PERMETHRIN AS A LONG-TERM PROTECTANT OF WOOLEN FABRIC[1]

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ABSTRACT

An aqueous pressurized spray and an oil aerosol formulation of permethrin were used to treat square foot samples of woolen cloth to protect it against fabric pests. Initial protection and protection through 6 months of aging was obtained against feeding damage by larvae of the black carpet beetle, *Attagenus unicolor* (Brahm), the furniture carpet beetle, *Anthrenus flavipes* LeConte, and the webbing clothes moth, *Tineola bisselliella* (Hummel). Additional samples were stored in a dark closet in a room maintained at ca. 24°C for 78 months and the feeding tests were repeated. Both formulations continued to provide a high degree of protection against the above species of fabric insects. Currently, a label is pending at the Environmental Protection Agency with a 6-month claim for protection in storage when applied as directed. However, an extremely high degree of protection may be obtained for several years when treated woolens are stored in the dark.

Key Words: Permethrin, carpet beetle, *Anthrenus flavipes*, clothes moth, *Tineola bisselliella*.

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INTRODUCTION

Aqueous pressurized sprays and oil aerosols of permethrin have been shown to be effective as short-term fabric protectants (Bry et al. 1979a; Bry et al. 1979b). A registration, with a 6-month claim for protection, is pending at the Environmental Protection Agency.

This paper reports the results of studies made on woolen cloths that had been treated with two permethrin formulations 78 months previously. The current study was intended to determine: (1) the amount of permethrin on the cloths after the treatments had aged for 78 months and (2) the effectiveness of the treatments in protecting woolen cloth against feeding damage by larvae of the black carpet beetle, *Attagenus unicolor* (Brahm), the furniture carpet beetle, *Anthrenus flavipes* LeConte, and the webbing clothes moth, *Tineola bisselliella* (Hummel).

MATERIALS AND METHODS

The woolen cloths used in this study were treated 78 months ago in a previous study (Bry et al. 1979b). The fabric was moth test cloth, 100 percent wool, which is the material designated as the standard test fabric for mothproofing tests by the

[1] This paper reflects the results of research only. Mention of a pesticide in this paper does not constitute a recommendation for use by the USDA nor does it imply registration under FIFRA as amended. Mention of a proprietary product does not constitute an endorsement by the USDA.

American Association of Textile Chemists and Colorists (AATCC) (Anon. 1984) and the Chemical Specialties Manufacturers Association (CSMA) (Anon. 1971).

The treatments were applied as described by Bry et al. (1979b) with 12-oz aerosol cans as formulations supplied by Fairfield American Corporation. Briefly $(30.5\ cm)^2$ swatches of moth test cloth were sprayed from a distance of 0.36 - 0.46 m with each formulation for 5 or 10 seconds. Two formulations were used. The first was an oil aerosol and contained 0.25 percent permethrin with the balance base oil plus carbon dioxide as the propellant. The second was an aqueous pressurized spray containing 0.25 percent permethrin with a mixture of propane-isobutane (1:4) as the propellant.

The cloths used in this study were extra samples treated at the time the original test was initiated 78 months ago. They were hung on clothes hangers and stored in a dark closet in a room maintained at ca. 24°C. During the work week, the room was illuminated with fluorescent lights and the closet was periodically opened to remove other samples.

Four swatches from each treatment were sampled for biological tests and chemical analysis as described by Bry et al. (1976). The biological tests were conducted with larvae of the black carpet beetle, furniture carpet beetle and webbing clothes moth from the laboratory colonies according to the excrement-weight and fabric-weight-loss procedures, respectively, established by CSMA (Anon. 1971). Thus, each of four 2.5×5.1 cm samples cut from the aged, treated swatches was tested for its resistance to damage by larvae of each of the three above species. Each sample was exposed to 10 larvae for 14 days in a darkened cabinet in a room maintained at 27 ± 1°C and $60 \pm 5\%$ RH.

The chemical analyses were conducted as follows: the wool samples were weighed, transferred to a Soxhlet apparatus and extracted under nitrogen with an 80:20 (vol/vol) mixture of acetonitrile-methanol for 6 hours. The analyses were performed with a gas chromatograph equipped with a flame ionization detector. The extraction cleanup and analytical procedures followed those described in detail by Bry et al. (1976).

RESULTS AND DISCUSSION

Results of the 78-month analyses for permethrin residues are compared in Table 1 with the initial deposits and with those obtained after the treatments had aged for 6 months. The residues on the cloths sprayed for 5 sec with the oil

Table 1. Deposits of permethrin on cloths sprayed with two pressurized formulations and residues on the cloths after the treatments had aged as indicated.

Formulation	Time sprayed (sec)	Initial permethrin deposit* (% by wt)	Permethrin residues (% by wt) on cloth† after indicated months	
			6	78
Oil	5	0.08	0.08	0.07
	10	0.17	0.16	0.16
Aqueous	5	0.01	0.01	0.01
	10	0.02	0.02	0.02

* Each figure is the average of 12 applications.
† Each figure is the average of 4 analyses.

Table 2. Excrement weights per larva and mortality in feeding tests with black (BCBL) and furniture (FCBL) carpet beetle larvae exposed to 2.5- × 5.1-cm cloth samples treated with permethrin; average for 16 samples each exposed to 10 insects.

Formulation	Time sprayed (sec)	Excrement per larva* (mg) after cloth aged indicated months			Mortality among larvae (%) after cloth aged indicated months		
		0	6	78	0	6	78
			BCBL				
Oil	5	0.08	0.07	0.10	79	91	18
	10	0.08	0.05	0.09	90	96	87
Aqueous	5	0.09	0.07	0.12	52	69	6
	10	0.05	0.06	0.09	81	84	11
None (Untreated check)	–	3.57	2.26	2.92	0	0	0
			FCBL				
Oil	5	0.10	0.05	0.09	98	98	44
	10	0.06	0.04	0.07	100	99	61
Aqueous	5	0.06	0.05	0.14	92	96	14
	10	0.06	0.04	0.09	99	98	26
None (Untreated check)	–	1.51	1.65	1.84	0	0	2

* Samples considered satisfactorily resistant if average weight of excrement did not exceed 5.0 mg (0.5 mg per larva) if no sample in a series had an amount exceeding 6.0 mg (0.6 mg per larva).

Table 3. Adjusted weight loss of 2.5- × 5.1-cm cloth samples treated with permethrin and mortality among webbing clothes moth larvae exposed 14 days in feeding tests; average for 16 samples each exposed to 10 insects.

Formulation	Time sprayed (sec)	Adjusted weight loss*† (mg) after cloth aged indicated months			Mortality among larvae (%) after cloth aged indicated months		
		0	6	78	0	6	78
Oil	5	-0.31	0.47	2.25	100	100	100
	10	0.18	0.56	0.14	100	100	100
Aqueous	5	1.03	0.09	1.00	100	100	100
	10	0.57	0.05	-0.28	100	100	100
None (Untreated check)	–	48.50	30.29	70.39	0	0	0

* Samples considered satisfactorily resistant if average loss of weight did not exceed 8.0 mg and if no sample in a series had a weight loss exceeding 10 mg.

† A figure preceded by a minus sign indicates that the humidity control samples lost more weight during the test period than did the samples exposed to the insects.

aerosol were 12.5% lower than those obtained initially and after 6 months, while those sprayed for 10 sec with this formulation were ca. 6% lower than the initial deposit but the same as the 6-month deposit. Residues on the cloths sprayed for 5 and 10 sec with the aqueous formulation were similar to those obtained previously.

Feeding test results with black and furniture carpet beetle larvae are shown in Table 2. Both formulations protected the cloth after 78 months as well as they did initially and after 6 months. However, mortality among both species was lower in this study than it was after 6 months; the highest mortality (87 and 61%, respectively) occurred among insects exposed to cloth treated with the oil aerosol for 10 seconds.

Results of the feeding tests with webbing clothes moth larvae are shown in Table 3. Both formulations continued to provide a high degree of protection against feeding damage by this species after 78 months. Mortality among the test larvae was still 100%.

The permethrin formulations discussed here have been considered only as short-term protectants for woolens stored in the home. However, our studies show that when woolens treated with these formulations are stored under darkened conditions they are protected against damage by black and furniture carpet beetle and webbing clothes moth larvae for an extended storage period.

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