DEGRADATION of PERMETHRIN in SOILS of LOW, NORMAL, and HIGH pH

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Abstract Soils of pH 5, 7, and 9 were treated with the equivalent of a commercial application of 0.50% permethrin. Over a period of 36 months post-treatment, the soil was analyzed to determine the concentration in parts per million of permethrin remaining in the soil. There was a significant difference in the concentration of permethrin over time. Generally, a significantly higher concentration of permethrin remained in the soils of pH 5.0 and pH 9.0.

Key Words Termiticide chemical analysis degradation

INTRODUCTION

The synthetic pyrethroids are the most common class of pesticides used as termiticides. They are applied to the soil beneath and around the foundation of a structure to form a barrier against the invasion of termites. Soils vary as to texture, organic matter content, and pH. In this study, I measured the effect of pH over time on the continued presence of the termiticide permethrin. Median degradation time of 50 days is given in the literature, but no values are available for more acidic environments (Tomlin, 2000).

Hypotheses

The test hypotheses used in this research were the following: When sampled over time, the amount of permethrin in parts per million (ppm) remaining in a soil will be greater in a soil of pH 5 than in a soil of pH 7, than a soil of pH 9. H_1: ppm permethrin at pH 5 >ppm permethrin at pH 7 >ppm permethrin at pH 9 ($p \geq 0.05$). When sampled over time, the amount of permethrin in parts per million (ppm) remaining in a soil will be inversely proportional to the time since application of the permethrin to that soil. H2: $ppm=time^{-1}$ ($p \geq 0.05$).

MATERIALS and METHODS

Soil from three locations in Texas was selected to provide three distinct levels of pH. Soil from Pecos was of pH 9.0, soil from College Station was of pH 7.0, and soil from Beaumont was pH 5.0. The soil was analyzed for pH by the State Soil Testing Laboratory, Texas A&M University, College Station, Texas. The soil was treated with a concentration of permethrin equivalent to a commercial application of permethrin at 0.50%. A commercial formulation of permethrin (Dragnet FT® at 0.50% A.I (FMC Corp., Philadelphia, Pa.) and a concrete mixer was used to form the mixture (Gold et al., 1996). There were 3 replications using soils of pH 5.0 and 7.0 and 4 replications of the soil of pH 9.0.

Treated soil was placed in a 30 cm long sections of a trench 30 cm wide by 30 cm deep. The experimental design was a completely randomized design. Each 30 cm long section of treated soil was separated from the adjacent sections by a 30 cm by 30 cm by 0.6 cm sheet of plexiglass. Soil samples were removed from each section at 6, 12, 18, 24, and 36 months post-treatment

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using a standard soil sampling probe of 2.0 cm in diameter. The treated soil was analyzed for permethrin by gas chromatography (Gold et al., 1996).

Data Analysis. All soil concentrations were measured in parts per million of permethrin, and those concentrations were converted to percent of initial concentration. All statistical analysis was conducted on these percents of initial concentration remaining at each sampling date. These resulting data were analyzed with PROC GLM by Time Post-Treatment and by pH. Means separations were effected with LSD at $p \geq 0.05$ (SAS, 1999).

RESULTS

Regardless of soil pH, the concentration of permethrin in the soil decreased over time (Table 1). Soil pH had an effect on the concentration remaining in the soil. The remaining concentrations of permethrin in the soils of pH 5.0 and 9.0 were higher than the remaining concentrations in soil of pH 7.0 after 18 months. However, by 36 months only soil of pH 5.0 contained a significantly higher concentration of permethrin. The concentrations in the other 2 soils were well below 1% of their original concentrations, whereas more than 2 % of the initial concentration of permethrin remained in the soil of pH 5.0.

DISCUSSION

The carboxylic acid moiety attached to the cyclopropane group in the permethrin molecule will hydrolyze more rapidly under a high alkaline medium of pH 9 than in a weak acidic medium of pH 5. This is a possible explanation for the significantly lower concentrations remaining after 36 months at pH 7 and pH 9.

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Table 1. Remaining percent of initial permethrin concentration by soil pH and time post-treatment

	Months Post-Treatment					
	6		12		18	
Soil pH	Mean	+/- Std Err	Mean	+/- Std Err	Mean	+/- Std Err
5.0	81.62% a[1] 1[2]	1.10	24.48% a 2	3.43	12.77% a 3	1.36
7.0	81.27% a 1	0.93	7.15% b 2	2.40	1.61% b 3	1.19
9.0	80.15% a 1	0.51	21.76% a 2	3.09	11.93% a 3	1.16

	Months Post-Treatment			
	24		36	
Soil pH	Mean	+/- Std Err	Mean	+/- Std Err
5.0	0.25% a 4	0.08	2.48% a 5	0.45
7.0	0.04% a 4	0.01	0.03% b 4	0.01
9.0	0.36% a 4	0.13	0.12% b 5	0.04

[1]Means in the same column followed by the same letter not significantly different (p</=0.05).
[2]Means in the same row followed by the same letter not significantly different (p</=0.05).