

Laundering as Decontamination of Apparel Fabrics: Residues of Pesticides from Six Chemical Classes¹

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Abstract. Research on reducing the level of pesticide residue on a textile substrate has examined many variables under many different conditions. This study controlled fiber type and the use of prewash product in an examination of residue levels for a number of pesticides in different pesticide classes.

For all pesticides examined, the use of prewash lowered pesticide residues regardless of fiber type. Differences in pesticide residue level attributable to fiber type were not consistent.

Decontamination of pesticide-soiled protective clothing has focused on a macroscopic examination of a complex, dynamic system in which variables are analyzed in a homeostatic state. The variables that have been studied include pesticide type (Easley *et al.* 1981; Keaschall *et al.* 1986); body and other oils (Laughlin and Gold 1990a); soiling mechanisms (Laughlin and Gold 1987; Kim and Kim 1988); textile substrate (Laughlin *et al.* 1985; Laughlin and Gold 1989, 1990b; Easter and DeJonge 1985; Raheel 1987); aqueous decontamination processes (Nelson and Flecker 1988); alternative decontamination processes such as dry cleaning (Ringenberg *et al.* 1988; Flecker *et al.* 1988); heat and light (Branson and Rajadhyksha 1988) or heat alone (Kim 1989); decontamination auxiliaries such as prewash agents (Keaschall *et al.* 1986; Hild *et al.* 1989); fabric softeners (Laughlin and Gold 1988, 1990b); or pesticide-specific auxiliaries such as salt (Olsen *et al.* 1986) and bleach (Perkins *et al.* 1991).

Keaschall *et al.* (1986) sought to establish whether decontamination effectiveness was consistent across chemical class, or whether it was specific to pesticide chemical class. In a study of 11 insecticides from three classes (organochlorine, carbamate, organophosphate), differences in laundering effectiveness were reported both among and within classes. Because the

fiber type (50% cotton/50% polyester) was controlled throughout the study, the differences were attributed to the specific pesticide.

However, some researchers examining a specific pesticide have reported differences in laundering effectiveness that may be attributable to fiber type.

Solbrig and Obendorf (1985) applied the technique developed by Obendorf *et al.* (1983) to malathion tagged with osmium tetroxide. The use of backscattered electron imaging and energy dispersive x-ray microanalysis showed that malathion penetrated into the lumen of cotton, but that it was absorbed only to the surface of polyester fibers. Malathion predominated on the surface of the yarn, interfiber capillary spaces, and in the crenulations of cotton fibers. Methyl parathion reacted in similar ways, except that higher concentrations were observed on the cotton fibers located near the yarn surface (Obendorf and Solbrig 1986). Kim and Kim (1988) also reported that fiber morphological irregularities serve as deposit sinks for ¹⁴C-labelled DDT and that the final deposit location within textile substrates is related to fiber type and morphology.

Despite these results, other researchers have reported no fiber content differences in response to other specific pesticides (Easley *et al.* 1982, 1983; Laughlin and Gold 1987).

Laughlin and Gold (1988) noted that the previous research, while addressing the issue of a decontamination procedure for pesticide contaminated clothing, varied considerably in specific objective and technique. They suggested control of variables in further research to understand the cause and effect attribution of pesticide and fiber type on residue removal.

The research reported here is an extension of the work by Keaschall *et al.* (1986) which reported a decrease in pesticide residue after laundering which included the use of a prewash product. It was theorized that the additional dose of surfactant may facilitate residue removal. The contribution of prewash product in residue removal has been confirmed (Laughlin and Gold 1990a, 1990c); as has been the contribution of solvent (Kim *et al.* 1986; Ringenberg *et al.* 1988; Flecker *et al.* 1988) which is sometimes incorporated in the prewash product. This study examined the effect of prewash products added to deter-

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