DDTR Relocation from Cotton Cultural Practices[1]

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A mixed farming operation containing more than 600 acres of cotton in Pinal County, Arizona, and participating in an Extension Service-coordinated insect pest management program, has used DDT on a restricted basis in its insect control program for the past three years. The application restrictions were: (1) by ground equipment only, (2) at a maximum of 1.0 lb. per application, (3) not to exceed 6.0 lbs. per acre in a growing season, and (4) only on the recommendation of an insect pest management specialist. The objectives of this large scale operation were to determine: (1) the extent of drift, (2) the level of contamination of crops grown in the general vicinity, (3) the increase in soil residues of treated fields, and (4) the overall change in crop residues on a long-term basis for the area following 4 years' use of DDT.

The purpose of this paper is to describe one source of downwind crop contamination through the movement of particulate matter bearing DDT residues resulting from standard cultural practices.

METHODS AND MATERIALS

Airborne particulate matter as a carrier for DDTR residues (DDT and related metabolites) was measured during several post-growing season cultural operations for two years. After the 1973 growing season, machine harvesting, stalk cutting and discing, mulching, and planting operations were monitored on December 13, January 15, April 11 and April 11 respectively. Downwind drift collection stations were established at 41', 82', 165', 330' and 660' from the edge of the test field. The high temperatures and air movement were: Dec. 13, 75° and 4-5 mph; Jan. 15, 75° and 7-8 mph; and April 11, 77° and 3-4 mph.

Dust collecting equipment included one Hurricane (TM) air sampler at 41', Cascade impactors at 41', 165', 330' and 660',

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and 24" X 30" nylon organdy sheets impregnated with ethylene glycol, mounted both horizontally and vertically, at all stations. The field monitored during machine harvesting, stalk cutting and discing had received two 1.0 lb/acre applications of DDT, the first on July 5 and the second on July 27. Immediately prior to chemical defoliation, cotton leaves taken from this field contained an average of 12 μg DDT/m^2 of leaf surface, while whole green leaves contained 3.7 ppm DDT. Soil samples taken in the top 3" layer following these cultural operations contained 0.26 ppm p,p'-DDE, and 2.1 ppm p,p'-DDT, or 2.36 ppm DDTR.

The field monitored during mulching and planting on April 11 had received four 1.0 lb/acre DDT applications in 1972, and two in 1973, the first on July 6 and the second on August 9. Cotton leaves contained 260 μg of DDT/m^2 of leaf surface, and 8.2 ppm in the whole leaves. Soil contained 1.61 ppm p,p'-DDE and 1.73 ppm p,p'-DDT, totaling 3.34 ppm DDTR residue. These data are provided to give some indication of the relative sources of airborne particulate matter as carriers of DDTR residues.

After the 1974 growing season, machine harvesting on Nov. 29, and stalk cutting on Jan. 8 were monitored for particulate matter-DDTR downwind drift. Drift stations were located at the same distances from the field as described above. Collecting equipment included Cascade impactors at 41', 165' and 330' and impregnated organdy sheets at all stations.

The machine harvested field had received one application of DDT in 1972 and two applications in 1974, the first on July 20 and the second on August 1. Soil residues in this field were 0.75 ppm p,p'-DDE, and 2.91 ppm p,p'-DDT, totaling 3.66 ppm. The wind movement averaged 6.4 mph during the 4.75 hour air sampling period while the air temperature dropped from 68°F to 56°F. No leaf samples were analyzed.

The stalk-chopping field had received two applications of DDT in 1973, the first on July 20 and the second on August 1. The wind movement averaged 11.3 mph during the 0.75 hour chopping operation, during which the temperature dropped from 71°F to 68°F. No soil or leaf residues were determined.

Analytical Procedures: Each organdy sheet was folded, rolled, and stuffed into a large Soxhlet extractor and extracted for four hours with a 1:1 mixture of hexane and acetone.

The extract was then washed three times with distilled H_2O to remove the acetone, dried with Na_2SO_4 and evaporated to approximately 10 ml.

All samples were dehydrochlorinated to o,p'-DDE and p,p'-DDE because of toxaphene contamination and for ease of analysis using the method of Cahill et al. (1970).

Table 1. DDTR dislodged and collected during cotton harvesting at selected downwind locations. La Palma, Arizona. Dec. 13, 1973.

Station (ft. from field edge)	Sampling Device	p,p'-DDE level in μg
41'	HF*	0.35
	VF**	0.41
	Hu F***	0.28
	CI****	0.013
82'	HF	0.38
	VF	0.51
165'	HF	0.38
	VF	0.43
	CI	0.009
330'	HF	0.61
	VF	0.78
	CI	0.011
660'	HF	0.39
	VF	0.65
	CI	0.015

* 2'x2½' organdy cloth impregnated with ethylene glycol, mounted in an aluminum frame and positioned horizontally in the field.

** Same as above except positioned vertically.

*** Glass fiber filter Gelman type A 8" x 10" from Hurricane air sampler.

**** Results from the first disc of a Cascade Impactor only. Discs 2, 3, and 4 contained <0.008 μg.

Table 2. DDTR dislodged and collected during combined cotton stalk cutting and discing operations at selected downwind locations. La Palma, Arizona. Jan. 15, 1974.

Station (ft. from field edge)	Sampling Device	p,p'-DDE level in μg
41'	HF*	0.66
	VF**	0.83
	Hu F***	0.40
	CI d-1****	0.016
	d-2	0.009
	d-3	0.009
	d-4	0.009
82'	HF	0.56
	VF	0.93
165'	HF	0.39
	VF	0.71
	CI d-1	0.014
	d-2	0.010
	d-3	0.010
	d-4	< 0.008
330'	HF	0.33
	VF	0.70
	CI d-1	0.010
	d-2	< 0.008
	d-3	< 0.008
	d-4	< 0.008
660'	HF	0.33
	CI d-1	0.013
	d-2	0.009
	d-3	0.008
	d-4	< 0.008

* 2'x2½' organdy cloth impregnated with ethylene glycol, mounted in an aluminum frame and positioned horizontally in the field.

** Same as above except positioned vertically.

*** Glass fiber filter Gelman type A 8" x 10" from Hurricane air sampler.

**** Cascade impactor discs 1, 2, 3, and 4.

Table 3. DDTR dislodged and collected during soil mulching operations prior to planting of cotton, La Palma, Arizona, April 11, 1974.

Station (ft. from field edge)	Sampling Device	p,p'-DDE level in μg
41'	HF*	1.3
	HV**	1.6
	CI d-1***	0.03
	d-2	0.02
	d-3	0.02
	d-4	0.01
82'	HF	1.0
	VF	1.4
165'	HF	0.85
	VF	1.3
	CI d-1	0.03
	d-2	0.02
	d-3	0.01
	d-4	0.01
330'	HF	0.59
	VF	0.91
	CI d-1	0.04
	d-2	0.02
	d-3	0.02
	d-4	0.02
660'	HF	0.44
	VF	0.52
	CI d-1	0.02
	d-2	0.01
	d-3	<0.01
	d-4	0.01

*2'x2½' organdy cloth impregnated with ethylene glycol, mounted in an aluminum frame and positioned horizontally in the field.

**Same as above except positioned vertically.

***Cascade impactor discs 1, 2, 3 and 4.

Table 4. DDTR dislodged and collected during cotton planting operations at selected downwind locations. La Palma, Arizona, April 11, 1974.

Station (ft. from field edge)	Sampling Device	p,p'-DDE level in μg
41'	HF*	0.68
	VF**	1.1
	Hu F***	0.17
82'	HF	0.60
	VF	1.3
165'	HF	0.69
	VF	1.3
330'	HF	0.44
	VF	0.73
660'	HF	0.56
	VF	0.74

* 2'x2½' organdy cloth impregnated with ethylene glycol, mounted in an aluminum frame and positioned horizontally in the field.

** Same as above except positioned vertically.

*** Glass fiber filter Gelman type A 8" x 10" from Hurricane air sampler.

Analyses were by ECGC under the following parameters: a 3.5 foot Pyrex glass column 6 mm OD, with inlet packing for dehydrochlorination (Cahill, et al. 1970), and the remainder packed with 1.5% OV-17 and 2.0% QF-1 on 100-120 mesh Chromosorb W (H.P.); inlet, column, and detector temperatures were maintained at 215°, 185°, and 300°, respectively, with a nitrogen flow of 70 ml/min.

Table 5. DDTR dislodged and collected at selected downwind locations during 4.75 hrs of cotton harvesting and air movement of 160,000 linear feet. La Palma, AZ. Nov. 29, 1974.

Station (ft. from field edge	Sampling Device	p,p'-DDE (μg)	SCFH
41'	HF*	1.6	
	VF**	2.3	
	CI***	0.061	25.2
82'	HF	0.82	
	VF	2.2	
165'	HF	0.42	
	VF	1.3	
	CI	0.023	27.0
330'	HF	0.33	
	VF	1.0	
	CI	0.011	41.2
660'	HF	0.29	
	VF	0.68	

* 2'x2½' organdy cloth impregnated with ethylene glycol, mounted in an aluminum frame and positioned horizontally in the field.

** Same as above except positioned vertically

*** Results from the first disc of a Cascade impactor only. Discs 2, 3, and 4 contained <0.008 μg.

RESULTS

The analytical results of both sets of experiments presented in Tables 1 through 6 indicate that all operations contribute to the off-target movement of particulate-associated DDTR.

In the post-1973 cultural operations the downwind collections of measurable DDTR were greatest for the mulching operation, followed by the stalk chopping and discing, planting, and harvesting operations. In the post-1974 operations, the stalk chopping operation generated more than 2X the air-borne particulate matter that resulted from mechanical harvesting.

Table 6. DDTR dislodged and collected at selected downwind locations during 0.75 hours of cotton stalk cutting and air movement of 60,000 linear feet. La Palma, AZ. Jan. 8, 1975.

Station (ft. from field edge)	Sampling Device	p,p'-DDE (μg)	SCFH
41'	HF*	0.67	
	VF**	0.89	
	CI***	0.029	25.4
82'	HF	0.55	
	VF	1.3	
165'	HF	0.51	
	VF	0.82	
	CI	0.014	37.7
330'	HF	0.53	
	VF	1.0	
	CI	0.008	32.4
660'	HF	0.42	
	VF	0.68	

* 2'x2½' organdy cloth impregnated with ethylene glycol, mounted in an aluminum frame and positioned horizontally in the field.

** Same as above except positioned vertically.

*** Results from the first disc of a Cascade impactor only. Discs 2, 3, and 4 contained <0.008 μg.

Generally, in a dry agricultural area, as in Arizona, any cultural procedure that disturbs the plant debris and immediate soil surface, where essentially 100% of the growing season's DDT residues reside, will relocate a substantial quantity by air movement of particulate matter to which these residues are attached. The importance of this form of contamination to crops where such residues could be detrimental, such as alfalfa and small grains grown for animal feeds, has not been determined. However airborne particulate matter can be assumed to contribute substantially to residues inherent, e.g. sorbed from the vapor phase.

REFERENCES

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