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DDT Moratorium in Arizona: Residues in Soil and Alfalfa After 12 Years

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The moratorium on agriculture use of DDT in Arizona originated in January 1969 and has completed its twelfth year (WARE, et al. 1978, 1974, 1971, 1970). This is the fifth report on DDT residues and related degradation products in Arizona following 18 years of unrestricted use and 4 years of restricted use.

ANALYTICAL METHODS

Soil and alfalfa samples were collected as described in the previous reports from three major irrigated areas in Arizona: Salt River Valley, which surrounds Phoenix; Pinal county in the vicinity of Casa Grande; and the Yuma mesa and valley in Yuma County. Soil samples from desert areas near cultivated fields were also collected, but only from the top 0.25 inch.

Alfalfa and soil samples were extracted and processed as described previously (WARE 1978, 1970) except that the dehydrochlorination step was not used with the alfalfa extracts. A lack of significant toxaphene interference allowed the deletion of this step in 1980. This is attributed to the restricted use imposed on toxaphene in 1979. Analyses were performed using a gas chromatograph fitted with a ^{63}Ni electron capture detector. Recovery studies at 0.02 ppm and reagent blanks were done with each run of extraction and cleanup. Recoveries were generally 90 $\pm$ 5%. These corrections were not applied to the data presented. The limit of detection for the method was set at 0.001 ppm for soil and 0.003 for alfalfa for both p,p'-DDE and DDT. No attempt was made to quantify o,p'-DDT or p,p'-DDD because of their low levels and substrate interferences. The standard curves for the gas chromatograph ranged from 0.01 to 0.10 ng. The volumes injected for both standards and samples ran from 2 to 6 ul.

Confirmation of p,p'-DDE and DDT residues was done on random basis by electron capture gas chromatography using a 4-foot column packed with 5% dexsil 300 on Chromosorb W (H.P.) 100/120 mesh. Gas chromatographic parameters were the same as those used for the main study.

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Table 1. DDTR residues (PPM) in green alfalfa, Baseline Rd., Maricopa Co., Arizona, 1969-1980.

SAMPLE	1969 SEPT.	1975 OCT.	1980 AUG.[4/]
2	.038	.009*[2/]	---[1/]
3	.027	.007*	---
4	.038	.016*	.019*
5	.020	.009*	---
6	.035	---	---
8	---	.023	.018*
9	.034	.027	.040*
10	.054	.022*	.031
11	.064	.027*	.080*
12	.025	.014*	.025*
13	---	.008*	.029*
MEANS	.04[a3/]	.02[b]	.03[c]

Table 2. DDTR residues (PPM) in green alfalfa during 1969-1980 DDT moratorium, Maricopa County, Arizona.

SAMPLE	1969 SEPT.	1975 OCT.	1980 AUG.4/
1	.042	.019*[2/]	.021*
2	.062	.037*	.054*
3	.078	.011*	.024*
4	.047	.017	.019*
5	.030	.015*	---[1/]
6	.064	.041*	.042*
7	.034	.021	.036*
8	.056	---	---
9	.044	---	---
10	---	---	.065*
MEANS	.051[a3/]	.023[b]	.037[c]

1/ --- = No samples analyzed

2/ * = Substitute adjacent fields

3/ Means with same letter are not significantly different at the 0.05 level

4/ p,p'-DDE only

Table 3. DDTR residues (PPM) in green alfalfa during 1969-1980 DDT moratorium, Pinal County, Arizona.

SAMPLE	1969 SEPT.	1975 OCT.	1980 AUG.[4]
1	.042	---[1]	---
2	.031	.068*[2]	.011*
3	.187	.006*	---
4	.076	---	---
5	.130	---	---
6	.058	---	---
7	.118	.023*	.031*
8	.071	.077*	.011
9	.068	.006*	.009
MEANS	.086	.036	.016[3]

Table 4. DDTR residues (PPM) in green alfalfa during 1969-1980 DDT moratorium, Yuma County, Arizona

SAMPLE	1969 SEPT.	1975 OCT.	1980 AUG.[4]
1	.373	.016*[2]	.012*
2	.098	.008*	.009*
3	.256	.040	.006*
4	.093	.025	.006*
5	.545	.030*	.019*
6	.317	.032*	---[1]
7	.241	.034*	---
8	.045	.005*	.004
9	.056	---	<.003
10	.074	.006	.004
MEANS	.210[a5]	.022[b]	.008[b]

1/ --- = No samples analyzed

2/ * = Substitute adjacent fields

3/ Significant differences not determined because of missing samples and sample substitution

4/ p,p'-DDE only

5/ Means with same letter are not significantly different at the 0.05 level

Table 5. DDTR Residues (PPM) in soils during 1969-80 moratorium, Maricopa County, Arizona.

Field No.	1969 Jan.			1975 Oct.			1980 Aug.		
	DDE	p,p'-DDT	Total	DDE	p,p'-DDT	Total	DDE	p,p'-DDT	Total
1	.35	.12	.47	.43	.13	.56	.22	< .001	.22
2	.48	.78	1.3	-	-	-	.82*	.11	.93
3	.33	.16	.49	1.0	.23	1.2	.79*	.05	.84
4	.49	.17	.66	.40	.12	.52	.38	< .001	.38
5	.29	.09	.38	.17	.02	.19	< .03	< .001	< .03
6	2.10	1.10	3.2	2.24	.58	2.8	1.4	.29	1.7
7	.84	.23	1.1	.68	.14	.82	.53	.07	.60
8	2.22	1.29	3.5	1.96	.98	2.9	2.1	.43	2.5
9	1.18	.91	2.1	.83	.55	1.4	.95	.02	.97
10	--[1/]	--	(.24)[2/]	.24	.06	.30	.27	.04	.31
Means	.92	.54[c 3/]	1.5[a]	.883	.31[d]	1.2[a]	.75	.10[e]	.85[b]
Desert									
1	.08	.03	.11	.04	.02	.06	.13	< .001	.13
2	.24	.06	.30	.04	.02	.06	.05	.01	.06
3	.44	.15	.59	.06	.02	.08	--	--	--
4	--	--	(2.39)	.69	.19	.88	.02	.01	.03
Means	--	--	.89	.21	.06	.27	.07	.01	.08

1/ -- = No samples analyzed

2/ Bracketed ( ) figures are missing values calculated by randomized blocks missing value formula

3/ Means with same letter are not significantly different at the 0.05 level

Table 6. DDTR residues (PPM) in soils during 1969-80 moratorium, Pinal County, Arizona.

Field No.	1969 Jan.			1975 Oct.			1980 Aug.		
	DDE	p,p'-DDT	Total	DDE	p,p'-DDT	Total	DDE	p.p'-DDT	Total
1	.64	2.43	3.1	.59	2.51	3.1	.53	1.8	2.3
2	.27	1.03	1.3	.37	1.03	1.4	.37	.88	1.2
3	1.05	1.38	2.4	.64	.42	1.1	.77	.30	1.1
4	.99	1.04	2.0	1.60	.25	1.8	1.3	.36	1.7
5	.16	.21	.37	.19	.10	.29	.13	.57	.70
6	.06	.07	.13	.04	.05	.09	.04	.02	.06
7	1.09	1.37	2.5	1.32	.31	1.6	1.1	.16	1.3
8	.09	.04	.13	.05	.01	.06	.03	< .001	.03
9	.67	.29	.96	.59	.08	.67	.57	.03	.60
10	.66	.36	1.0	.91	.08	.99	.83	.10	.93
Means	.57	.82[c]	1.4[a1/]	.63	.48[d]	1.1[a,b]	.57	.42[d]	.99[b]
Desert									
1	.09	.06	.15	.04	.01	.05	.05	< .001	.05
2	.18	.11	.29	.07	.02	.09	.04	< .001	.04
3	.05	.10	.15	.04	.01	.05	.02	< .001	.02
4	.09	.10	.19	.49	.07	.56	.43	< .001	.43
Means	.10	.09[e]	.19	.16	.03[f]	.19	.14	.001[g]	.14

1/ Means with same letter are not significantly different at the 0.05 level

Table 7. DDTR residues (PPM) in soils during 1969-80 moratorium, Yuma County, Arizona.

Field No.	1969 Jan.			1975 Oct.			1980 Aug.		
	DDE	p,p'-DDT	Total	DDE	p,p'-DDT	Total	DDE	p,p'-DDT	Total
1	.10	.07	.17	.06	.01	.07	.06	.01	.07
2	.24	.25	.49	.24	.06	.30	.19	.03	.22
3	.72	.72	1.4	.71	.29	1.00	.48	.12	.60
4	.59	.47	1.1	.84	.22	1.06	.70	.12	.82
5	.48	.30	.78	.54	.15	.69	.31	<.001	.31
6	.29	.74	1.0	.45	.29	.74	.35	.12	.47
7	1.29	.37	1.7	.91	.01	.92	.69	.05	.74
8	.06	.01	.07	.02	< .01	.02	.01	<.001	.01
9	<.01	<.01	<.01	<.01	<.01	<.01	<.001	<.001	<.001
10	.26	.03	.29	.08	.01	.09	.04	.003	.04
Means	.40	.30[c1/]	.70[a]	.39	.10[d]	.49[b]	.28	.05[d]	.33[b]
Desert									
1	.27	.07	.34	.10	.03	.13	.12	.11	.23
2	.03	.02	.05	.02	.01	.03	.002	.001	.003
3	.02	.03	.05	.02	.02	.04	.002	<.001	.002
4	<.01	.01	.01	<.01	<.01	<.01	.001	<.001	.001
Means	.08	.03	.11	.035	.02	.06	.03	.03	.06

1/ Means with same letter are not significantly different at the 0.05 level

RESULTS AND DISCUSSIONS

Residues observed in alfalfa and soil samplings during the past 12 years are presented in Tables 1 through 7. Because o,p'-DDT was not quantitated in the 1980 sampling, it was deleted from the DDTR totals from previous samplings for the purpose of statistical comparison. A one-way analysis of variance was performed among the residue means for the three sampling dates. The means were compared at the 0.05 confidence level.

On the whole, the residue on alfalfa from the four sampling areas have remained at approximately 0.02 ppm wet weight. The anomalous increases or decreases in residues in individual fields may be due to field conditions or the substitution of nearby fields for ones no longer in alfalfa. Half-lives were determined for DDE in soil from linear regression analysis of residue means versus year. Zero order kinetics were assumed for residue degradation. In the past, the decline of DDTR residues suggested a 7 year half-life in Arizona cultivated soils and a 2½ year half-life for desert soils. The steady increase in the percent DDE in the total residue seems to be related to an increase in the DDTR half-life to about 12 years in cultivated soils and 7 years in desert soils. The apparent half-life for p,p'-DDT in both desert and cultivated soil is around 7 years. The seeming increase in both p,p'-DDT and DDTR half-lives in desert soils in the past 5 years could be a function of the continuing deposition of residue-bearing dust from nearby cultivated fields. Contributions by this mechanism to the already low DDTR residues in the desert soils would have more relative significance as the residues decrease.

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