DDT Volatization from Desert and Cultivated Soils[1]

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In a previous report (Ware et al. 1975) of simulated field studies we explained the need for information relative to DDT movement from soil in the vapor phase and referenced a rather complete set of studies relating to its volatility as well as that of DDE. This report expands that study to real field conditions of an uncultivated desert plot and an irrigated cotton field, for 52- and 11-week degradation studies, respectively.

The objectives of this experiment were to determine the loss rate of DDT from desert and irrigated soil surfaces and the accumulation of its metabolite DDE.

METHODS AND MATERIALS

On August 28, 1974, two bare, virgin desert plots (Casa Grande loam soil type, 40' x 180') were treated topically with DDT at 2.0 lbs. AI/acre. This was done by spraying them twice with DDT, 1.0 lb. AI/acre, in 10 gallons of spray per acre, using a 12-row International high-clearance (Hi-Boy) self-propelled, ground sprayer equipped with 3 TX-6 nozzles per row (equivalent), at 40 psi. Similarly, two half-acre cotton plots, never treated previously with DDT, were sprayed at 1.0 or 2.0 lbs. AI/acre.

Simultaneous with the plot treatments, samples of the spray deposit were collected on 2 thicknesses of household grade paper toweling stapled to large panels of corregated cardboard, laid across the path of the entire swath of the desert plots. In the cotton plot (Casa Grande loam) treated with 2.0 lb/acre, individual paper towels attached to cardboard panels were placed on each side of the 12 treated rows and in the furrows prior to spraying. Deposits were not sampled in the 1.0 lb/acre plot. After spraying, the towels were rolled and held in quart jars at 0°C for later extraction and analysis.

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[1] Contribution to Regional Project W-45, "Residues of Pesticides and Related Chemicals in the Agricultural Environment--Their Nature, Distribution, Persistence, and Toxicological Implications." University of Arizona Agricultural Experiment Station journal series #2618.

Bulletin of Environmental Contamination & Toxicology,
Vol. 17, No. 3 © 1977 by Springer-Verlag New York Inc.

Table 1. DDTR losses from 2#/A DDT-treated east desert plot as indicated by 20 ft^2 areas/sample (mg/m^2). La Palma, AZ. Aug. 1974.

Week No.	East Half				West Half			
	p,p'-DDE	o,p'-DDT	p,p'-DDT	Total DDTR	p,p'-DDE	o,p'-DDT	p,p'-DDT	Total DDTR
0	6.50	26.4	130	162	6.50	26.4	130	162
1	10.7	11.3	73.1	95.1				
2					11.2	10.9	77.4	99.5
3					8.78	5.72	43.6	58.1
5	5.63	3.22	21.0	29.8				
7					5.82	3.90	21.5	31.2
11	4.85	2.84	15.4	23.1				
16					4.93	3.12	22.0	30.0
25	5.74	1.93	14.1	21.8				
34					9.34	3.22	20.4	33.1
43	7.76	1.49	9.92	19.2	13.0	3.09	19.5	35.6
52	8.16	1.06	5.48	14.7	11.2	2.08	8.98	22.3

Table 2. DDTR losses from 2#/A DDT-treated east desert plot as indicated by 40 2-in. plugs/sample (mg/m^2). La Palma, AZ. Aug. 1974.

Week No.	East Half				West Half			
	p,p'-DDE	o,p'-DDT	o,p'-DDT	Total DDTR	p,p'-DDE	o,p'-DDT	p,p'-DDT	Total DDTR
0	6.47	30.3	127	164	6.47	30.3	127	164
1	18.1	10.7	101	130				
2					13.1	11.1	85.1	109
3					16.4	9.32	54.8	80.5
5	8.74	3.56	32.6	44.9				
7					14.6	7.04	42.8	64.4
11	8.28	3.99	24.3	36.6				
16					13.0	5.76	36.7	55.5
25	8.62	4.17	26.2	39.0				
34					14.4	4.95	32.4	51.8
43	11.7	2.07	12.4	26.2	13.6	3.61	19.7	36.9
52	9.41	1.18	4.52	15.1	14.2	2.00	9.21	25.4

Table 3. DDTR losses from 2#/A DDT-treated west desert plot as indicated by 20 ft^2 areas/sample (mg/m^2). La Palma, AZ. Aug. 1974.

Week No.	East Half				West Half			
	p,p'-DDE	o,p'-DDT	p,p'-DDT	Total DDTR	p,p'-DDE	o,p'-DDT	p,p'-DDT	Total DDTR
0	7.24	24.6	108	140	7.24	24.6	108	140
1	14.2	17.0	100	131				
2					12.8	13.4	88.7	115
3					9.14	6.93	46.4	62.5
5	8.37	5.18	34.3	47.8				
7					12.9	6.62	42.1	61.6
11	14.4	7.75	46.6	68.8				
16					13.3	8.61	46.9	68.8
25	12.0	5.62	35.5	53.1				
34					15.4	6.42	37.0	58.8
43	21.5	4.80	27.8	54.1	24.0	6.02	33.8	63.8
52	21.6	2.99	12.2	36.8	25.4	3.37	13.6	42.3

Table 4. DDTR losses from 2#/A DDT-treated west desert plot as indicated by 40 2-in. plugs/sample (mg/m^2). La Palma, AZ. Aug. 1974.

Week No.	East Half				West Half			
	p,p'-DDE	o,p'-DDT	p,p'-DDT	Total DDTR	p,p'-DDE	o,p'-DDT	p,p'-DDT	Total DDTR
0	12.0	31.6	147	191	12.0	31.6	147	191
1	21.4	17.7	115	154				
2					19.3	12.4	89.5	121
3					17.6	12.2	78.8	109
5	15.2	6.98	48.9	71.1				
7					16.4	8.78	61.8	87.0
11	25.6	9.76	58.2	93.6				
16					13.6	6.34	43.8	63.7
25	19.3	8.82	47.5	75.6				
34					19.1	6.18	38.0	63.3
43	22.9	5.65	30.4	59.0	22.5	7.04	37.2	66.7
52	24.1	3.27	14.5	41.9	26.4	3.48	16.1	46.0

Sampling: Pretreat control soil samples, consisting of two 11-ft^2 areas, two 11-plug and one 40-plug samples, 2 in. diameter X 1 in. deep, were collected from the desert plots, and one 40-plug sample from the cotton field. Posttreatment samples consisted of 20-ft^2 subsamples, spaced 1 ft apart across the swath, plus 40 plugs from the desert plots and 3 35-plug and 1 33-plug subsamples from each of the treated cotton plots.

The desert ft^2 samples were taken by scraping up the entire soil surface to a depth approximately 1/4-1/2 in. within a 1-ft^2 iron frame, and compositing them in a large, polyethylene poultry bag. The desert plugs were taken adjacent to each of the ft^2 samples and also composited. Three cotton field plug samples were collected from the two sides and the furrows of each of 12 rows (35 plugs) and composited. A fourth sample, consisting of 3 plugs per furrow from the 11 furrows, was taken to determine if there was a shifting of residues on the soil surface as a result of irrigation or rain.

Analysis: All soils were air-dried at lab temperature, ground in a soil pulverizing machine, mixed thoroughly, and stored in plastic bags at 0°C. Subsamples of 50 grams were Soxhletted 15 hrs with 41:59 hexane:acetone. The acetone was removed by three washings, and the hexane dried through anhydrous Na_2SO_4. All soils were extracted in duplicate or triplicate, and each extract sample was analyzed by ECGC, using duplicate injections. All analyses were conducted on a Microtek DSS-162 GC equipped with a ^{63}Ni source and N_2 carrier at 69 ml/min. The 107 cm X 4 mm I.D. Pyrex glass column was packed with 1.5% OV-17 and 2% WF-1 on 100/120 mesh Chromosorb-W (H.P.). Inlet, column and detector temperatures were 210°C, 190°C, and 290°C., respectively.

RESULTS

The decline of DDT and accumulation of DDE residues are conveniently expressed as mg/m^2. Theoretically, a 2 lb/acre application would result in 224 mg/m^2 deposit; however, results from the two desert plots indicated that the paper toweling received an average of only 125 mg/m^2 while the soil showed an average of 164 mg/m^2. In the cotton plots the sides of the rows received 115 mg while the row middles received 94 mg/m^2. The deposit reaching the cotton field soil was 66% of that applied to the desert plots, indicating that the remaining 34% probably was deposited on the cotton plants (Ware et al. 1975).

The results of a year's weathering for the desert samples and 76 days for the treated cotton field soil are shown in Tables 1-6. These indicate that in the desert the total DDTR declines to about 20% of the original over a 12-month period, while the p,p'-DDT is reduced to approximately 8% of the original. In the cotton field, DDTR accumulates in the row middles following irri-

Table 5. DDTR losses from DDT-treated cotton field soil over 76 days, as indicated by 105 2-inch plugs/sample from row sides and middles (mg/m^2). La Palma, AZ. Aug. 1974.

Week No.	2#/A				1#/A			
	p,p'-DDE	o,p'-DDT	p,p'-DDT	Total DDTR	p,p'-DDE	o,p'-DDT	p,p'-DDT	Total DDTR
Pretreat	3.84			3.84	3.84			3.84
0	8.42	19.1	98.3	126	- - - - - No Sample - - - - -			
1	- - - - - No Sample - - - - - -				5.95	8.48	43.9	58.3
2	10.9	12.8	76.9	101	7.58	6.32	37.1	51.0
3	10.5	11.4	69.2	91.1	8.04	12.3	57.6	77.9
5	12.6	12.6	71.9	97.1	8.26	5.87	43.1	57.2
7	12.1	12.2	71.8	96.1	7.37	5.81	36.8	50.0
11	12.9	15.0	78.7	107	6.62	5.23	36.2	48.0

Table 6. DDTR losses from DDT-treated cotton field soil over 76 days, as indicated by 33 2-inch plugs/sample only from row middles (mg/m^2). La Palma, AZ. Aug. 1974.

Week No.	2#/A				1#/A			
	p,p'-DDE	o,p'-DDT	p,p'-DDT	Total DDTR	p,p'-DDE	o,p'-DDT	p,p'-DDT	Total DDTR
0	5.50	12.8	70.8	89.1	- - - - - - No Sample - - - - - -			
1	8.13	15.5	76.0	99.6	9.06	11.8	57.8	78.7
2	13.6	15.9	95.1	125	7.91	7.66	48.7	64.3
3	20.6	29.6	169	219	9.61	12.7	70.6	92.9
5	17.7	29.7	137	184	12.3	12.0	80.6	105
7	20.9	26.8	137	186	14.7	14.9	80.9	110
11	21.3	28.7	163	213	12.5	14.4	75.6	102

gations and rains, while declining only 20% during 76 days of fall weather. Within that period DDTR in the desert plots declined 63%, undoubtedly due to the increased heating of the dry soil and continuous exposure to direct sunlight, as opposed to the shading which occurs in the cotton field. Both methods of sampling proved equally satisfactory for measuring soil surface residues.

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