

## **NEW TECHNIQUES FOR SUBTERRANEAN TERMITE CONTROL**

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**Abstract** Subterranean termites are important pests in the U.S. and many parts of the world. Most products available for subterranean termite control are registered in Florida and currently there are 76 products. Most are either repellent or non-repellent soil treatment products. In recent years the number of products has increased from 8 to 76 mostly as a result of patents expiring. Two off-patent products, bifenthrin and imidacloprid, are now available in 49 different products. Forty-three percent of termiticide products are from primary manufacturers, and the rest are from off-patent producers. Termiticides have become “greener” with US EPA giving reduced-risk status to 6 termiticide products, 4 of which are baits. In 2010 the first soil termiticide, chlorantraniliprole, was given reduced-risk status.

**Key Words** Termiticide, residual soil treatment, termite bait, wood treatment

Approximately one third of pest control in the U.S. is conducted in Florida, and termite control is one of the most important aspects of the industry. About 80% of the cost of termite control is for subterranean termite prevention and/or remediation. Despite the serious problems with subterranean termites and their consequent damage, the building code in Florida did not require termite prevention as a requirement for building construction until 2002.

Before 2002, it was up to the discretion of the building official whether termite treatments would be required or not. In most cases, the building code was so complex that inspectors would look at other elements of construction but not pay attention to the treatment of a structure for subterranean termites. In 2002, the building code was changed to require termite protection of structures. Section 1816 required that “Termite protection shall be provided by registered termiticides or other approved methods of termite protection labeled for use as a preventative treatment to new construction.” This change in the building code set in place a series of steps in 2002 that required new rules for regulation of termiticides in Florida and a review of all termiticide registrations intended for new construction. The intent was to require all structures built in the state to be protected from subterranean termites using products registered for that use by the Florida Department of Agriculture and Consumer Services under Florida Statute 487, or non-chemical methods if they are evaluated and determined to be acceptable.

Since 2002, termiticide efficacy tests have been reviewed for each product to determine whether it would protect a structure from subterranean termites when used as directed. In 2002 there were eight products registered and available for protection of structures. Over the past 9 years, there has been a drastic increase in numbers of products available for subterranean termite control. There now are 76 products registered for the protection of new structures built in the state (Table 1) (FDACS, 2011), and virtually every product intended to be used on new construction in the U.S. is registered in Florida because of the size and importance of the industry. There are currently 12 active ingredients registered for control of subterranean termites, and these can be subdivided as 3 repellent soil treatments, 4 non-repellent soil treatments, 3 baits, 1 wood treatment, and 1 physical barrier active ingredients. Not all these products are currently available for pest control companies to use.

The repellent soil treatment products are all pyrethroids (Smith et al., 2008), and they are persistent in soil tests (Mulrooney, 2006). All these have been registered for at least 17 years (Su, 1993). Toxicity of the pyrethroids used for soil treatment range from 54-430 mg/kg and usually have labels with a “Caution” signal word. The non-repellent soil treatment products are each in separate chemical classes. Toxicities of these chemicals range from 97 mg/kg for fipronil to >5,000 mg/kg for chlorantraniliprole.

**Table 1.** Termiticides registered in Florida for new construction.

Type	Common Name	Chemical class	# Products	LD50 (Rat)
<b>Repellent Soil Treatments</b>			42	
	Bifenthrin	Pyrethroid	27	54 mg/kg
	Permethrin	Pyrethroid	6	430 mg/kg
	Cypermethrin	Pyrethroid	8	250 mg/kg
<b>NonRepellent Soil Treatments</b>			26	
	Imidacloprid	Neonicotinoid	22	450 mg/kg
	Fipronil	Pyrazole	2	97 mg/kg
	Chlorfenapyr	Pyrrole	1	441 mg/kg
	Chlorantraniliprole	Anthranilic diamide	1	>5,000 mg/kg
<b>Baits</b>			5	
	Noviflumuron	Benzoylphenylurea	3	>5,000 mg/kg
	Hexaflumuron	Benzoylphenylurea	1	>5,000 mg/kg
	Diflubenzuron	Benzoylphenylurea	1	>5,000 mg/kg
<b>Wood treatment</b>			3	
	Disodium octaborate tetrahydrate	Borate	3	>5,000 mg/kg
<b>Barrier Product</b>				
	Lambda-Cyhalothrin	Pyrethroid	1	79 mg/kg
<b>Total Products</b>			76	

The explosion of numbers of products for soil treatment is a result of active ingredients no longer having patent protection. Almost 90% of available products for subterranean termite control are soil treatment products. Two of them, bifenthrin with 27 products and imidacloprid with 22 products, account for almost 65% of the available products. Both are no longer patent protected and are supplied by a wide range of manufacturers.

Termite baits are available as 3 active ingredients, all of which are benzoylphenylureas. Toxicities of these products are all >5,000 mg/kg with a signal word of "Caution" or in the case of one product there is no signal word. The baits are usually applied to new construction in a station located in the ground around the structure. The bait contains a cellulose-containing matrix which termites consume. Benzoylphenylureas have dose independent mortality so termites will die later when they molt, as opposed to dying at various times after ingesting bait depending on how much bait they ingested. The result is suppression of termite colony numbers or even colony elimination underneath and around the structure.

For new construction in Florida, bait contracts must be initiated at the time of construction and specifies that the structure will be treated with a baiting system after construction is completed. Usually bait stations are placed in the ground after final grade to prevent them from being disturbed during construction. The contract must be transferable to the new home or structure owner at the time of initial sale.

Wood treatment products are the most recent advance in subterranean termite treatments in Florida. These wood treatments are all done with the sodium salt of boron in a crystalline lattice of water. The chemical structure provides a greater degree of water solubility than the sodium salt alone. For wood treatments, the wooden construction elements of the structure are directly treated with borates. Only structures that have at least 60% wooden baseplates within the structure qualify for this type of treatment. In places (up to 40% of the structure) where wooden baseplates are not present, the material is applied to concrete so termites would have to tunnel over the treatment. Otherwise complete protection of the structure cannot be achieved. Usually the application is with a green or blue dyed spray solution so the applicator can determine that the application was done thoroughly. Borates have low toxicity and have an LD50 >5,000.

There is only one barrier product approved for use in Florida and it contains the lambda-cyhalothrin. The product is a layered plastic with the active ingredient located on the interior layer where people would not contact it. The sleeve was installed around plumbing elements and was commercialized. It was a part of the treatment of a structure but was not something that would protect the entire structure. With the downturn in the construction industry in the past few years, this product was discontinued.

The manufacturers of termiticides are classified as primary manufacturers, off-patent, multiple label manufacturers, and off-patent, single label manufacturers (Table 2). There are currently 7 primary manufacturers, 9 other multiple label manufacturers, and 10 other single label manufacturers. A total of 43% of termiticide products are with the primary manufacturers, but the majority of products is now from off-patent manufacturers.

**Table 2.** Manufacturers of termiticides registered for new construction in Florida.

<b>Primary Manufacturers</b>	<b># Products</b>	<b># Products &amp; Common names of AI</b>
FMC/Waterbury	14	12 bifenthrin, 1 permethrin, 1 cypermethrin
Bayer	6	6 imidacloprid
Dow AgroSciences	4	3 noviflumuron, 1 hexaflumuron
BASF/Whitmire	4	1 chlorfenapyr, 1 diflubenzuron, 2 fipronil
Syngenta	3	2 cypermethrin, 1 lambda-cyhalothrin
Nisus	1	1 disodium octaborate tetrahydrate
Dupont	1	1 chlorantraniliprole
<b>Off-Patent, Multiple Label Manufacturers</b>		
Control Solutions	5	2 bifenthrin, 1 cypermethrin, 1 permethrin
Ensystem	5	2 bifenthrin, 3 imidacloprid
Univar	4	2 imidacloprid, 2 bifenthrin
Nufarm	3	3 imidacloprid
Etigra	3	2 imidacloprid, 1 cypermethrin
Amvac	2	1 permethrin, 1 bifenthrin
Cheminova	2	2 imidacloprid
Speckoz	2	2 imidacloprid
United Phosphorus	2	1 cypermethrin, 1 bifenthrin
<b>Off-Patent, Single Label Manufacturers</b>		
Gro-Pro	1	1 cypermethrin
Micro Flo	1	1 bifenthrin
Loveland Products	1	1 bifenthrin
Sostram	1	1 disodium octaborate tetrahydrate
Lesco	1	1 bifenthrin
Stratechem	1	1 disodium octaborate tetrahydrate
LG International	1	1 permethrin
Helena	1	1 bifenthrin
Farmsaver	1	1 bifenthrin
Gharda	1	1 permethrin

With customers now wanting “greener” methods of pest control, termiticides have been classified by the U.S. Environmental Protection agency as “reduced risk” (Table 3). Reduced risk products are conventional termiticides that have obtained registration through a special registration program. The program is shorter in duration and less costly than normal registration. The reduced-risk designation provides a marketing advantage for companies; however, the classification cannot be included on the pesticide label. However, it can be used in marketing material

about the product. In general, reduced-risk products pose less risk to humans and the environment than existing alternatives. Also, these products tend to be less toxic and better choices for a “greener” approach to termite control. The classification is relative to existing products so there are no benchmark data requirements for qualification. A total of 6 termiticide products have been granted reduced-risk status, but 2 of those products were either not commercialized or are no longer available.

**Table 3.** EPA reduced risk termiticides

Common Name	Year	Company	Type of Use
Hexaflumuron	1994	Dow AgroSciences	In-ground termite bait
Hexaflumuron	1997	Dow AgroSciences	Above-ground termite bait
Diflubenzuron	1998	Ensystem	In-ground termite bait
Lambda-cyhalothrin	2002	Syngenta	Termite barrier
Lufenuron	2004	Syngenta	Termite bait
Chlorantraniliprole	2010	Dupont	Soil termiticide

The first reduced-risk termiticide was hexaflumuron in Recruit bait for use in in-ground Sentricon bait stations. The in-ground bait was given reduced-risk status in 1994 and was granted to Dow AgroSciences. Subsequently, reduced-risk status was given to hexaflumuron in 1997 for the Sentricon above-ground bait stations. For 16 years, no soil termiticide was awarded reduced-risk status. In 2010, chlorantraniliprole in Altriset termiticide was listed as reduced-risk. The product is in a new chemical class, anthranilic diamides, and affects the ryanodine receptors in muscle cells. The result is immediate paralysis of termites. The compound is highly selective and has no hazard to humans or domestic animals when used as directed. Consequently, the product does not require personal protective equipment for mixing concentrates or for application. The only requirements are long-sleeved shirts, long pants, shoes and socks.

Overall, the availability of termiticides for subterranean termite control has increased in recent years and the variety of modes of action for products has also diversified. In the past, most termiticides affected the nervous system. Right now, the only ones that affect the nervous system are residual soil treatments. There is one product, chlorfenapyr, that affects energy production and is used as a residual soil termiticide. The borates used for wood treatment are cellular toxins and are active both by ingestion and contact. The bait products are all affecting growth and metamorphosis of the insect by disrupting the production of chitin. The most recent residual soil termiticide, chlorantraniliprole, affects muscles and causes paralysis and is active in the soil for 6 years in the southeastern U.S (Wagner et al., 2011). Overall, the newer products for termite control have great potential for protecting structures and their contents from termite damage. The true benefit is in protecting wood so newer wood does not have to be grown and harvested from tropical rain forests or temperate forested regions.

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