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How to Select, Apply, and Develop Insecticides for Imported Fire Ant Control

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I. How to Select Imported Fire Ant Control Insecticide Products

Many people have concerns about selecting insecticides to control the red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera; Formicidae). They want more information about product toxicity and its effects on the environment, other insects, and pets. The risks of having fire ant infestations and using insecticides for their control must be balanced with the benefits of carefully using insecticides to eliminate the pest. Several considerations are necessary to minimize and assess risk when selecting insecticide treatments.

Although primarily a nuisance, red imported fire ants can cause medical and, occasionally, legal problems when they sting, and economic problems when they invade homes and electrical units. Their mounds can be unsightly and damage field-working equipment.

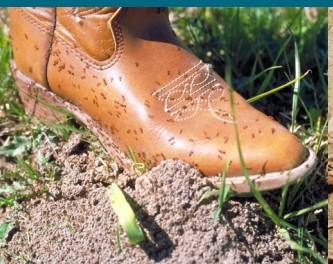
There are ecological as well as health benefits to controlling fire ants. Some ecologists believe that controlling fire ants because of their negative impact on biodiversity is the best way to preserve a natural ecology on nature preserves.

Currently, treatment to suppress these ants relies largely on the judicious use of selected insecticides. Fire ant insecticides can be used with minimal risk. But, lack of knowledge about insecticides, control approaches, and, perhaps, mistrust of information sources (government agencies and pesticide manufacturers) has resulted in environmental contamination, ineffective control methods, and misuse of insecticides. For example, higher levels of diazinon, an organophosphate insecticide, were found in surface runoff water in 15 Texas communities, due to overuse and misuse of the pesticide.

Learning about fire ants, management approaches, and the toxicology of insecticides is a challenge. And, unfortunately, there is no quick-and-easy single "best" method for dealing with this pest. However, the largest benefit may be the knowledge gained from considering which pesticide product(s) to use in the battle against imported fire ants.

Minimizing Risk

Follow label directions. Not following directions printed on the product label is the greatest risk associated with using insecticides. The Environ-





mental Protection Agency (EPA) requires all companies developing insecticides to demonstrate that their product poses minimal risks to the user, the environment, and non-target organisms in order to become a registered product. This process costs millions of dollars and can take years to complete. The EPA registers pesticides if it is satisfied that there will be no unreasonable adverse effects on people or the environment. But this only pertains to pesticides used according to the directions provided on the label. When using home remedies or concoctions with insecticidal claims, the consumer has no specific-use directions or the ability to evaluate the risks involved. Using petroleum products such as gasoline or diesel fuel is the most risky and environmentally damaging way to try to control fire ants.

"Toxicity is the inherent capability of a substance to produce injury or death. Hazard is a function of toxicity and exposure. The hazard can be expressed as the probability that injury will result from the use of the pesticide in a given formulation, quantity, and manner." – B. L. Bohmont, *The Standard Pesticide User's Guide*

Limit exposure. Each pesticide product label describes the appropriate personal protective clothing required when using the product. These items include the proper type of clean gloves, eye protection, long pants, long-sleeved shirt, shoes, and, occasionally, a respirator. Even relatively less-toxic pesticides can be hazardous to the user when in contact with the skin for prolonged periods. Avoid contact with pesticides and use equipment that is clean, in good working condition, and not used for any other purpose. For example, never use kitchen utensils for measuring pesticides. Clean up after making the application. Discard contaminated or worn articles. Wash the clothing used during treatment separately and preferably dry them on a clothesline in the sun. This avoids contaminating the clothes dryer and the ultraviolet light helps pesticide residues decompose.

Store unused pesticides properly. Storing unused pesticides presents one of the more substantial risks associated with using pesticides. Purchase only enough product to address the pest situation at hand. This helps avoid having to store products and allows more flexibility for selecting products for future pest problems. Store pesticides in a secure (locked) location inaccessible to children or animals, in their original containers, and accompanied by the product label. Avoid storing pesticides for more than a year or so. Bait-formulated pesticides, in particular, degrade rapidly over time. Bait in unopened containers will remain fresh for about 2 years when stored in a cool, dry location. When a fire ant bait is exposed to air, the soybean oil spoils within weeks and becomes unattractive to foraging ants. Dispose of unused pesticides properly, following the guidelines of your municipality. Participate in opportunities for hazardous waste chemical disposal offered in your community. DO NOT pour unused pesticides in the sink or toilet or outside in the landscape or drainage system!

Use pesticides judiciously. There is no risk-free pesticide—natural, "organic," or synthetic. To be a pesticide chemical, it must affect a biological system or at least be poisonous to the target organism. The goal is to select an approach that uses the lowest effective amount of the least toxic materials available. Over-use of any product can be costly, labor intensive, and environmentally undesirable. For instance, treating each fire ant mound using a bait, dust, granular, or liquid formulation will cost $0.10 to $1.50 (or more) per ant mound, not counting labor costs. Some areas of Texas are infested with 200 to 1,000 ant mounds per acre! Even at 10 cents per mound, treating each ant hill in these areas is unquestionably too expensive, labor intensive, and uses too much insecticide. In areas with 20 or fewer ant mounds per acre (about 5 per yard), the use of mound treatments only is encouraged. However, in areas with more ant mounds, a broadcast application of a bait can be more economical and provide longer-lasting 80 to 90 percent control. This is the

basis of the Two-Step Method of fire ant control (see *Fire Ant Control: The Two-Step Method and other Approaches* as well as *Managing Red Imported Fire Ants in Urban Areas*, and *Broadcast Baits for Fire Ant Control*).

Evaluating Pesticide Toxicity

Signal word. Each EPA registered insecticide label boldly displays a signal word: "Danger," "Warning," or "Caution." This descriptor applies to the material as formulated in the product container and indicates the relative toxic level of the product, with "Danger" being the most toxic and "Caution" being the least toxic.

Mixing the product from the container is usually the most hazardous aspect of using a pesticide. Diluting the product as directed for use reduces the toxicity. Carefully follow the directions provided on the product label and read other precautionary statements, for instance, those describing hazards to bees and other pollinators. Regardless of the signal word, always treat an insecticide as a poison. Also consider that label directions on a less-toxic insecticide may require application at a higher concentration or volume. Or, you may need to apply the product more frequently, relative to a more potent or "stronger" insecticide, which could offset any initially reduced risks.

LD50 values. The LD50, or "Lethal Dose of 50 percent of a population," is a measure of toxicity and indicates the amount of pesticide that would kill 50 percent of the animals tested. These data are found in many references describing pesticide toxicity profile (see sources below). Occasionally, this information is used incorrectly. The LD50 value is expressed as the amount in milligrams (mg) of pesticide per kilogram (kg) body weight of the test animals (usually rabbits or rats). The pesticide is generally administered orally or dermally and provides an indication of the toxicity level of a pesticide's active ingredient. Lower LD50 values indicate that the pesticide is relatively more toxic.

Extrapolation of this information to other organisms such as humans is questionable. Furthermore, most published values refer to the toxicity of the active ingredient (a.i.) rather than to the product as formulated for sale (diluted). If the product has a low percent a.i., the toxicity of the formulation is much lower than the toxicity of the technical material (99 to 100 percent concentrate used to prepare the commercial formulations). For example, most bait-formulated fire ant products contain less than one percent a.i., so one pound of product contains only 1/100th pound of insecticide or less. Another consideration, particularly for liquid pesticide formulations, is that occasionally they contain some other ingredients (active ingredients or inert materials) in the formulation that can affect the toxicity of the product (see *Broadcast Baits for Fire Ant Control*).

Material safety data sheet (MSDS). Each pesticide is required to have, in addition to the product label, a Material Safety Data Sheet (MSDS). This document provides specific toxicological information about the pesticide in the product, including risks to the user and the environment. These documents are available from pesticide manufacturers and distributors but may also be found in some publications and Internet sites (see sources below).

Toxicity profiles. A greater understanding of the toxicological properties of pesticides can help when choosing the most appropriate product. Each pesticide has certain properties to consider for selection and use and each has a distinct toxic effect on different organisms. The combined information on the effects is known as the toxicological profile. For instance, although the insecticides containing ingredients called pyrethrins (extracted from a plant) as well as pyrethroids (synthetically-produced class of insecticides) have low toxicity to man, mammals, and birds, they are all highly toxic to fish and aquatic organisms. On the other hand, acephate (the ingredient found in products like Orthene), an organophosphate insecticide, is usually formulated at relatively high concen-

trations and can be toxic to the user and pets if exposure (through prolonged skin contact or inhalation) is excessive. However, this ingredient decomposes rapidly in the environment and is much less toxic to fish.

Persistence in the environment varies greatly between pesticides and can be a desired benefit or a risk, depending on the degree of pest control desired. Water solubility can become a problem if the product is leached away from its intended use site and contaminates ground or surface runoff water. Most pesticide manufacturers employ technical representatives that can help answer questions about the toxicity profiles of their products.

Evaluating Environmental Risks

Effects on nontarget arthropods and other soil organisms. The MSDS provides information about hazards to the user (human toxicity) and environment, but information about the effects of a pesticide on other organisms (insects and other arthropods) is lacking. Frequently, technical support brochures developed by manufacturers will describe whether the product has a broad-spectrum effect on a wide variety of insects or whether it is target-specific or toxic only to certain arthropod groups. Beyond that, a search of scientific literature might be necessary to obtain data on the specific effects of products on beneficial organisms such as earthworms, soil microorganisms (microbes), or biological control agents such as insect diseases, parasites, and predators. Bait-formulated fire ant products, for instance, contain active ingredients that could kill a wide range of other insects and arthropods. However, as formulated and applied, they are primarily consumed by red imported fire ants and perhaps other ants that eat soybean oil, the attractant in most of these products. Consequently, there is some concern about using broadcast applications of these bait products in areas where the preservation of native, competitor ant species is desired. On the other hand, dust, granular, or liquid insecticide treatments applied only to imported fire ant mounds will not affect other ant species nesting elsewhere (or other nontarget organisms) unless they are contacted by the treatment.

Secondary pest outbreaks. Although imported fire ants are largely considered to be a pest, they are effective predators of other insects and arthropods considered to be pests as well. If imported fire ants were eliminated on a large scale, the populations of the organisms on which they feed would probably increase. These groups would include chigger and tick species and many species of beetles and caterpillars. Particularly in agriculture, the decision to eliminate fire ants should be carefully made after evaluating the collective impact of the ant on the ecosystem and the production system. In cotton and sugarcane, the impact of the imported fire ants is generally thought to be beneficial.

Sources of Additional Information

EXTONET, The Extension Toxicology Network, Pesticide Information Profiles, http://ace.ace.orst.edu/info/extoxnet

Oregon State University Extension Pesticide Properties Database, http://npic.orst.edu/info/ingred/ppdmove.htm

Agricultural Research Service, US Department of Agriculture Pesticide Properties Database, http://www.ars.usda.gov

Hazardous Substance Databank, Toxnet, National Library of Medicine, http://toxnet.nim.nih.gov/cgi-bin/sis/htmlgen?HSDB

Registered Pesticides:

National Pesticide Information Retrieval System (VPIRS), http://ppis.ceris.purdue.edu

Modes of Action:

Insecticide Resistance Action Committee, http//www.irac-online.org

Pesticide labels and information references:

C&P Press, 888 Seventh Ave., 28th floor, New York, NY 10106; 212/621-4600, FAX 212/399-1122 1/800-544-7377.

Farm Chemicals Handbook, Meister Publishing Company, 37733 Euclid Ave., Willoughby, OH 44094; 440/942-2000; 800/572-7740; FAX 440/975-3447.

The Pesticide Manual: A World Compendium (15th ed.). C. Tomlin (ed.) 2011. CABI, British Crop Protection Council, 7 Omni Business Centre, Alton, Hampshire GU 34 2QD, United Kingdom. 1457 pp.

Acknowledgments

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II. How to Develop and Apply Individual Red Imported Fire Ant Mound Drenches

All too often, individual fire ant mound treatments are ineffective, causing people to "chase" fire ant colonies around their yards instead of killing them. Individual mound treatments often kill large numbers of worker ants close to the surface of the mound. However, in order to successfully eliminate a colony, you must eliminate all of the egg-laying queen ants. The queen ants may be deeper in the mound and quickly moved away from danger by worker ants. Understanding the factors that affect the success or failure of individual mound treatments can lead to more effective use of these treatments.

Season/temperature. Red imported fire ants move up and down within their mounds depending upon temperature, a behavior called thermoregulation. On cool mornings, they will nest just under the mound's surface on the sunny, east side. In very hot or cool weather, they nest deeper in the mounds, 6 or more inches below the surface. For better results, apply mound drenches during periods when the ants are nesting closer to the mound surface.

Soil type. Clay-type soils retain the structure of the mound developed by the ants. Mounds can be up to 18 inches tall and contain many tunnels and galleries, extending deep into the soil. In areas where ants have no access to surface water, tunnels can be several yards deep to access soil moisture at the water table. In sandy soils, the mounds are less structured because sand does not hold the mound structure. The mounds are generally not as tall and are much wider. Applying a solution to mounds in clay soil can be effective, provided that the galleries are flooded and the solution does not run off of the sides of the mound and away from the colony. In sandy soils, treatments flush more quickly through the soil, possibly reducing the exposure of the ants to the treatment material.

Soil moisture. Mound drenches are most effective when all ants in a mound come into contact with the solution. The best time to apply a mound drench is when the soil is neither too wet nor too dry. If soils are already saturated with rain, the solution may not penetrate into the soil profile. On the other hand, when ants are forced up to the soil surface by saturated soils, they will be easier to contact. When soil moisture is very dry, the solution is quickly absorbed by the soil and may reduce the time the ants are soaked in and exposed to the diluted insecticide.

Concentration and dose. Registered insecticide products have been tested to be effective using the concentration (use rate) described on the product label. Generally, higher concentrations are more toxic to the ants. They are usually applied with some type of watering can as a "gentle rain" over the colony. This method is least disruptive to the mound and extends the time that ants are soaked in the diluted insecticide solution, increasing the exposure period. Using a bucket to apply the solution floods the mound more quickly and often causes the surface to collapse, flushing the solution into the tunnels and galleries. Although this may provide more thorough "coverage" by flooding the galleries, it can also reduce exposure time.

Agitation. Some insecticides such as dust-formulated products or emulsifiable concentrate insec-

ticides must be mixed with water before application. Thoroughly mixing the materials in water is critical. First, put some water in the tank; then add the insecticide material before filling the tank with the remaining amount of water needed. If you use oil-containing ingredients, which tend to separate from water, periodically agitate the mixture to assure thorough mixing before application, particularly if the mixture has been allowed to sit for a while.

Volume. Most mound treatment product labels recommend applying 1 gallon of diluted insecticide to each ant mound. There are exceptions, such as Exxant, which required the application of 4 gallons of solution. Other products allow you to use less material based on the size of the mound. For contact insecticides, all ants in the mound must come into contact with the insecticide in order to achieve control of the colony. Some products have residual action that will kill ants walking on the treated surface for some time after the material has been applied to the soil. However, other treatments, like using very hot water, require direct contact of the solution with the ants to be effective since there is short or no residual action.

Drench temperature. Most fire ant drench products do not specify a water temperature for diluting the concentrate material, so using water at temperatures from the source is acceptable. However, temperature can make a difference. Very hot, almost boiling, water can be effective in killing about 60 percent of the mounds on which 2 gallons of water has been applied (during periods when the ants are nesting close to the mound surface). One product label, Exxant, suggested using cold water ("The colder the better."), but the rationale behind this has not been evaluated. Ingredients move into ant bodies when temperatures are higher since the metabolic rate of these cold-blooded animals will be increased. Conversely, cooler temperatures slow the ants down and presumably could increase their exposure time to the insecticide solution.

Disturbing mounds. Most ant mound treatment products recommend NOT disturbing the mound prior to treatment in order to keep the ants concentrated close to the mound surface where they will more likely be in contact with the solution than when they scatter to defend the mound. Also, the queen ants move deeper into the mound upon disturbance, reducing the possibility of contact with the solution. Some products instruct you to use a stick to poke a hole into the top of the mound. This provides a point of entry to pour the solution into the hole to flood through the tunnels and galleries in the mound, but it also causes a mound disturbance.

Monogyne (large) versus polygyne (small) ants. Polygyne (multiple queen) ants are more difficult to control with individual mound treatments because infested areas have dramatically higher numbers of ant mounds per acre (200 or more mounds) than areas infested with the monogyne (single queen) form (40 to 150 mounds). However, worker ants in polygyne colonies have smaller bodies, on average, making them more susceptible to contact insecticides than larger ants are. In addition, all queen ants in multiple queen ant colonies must be killed in order to eliminate the colony. Elimination of all of the colony's queens is generally not a problem when using conventional nerve-active contact insecticides as directed because of the relatively longer residual activity of these products. However, it may be more of a factor in the effectiveness of soap- and oil-based insecticides that kill by physical or cytotoxic means (such as desiccating, drowning, and suffocating).

Treatment diameter around mounds. Most ant mound treatments instruct you to drench the actual mound and the soil in a 3- to 4-foot diameter circle around the mound because mounds have subsurface tunnels radiating away from the mound proper that can harbor worker ants and queens. Occasionally, the entire colony is not actually nesting under the pile of soil thought of as the mound. This can be the case with colonies nesting next to curbs and other "hardscape"

objects where the nest is actually under the object but the mound is build next to the object. In these situations, mound drench treatments may be ineffective because not all of the ants in the colony come into contact with the insecticide.

Injection and other treatment devices. Numerous attempts have been made to develop devices to inject insecticide solutions into ant mounds to reduce surface insecticide residues. These devices often take more time to apply a given volume (1 gallon) of solution. In addition, ants nesting close to the mound surface are often bypassed by the injector rod, sparing them from contact with the solution. These devices are less reliable for treating ant mounds in sandy soils where there are fewer or no tunnels or galleries associated with the shallow mounds the ants form. Few insecticide product labels provide directions for application through injector devices. Hose-on applicators are difficult to calibrate. The amount of concentrate to add to the jar is not provided on most product labels and applying a given amount (1 gallon) of solution to the mound takes more time. The spray nozzle may not allow enough of the diluted solution to sufficiently penetrate into the mound. Use nurse tanks to mix up larger volumes of diluted solutions. However, thoroughly mixing the material in the larger tank requires proper agitation of the solution and the spray nozzle may only provide a stream of solution unless you attach a breaker or injection rod to the hose end.

Acknowledgments

Charles Barr and Kathy Flanders reviewed the manuscript for this fact sheet.

III. How to Develop Red Imported Fire Ant Insecticide Products

In the United States, ANY chemical-containing product sold that claims on the product label or marketing literature to control any pest(s) must be registered by the United States Environmental Protection Agency (EPA) unless the active and inert ingredients are exempt under section 25(b) of the Federal Insecticide Fungicide and Rodenticide Act (FIFRA). All pesticides sold in Texas must also be registered with the Texas Department of Agriculture (TDA).

Registration of a pesticide may take millions of dollars and years to develop the documentation to satisfy regulatory requirements. Requirements change over time and it is best to contact EPA and TDA personnel directly to determine the steps to take in developing an imported fire ant insecticide. Because fire ants sting and are a pest of human medical significance, the EPA requires product performance (efficacy) data to support product claims. (see Product Performance Test Guidelines, OPPTS 810.3100. However, the cost in dollars and time to develop these performance data may be small compared to the cost of the rest of the data required.

Companies wanting to develop and market a fire ant control product should consider:

- Cost of registration (federally and within target states where the product will be sold)
- Existing fire ant product market (What products are already registered? Will potential sales recover the developmental costs?)
- Cost of the end product and the labor needed to apply it compared to available products
- Product effectiveness relative to "standard" products
- Usage sites—locations in which the product's use will be supported such as cropland, electrical boxes, lawns, pastures, and vegetable gardens

The Texas A&M AgriLife Extension Service has information at *Information for Texas Residents* to assist in developing effectiveness or efficacy data.

Acknowledgment

This fact sheet was originally released as three Fire Ant Plan Fact Sheets: FAPFS #25, *Considerations for Development of Red Imported Fire Ant Insecticide Products;* FAPFS #36, *Considerations for Selecting Imported Fire Ant Control Insecticide Products;* and FAPFS #37, *Considerations for Developing and Applying Individual Red Imported Fire Ant Mound Drenches.*

References

Fire Ant Control: The Two-Step Method and Other Approaches
www.agrilifebookstore.org/product-p/ento-034.htm

Managing Red Imported Fire Ants in Urban Areas
www.extension.org/pages/11004/managing-imported-fire-ants-in-urban-areas-printable-version

Broadcast Baits for Fire Ant Control
www.agrilifebookstore.org/product-p/e-628.htm

Texas Department of Agriculture
www.texasagriculture.org/Regulatory/Programs/Pesticides.aspx

Product Performance Test Guidelines
www.caslab.com/EPA-Methods/PDF/EPA-Method-810-3100.pdf

Information for Texas Residents
www.extension.org/pages/14901/information-for-Texas-residents

For more information regarding fire ant management, see Extension publications *Managing Red Imported Fire Ants in Urban Areas, Broadcast Baits for Fire Ant Control*, or *Fire Ant Control: The Two-Step Method and Other Approaches* posted on http://AgriLifeBookstore.org.

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