

Control Fleas on Your Pet, in Your House, and in Your Yard



Joe MacGown

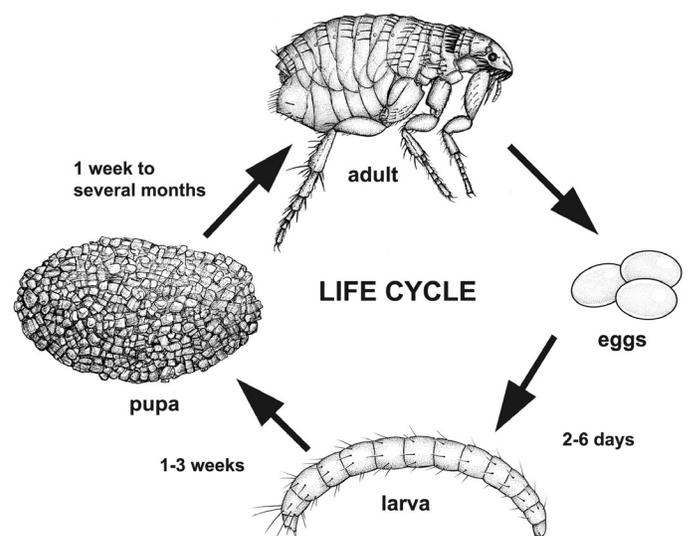
If you own a dog or cat, you will have to control fleas. Even light flea infestations are annoying to pets, and some dogs and cats develop skin problems because they are allergic to flea bites. Heavy flea infestations can cause pets to be unthrifty and cause anemia in puppies and kittens. Fleas may also host tapeworms, and pets become infected when they ingest infected fleas while grooming. The dog tapeworm may rarely infect humans if they accidentally eat infected fleas (primarily only a problem in children). Other than potential infection with tapeworm, fleas are generally not vectors of any human diseases east of the Mississippi River. Fleas also bite people, and heavy infestations in the home or yard can make life miserable for pet owners and their family and friends. Although there are many different species of fleas in the world, the cat flea, *Ctenocephalides felis*, is the species that most commonly occurs on dogs and cats in the United States.

To control fleas successfully, you need to control them in all areas where they occur: on the pet, in the house, and in the yard. Not allowing pets inside the house is the surest way to avoid having fleas inside the house, but not all pet owners favor this method. Whether or not pets are allowed inside, the first step in flea control is to treat the pet(s) with an effective and appropriate on-pet treatment.

Fortunately, there are several highly effective treatments that can be applied to pets for preventive flea control. Good, on-pet flea prevention, combined with frequent cleaning of pet bedding areas, can keep fleas from becoming established in the house or yard. But if pets are infested with adult fleas, the house and yard will also be infested with immature fleas, and these areas will need to be treated, too.

Flea Biology

To control fleas effectively, you need to have a basic understanding of flea biology. Only adult fleas live on the animal and suck blood. Female adult fleas lay eggs on their hosts, but, because the small, white eggs are not sticky, they roll off the host and fall to the floor, accumulating in those areas where the pet sleeps or rests. In 2 to 6 days, the eggs hatch into slender, dirty-white-looking larvae that feed on dander, dried excrement of adult fleas, dried blood, and other organic material that falls from the host or accumulates from other sources. Notice that this “flea food” is also concentrated in areas where pets sleep or rest—right where the developing flea larvae need it to be.



Fleas have a complete life cycle and can complete a generation in as short a time as 3 weeks. Only adult fleas bite pets or people.

Flea larvae are only about one-fourth of an inch long when fully mature and can be difficult to find, even when present in large numbers. But if your pet is infested with adult fleas, the larvae are there and will quickly develop into more blood-sucking adults. In an established flea infestation, adult fleas represent only a fraction of the total flea population. The eggs, larvae, and pupae far outnumber the adults, and you will not control fleas unless you control these immature stages.

Because flea larvae require high humidity and are repelled by sunlight, they usually move into cracks and crevices or burrow deep in carpet or rugs. The larvae mature in 1 to 3 weeks and then spin a small cocoon in which they develop into adults. This cocoon, or pupal, stage can be just a week long or several months long. You must wash your pet's bedding and vacuum carpets regularly to complete your flea control regimen.

Newly developed adult fleas that are still inside their cocoons can sense whether or not host animals are present in the area, based on vibrations and carbon dioxide concentrations. When no hosts are present, they will delay

emergence from the cocoon for up to several months. This is why heavy flea infestations can emerge suddenly in homes that have been vacant for weeks or months. A new homeowner might exclaim, "We just moved in and the house is full of fleas! No one has lived here for over 3 months and we don't even have a pet!" What has usually happened in such situations is that the previous occupants did have indoor pets. After they moved, the flea eggs and larvae that were left behind developed to the pre-adult stage and waited for a new host to arrive. They emerged as soon as they sensed renewed activity, and, in the absence of a dog or cat, began biting people.

Flea Control on the Pet

Fleas can be present year-round, but they become much more plentiful in the spring and summer. Protecting pets from these parasites also helps protect humans and helps prevent infestations in the home and yard. Fortunately, there are several effective products that can be applied directly to the animal to control fleas. Be sure to read the label carefully and understand what you are

Table 1. Some widely available oral and topical treatments for flea and tick control on dogs and cats.

Product name	Adulticide ¹	IGR ²	Admin	Controls ticks	Active ingredients	For use on
Advantage	yes	no	topical	no	imidacloprid	dogs or cats
K9 Advantage	yes	no	topical	yes	imidacloprid/permethrin	dogs only
Advantage Multi	yes	no	topical	no	imidacloprid/moxidectin	dogs or cats
Bravecto	yes	no	oral	yes	fluralaner	dogs or cats
Capstar	yes	no	oral	no	nitfenpyram	dogs or cats
Comfortis	yes	no	oral	no	spinosad	dogs or cats
Frontline Top Spot	yes	no	topical	yes	fipronil	dogs only
Frontline Plus	yes	yes	topical	yes	fipronil/methoprene	dogs or cats
Nexgard	yes	no	oral	yes	afoxolaner	dogs only
Preventic collar	no	no	topical	yes	amitraz	dogs only
Program	no	yes	oral	no	lufenuron	dogs or cats
Program Plus	yes	no	oral	no	milbemycin oxime/lufenuron	dogs only
Sentinel spectrum	yes	no	oral	no	milbemycin oxime/lufenuron/praziquantel	dogs only
Promeris	yes	no	topical	yes	metaflumizone/amitraz	dogs only
Promeris for Cats	yes	no	topical	no	metaflumizone	cats
Proticall	yes	no	topical	yes	permethrin	dogs only
Revolution	yes	no	topical	yes ³	selamectin	dogs or cats
Seresto	yes	no	topical	yes	imidacloprid + flumethrin	dogs or cats
Trifexis	yes	no	oral	no	spinosad + milbemycin oxime	dogs only
Vectra 3D	yes	yes	topical	yes	dinotefuran/pyriproxyfen/permethrin	dogs only
Vectra for Cats and Kittens	yes	yes	topical	no	dinotefuran/pyriproxyfen	cats

¹ Kills adult stage.

² Insect growth regulator. Kills larval stage.

³ Kills only the American dog tick (*Dermacentor variabilis*).

buying. Some of these products work on both ticks and fleas, while some work only for fleas or only for ticks. Some control internal parasites while others do not. Some of these products may be used on dogs or cats, while some may not be used on cats.

Table 1 provides general information about on-pet flea treatments. Note that this table focuses on flea products and flea and tick products. It does not address products that are used primarily for internal parasite control. When using on-pet treatments, it is important to be sure the product is labeled for use on the type of animal being treated, as some of these products should not be used on cats. Never use a product that contains either permethrin or amitraz on a cat. Be sure the dose and frequency of use are appropriate for the weight of the animal. Many of these products are available in different sized packages that are for animals in a specific weight range. Some of the listed products require a prescription and may be purchased only through a veterinarian, but many are available over-the-counter or through online sources. Flea collars are generally ineffective and are not recommended. However, effective tick collars are available for dogs.

There are many options for on-animal flea control in Mississippi. Following is a brief review of a few of the more popular flea control products for use on dogs and cats.

Advantage, K9 Advantix, and Advantage Multi all contain the active ingredient imidacloprid, which kills adult fleas. K9 Advantix also contains permethrin, which kills ticks but renders the product unsafe for cats. Advantage Multi contains imidacloprid plus moxidectin, which enables it to kill adult fleas and prevent heartworms and a number of other intestinal parasites in dogs.

Capstar is an oral flea-control product popular in veterinary clinics because it kills adult fleas within 30 minutes and can be used for both dogs and cats. However, its effectiveness lasts only about 24 hours, so it is not a good choice for long-term control of fleas.

Comfortis is an oral product for dogs and cats that begins killing adult fleas within 30 minutes and remains effective for approximately 30 days. The primary disadvantage is that the flea has to bite the dog or cat for the product to take effect. The dosages are different for dogs and cats, so be sure to read the label carefully. This product must be given with a meal.

Frontline Plus is applied topically to cats and dogs and kills adult fleas, flea larvae, and flea eggs. It also kills chewing lice and all stages of a number of tick species. Although it is applied topically, the manufacturer claims resistance to bathing or swimming and good efficacy for a 30-day period. Fipronil-resistant flea strains have been reported.

Promeris provides control of existing flea and tick infestations in dogs and protects against reinfestation. The formulation for cats contains metflumizone but no amitraz and claims up to 7 weeks of flea control.

Revolution kills adult fleas, prevents flea eggs from hatching for 1 month, prevents heartworm disease, and is used for the treatment and control of ear mite infestations. Revolution is also indicated for the treatment and control of sarcoptic mange and for the control of tick infestations due to the American dog tick in dogs and roundworm and hookworm infections in cats.

Seresto is a collar with a unique polymer matrix of two active ingredients: imidacloprid to control flea infestations and flumethrin to repel and kill ticks. The active ingredients spread from the site of direct contact over the skin surface of the cat or dog. It works similarly to a monthly topical, but, as the active ingredients wear off over time, a new supply is continuously replenished in low concentrations. The active ingredients spread from the site of direct contact over the skin surface to slowly and continuously release the active ingredients over 8 months. It is water resistant, so it is not necessary to remove the collar before the pet is immersed in water. The manufacturer states that, in order to remain effective for the 8-month period, dogs must not be bathed more than once per month. Also, for dogs that swim once a month or more, the control duration is reduced to 5 months.

Trifexis is a once-monthly tablet that kills fleas, prevents heartworm disease, and treats and controls adult hookworm, roundworm, and whipworm infections. It is beef-flavored and can be offered as a treat. It combines two active ingredients that are safe and effective. One of its active ingredients, spinosad, is the active ingredient in Comfortis, which begins killing adult fleas within 30 minutes and remains effective for approximately 30 days. The second active ingredient, milbemycin oxime, prevents heartworms and intestinal parasites. Even though Comfortis is also labeled for cats, Trifexis is not. Similar to Comfortis, a disadvantage of this product is that the flea has to bite the dog for it to take effect. However, it is especially appealing to dog owners who want to give one tablet to prevent heartworms, kill fleas, and control the common intestinal parasites listed.

Vectra 3D kills through contact; parasites don't have to bite to die. It begins reducing flea feeding in 5 minutes and kills fleas in 6 hours. Vectra 3D repels and kills fleas, ticks, mosquitoes, biting and sand flies, lice, and mites (excluding mange mites). A repelled vector does not attach to or bite the dog. It kills adult fleas, prevents the development of all immature stages of fleas (eggs, larvae, and pupae), and

remains effective after bathing and swimming. It protects dogs for 1 month and may be used on puppies as young as 7 weeks of age. There is a separate product for cats and kittens.

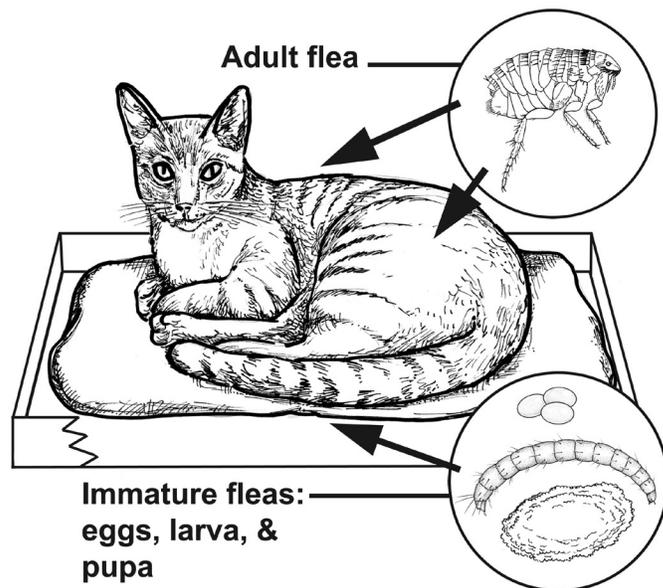
Vectra for Cats and Kittens is a once-a-month topical treatment for use on cats against all flea life stages (eggs, larvae, pupae, and adult fleas). It is fast-acting, killing fleas in 6 hours. It kills by contact, so fleas do not have to bite. It is quick-drying and non-greasy, controls development of all flea stages for 1 month, controls and stops flea infestations, and prevents reinfestation. It can be used on cats as young as 8 weeks of age.

NexGard kills adult fleas and is indicated for the treatment and prevention of flea infestations by the most common flea in dogs (*Ctenocephalides felis*). It is also used to treat and control the four most common tick species in dogs, black-legged tick, American dog tick, Lone Star tick, and brown dog tick. It can be used on dogs and puppies 8 weeks of age and older that weigh at least 4 pounds. The manufacturer claims protection lasts for 1 month. NexGard should not be used in dogs with a history of seizures or neurologic disorders.

Veterinarians usually recommend controlling pests on the animals as well as in the environment and selecting flea-control products based on the individual animal's needs. **It is important to emphasize that some flea products are deadly to cats.** If you intend to use a product on cats, always check the label to make sure the product is approved for use on cats, and always follow the manufacturer's directions. Do not use products that contain amitraz or permethrin on cats!

Use on-pet flea treatments properly. Be sure to apply only at the recommended time intervals, and use the dose and frequency that is appropriate for the size animal you are treating. If a product that previously worked well on your pet appears to lose its effectiveness, change to another product that uses a different active ingredient. Also, with heavy flea infestations, it may be necessary to use more than one method of application. For example, Capstar may be used in both dogs and cats to kill all fleas on the pet within 30 minutes. However, this approach would not provide long-term control and would not control fleas in the environment. Heavy infestations usually require multiple approaches starting with a quick knock-down, followed by a long-term product and treatment of the environment.

It is very difficult to treat a newborn puppy or kitten for fleas safely because of their age and size. It is, therefore, wise to treat a pregnant animal for fleas before she gives birth. Use bedding that can be washed frequently, and keep the whelping area flea-free if at all possible. Do not use any flea treatments directly on newborn puppies or kittens!



Only adult fleas live on pets. Eggs fall off the pet and accumulate in bedding areas. Flea larvae feed on the feces of adult fleas, dried blood, and dander, which also falls off the pet and accumulates in bedding areas.

Flea Control in the House

Given the biology and habits of immature fleas, it is easy to see why indoor flea infestations are usually concentrated in areas where pets rest and why infestations are often more severe in rooms that are not cleaned regularly and in rooms with carpet or rugs. It is also easy to see why vacuuming and other methods of cleaning pet bedding and floors play such an important role in indoor flea management. Weekly cleaning of pet bedding and the surrounding area removes many eggs and immature fleas before they become adults, and it also removes much of the dander, dried blood, and other organic accumulations on which immature fleas feed. Cleaning is essential to successful indoor flea control!

Not allowing pets indoors is the best way to avoid indoor flea infestations. If pets are allowed indoors, designating special areas for pets to sleep, rest, and spend most of their time can let you concentrate your frequent cleaning efforts on these areas. If pets are allowed on furniture, keep in mind that immature fleas will occur under seat cushions and in other cracks and crevices within the furniture, and vacuum these areas regularly. You will also need to move furniture and vacuum underneath. When you finish vacuuming, remove the vacuum bag, seal it in a plastic garbage bag, and discard it.

When using insecticide sprays to treat established indoor flea infestations, it is important to target both the adult and immature stages. There are many products labeled for indoor control of adult fleas that can be applied as directed sprays. These contain active ingredients such

as permethrin, deltamethrin, or pyrethrins. While these products also have activity against immature fleas, flea larvae are difficult to control with traditional adulticide type insecticides because of their habit of burrowing deep into cracks and crevices where they are difficult to reach with insecticides.

You can improve control of immature fleas in indoor settings by using a product that includes an insect growth regulator (IGR) product, such as methoprene or nylar (pyriproxyfen), in your flea treatment. These IGR products work by disrupting the growth of immature fleas, causing them to die before they reach adulthood, and/or by interfering with the female flea’s ability to produce viable eggs. The greatest strength of these IGR products is that, when used indoors where they are not exposed to sunlight, they last several months and provide long-term control of immature fleas. Because these IGR products will not control adult fleas, it is best to apply a combination treatment containing an adult flea control product and one of the IGRs when attempting to control established indoor flea infestations. In situations where there is no established infestation of adult fleas and the objective is to simply apply a preventive treatment in areas frequented by pets, the IGR products may be effective when used alone.

Most flea treatments for indoor use by homeowners are sold as pre-diluted, ready-to-use (RTU) sprays. These products usually contain an adulticide, such as permethrin, bifenthrin, cyfluthrin, or deltamethrin, and some treatments contain both an adulticide and one of the IGR products.

Another option is to buy adulticides and IGR products separately, as concentrates, and mix them together in pump-up type household sprayers. If you use a pump-up type sprayer, be sure to choose one that applies a fine spray pattern or a small pin-stream spray. Many pump-up sprayers apply spray patterns that are too heavy for indoor use.

Indoor flea treatments are also sold as total-release aerosol foggers that contain an adulticide, an IGR, or both. However, the insecticide fog they release does not penetrate well underneath furniture, floor coverings, or seat cushions, and into the cracks and crevices where most immature fleas live. Most of the insecticide applied by total-release foggers settles in places where it is more likely to contact people and pets than fleas. Whether you use one of the ready-to-use pre-mixes or buy concentrates and mix your own spray, directed sprays will provide much better flea control.

When applying insecticides in indoor situations, it is especially important to carefully read and follow all label directions. Do not apply insecticides to areas where they are not approved for use. For example, some flea treatments may not be applied in areas where food is prepared, some may not be applied directly to furniture, and few flea products are labeled for broadcast application to carpets and floors. Do not apply any insecticide directly to pets unless the label says you can. Do not apply any insecticide as a broadcast spray to carpets or floors or to exposed surfaces of furniture unless the label clearly allows

Table 2. Some indoor flea control sprays (not for use on pets).

Active ingredient	Brand name (examples)
Pre-mixed, ready-to-use sprays	
bifenthrin + zeta-cypermethrin	Ortho Home Defense Max Insect Killer (RTU)
deltamethrin	Enforcer BugMax Home Pest Control (RTU)
dinotefuran	Alpine Flea & Bed Bug (aerosol)
nylar + permethrin	Enforcer Flea Spray for Homes (RTU)
methoprene + permethrin	Zodiac Fleatrol Carpet & Upholstery Pump (RTU), Adams Home Flea & Tick Spray (RTU)
nylar + tetramethrin + sumithrin	Enforcer Flea Spray for Carpets & Furniture (aerosol)
nylar + permethrin + linalool	Bio Spot Inverted Carpet Spray (aerosol)
permethrin + pyriproxyfen	Sentry Home and Carpet Spray
Insecticide concentrates	
dinotefuran (40% concentrate)	Alpine WSG
permethrin (13.3% concentrate)	Martins Multipurpose Insecticide
permethrin (10% concentrate)	Hi-Yield Indoor/Outdoor Broad Use Insecticide
Insect growth regulators	
nylar (pyriproxyfen)	Martins IG Regulator
methoprene	Precor IG Concentrate

such use. Also, be sure to observe the re-entry period specified on the label. Most products require that people and pets be kept out of the area until spray has dried, but some may have longer re-entry restrictions. Do not apply more insecticide than the maximum rate indicated on the label. Increasing the rate or concentration will not improve control, but it will increase pesticide exposure to your family and pets.

The key to successful indoor flea control is to be thorough in cleaning and treating all areas in the house where fleas occur, giving special attention to areas where pets sleep or rest. A cursory, hastily applied flea treatment is not likely to produce satisfactory results, but a well-planned, carefully conducted treatment will provide good control. Clean and vacuum floors and pet bedding. Move furniture and vacuum underneath, and vacuum cracks and crevices in seats and under seat cushions. Then make a thorough application of an adulticide plus an IGR according to label directions.

Keep in mind that fleas that are already in the pupal stage are especially difficult to control, and newly emerged adult fleas will hop onto a host as soon as possible. This means adult fleas may continue to appear for a few weeks following treatment, even when the treatment was properly applied using effective products, and follow-up treatments are sometimes required. When attempting to control heavy indoor flea infestations, it may be necessary to treat two or three times at 2-week intervals, keeping in mind that the cleaning and vacuuming is as important as the spraying. If you properly clean and treat all of the areas that harbor immature fleas and treat all pets with an effective on-pet treatment, you will be successful in controlling fleas. After you have gotten the fleas under control, you can maintain control by preventive use of on-pet treatments, weekly cleaning of bedding and other areas frequented by pets, and application of IGR treatments at appropriate intervals.

While not allowing pets inside the house is the best way to prevent indoor flea infestations, you might not want to ban indoor pets from the house after a heavy flea infestation has developed and you have treated as described above. Any remaining emerging adult fleas are eager for a blood meal and, in the absence of pets, are more likely to bite people living in the house. Instead, treat the pet with one of the long-lasting on-pet treatments and allow it to remain indoors. Most emerging adult fleas will be attracted to the pet, where they will be controlled by the on-pet treatment. Essentially, you are using the pet as a flea trap.

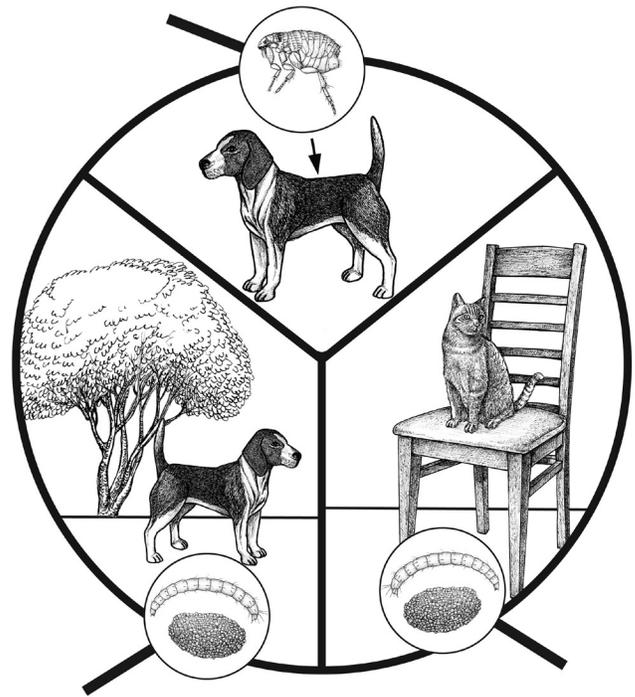
Of course, you can also hire a professional pest control company to apply indoor flea treatments. The pest control technician will have effective insecticides and growth regulators and the knowledge and equipment to apply them safely and properly. However, you will still need to do the necessary cleaning before the technician arrives, and you will still need to be present at the time of treatment to move furniture and work with the technician to assure an effective treatment. Omitting the cleaning steps and hiring a pest control company to “just treat the areas you can reach” will not give satisfactory results. You have to do your part with cleaning and making sure the technician has access to all areas that need to be treated.

Key Steps to Control Heavy Indoor Flea Infestations

- Treat pet(s) with an on-pet flea treatment.
- Thoroughly vacuum pet bedding and the surrounding area.
- Wash pet bedding in hot, soapy water or discard and replace.
- Vacuum floors, carpets, and rugs. (Give special attention to cracks and crevices, under furniture, along walls, and around pet bedding areas.)
- Vacuum furniture where pets rest, being sure to move seat cushions and vacuum underneath.
- Move furniture and vacuum underneath.
- Apply directed spray of adulticide + IGR. (Do not fan spray or broadcast spray carpets or floors unless the label says you can. Apply spray to cracks and crevices, under furniture, along edges where walls or furniture meets the floor, and around and under pet bedding areas.)
- Repeat cleaning and treatment in 14 days.
- Repeat again in 14 more days if fleas are still present.
- Maintain control by cleaning bedding areas weekly and regularly using on-pet treatments.

Flea Control in the Yard

Occasionally, high numbers of fleas will occur outside, in the yard or landscape. This usually happens when the area is frequented by flea-infested pets or wild animals. When attempting to control fleas in an outdoor situation, keep in mind that you will not have lasting success unless you also control fleas on all animals that frequent the area. On-pet flea treatments are an excellent way to treat pets, but, in cases where the area is being frequented by stray dogs or cats or wild animals, such as opossums or raccoons, treating the animal itself may not be an option. However, it may be possible to prevent or discourage the animals from using the area. Fencing the yard or sealing crawlspaces under buildings and openings to attics (be sure to maintain proper ventilation) are examples of ways to achieve this. If you feed pets outside, avoid feeding free-choice in areas where strays or wild animals can access the food. Otherwise, you will be attracting unwanted animals, and the fleas they carry, onto your property.



Fleas can occur in three places: on the pet, in the house, and in the yard.

Table 3. Some treatments to control fleas in the yard.

Active ingredient	Brand name (examples)	Rate/1000 sq ft	Comments
Treatments applied as sprays			
bifenthrin (0.3%) + zeta-cypermethrin (0.075%)	Ortho BugClear Insect Killer Ready-to-Spray	6 fl oz	Sold in a ready-to-use, hose-end spray bottle. Attach to garden hose and spray per label directions.
dinotefuran (40%)	Alpine WSG	10 g/gal	Apply to lawns, landscape beds, porches, patios, and other areas where pets rest or spend time. Do not apply to animals.
permethrin (38% concentrate)	Hi-Yield 38 Plus Turf, Termite, & Ornamental Insect Concentrate	0.4 to 0.8 fl oz/gal	Apply as a broadcast spray using a hose-end sprayer or other appropriate sprayer.
permethrin (10%)	Hi-Yield Indoor/Outdoor Broad Use Insecticide	1.5 fl oz in 10 gal per 1000 sq ft	Apply as a broadcast spray.
Treatments applied as granules			
bifenthrin (0.2% granules)	Ortho Bug-B-Gon Lawn Insect Killer	0.6–2.3 lb	Water following application.
gamma-cyhalothrin (0.05% granules)	Triazicide Insect Killer for Lawns	0.8 lb	Water following application.
permethrin (0.5% granules)	Hi-Yield Kill-A-Bug II Lawn Granules	2–3 lb	Water following application.

In situations where lawns become infested by fleas, broadcast insecticide treatments, applied either as sprays or granules, can aid in reducing the incidence of bites on people who are using the area. But keep in mind that most immature fleas occur in areas where pets sleep or rest, and these areas may not be in the lawn itself. Instead, they may be in some nearby, more protected site, such as under porches, under shrubs, under crawl spaces of homes, and in garages or utility sheds. Remember that cats can climb, and flea breeding sites sometimes occur in overhead areas of garages and sheds. Especially heavy flea infestations often occur in garages, storage sheds, or crawlspaces of houses where litters of kittens or puppies are being raised. Some insecticides labeled for use against fleas in a lawn are not labeled for use in these other situations, and some insecticides labeled for use in these other situations are not labeled for broadcast treatment of lawns. Be sure to check the product label before making applications, and use products that are labeled for the site you are treating.

Successful outdoor flea control depends more on controlling fleas in areas where pets routinely rest than in the open, sunny areas of the yard—immature fleas rarely occur in these open, sunny areas. You might need to treat the sunny part of the yard to control adult fleas that have hopped out there, but spend most of your effort on identifying and treating those areas where pets sleep and rest and immature fleas breed.

Products for treating fleas in lawns are available for application as granules or as liquid sprays. Although they might be easier to apply, granules are generally less effective than liquid sprays, and liquid sprays are better suited for treating under shrubs and porches and other resting areas. When attempting to control heavy outdoor flea infestations, apply a second application in 7 to 10 days. Be sure to observe the restricted entry interval specified on the label of the product you use.

This work is partially supported by Crop Protection and Pest Management, Extension Implementation Program grant no. 2021-70006-35580/CRIS Number 1027242 from the USDA National Institute of Food and Agriculture. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.



The information given here is for educational purposes only. References to commercial products, trade names, or suppliers are made with the understanding that no endorsement is implied and that no discrimination against other products or suppliers is intended.

Publication 2597 (POD-12-23)

Revised by **Blake Layton**, PhD, Extension Professor, **Jerome Goddard**, PhD, Extension Professor, and Joe MacGown, Scientific Illustrator, Department of Biochemistry, Molecular Biology, Entomology, and Plant Pathology.

Copyright 2023 by Mississippi State University. All rights reserved. This publication may be copied and distributed without alteration for nonprofit educational purposes provided that credit is given to the Mississippi State University Extension Service.

Produced by Agricultural Communications.

Mississippi State University is an equal opportunity institution. Discrimination in university employment, programs, or activities based on race, color, ethnicity, sex, pregnancy, religion, national origin, disability, age, sexual orientation, gender identity, genetic information, status as a U.S. veteran, or any other status protected by applicable law is prohibited.

Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. ANGUS L. CATCHOT JR., Director