

DDT and Methyl Parathion Residues found in Cotton and Cotton-Polyester Fabrics worn in Cotton Fields

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Frequent spraying of cotton fields with chemicals to control insect pests is generally practiced in the Mississippi Delta area. The clothing worn by agricultural workers is subjected to direct contact with insecticide residues present in the field environment. The fiber content and special finishes in the fabrics worn by these workers may affect the pick-up, retention, and/or release of insecticide residues.

The Human Nutrition and Consumer Use Research Advisory Committee considered that the possible presence of insecticide residues in clothing was a problem worthy of being researched. No reference to studies on insecticide residue present in clothing from field contamination was found in the literature surveyed.

The purpose of this study was to determine whether DDT and methyl parathion residues were present in field-exposed cotton and cotton-polyester fabrics and the effectiveness of laundering for removing such residues.

METHODS AND MATERIALS

Five shirting-type fabrics obtained directly from textile mills were selected for the study. Three were made of cotton-polyester fiber in blends of 35/65, 50/50, and 65/35, respectively, and were

treated with a post-cured durable press finish. The fourth fabric, a 65/35 cotton-polyester blend, had a soil release finish in addition to the durable press finish. The fifth fabric, composed of 100% cotton, was mercerized and sanforized. All fabrics were constructed in a 3/1 twill weave and a 5-6 oz. weight.

Control Study. Eight samples, measuring 6 x 10 in., were cut from each of the five fabrics and treated by pipetting on to the cloth 1 ml. of a standard solution which contained 250 ug of methyl parathion and 1000 ug of DDT. Four samples of each fabric were analyzed for DDT and methyl parathion residues before laundering. The remaining four samples were analyzed after laundering. No methyl parathion or DDT residues were detected at 0.1 ppm in untreated samples of the fabrics.

Field Study. Eight samples, measuring 12 x 20 in., were cut from each experimental fabric. Cotton insect scouts wore the swatches of experimental fabrics, one swatch pinned to each trouser leg above the knee, for an 8-hour work period in the fields on the day after cotton was sprayed with DDT and methyl parathion mixtures. Fabrics were collected and returned immediately to the laboratory and stored in sealed polyethylene bags in a freezer at -5°C. The exposure of test fabric swatches in the field resulted in an uneven distribution of chlorophyll stains and dirt. The swatches were cut in half in the long dimension and separated at random to minimize this effect for extraction trials. They were then stored in sealed polyethylene bags in a freezer at -5°C. One portion of each field-exposed fabric was extracted before laundering to determine the

amount of DDT and methyl parathion collected. The remaining portion was extracted after laundering to determine how much DDT and methyl parathion remained in the fabric.

Laundering Method. All fabrics were laundered using an automatic washer and an electric dryer according to AATCC Test Method 124-1967 (2). After laundering, the fabrics were sealed in polyethylene bags and stored in the freezer at -5°C. until analyzed.

Residue Extraction. Fabrics were extracted by a modified acetonitrile extraction procedure recommended by Bonner (3). Fifteen gm. of each test fabric was cut into 1/2 in. pieces and placed in a pint jar containing 75 ml of acetonitrile and 30 steel balls (1/8 in. diam.). The jars were sealed, clamped to the rotating shaft (43 rpm) of a Launder-Ometer and the samples were extracted for 2 hours. The temperature of the water in the tank was 80°F (27°C.).

The acetonitrile was decanted from the jar into a 2 L. separatory funnel and the sample was rinsed twice with 25 ml. portions of acetonitrile which were transferred to the separatory funnel. After adding 750 ml dist. water, 7.5 ml conc. HCl and 80 ml petroleum ether, the funnel was shaken for 1 min. occasionally venting pressure. After the layers separated, the water was discarded and the petroleum ether layer filtered through anhydrous sodium sulfate and glass wool. The extract was evaporated to 15 ml at 40°C. under a slight current of air.

Residue Analysis. Extracts were analyzed by gas chromatography

(GLC) without further cleanup (4). Varian Aerograph Pestylizers, Models 680 and 682, equipped with electron capture detectors, were used for the qualitative and quantitative measurement of the residues.

RESULTS AND DISCUSSION

Control Study - The percent recoveries of known quantities of DDT and methyl parathion (Table 1) applied on the various unlaundered fabrics were within an acceptable range as determined by analyses of other products (3). Recovery of DDT was consistent among fabrics 1, 2, 3, and 5 and ranged from 77.6%, 81.4%, 83.5%, to 81.3%, respectively. Formation of emulsions during extraction probably accounted for the low recovery (42.0%) of DDT from fabric 4. Recovery of methyl parathion was similar for all fabrics and ranged from 61.6% (fabric 4) to 71.3% (fabric 5).

A highly significant amount of both DDT and methyl parathion was removed from all fabrics by one laundering. (Table 1). However, methyl parathion was removed more efficiently than was DDT. Less than 1% of the methyl parathion applied to fabrics 1, 2, 3 and 4 remained after laundering. Approximately 10 times as much methyl parathion was found in the all-cotton fabric after laundering as was present in the other fabrics (6.3% of the methyl parathion applied). However, the amount of DDT in the fabrics after laundering ranged from 7.2 to 21.2%. Considering all fabrics, 14.5% of the applied DDT remained after one washing and drying. Except for fabric 4, it appeared that with an increase in the amount of cotton fiber in the fabric, there was a corresponding increase in the

TABLE 1

INSECTICIDE RESIDUES RECOVERED FROM TREATED CONTROL FABRICS

Fabrics	Reps	% Methyl Parathion Recovered		% DDT Recovered	
		A	B	A	B
1. 50/50 cotton- polyester	1	33.6	0.5	53.2	10.7
	2	65.0	0.3	80.4	10.8
	3	88.0	1.0	92.4	13.3
	4	68.8	1.4	84.4	15.0
	Mean	63.9	0.8	77.6	12.5
2. 35/65 cotton- polyester	1	67.2	0.0	86.8	10.6
	2	75.2	0.8	80.0	12.3
	3	61.6	0.0	79.4	7.2
	4	58.6	1.5	79.3	13.4
	Mean	67.6	0.6	81.4	10.9
3. 65/35 cotton- polyester	1	57.7	0.0	73.9	22.2
	2	67.2	0.0	81.1	17.5
	3	61.3	2.2	79.0	19.3
	4	74.2	0.0	99.9	25.3
	Mean	65.1	0.6	83.5	21.2
4. 65/35 cotton- polyester, soil release finish	1	53.9	2.1	68.5	14.4
	2	55.6	0.0	34.7	5.8
	3	70.7	0.0	32.3	4.2
	4	66.0	0.0	32.6	4.6
	Mean	61.6	0.5	42.0	7.2
5. 100% Cotton	1	71.9	6.5	77.9	17.3
	2	66.9	7.6	77.7	25.6
	3	80.1	7.1	87.4	18.4
	4	66.1	3.9	82.1	19.3
	Mean	71.3	6.3	81.3	20.2
Overall	Mean	65.9	1.8	73.2	14.5

A. Not laundered.

B. Laundered.

TABLE 2
INSECTICIDE RESIDUES RECOVERED FROM FIELD-EXPOSED FABRICS

Fabrics	Reps	Methyl Parathion		DDT	
		A	B	A	B
		Collected (ppm)	Retained (ppm)	Collected (ppm)	Retained (ppm)
1. 50/50 Cotton- polyester	1.	2.6	ND	55.0	8.2
	2.	7.4	0.2	102.6	25.4
	3.	3.8	ND	55.0	4.3
	4.	1.4	ND	82.5	17.2
	5.	2.3	ND	73.8	18.7
	6.	4.9	ND	44.0	14.3
	7.	7.2	ND	60.0	17.5
	8.	1.7	ND	64.2	4.5
	Mean	3.9	0.0	67.1	13.8
2. 35/65 Cotton- polyester	1.	7.0	0.2	56.5	6.1
	2.	9.0	0.2	50.0	7.5
	3.	10.0	0.3	91.8	10.7
	4.	1.4	ND	55.0	8.3
	5.	3.6	ND	24.7	12.4
	6.	25.7	0.4	90.0	22.0
	7.	0.9	ND	22.1	6.5
	8.	1.2	ND	33.5	12.7
	Mean	7.4	0.1	53.0	10.8
3. 65/35 Cotton- polyester	1.	33.0	0.6	332.4	60.5
	2.	15.0	0.4	94.0	76.1
	3.	10.5	0.2	65.0	11.1
	4.	9.9	ND	160.0	90.2
	5.	5.5	ND	150.0	36.4
	6.	6.5	0.1	144.4	31.9
	7.	1.9	ND	13.0	8.0
	8.	13.4	0.3	132.6	8.5
	Mean	11.9	0.2	136.4	40.3
4. 65/35 Cotton- polyester soil release finish	1.	4.5	ND	27.5	21.3
	2.	6.5	ND	50.5	13.8
	3.	3.4	ND	55.0	25.5
	4.	1.8	ND	50.0	11.5
	5.	2.9	0.1	67.3	37.5
	6.	2.5	ND	50.0	19.9
	7.	3.5	ND	95.1	13.8
	8.	2.0	ND	41.1	7.3
	Mean	3.4	0.0	54.5	18.8
5. 100% Cotton	1.	14.5	0.9	128.6	20.0
	2.	15.1	1.0	69.2	25.9
	3.	9.0	0.8	141.9	49.4
	4.	9.9	0.5	40.7	16.5
	5.	7.3	0.8	90.3	46.8
	6.	14.0	0.7	141.2	51.9
	7.	10.5	0.6	83.6	48.7
	8.	14.7	1.0	89.6	66.4
	Mean	11.9	0.8	98.1	40.7
Overall Mean		7.7	0.2	81.8	24.9

A. Not Laundered

B. Laundered

ND, not detected at 0.1 ppm.

amount of DDT retained after laundering.

Field Study - Surprising amounts of methyl parathion and DDT were recovered from all fabrics after only 8 hours field exposure (Table 2). Considering all fabrics, methyl parathion and DDT contamination averaged 7.7 ppm and 81.8 ppm, respectively. The lower recovery of methyl parathion was probably due to both a lower rate of application and its rapid decomposition in the field due to light, high temperatures, and moisture.

The amounts of methyl parathion and DDT found in fabrics 3 and 5 were greater than that found in 1 and 2 indicating that increased cotton fiber content probably resulted in increased pick-up of insecticides from sprayed cotton plants (Table 2). Fabric 4 collected the least amount of methyl parathion and DDT although the cotton fiber content was 65%. Possibly the soil release on this fabric and/or the formation of emulsions during extraction explain this exception.

After laundering, the amount of methyl parathion found in all fabrics averaged 0.2 ppm (Table 2). However, the all-cotton fabric retained much more than did the cotton-polyester blends. DDT was not removed efficiently by laundering. Considering all fabrics, nearly 2/3 or 24.9 ppm of the DDT that was collected on the fabric was retained after one laundering. As previously noted, increased cotton fiber content in fabric resulted in increased retention of DDT in fabrics through the laundering process.

Data collected in this study indicated that for both insecticides, residue retention increased with cotton fiber content of a

fabric as shown in increased absorption and retention of methyl parathion and DDT (Table 2). Very high levels of DDT were found in all-cotton fabrics exposed to treated cotton plants for 8 hours (an average of 98.1 ppm). Even after laundering, an average of 40.7 ppm of DDT remained. Great similarity exists between the chitin of the insect exoskeleton and the cotton cellulose fiber (5). The only difference in the structure of the two polymers is that chitin has an acetlyamine group substituted for the hydroxyl group on carbon 2 or the glucose units of cellulose (Figure 1).

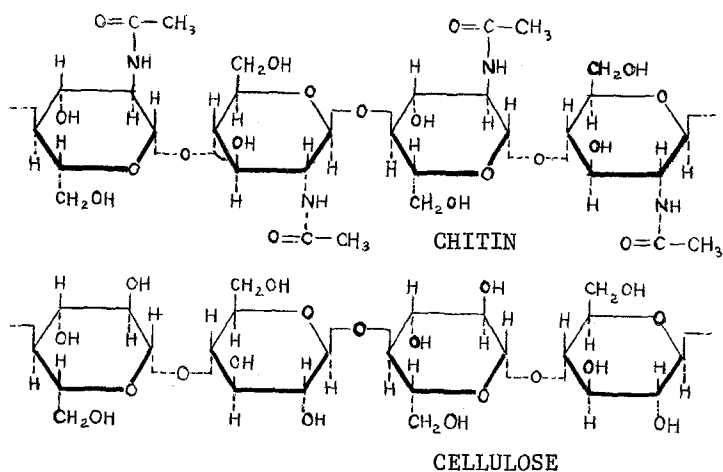


Figure 1. Steric Configuration of Portions of Chains of Chitin and Cellulose.

The affinity of DDT for chitin has been documented in the literature. This affinity may explain why DDT was absorbed and retained at a higher rate in the all-cotton fabrics. This does not necessarily

mean that the all-cotton fabric is more hazardous to the wearer. Theoretically, cotton could be the safer material since the DDT appears to be "tightly bound" to the cellulose. The biological significance of these residues in fabrics was not determined in this preliminary study. Studies should be initiated to determine the biological significance of insecticide residues in fabrics to the wearers.

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