Update of Forest Service Research Data

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Speaker: Dr. Terry Wagner

Dr. Wagner received a B.S. degree in Biology from West Virginia Wesleyan College in 1970, a B.S.F. and M.S. in Forestry from the University of Michigan in 1971 and 1974, respectively, and a Ph.D. in Forest Resources from the University of Maine in 1977. His graduate research focused on soil invertebrates and insect defoliators in aspen stands in the Lake States and the Northeast. As a postdoctoral fellow and Assistant Research Scientist at Texas A&M University, he spent eight years studying population dynamics of bark beetles in southern pines. He joined the USDA Agricultural Research Service in 1985, serving as the Lead Scientist of the Insect Modeling Project while working on cotton insects in the Midsouth region. He transferred to the Forest Service in 1999, where he presently serves as the Project Leader of the Wood Products Insect Research Unit located in Starkville, MS. In this capacity, he provides leadership of a research team consisting of nine personnel responsible for improving the protection of wood products against subterranean termite damage, investigating the role of termites in forest ecosystems, and understanding their impact on forest health and productivity. Dr. Wagner is recognized for research on insect life-process biology, population dynamics, pest-complex biology and ecology, modeling, and boll weevil eradication. He has over 100 publications, more than 55 invited presentations, received in excess of $2 million in extramural funding, and has received numerous research awards.

The U.S. Forest Service undertakes research to improve the protection of wood products against subterranean termite damage, define the role of termites in forest ecosystems, and understand their impact on forest health. Specifically, the Wood Products Insect Research Unit concentrates efforts on developing, refining, and assessing new and alternative compounds, materials, and treatment techniques for effective protection against damage caused by termites and on investigating termite biology, ecology, and behavior to promote an understanding of forest ecosystems and efficacy of protection techniques in urban environments. Research is formulated with an understanding that termites play dual roles as pests in urban environments and, conversely, as contributors to forest productivity and health. Their role in forest ecosystems as wood decomposers contributes to soil genesis, fertility, stability, and hydrology -- aspects that are little studied and poorly understood. Their role as wood-product pests is better understood. The cost of controlling termites and repairing their damage is estimated at $2 billion annually in the United States. These losses do not include those incurred by the military or the growing impact from the Formosan termite. Termite control also carries the highest risk for the pest control industry of all categories in urban pest management, and increasing restrictions and cancellations on insecticides make their control less reliable and more costly. For these reasons, the Forest Service

considers applied research a high priority and part of this effort involves the termiticide testing program.

TEST METHODS

Termiticides. The Forest Service has a long history of providing reliable termiticide efficacy data to its pest control stakeholders. We began evaluating chemicals as soil treatments for termite control in 1939. In 1943, research was initiated for the U.S. Army to help prevent damage to wooden structures on tropical islands, and "used" motor oil was among the early "products" evaluated. The *ground* board *test* originated from this work, which is still used today. It consists of a 6 by 6 by l-inch sapwood board placed in the center of a 17 by 17-inch plot of exposed treated soil, replicated 10 times at sites in Arizona, Florida, Mississippi, and South Carolina. The test was the principal method for evaluating the chlorinated hydrocarbon termiticides for more than 20 years.

The ground board test was replaced as the principal method for assessing termiticide efficacy in 1967 because the emerging organophosphates, pyrethroids, and carbamates were prone to degradation and leaching in the exposed plots. The *concrete slab test* was introduced at this time to simulate a pre-construction treatment. It consists of a 17 by 17-inch treated soil plot covered by a 21 by 21 -inch concrete slab. A polyethylene vapor barrier separates the treated soil and the slab. A 4-inch diameter pipe extends through the center of the slab through the vapor barrier and contains a wooden test block placed on the treated soil. Plots are inspected annually. Termiticides are considered effective at the lowest concentrations that prevent termites from penetrating the treated soil in 100% of ten replicated plots for at least five years on the four test sites.

Another aspect of the testing program involves screening potential termiticides as a condition for field evaluation. Beginning in 1970, all termiticides were tested in the laboratory to assess their ability to kill termites in timed exposures to soil treated at different concentrations. An initial evaluation is made, followed by assessments on the same soil every six months over a two-year period. *Laboratory screening* prevents unnecessary field work on ineffective chemicals and is useful in establishing the lowest concentration to be installed in the field. Many products fail this initial screening and never make it to the field.

Chemically-Impregnated Barriers. Impregnated barriers are evaluated using two methods: *concrete slab* and *concrete block tests*. The concrete slab is similar to that used with termiticides except the polyethylene vapor barrier is replaced with an impregnated barrier, left uncut (intact) within the 4-inch pipe. The concrete block test consists of an impregnated barrier wrapped and banded securely around an open end of a 16 by 16 by 8-inch flue LW concrete block. A 4-inch diameter PVC pipe is inserted through the center of the barrier, wrapped with a barrier sleeve and held to the pipe with cable ties. The block is centered over a 21 by 2 1 -inch bare soil plot, barrier-side down. A wooden block is placed on the soil in the pipe (internal control to assess termite activity), two wooden blocks are placed on the barrier sheet, and the entire block is covered. In both methods, a small wooden board is buried just below the soil surface in the center of the plot to insure termite pressure on the barrier. Ten replicated plots are inspected annually.

RESULTS

The Forest Service's termiticide testing program provides unbiased efficacy data to federal and state regulators for product registration. In 2001, the Forest Service had 26 funded agreements with industry involving laboratory screening of three termiticides and field evaluations of 20 termiticides and four impregnated barriers. We also continued to monitor plots on five termiticides and two physical barriers from expired agreements. Test results are presented in Tables 1 and 2 for eight marketed termiticides and three candidate termiticides, some of which are discussed below'.

Chlorpyrifos. Manufacturers of chlorpyrifos signed a memorandum of agreement with the Environmental Protection Agency in 2000 stating, in part, that the end-use dilution of the product for termite control cannot exceed 0.5% active ingredient (AI) and the use of the labeled rates at 0.75 and 1.0% AI would be phased out. Subsequently, the Mississippi Department of Agriculture and Commerce, Bureau of Plant Industry denied the use of chlorpyrifos at 0.5% in Mississippi based on Forest Service data. These data indicate three years of 100% control at 0.5% in the state (Table 1), instead of the five years required by EPA Pesticide Registration Notice 96-7. Several other states have taken similar action. In a related development, EPA issued a Section 3 registration to a manufacturer of chlorpyrifos at 0.25% AI. Based on the lack of Forest Service data for this specific product, and the general failure of chlorpyrifos at 0.25% (Table 1), this action prompted the Association of .Structural Pest Control Regulatory Officials (ASPCRO) to request that EPA withdraw this registration for the product.

[1] Mention of company or trade names does not imply an endorsement by the U.S. Forest Service.

Cyfluthrin. Bayer is holding registration of Tempo@. The product was installed in the field in 1987 and has provided 100% control in preventing termite penetration through the treated soil in concrete slab tests at all four test sites for at least six years at 0.25% AI and above (Table 1).

Deltamethrin EC. Aventis is pursuing registration of DeltaGard® at 0.125% and, for more difficult situations, 0.25% AI. The product was installed in the field in 1988 and has provided 100% control for at least five years at 0.125% and above, except in Mississippi where four years of complete control were observed (Table 1).

Imidacloprid. Premise@ was registered in the U.S. at 0.05 and 0.1% AI in 1995, and it has since become a widely used termiticide. The Forest Service installed the compound in the field in 1992, and it has been 100% effective in preventing termite penetration through treated soil in concrete slab tests in Arizona and Florida for at least five years at all eight test concentrations (Table 2). In South Carolina, Premise@ remained 100% effective during five or more years at all but the lowest rate, 0.025%, where it failed after the third year. The product had difficulty in Mississippi -- noted for its high termite populations -- where terrnites penetrated the soil after the first year at 0.025%, after the second year at 0.05, 0.1, 0.2, and 0.25%, the third year at 0.15%, and the fifth year at 0.3 and 0.4%. These results changed somewhat using damage as the criterion for failure instead of soil penetration, e.g., damage greater than ASTM 9 (light). Using this criterion the product remained 100% effective for four **years** at 0.1 and 0.15%, and for nine years at 0.3 and 0.4%.

Table 1. Years termiticides remained 100% effective in concrete slab (CS) and ground board (GB) tests at four field sites (* = registered rates)

% A.I.	Test Method	Site AZ	FL	MS	SC
Bifenthrin – Biflex TC (1986 – present)					
0.03	CS	0	4	2	2
0.062*	CS	15	15	7	10
0.125*	CS	10	9	2	15
0.25	CS	15	15	15	15
0.5	CS	6	15	15	15
0.03	CB	6	4	2	3
0.5	GB	10	14	12	8
Chlorpyrifos (1971 – 2000)					
0.1	CS	2	2	1	4
0.25	CS	2	3	4	6
0.5*	CS	4	7	3	7
1.0	CS	6	9	11	12
2.0	CS	11	19	15	21
0.5*	GB	3	3	2	6
1.0	GB	2	7	4	8
Cyfluthrin -Tempo TC (1987 – present)					
0.125	CS	4	9	2	4
0.25	CS	10	12	6	14
0.5	CS	11	14	14	14
1.0	CS	14	14	14	14
0.5	CB	5	6	5	6
1.0	GB	5	7	4	7
Cypermethrin (1982 - present)					
0.125	CS	1	1	1	2
0.25*	CS	4	11	3	4
0.5*	CS	4	5	7	12
1.0	CS	8	8	6	12
1.0	GB	5	5	5	5
Deltamethrin (1988 – present)					
0.05	CS	1	3	3	2
0.125	CS	5	13	4	7
0.5	CS	9	13	13	13
1.0	CS	13	13	13	13
0.5	GB	2	13	2	12
1.0	GB	9	13	2	13
Fenvalerate (1978 - present)					
0.25	CS	8	1	2	3
0.5*	CS	12	3	7	4
1.0*	CS	12	6	10	6
1.0*	GB	7	4	4	6
Permethrin – Dragnet (1978 – present)					
0.25	CS	8	2	1	0
0.5*	CS	13	4	5	5
1.0*	CS	15	15	5	10
1.0*	GB	9	6	2	1
Permethrin – Torpedo (1980 - present)					
0.25	CS	9	3	2	0
0.5*	CS	11	6	4	1
1.0*	CS	20	21	3	6
0.5*	GB	4	4	1	1
1.0*	GB	8	5	2	1

Fipronil. Termidor® was installed in Forest Service tests in 1994 using a water dispersible granule (80 WC) formulation and in 1995 using a micro-emulsion (MEM) formulation. No failures have been observed in either of these tests (Table 2). Termidor® 80 WG was registered for pre- and post-construction use in September 1999 at 0.062 and 0.125% AI, and the product became available in Spring 2000. Because treated and control plots in these tests were grouped together (a standard practice in Forest Service tests), and termite activity decreased dramatically in control plots compared to surrounding control plots for other products (suggesting an effect on colonies), additional tests were installed with a micro-encapsulated concentrate (5 MEC) in 1998. Fipronil concentrations were separated from each other to prevent overlapping effects among rates and to further evaluate changes in termite activity. A fourth segregated test was installed in 1999 using Termidor® SC (registered in 1999 for post-construction use only). No failures have been observed in concrete slabs at or above the registered rates in these two tests.

Table 2. Years termiticides remained 100% effective in preventing penetration through treated soil and, if different, damage to wooden blocks greater than ASTM 9 (parenthetic) in concrete slab (CS) and ground board (GB) tests at four field sites (* = registered rates)

	Test	Site			
% A.I.	Method	AZ	FL	MS	SC
Imidacloprid – Premise 75 WSP (1992 – present)					
0.025	CS	9	9	1	3
0.05*	CS	9	6	2	9
0.1*	CS	9	9	2 (4)	5
0.15	CS	9	9	3 (4)	5
0.2	CS	9	9	2	5
0.25	CS	9	9	2	8
0.3	CS	9	9	5 (9)	5
0.4	CS	9	9	5 (9)	5
0.1*	GB	3	2	1	2
0.2	GB	8 (9)	2	2	2
0.3	GB	5	2	2	1
0.4	GB	7	2	2	4
Fipronil- Termidor 80 WG (1994 -present)					
0.0625*	CS	7	7	7	7
0.125*	CS	7	7	7	7
0.25	CS & GB	7	7	7	7
0.5	CS & GB	7	7	7	7
I.0	CS & GB	7	7	7	7
Fipronil – Termidor MEM (1995 – present)					
0.0625*	CS	6	6	6	6
0.125*	CS & GB	6	6	6	6
0.25	CS & GB	6	6	6	6
0.5	CS & GB	6	6	6	6
I.0	CS & GB	6	6	6	6
Fipronil – Termidor MEC (1998 -- present)					
0.06*	CS & GB	3	3	3	3
0.125*	CS & GB	3	3	3	3
0.25	CS & GB	3	3	3	3
Fipronil- Termidor SC (1999 -present)					
0.06*	CS & GB	2	2	2	2
0.125*	CS & GB	2	2	2	2
0.25	CS	2	2	2	2
0.25	GB	0	2	2	2
Chlorfenapyr – Phantom (1996 – present)					
0.125*	CS	5	1	1	5
0.25*	CS	5	5	2 (5)	5
0.5	CS	5	5	4	5
0.75	CS	5	1	5	5
1.0	CS & GB	5	5	5	5
2.0	CS	5	5	1	5
0.25*	GB	5	0	2	5
0.5	GB	5	1	4 (5)	5
0.75	GB	5	4	5	5
2.0	GB	5	5	5	5

Chlorfenpyr. Phantom@ was installed in the field at six rates in concrete slab tests in 1996 using a suspension concentrate formulation. The product has remained 100% effective in preventing termites from penetrating the treated soil through five years in Arizona and South Carolina at all concentrations (Table 2). In Florida, the product provided 100% control through five years at 0.25, 0.5, 1.0 and 2.0% AI, but failed after the first year at 0.125 and 0.75%. Chlorfenapyr provided complete control in Mississippi through five years at 0.75 and 1.0%, but failed after the first year at the lowest and highest rates (0.125 and 2.0%), the second **year** at 0.25%, and the fourth year at 0.5%. The only change from

these results using damage (ASTM > 9) as the criterion for failure (instead of soil penetration) occurred at 0.25% in Mississippi, where the product remained effective through five years. Phantom@ is presently under registration review for post construction use at 0.125% and, for severe infestations, 0.25% AZ.

Chemically-Impregnated Barriers. Four impregnated barriers are presently undergoing evaluation: Kordon Blanket@ (Aventis, installed 1997), Termi-Film@ (Cecil, installed 1998), Impasse@ (Syngenta, installed 1999), and A+Protect® (HPC Enterprises, installed 2001). No failures have been observed to date.