdown and rapid paralysis in the target insects. Because pyrethrum breaks down very quickly in the environment, it is not very useful as a termiticide.

To increase the effectiveness of pyrethrum, chemists have synthesized similar, more stable compounds in the laboratory. These laboratory-created insecticides are known as the synthetic pyrethroids and a number of these chemicals are long-lasting enough to be useful for termite control.

Synthetic Pyrethroids

There have been dozens of synthetic pyrethroids identified and synthesized. A few used in termite control include *fenvalerate*, *permethrin*, *cypermethrin* and *deltamethrin*. (Notice the “thrin” part of the name of many of these common names.) Chemists have made these compounds more stable and more persistent than natural pyrethrum. A chemical, like piperonyl butoxide, is often added to the synthetic pyrethroid to further increase its effectiveness.

When used against termites, synthetic pyrethroids are highly repellent but kill very few termites. These products work because termites avoid the areas where these chemicals have been applied. Pyrethroids are very toxic to fish so precautions must be taken to prevent these chemicals from getting into streams and other surface waters.

Compared with some formulations, there is less odor associated with synthetic pyrethroids, and they may be preferred for inside treatments, like drilling through slabs or basement walls. Even though the odor may be less, the solvents in synthetic pyrethroids sometimes trigger asthmatic attacks in persons who have respiratory problems.

Chloronicotinyls

This class of non-repellent termiticides was introduced in 1996 when Premise® 75 became available as a barrier treatment. The active ingredient of Premise® 75 is *imidacloprid*, which acts by attaching to specific binding sites at the nerve endings of termites. Because warmblooded animals have fewer of these receptor sites, imidacloprid has a very low toxicity to mammals, when compared with organophosphates and synthetic pyrethroid products.

Unlike synthetic pyrethroids, that are readily detected in the soil, termites do not detect imidacloprid and tunnel into treated soil. After contacting imidacloprid, termites soon stop feeding, become disoriented, and eventually die. The termites exposed to lower concentrations of imidacloprid are left susceptible to naturally occurring pathogens in the soil and later die from diseases.

Phenyl pyrazoles

This is a new class of non-repellent termiticide. *Fipronil* was made available as a termiticide during 2000. After 5 years of testing, results indicated that fipronil provided 100 percent protection against termite attack at several USDA field testing locations in the United States. This active ingredient is sold under the name Termidor®.

Pyrroles

Chlorfenapyr is a slow acting, non-repellent termiticide. The slow acting action allows time for the termites to transfer the chlorfenapyr to other colony members. It was introduced into the termiticide market in 2002 as Phantom®. Termites pick up chlorfenapyr via ingestion and through contact. The activity via the oral route is excellent, and the contact activity is roughly equal to that of organophosphates. The mode of action is novel among termiticides. After chlorfenapyr enters the termite, it keeps the termite from generating its own energy. As a result, the exposed insect will die.

Fluoroaliphatic Sulfonamides

The fluoroaliphatic sulfonamides are relatively new, especially as termiticides. *Sulfluramid* is a slow-acting stomach poison. There are two termiticide products containing sulfluramid: FirstLine® Termite Bait Stations (FMC Corp.) and Terminate (Spectracide Corp). Both products are formulated as termite baits. Sulfluramid use results in termite colony suppression, not colony elimination.

Trifluoromethyl aminohydrazones

Hydramethylnon is the active ingredient in a termite bait system called Subterfuge®. Hydramethylnon acts to inhibit the production of energy inside the insect. Insects killed by these chemicals die on their feet, basically “running out of gas”.

Hydramethylnon has a relatively low toxicity to mammals. When hydramethylnon is eaten, the termite colony is suppressed. The speed that the colony is suppressed depends on the amount of bait that is eaten.

Inorganics

Borates. There are several products labeled for termite control that have a compounds containing boron as their active ingredient. *Boric acid* and *disodium octaborate tetrahydrate* are chemical forms of boron. The borates are used to treat the surface of wood, either as a preventative or remedial treatment. These products work because the borate penetrates wood and is ingested by termites as they attempt to eat the wood. Boric acid has been known to successfully kill insects for decades, but little is known about its mechanism of activity. The most accepted hypothesis is that boron kills intestinal microorganisms that allow insects to digest their food.

Borates are formulated as a liquid (Bora-Care™), or a powder (Tim-bor®) that are mixed with water and applied to the surface of wood. It is also formulated as a gel, Jecta®, that is injected with

a syringe into posts, poles and high risk areas through cracks in the wood or predrilled holes. Borates have also been impregnated into rigid foam and fiberglass insulation products.

Microbials

Nematodes. Insect-eating *nematodes* are tiny parasitic roundworms that naturally live in the soil. They are sold for termite control. However, there is a problem when using nematodes for termites control. In laboratory studies, the nematodes killed termites, but these results have not been repeated in conditions such as in a termite infested home. In addition, applications of nematodes have not been shown to prevent termite infestations.

Based on the lack of effectiveness under real conditions, nematode products should not be considered a practical, effective method of termite control.

Pathogenic Fungi. Many species of fungi live in the soil and some infect and kill insects that live there. It has been known for many years that a fungal pathogen, *Metarhizum anisopliae*, naturally kills termites. This pathogen has been studied extensively and is now marketed as a termiticide called BioBlast™; however, this product is not currently registered for use in Nebraska. Infection occurs when the fungal spores germinate, penetrate the termite's body, and grow inside the body. Studies have shown that this disease is highly infectious. After termites become infected, the spores are quickly spread to other colony members. However, once termites start dying, noticeably sick termites are shunned by healthy termites. This behavior reduces the further spread of the disease. Studies have shown that if 10 percent of colony members can become infected initially, it is likely that the remaining 90 percent of the colony will be infected.

These pathogenic fungi are not applied as a barrier or a bait treatment. Instead, they are applied as a suspension of fungal spore particles that act as a contact termiticide, except the infected termites don't die immediately. It must be applied so that it gets right onto the termites, not just their environment. For the whole colony to become infected and possibly eliminated, this pathogen must be applied to as many termites as possible. When used correctly, this pathogen can be very effective to control termite colonies that are colonizing the wood itself, such as some drywood species.

At the present time, the *Metarhizum anisopliae* pathogen is less likely to effectively control subterranean termites because it is nearly impossible to infect enough foraging termites to get the infection started. A second problem is that it has no long-lasting residual activity. After the termites die, the fungal spores also die. In addition, this pathogen is not like anything else available on the market and needs special application and handling techniques. It needs to be stored properly and will not be effective if tank-mixed with insecticides. This fungi pathogen has its best chances of use in subterranean termite control, when used in conjunction with baiting programs applied directly to foraging termites, or in sensitive environments where more toxic chemical treatments cannot be used.

Insect Growth Regulators

Insect growth regulators are a group of compounds that alter growth and development of termites and other insects. They are much less toxic to humans and other nontarget organisms than the majority of termiticides. These synthetic biochemicals cause abnormal growth and/or develop-

ment and either kill the termite outright or prevent it from reproducing. This group of termiticides are most often used in termite baiting technologies, to be discussed in Chapter 7. *Hexaflumuron* and *noviflumuron* (Sentricon®) and *diflubenzuron* (Exterra® and Advance®) are two IGRs currently registered by the EPA and labeled for termite control. All belong to the group of IGRs that are called *Chitin Synthesis Inhibitors*, which means that they inhibit the growth of chitin, which is the main component of the insect exoskeleton (insect “skin” or “shell”). Because only insects, other arthropods and fungi contain chitin, these hormone mimics are more specific to insects than other termiticide treatments that effect the nervous system, for example. This makes them more environmentally friendly and safer for humans and other nontarget animals.

Repellency vs. Non-repellency

Termites are affected differently by termiticides, depending upon the way the termiticides are applied (soil, surface of the wood, bait), and by the unique characteristics of each termiticide class or group. Soil-applied termiticides are designed to provide a protective barrier between the termites and your house. You might wonder if it is best to use a repellent or a non-repellent liquid barrier termiticide. Chloronicotinyls, phenyl pyrazoles, and pyrroles are relatively new non-repellent to the termite termiticides compared to the older synthetic pyrethroids that are highly repellent to termites. Research evidence has accumulated over the last several years indicating that the newer non-repellent termiticides are more effective than repellent termiticides at protecting your home from termites.

Non-repellent termiticides are not detected by termites. Because they don't know it's there, the termite workers forage freely in the treated soil. Like any termiticide, non-repellents are lethal to termites. Non-repellents are lethal to termites if they eat it and lethal by contact. However, because non-repellents are slow to kill, termites that contact the chemical in the soil carry it back to the colony on their bodies. Every other termite that the original termite touches will itself become “infected.” This is known as the so called “transfer effect” or “domino effect.” Because these newer non-repellent termiticides are lethal to termites at very low doses, the transfer from contaminated termites to “clean” termites can result in the eventual weakening or elimination of the colony.

Termiticide Testing

All soil applied termiticides must pass a two-step process before EPA will register the product. Compounds are first screened in the laboratory, and from among those tested in the lab, only a very few ever make it to field testing. Field testing is done at testing facilities in Arizona, Florida, Mississippi, and South Carolina. The test sites represent dry, subtropical, and mild climates, as well as different soil types. These field testing locations represent a “worst case scenario” for the termiticide. If it can provide protection against termites under these conditions, it is a good indication that it will also perform well in most other conditions across the United States. Termiticides are evaluated for as long as they remain effective against subterranean termites. These tests provide the information necessary to register and label soil termiticides in the U.S. A summary of these tests is provided at the end of chapter 6.

Unlike chemicals used for barrier treatments, baits have not had rigorous testing to determine their effectiveness. Since there are no performance guidelines, at the present, persons should be somewhat skeptical regarding claims made about these bait products. In the future, performance criteria will be established for both new and existing bait products and products lacking performance data will be required to generate additional data and/or adjust their claims. In the meantime, be cautious about outlandish claims that seem to be too good to be true.

How Long Do They Last?

Recent studies have shown that all registered soil applied termiticides disappear over time. In one extensive study, it was found that after 5 years less than 10 percent of the initial application rate remains. The loss of termiticide in soil could be the result of individual peculiarities at each treatment site. Evidence indicates that some microbes “eat” termiticides, which could explain part of the disappearance. Some termiticides disappear because chemical reactions in the soil break the termiticide molecules into smaller, less effective pieces. Soil conditions that are known to affect termiticide degradation include the acidity of the soil, the amount of organic matter present, and the soil type (clay, silt, sand). Whatever the cause, it should be assumed that the concentration of termiticide will be less each year following the application.