Testing Soil Insecticides In Paradise

University of Hawaii researchers get an overall view of termiticide performance in island soils.

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Hawaii's diverse soil types, tropical environment and notorious Formosan subterranean termites (*Coptotermes formosanus*) present real challenges to soil insecticides. The University of Hawaii has conducted field trials with termiticides since the late 1950s. Chlorinated hydrocarbon insecticides were evaluated in the early tests, and a report on the persistence of chlordane and other popular, but no longer available, termiticides was recently prepared (Grace *et al.* 1993).

In 1978, field tests with organophosphate and pyrethroid insecticides were initiated at six different locations in Hawaii: three sites on the island of Oahu, and one site each on Kauai, Maui and the island of Hawaii.

At each location, clay soil, sand, or gravel was sprayed at low pressure with termiticide solution. The solutions were applied at the rate of four gallons per 10 square feet rather than the usual preconstruction recommendation of one gallon per 10 square feet to match the amount used in remedial soil treatments.

To simulate typical building construction, each treated substrate was covered by a polyethelene vapor barrier and then a small (about five feet square) four-inch thick monolithic concrete slab. There were three copies of each insecticide treatment (with each substrate) at each site.

Each year, the test substrates were sampled by drilling through the top of the concrete slab and taking a two-inch deep soil core. Each soil core was brought back to the laboratory, homogenized and sandwiched between two plugs of agar in a glass tube. Formosan subterranean termites (131 workers and 19 soldiers) were placed at the bottom of the tube, and termite mortality and distance tunneled through the test substrate was recorded after four days.

This bioassay procedure is more labor-intensive than the inspection procedure used in termiticide field tests by the USDA Forest Service, but it is better suited to the foraging habits of Formosan subterranean termites in Hawaii. This termite species does not forage evenly throughout field test plots. So, field evaluations based upon whether or not termites have damaged blocks of wood placed on top of small areas of insecticide-treated soil run the risk of labeling a treatment as effective when termites may simply not be active at that particular location in the test plot. For example, when we placed 30 wooden stakes in the ground at a site on Oahu that is heavily infested by Formosan subterranean termites, only half of the stakes had been attacked five years later (Tamashiro *et al.* 1991).

As another example, Formosan subterranean termites did not attack wooden stakes placed in soil treated only with water for over two years after installation of the USDA termiticide test site on Midway Island (Kard *et al.* 1989). Certainly, few PCOs would conclude from this that water provides effective protection from termite attack for two years. We might be tempted to draw that erroneous conclusion from the same results with an insecticide treatment.

This is not necessarily a problem at test sites occupied by termites other than the Formosan subterranean termite, and over a period of many years valuable information is undoubtedly obtained from any field test. However, in Hawaii's tropical environment, soil insecticides are unlikely to remain effective over a great many years, and a bioassay approach provides the most useful means of comparing performance.

Results from the first 10 years of this field test (1979-89) were summarized in a 1990 University of Hawaii report (Tamashiro *et al.* 1990). Results with chlorpyrifos, which was not in test during the period reported here, were summarized in an earlier report. (Tamashiro *et al.* 1989).

Over the years, new insecticides have been placed in the field as the biological activity of older materials declined or as interest in older formulations declined for various reasons. For example, field tests with several newer chlorpyrifos formulations were initiated this year. Gravel was not readily treated with insecticide nor bioassayed, and is no longer included as a test substrate.

Summarizing results

In table 1, we have summarized the most recent results (1989-92) from this 13-year field study. Three of the insecticides included in the study during this period (cypermethrin, fenvalerate and permethrin) are pyrethroids available in commercial termiticide formulations, cyhalothrin is an experimental pyrethroid, and isophenfos is an organophosphate that was recently (fall 1992) withdrawn from sale as a termiticide by the manufacturer.

Insecticides are referred to here in terms of the active ingredient, since commercial formulations change frequently and some of these were applied as agricultural or experimental formulations.

The table expresses our results as the "percent protection" against Formosan subterranean termite penetration provided by each insecticide in either clay soil or sand weathered in the field for a given number of years. The "percent protection" is the proportion of bioassays (18 total) from all six field sites (except for 0.25 percent cypermethrin, which was installed at five sites) in which four cm (about two inches) of each test substrate was not fully penetrated by termites within four days.

This summary of data from our six field sites gives an overall picture of insecticide performance in Hawaii and the longevity of these termiticides in a tropical environment with high termite pressure. Last year (1992) we initiated a new series of field tests with both commercial termiticide formulations and experimental insecticides.

We hope that this continuing study will help PCOs, insecticide manufacturers and the general public estimate the field life of soil insecticide treatments, and select termiticides that will be most effective in providing protection from Formosan subterranean termites. PC

Drs. Ken Grace, Julia Yates and Minoru Tamashiro are urban entomologists in the Department of Entomology, University of Hawaii, Honolulu. Richard Ebesu and Robin Yamamoto also helped extensively with this study.

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Percent protection provided by insecticide treatments against penetration of soils in Hawaii by Formosan subterranean termites

INSECTICIDE	CONC.	PERCENT PROTECTION / YEARS IN TEST 1989	1990	1991	1993
			CLAY SOIL		
Cyhalothrin	0.20%	-	100% / 1 yr	100% / 2 yr	100% / 3 yr
Cypermethrin	0.25	93% / 2 yrs	93 / 3	87 / 4	80 / 5
	0.01	72 / 2	39 / 3	17 / 4	22 / 5
Fenvalerate	1.00	56 / 10	56 / 11	56 / 12	56 / 13
	0.50	0 / 10	0 / 11	0 / 12	0 / 13
Isophenfos	0.75	78 / 1	44 / 2	11 / 3	6 / 4
Permethrin	1.00	100 / 10	78 / 11	72 / 12	71 / 13
	0.50	83 / 7	61 / 8	39 / 9	33 / 9
Water Controls	-	0 / 10	0 / 11	0 / 12	0 / 13
			SAND		
Cyhalothrin	0.20%	-	89% / 1 yr	94% / 2 yr	89% / 3 yr
Cypermethrin	0.25	73% / 2 yrs	60 / 3	60 / 4	40 / 5
	0.01	72 / 2	50 / 3	50 / 4	22 / 5
Fenvalerate	1.00	83 / 10	72 / 12	72 / 12	61 / 13
	0.50	39 / 10	39 / 12	39 / 12	33 / 13
Isophenfos	0.75	94 / 1	33 / 2	11 / 3	6 / 4
Permethrin	1.00	100 / 10	100 / 11	94 / 12	94 / 13
	0.50	100 / 7	89 / 8	94 / 9	94 / 10
Water Controls	-	0 / 10	0 / 11	0 / 12	0 / 13