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Fabric Contamination from Pesticides on Tractor Tires

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The safety of recycled tires for use as children's playground equipment has been questioned because previous research has demonstrated that pesticide residues could be wiped easily from chemically resistant neoprene and nitrile gloves (Stone et al. 1997). If pesticide residues that can be absorbed by children's clothing or skin remain on tires, other materials might be preferred for playground equipment.

Tractor and other vehicle tires are exposed to various types of pesticides during crop production. In addition, tires in storage facilities sometimes are treated with pesticide to control mosquitoes, because rainwater can pool in each tire. Many years ago used tires were identified as a breeding site for mosquitoes, (e.g. *Aedes albopictus*) that can spread dengue, yellow fever, and encephalitis (Hawley et al. 1987). In 1985, Novak, et al. reported that slow-release formulations of temephos (Abate) were useful in controlling mosquito larvae found in the rainwater pools in used tires at storage facilities.

Temephos is a toxicity class III, Caution Label chemical that can be skin-absorbed, so that protective clothing is required for application (Farm Chemical Handbook 1997). The "Clarke Abate 5% Tire Treatment" is one temephos-containing pesticide available to control the Asian tiger mosquito that has a "Danger" label. This granular product is applied with a power backpack blower to give even distribution of granules every 30 days (Clarke Sample Label, 1998). The use of such pesticides is considered helpful in limiting mosquito populations and protecting human populations from mosquito-borne diseases.

Recycled tires have the potential to be contaminated with pesticides from treatments during storage and transit as well as from exposure during use on vehicles employed in crop production. No previous research has been identified that documented whether pesticide residues could be transferred from tire surfaces to clothing.

To examine an assumed worst-case scenario of agricultural contamination of tractor tires, this study was initiated to determine whether pesticide could be recovered from fabric swatches that came into direct contact with tractor tires used in spraying and in fields where pesticides had been applied.

The purposes of the study were to determine whether 1) pesticide residue could be extracted from fabric swatches rubbed on tires, 2) levels differed with tractor exposure based on the tractor's use history, and 3) levels differed with seasonal tractor usage. After considering the 1996 test results, in 1997 we aimed to improve

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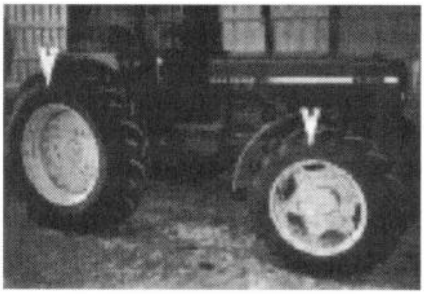

Figure 1. Pointer shows location where tires were wiped.

the rubbing procedure and to determine whether or not residue levels differed if swatches used for rubbing were wet or dry.

MATERIALS AND METHODS

To begin the 1996 study, 12 tractors used in crop production at the Iowa State University research farms were identified, as listed in Table 1. Pesticide application records at the farm were consulted to establish whether a tractor should be assigned to the low, moderate, or high pesticide exposure level based on its use history.

Tractors A, C, F, G, H, I, and K were used for field spraying in 1996; other tractors were used in fields either before or after spraying. In 1997, tractors A, C, F, H, and K were used for field spraying of Broadstrike, flumetsulam; Dual, metolachlor; Harness, acetochlor; Lasso, alachlor; Sencor, metribuzin; and/or Roundup Ultra, glyphosate. Other tractors, except E which was not sampled, were used in field work after spraying had occurred.

For the 1996 tests, specimens of white, 100% cotton denim cloth were cut on the bias to 8x8 cm and randomly assigned to a right or left, front or back tire of each of the 12 tractors. For each collection period, 48 dry swatches were contaminated by rubbing each by hand on the sidewall of one tire; all specimens were collected by the same person. Specimens were wiped on the sidewall of the tire as shown in Figure 1. Swatches were rubbed in one place at least eight or ten strokes, or until the tire appeared nearly free of soil; all tires had some dried mud. The exact surface area wiped was not measured, but only a part of each swatch was contaminated.

To establish the off-season or base contamination levels, the tractor tires were wiped first in January 1996. In June 1996, after the planting season, tires were wiped in the same way using fresh, uncontaminated fabric swatches. These specimens were stored in polyethylene bags and frozen until extracted for analysis by gas chromatography.

In May 1997, 44 wet and 44 dry 8x8 cm white cotton denim specimens were contaminated by rubbing them over a 5x5 cm tractor tire sidewall surface area that was defined by using templates cut from transparency film. Again, only part of each swatch was contaminated. Eight hours before wiping the tires, wet specimens were moistened with 1 ml distilled water and stored individually in zip close bags until contamination time. The day wiping specimens were collected was very windy. After wiping, each specimen was individually wrapped with aluminum foil, labeled by tire, and placed in aluminum foil packets labeled according to

Table 1. Tractor use and herbicides applied in 1996 and 1997.

	1996 Spring Use*	1997 Spring Use*
Low Exposure		
(J) White 160	Heavy tillage before spraying	In fields after spraying, Broadstrike, Dual, Harness**
(L) J. Deere 4450	Teaching lab* *	In fields after spraying Broadstrike, Dual, Harness**
Moderate Exposure		
(B) Ford 2600	In fields after spraying Basagran, Blazer, Broadstrike, Dual, Harness, Lasso**	In fields after spraying Bladex, Broadstrike, Dual, Harness*
(D) Case IH 885	Planting & cultivating**	In fields after spraying Broadstrike, Dual, Harness**
(E) IH 1466	Chemical incorporation Broadstrike, Dual, Harness, Lasso; not often for spraying	Not wiped; tractor not on farm
(G) J. Deere 6400	Spraying: Lasso; in fields after spraying as in B above	In fields after spraying Broadstrike, Dual, Harness**
High Exposure		
(A) IH 986	Spraying: Basagran Blazer, Broads&e, Dual, Harness, Lasso	Spraying: Broadstrike Dual, Sencor, Roundup-Ultra
(C) J. Deere 6000	Spraying: Basagran, Blazer incorporation as E above	Spraying: Broadstrike, Dual, Harness
(F) J. Deere 2955	Spraying: Treflan, Sonalan; chemical incorporation as E above; cultivating	Spraying: Lasso; in fields after spraying Broadstrike, Dual, Harness
(H) J. Deere 2955	Spraying: Bladex, Buctril Harness, Lasso, Pursuit	Spraying: Broadstrike, Dual Harness; in fields after spraying
(I) J. Deere 2755	Spraying: Accent, Buctril, Harness, Lasso, Pursuit, Roundup	In fields after spraying Broadstrike, Dual, Harness**
(K) J. Deere 2955	Heavy spraying: 2-4-D, Bauvel, Dual, Frontier Harness, Pursuit, Poast Plus. Roundup. Sencor	Spraying: Broadstrike, Dual Roundup-Ultra; not a lot of application.

*Chemicals listed by brand names. ** Not used for crop spraying.

tractor. The packets were then placed individually in polyethylene bags and all specimens were frozen until extracted. Specimens were coded and extracts randomized for analysis.

All specimens collected were analyzed using GC. Pesticide-quality ethyl acetate was used for extraction; all glassware was cleaned by first rinsing in acetone, then oven cleaning. Blanks were run on all apparatus. Spiked 100% cotton specimens from the same sources used in the wiping experiment were used. In the 1996 tests, extracts from each specimen were examined for seven pesticides that are identified here by both trade and common chemical name: Accent, nicosulfuron; Broadstrike, flumetsulam; Blazer, acifluorfen-sodium; Dual, metolachlor; Harness, acetochlor; Pursuit, imazethapyr; and Sencor, metribuzin. In the 1997 tests, extracts from each specimen were examined for five pesticides: Bladex, cyanazine; Broadstrike, flumetsulam; Dual, metolachlor; Harness, acetochlor; and Sencor, metribuzin.

For extraction, the contaminated cloth swatches were individually placed in 30-ml glass tubes with Teflon-lined phenolic caps, and 10 ml of ethyl acetate were added. The denim cloth was submerged in ethyl acetate and allowed to extract pesticide overnight (at least 15 hours). Aliquots at this volume were injected directly into the GCs. Spikes made like the samples, with uncontaminated cloth, were analyzed at the same time. The spiking level made the solvent ng/ml. Spikes were recovered without concentration. One-ml aliquots from each sample were concentrated to 0.1 ml and reinjected in the GC.

All analytical procedures were consistent with those described previously by Stahr (1992). Three gas chromatographs were used: a Packard 320, a Varian 3600, and a Varian 3400. The Packard had two Ni^{63} electron capture detectors with packed columns, OV- 17 (1.5%), OV-210 (1.95%), Column #4(4%) SE30, (6%) QF-1. The columns were 28.8 cm with 3 mm id. The column temperature used was 225°C with a flow of 35 ml/mm research-grade nitrogen carrier gas. The 3400 Varian had one electron capture of Ni^{63} with DB 30 meter fused silica column and a TSD detector with a 1.5% OV-17 and 1.95% OV-210 in a 28.8 cm 3 mm id glass column. The solid phase was Gas Chrom Q. The flow was 35 ml/mm of research-grade nitrogen. These columns were programmed from 160°C-250°C. The 3600 Varian detector had two 30m, DB-5 columns, TSD and FPD (P & S) detectors, and was programmed from 160°C-250°C. The Varian 3600 was used for the Broadstrike analysis.

RESULTS AND DISCUSSION

No detectable pesticide residues were found on the denim specimens that were used to wipe tractor tires in the January 1996 collection. These results were confirmed by thin layer chromatography on samples that appeared to be suspect. It had been extremely cold and the tractors were all in storage sheds at the time the tires were wiped.

Rainy weather and a late spring delayed the planting season specimen collection until June 1996. Detectable amounts of Blazer were found on the tires of two tractors in 1996 and detectable amounts of Dual were found on four tractors in the planting season specimens, as shown in Table 2. In all, 27% of the specimens (n = 48) were contaminated. Only these two pesticides were detected. No pesticide was detected on tires of tractor B, F, H, I, K, or L.

Table 2. Herbicides detected in June 1996 from cotton swatches in ng/cm^2.

Tractor Exposure	Herbicides*	Front Tires	Back Tires
Low			
J	Blazer[a]	nda**	4.0
Moderate			
D	Dual[b]	14.0	11.6
E	Dual	nda	7.2, 4.0 [r & l]
G	Blazer	nda	0.4, 1.2
High			
A	Dual	8.8	32
C	Dual	12.0, 12.0	10.0, 64.0

*Common chemical names: [a] acifluorfen-sodium; [b] metolachlor.
**nda = No detectable amount. [r & l] = Right and left tires, respectively.

In the 1997 analysis, residue of four herbicides was found on both wet and dry specimens as shown in Table 3. Bladex, Dual, Harness, and Sencor were found, but no Broadstrike was found on any specimen. Tractor C, the High Boy, showed the most contamination. In all, 55% of the 1997 specimens showed some contamination with herbicide. Tires of tractors C and K showed the highest levels of contamination, consistent with their higher spraying use history. Residue levels found in the 1997 tests were highly variable, from nda (no detectable amount) to 27 ng of Dual/cm sq. Only five specimens showed contamination with two pesticides. Results did not differ whether the specimens were wet or dry.

On family farms, tractor use history is likely to be more diverse than with the research farm tractors, but tractor history does not seem to be directly reflected in the specimen contamination results of this study. For example, tires not used in crop spraying in 1997 showed Bladex and Harness contamination and residues were found on the specimens from the tractors that had low exposure.

Somewhat surprisingly, Bladex was detected on tractors B, C, D, F, G, H, I and J although none of these tractors had applied Bladex in 1997. In fact, during 1996 and 1997 Bladex was being phased out and was used on less than 10% of the land area in the research farm operations. It had not been used on a large acreage since 1995, but during the 1980s and early 1990s Bladex was used annually on up to half the land area.

If compared to a typical land application of herbicide for weed control, the amounts found on fabric swatches appear fairly inconsequential. A typical land application of herbicide for weed control may be of the order 1 kg/ha or 10,000 ng/sq cm. Thus each ng of herbicide removed from a tire sidewall represents approximately 1/10,000 of a land application.

Table 4 shows the common chemical name, toxicity classes, and signal words of the pesticides identified in denim fabric swatches wiped on tractor tires. In 1997, the proportion of specimens contaminated by “Warning” or “Caution” label herbicides was nearly equal.

If the total surface area of the tire were considered, the contamination a child might possibly be exposed to would be greater than it appears in this report on the basis of

Table 3. Herbicides detected in May 1997 in cotton swatches in ng/cm^2.

Tractor Exposure		Swatch Condition	Herbicide*	Front Tires	Back Tires
Low					
	J	Wet	Bladex[a]	nda**	1.9
		Dry	Bladex	nda	4.0
	L***	Wet	nda		
		Dry	Harness[b]	nda	0.02
Moderate					
	B***	Wet	Harness	nda	0.4
		Wet	Bladex	1.2	nda
		Dry	Bladex	3.4	4.8
	D***	Wet	Bladex	1.72	1.2
		Dry	Bladex	nda	4.2
	G	Wet	Sencor[c]	nda	2.0, 0.5[r & l]
		Dry	Bladex	nda	0.5, 3.1
High					
	A	Wet	Sencor	nda	0.2, 2.6
		Dry	Harness	1.4	0.5
	C	Wet	Dual[d]	1.2, 1.2	13.4, 16.3
		Wet	Bladex	nda	2.3
		Dry	Dual	2.5, 8.9	26.7, 12.9
		Dry	Bladex	3.6	nda
	H	Wet	Bladex	0.9	1.2
		Wet	Harness	0.9	nda
		Dry	nda		
	F	Wet	Bladex	nda	1.1
		Dry	Bladex	8.2	2.6, 2.2
	I	Wet		nda	nda
		Dry	Bladex	nda	1.2
	K	Wet	Dual	6.7	6.4
		Wet	Sencor	4.7	5.1, 4.8
		Dry	Dual	6.8, 5.5	27.2, 18.2
		Dry	Sencor	0.5	2.4, 3.6

*Chemical names: [a] cyanazine; [b] acetochlor; [c] metribuzin; [d] metolachlor. **nda = no detectable amount. ***Tractors not used in crop spraying; only for field work. [r & l] = Right and left tires, respectively.

a single cm sq of fabric. A child sitting or climbing on a playground tire sandbox has the potential for contacting a large area of tire surface. The amount of pesticide that might be transferred and/or be absorbed by the skin through tire contact is unknown.

The questions about clothing contamination from contact with tires have only begun to be examined by this study. Although each specimen was analyzed for seven pesticides in 1996 and five in 1997, a research plan that allows multiple specimens per tire, or wipes from tire tread as well as sidewalls might give a clearer picture of actual contamination.

Table 4. Toxicity of herbicides found in swatches rubbed on tractor tires.

Trade Name	Common Chemical Name	Toxicity Class	Signal Word	Swatches with Residue No.	%
1996 (N = 48)					
Blazer	acifluorfen-sodium	I	Danger (eyes)	3	6
Dual	metolachlor	III	Caution	10	21
1997 (N = 88)					
Bladex	cyanazine	II	Warning	19	22
Dual	metolachlor	III	Caution	14	16
Harness	acetochlor	II	Warning	5	6
Sencor	metribuzin	I	Caution	10	11

Because the presence of Bladex was not tested in 1996, it is unknown whether the detections of Bladex in 1997 were linked to a limited application in Spring 1997 or application over larger acreages in previous years. An off-season test for the presence of Bladex also would be beneficial.

Furthermore, it would be helpful to know if pesticide residues could be found in the rubber of tires from recycling facilities. The pesticide known to be used to control mosquitoes in tire storage areas was not among those tested for in this study.

Although human skin absorption of pesticides from the inner structure of textile materials is still under study, it is known that residues can be transferred from cloth to skin and that many pesticides are skin absorbed. Given that the "no observable effect level" for children is lower than for adults, it would seem that the potential health hazard for children from recycled tires used in playground equipment should be studied further.

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