

DEGRADATION OF DISLODGEABLE RESIDUES
OF CHLORPYRIFOS AND DIAZINON ON TURF
A PRELIMINARY SURVEY

By

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SUMMARY

This study was conducted in order to assess potential human exposure and the possible necessity of safety intervals or precautions following application of insecticides to residential and public turf areas. Diazinon and chlorpyrifos were each applied to eight, 64 square foot plots according to product label specifications. In general, the residue levels found were low and did not present significant concerns. As evidenced by the wide variation of detected residue levels, further refinement in methodology appears to be necessary before a final decision is made as to the safety of this application procedure to persons who will walk and play on turf subsequent to treatment.

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INTRODUCTION

In recent years there has been an increasing number of fairly toxic chemicals, primarily organophosphates, registered for use on turf, ornamentals, and recreational areas. Some concern has developed about the necessity of having a safety interval or special entry precautions following use on residential or recreational (i.e., parks) turf. Most product labels recommend that children and pets be kept off the turf until the spray has dried. There is some concern that children playing or people walking on treated turf might be exposed to hazardous levels of an organophosphate pesticide residue.

The two pesticides used in this study were Diazinon (0,0-diethyl 0-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate) and chlorpyrifos (0,0-diethyl 0-(3,5,6-trichloro-2-pyridyl)phosphorothioate; Dursban). Diazinon has an acute oral LD₅₀ (rat) of 250-285 mg/kg and an acute dermal LD₅₀ (rat) of 455-900 mg/kg (1,2). A safe level (3) has not been calculated for Diazinon. By using the ratio of the dermal LD₅₀'s for Diazinon and azinphos-methyl (220 mg/kg) and the calculated safe level for azinphos-methyl (1.6 ug/cm²) (3) a safe level can be estimated for Diazinon. The estimated safe level of residue on foliage is 3.3 ug/cm². Chlorpyrifos has an acute LD₅₀ (rat) of 97-155 mg/kg and an acute dermal LD₅₀ (rat) of 202 mg/kg (1,2). Since the dermal LD₅₀ of chlorpyrifos is close to that of azinphos-methyl it would seem reasonable to use the safe level calculated for azinphos-methyl (1.6 ug/cm²). Signs and symptoms of illness are primarily due to the accumulation of acetylcholine in the body. These signs and symptoms include nausea, vomiting, diarrhea, blurred vision, headache, pinpoint pupils, weakness, and in severe cases muscle spasms and coma.

MATERIALS AND METHODS

Eight plots for each chemical were selected and marked prior to application. Each plot was 8'x8' or 64 square feet. All plots were treated at the maximum rate allowed on the labels. Application rates were as follows:

Active Ingredient (A.I.):	Chlorpyrifos	Diazinon
Product Name:	Dexol Dexa-Klor Soil Insect Spray	Spectracide Lawn & Garden Insect Control
Percentage A.I. in Formulation:	6.7%	25%
Application Rate:	0.023 lb. A.I./1000 sq. ft.	0.25 lb. A.I./1000 sq. ft.
Dilution Rate:	30 gallons water	24 gallons water
Application Equipment:	2 gallon Hudson sprayer	2 gallon Hudson sprayer

Samples were collected before the application, immediately post-application, and at one, two, six, 12, 24, 48, 72 and 96 hours post-application. Each sample consisted of grass cut from a 50 - 200 cm² area of the treated plot. A 50 cm² template was placed randomly on the plot surface. Grass was cut from within the template area and placed in a small jar. All samples were sealed with a foil-lined lid and stored on ice until delivered to the WHS chemistry laboratory.

The product labels do not require the treated area to be watered following the particular types of applications chosen for this study. Applications for other pests require the area to be watered thoroughly after each treatment. One-half of the plots (four treated with Diazinon, and four with chlorpyrifos) were not watered during the first 48 hours after application. The other half were thoroughly watered within 24 hours of application. The watering schedule was as follows:

<u>Plot #</u>	<u>Time After Application</u>
Plot 5 (Diazinon & chlorpyrifos)	6 hrs., 30 hrs., 54 hours
Plot 6 (Diazinon & chlorpyrifos)	23 hours
Plot 7 (Diazinon)	12 hours (1/2" water)
Plot 7 (chlorpyrifos)	1/2 hour (1/2" water)
Plot 8 (Diazinon & chlorpyrifos)	12 hours (1/2" water)

To calculate a surface area per weight ratio, the following method was used:

- 1) A preapplication turf blade sample was taken.
- 2) Individual turf blades from the same sample were placed as close together as possible, without overlapping, in an area of known dimensions.
- 3) The blades from step #2 were then weighed.
- 4) A ratio was calculated from the weight of the grass blades and surface area covered by the blades.

RESULTS

The calculated results are recorded in Tables 1-6. The results were calculated by using three different methods. The first calculation (Tables 1 & 4) involved finding the surface area to weight ratio for the grass blades in each plot. The dislodgeable residue detected was then calculated as micrograms per square centimeter (ug/cm²) of the surface of the actual grass blade(s). This calculation was done in order to compare the results with the available dermal-dose-response data (4).

The second calculation (Tables 2 & 5) involved the surface area of the plot (as compared to the individual grass blades) sampled. These results are reported in ug/cm² of plot area sampled.

The last two tables (3 & 6) report the results as ug/10 grams of grass sampled.

DISCUSSION

In general, the residues of chlorpyrifos and Diazinon detected were low (Tables 1 & 4). The residues found never exceeded the estimated safe levels. The residue levels show a gradual decrease with time. However, the rather dramatic standard deviations seen in the tables indicate some problems with the sampling methodology and/or the methods of calculation. For the calculations in Tables 1, 2, 4 & 5 the grassblades are all assumed to be uniform when, in fact, there are probably differences arising from the grass blade structure, maturity, plot location, etc.

Calculations for ug/cm² of plot area sampled (Tables 2 & 5), indicate a more constant degradation. However, problems also seem to exist with the calculation (i.e. - different densities of grass within the plot, sampling errors, etc.). Calculations made on a weight per weight basis (Tables 3 & 6), also seem to be variable. The residue levels, however, do demonstrate a general decrease over time.

When comparing residue data obtained from the plots receiving water after application with those receiving no water, it does not appear that the addition of water post-application had any significant effect on reducing residue levels. One factor to consider is that a large volume of water was put on the plot as part of the pesticide application process (approx. 1.9 gallons on 64 sq. ft. for the chlorpyrifos applications); this volume of water was the label dilution rate. It is not known if the addition of this volume of water may have "washed" the chlorpyrifos or Diazinon off the grass and onto the soil substrate.

CONCLUSION

In conclusion, the methodology for this type of study would appear to require further refinement. The calculations in Tables 1 and 4 were done to allow a comparison with a standard (i.e., established safe reentry levels recently developed for field workers). Sampling methodology may not measure the exposure potential following the application of pesticides to turf. Future studies should be conducted in a manner which would determine potential human exposure in a more direct manner.

TABLE 1

CALCULATED DISLUDGEABLE CHLORPYRIFOS RESIDUES (MICROGRAMS PER SQ. CM OF GRASS BLADE SURFACE AREA)

Plots Not Watered In' After Application												
	Post-app	1 hour	2 hours	6 hours	12 hours	24 hours	48 hours	72 hours	96 hours			
Plot 1	.062	.023	.047	.059	.031	.015	.015	.012	N/S			
Plot 2	.022	.023	.012	N/S	.033	.007	.007	.005	.005			
Plot 3	.064	.029	.046	.043	.016	.048	.011	N/S	.012			
Plot 4	.062	.092	.088	.047	.038	.043	.073	.155	.013			
Total	.210	.167	.193	.149	.118	.113	.106	.172	.030			
Number	4	4	4	3	4	4	4	3	3			
Average	.053	.042	.048	.050	.030	.028	.027	.057	.010			
Maximum Value	.064	.092	.088	.059	.038	.048	.073	.155	.013			
Minimum Value	.022	.023	.012	.043	.016	.007	.007	.005	.005			
Standard Deviation	.018	.029	.027	.007	.008	.018	.027	.069	.004			
Plots Watered In' After Application												
	Post-app	1 hour	2 hours	6 hours	12 hours	24 hours	48 hours	72 hours	96 hours			
Plot 5	.037	.013	.008	.011	.015	.026	.008	.004	N/S			
Plot 6	.021	.014	.020	N/S	.014	.005	.004	.004	.005			
Plot 7	.060	.029	.029	.054	.026	.038	.008	N/S	.017			
Plot 8	.060	.086	.074	.053	.044	.027	.014	.014	.012			
Total	.178	.142	.131	.118	.099	.096	.034	.022	.034			
Number	4	4	4	3	4	4	4	3	3			
Average	.045	.036	.033	.039	.025	.024	.009	.007	.011			
Maximum Value	.060	.086	.074	.054	.044	.038	.014	.014	.017			
Minimum Value	.021	.013	.008	.011	.014	.005	.004	.004	.005			
Standard Deviation	.017	.030	.025	.020	.012	.012	.004	.005	.005			

*N/S - No sample taken

TABLE 2

CALCULATED DISLUDGEABLE CHLORPYRIFOS RESIDUES (micrograms per sq. cm of plot sampled)

		Plots Not 'Watered In' After Application									
		Post-app	1 hour	2 hours	6 hours	12 hours	24 hours	48 hours	72 hours	96 hours	
Plot 1		.892	.450	1.038	.468	.412	.252	.362	.100	N/S	
Plot 2		.121	.103	.066	N/S	.175	.028	.031	.026	.025	
Plot 3		.280	.124	.098	.114	.058	.120	.022	N/S	.044	
Total		1.293	.677	1.202	.582	.645	.400	.415	.126	.069	
Number		3	3	3	2	3	3	3	2	2	
Average		.431	.226	.401	.291	.215	.133	.138	.063	.035	
Maximum Value		.892	.450	1.038	.468	.412	.252	.362	.100	.044	
Minimum Value		.121	.103	.066	.114	.058	.028	.022	.026	.025	
Standard Deviation		.332	.159	.451	.177	.147	.092	.158	.037	.010	
		Plots 'Watered In' After Application									
Plot 5		.824	.394	.204	.210	.216	.478	.164	.078	N/S	
Plot 6		.123	.084	.079	N/S	.071	.033	.027	.024	.027	
Plot 7		.280	.124	.098	.114	.058	.120	.022	N/S	.044	
Total		1.227	.602	.381	.324	.345	.631	.213	.102	.071	
Number		3	3	3	2	3	3	3	2	2	
Average		.409	.201	.127	.162	.115	.210	.071	.051	.036	
Maximum Value		.824	.394	.204	.210	.216	.478	.164	.078	.044	
Minimum Value		.123	.084	.079	.114	.058	.033	.022	.024	.027	
Standard Deviation		.300	.138	.055	.048	.072	.193	.066	.027	.009	

*N/S - No sample taken

TABLE 4

CALCULATED DISLODGEABLE DIAZINON RESIDUES (micrograms per sq. cm grass blade surface)

	Plot Not Watered In' After Application									
	Post-app	1 hour	2 hours	6 hours	12 hours	24 hours	48 hours	72 hours	96 hours	N/S
Plot 1	1.069	.999	.948	1.412	.853	1.074	.325	.344	.344	.153
Plot 2	.770	.557	.625	.683	.751	.447	.356	.187	.187	.186
Plot 3	1.147	1.239	1.122	.997	.494	.553	.491	N/S	N/S	.254
Plot 4	1.658	1.533	1.262	1.506	.939	.650	.461	.194	.194	.593
Total	4.644	4.328	3.957	4.598	3.037	2.724	1.633	.725	.725	.593
Number	4	4	4	4	4	4	4	3	3	3
Average	1.161	1.082	.989	1.150	.759	.681	.408	.242	.242	.198
Maximum Value	1.658	1.533	1.262	1.506	.939	1.074	.491	.344	.344	.254
Minimum Value	.770	.557	.625	.683	.494	.447	.325	.187	.187	.153
Standard Deviation	.320	.357	.238	.330	.167	.238	.069	.072	.072	.042

	Plot Watered In' After Application									
	Post-app	1 hour	2 hours	6 hours	12 hours	24 hours	48 hours	72 hours	96 hours	N/S
Plot 5	.514	.632	.525	1.235	.508	.715	.171	.098	.098	0
Plot 6	.741	.576	.548	.501	.614	.274	.215	.138	.138	.048
Plot 7	.977	.932	.762	.859	.266	.335	.489	0	0	.266
Plot 8	1.396	1.423	2.298	2.745	2.411	.683	.581	.482	.482	.720
Total	3.628	3.563	4.133	5.340	3.799	2.007	1.456	.718	.718	1.034
Number	4	4	4	4	4	4	4	3	3	3
Average	.907	.891	1.033	1.335	.950	.502	.364	.239	.239	.345
Maximum Value	1.396	1.423	2.298	2.745	2.411	.715	.581	.482	.482	.720
Minimum Value	.514	.576	.525	.501	.266	.274	.171	.098	.098	.048
Standard Deviation	.326	.336	.736	.854	.853	.199	.175	.172	.172	.280

* N/S - no sample taken

TABLE 5

CALCULATED DISLUDGEABLE DIAZINON RESIDUES (micrograms per sq. cm. of plot sampled)

	Plots Not Watered In' After Application									
	Post-app	1 hour	2 hours	6 hours	12 hours	24 hours	48 hours	72 hours	96 hours	N/S
Plot 1	32.040	24.860	16.480	7.824	8.412	9.332	5.014	5.248	5.248	N/S
Plot 2	7.275	6.555	4.295	3.366	3.391	2.683	2.263	1.343	1.343	1.195
Plot 3	4.336	4.564	3.306	3.246	1.340	1.746	1.276	N/S	N/S	.548
Total	43.651	35.979	24.081	14.436	13.143	13.761	8.553	6.591	6.591	1.743
Number	3	3	3	3	3	3	3	2	2	2
Average	14.550	11.993	8.027	4.812	4.381	4.587	2.851	3.296	3.296	.872
Maximum Value	32.040	24.860	16.480	7.824	8.412	9.332	5.014	5.248	5.248	1.195
Minimum Value	4.336	4.564	3.306	3.246	1.340	1.746	1.276	1.343	1.343	.548
Standard Deviation	12.425	9.135	5.991	2.130	2.971	3.377	1.582	1.953	1.953	.324

	Plots Watered In' After Application									
	Plot 5	Plot 6	Plot 7	Total	Number	Average	Maximum Value	Minimum Value	Standard Deviation	N/S
Plot 5	20.400	13.940	12.520	6.794	8.450	8.818	3.636	2.694	2.694	N/S
Plot 6	6.395	4.350	3.240	2.882	2.456	1.742	1.236	1.044	1.044	.309
Plot 7	4.032	2.204	2.258	2.232	.762	.922	1.374	N/S	N/S	.826
Total	30.827	20.494	18.018	11.908	11.668	11.482	6.246	3.738	3.738	1.135
Number	3	3	3	3	3	3	3	2	2	2
Average	10.276	6.831	6.006	3.969	3.889	3.827	2.082	1.869	1.869	.568
Maximum Value	20.400	13.940	12.520	6.794	8.450	8.818	3.636	2.694	2.694	.826
Minimum Value	4.032	2.204	2.258	2.232	.762	.922	1.236	1.044	1.044	.309
Standard Deviation	7.224	5.102	4.624	2.015	3.298	3.545	1.100	.825	.825	.259

*N/S - No sample taken

TABLE 6

CALCULATED DIAZINON RESIDUES PER 10 GRAMS GRASS SAMPLED (micrograms)

		Plots Not Watered In' After Application									
		Post-app	1 hour	2 hours	6 hours	12 hours	24 hours	48 hours	72 hours	96 hours	
Plot 1		2027.85	1894.82	1799.13	2679.45	1617.69	2037.55	615.97	652.74	N/S	
Plot 2		1002.07	725.11	813.45	889.30	978.50	581.89	463.63	242.86	198.92	
Plot 3		1111.79	1201.05	1087.50	966.07	478.57	535.58	476.12	N/S	180.26	
Plot 4		2801.03	2590.28	2132.28	2543.13	1586.32	1097.32	779.14	327.10	429.74	
Total		6942.74	6411.26	5832.36	7077.95	4661.08	4252.34	2334.86	1222.70	808.92	
Number		4	4	4	4	4	4	4	3	3	
Average		1735.69	1602.82	1458.09	1769.49	1165.27	1063.09	583.72	407.57	269.64	
Maximum Value		2801.03	2590.28	2132.28	2679.45	1617.69	2037.55	779.14	652.74	429.74	
Minimum Value		1002.07	725.11	813.45	889.30	478.57	535.58	463.63	242.86	180.26	
Standard Deviation		732.76	705.72	530.03	843.62	471.28	604.27	127.70	176.74	113.46	
		Plots Watered In' After Application									
Plot 5		974.21	1199.66	995.23	2342.76	964.61	1356.62	323.49	186.82	N/S	
Plot 6		965.28	749.35	713.66	652.77	799.84	356.50	279.84	180.07	62.77	
Plot 7		946.48	903.28	737.91	832.84	257.43	324.65	473.79	N/S	258.13	
Plot 8		2358.18	2403.23	3881.77	4637.43	4073.39	1153.54	982.26	814.38	1215.94	
Total		5244.15	5255.52	6328.57	8465.80	6095.27	3191.31	2059.38	1181.27	1536.84	
Number		4	4	4	4	4	4	4	3	3	
Average		1311.04	1313.88	1582.14	2116.45	1523.82	797.83	514.85	393.76	512.28	
Maximum Value		2358.18	2403.23	3881.77	4637.43	4073.39	1356.62	982.26	814.38	1215.94	
Minimum Value		946.48	749.35	713.66	652.77	257.43	324.65	279.84	180.07	62.77	
Standard Deviation		604.65	649.43	1332.27	1596.60	1495.07	462.99	279.29	297.44	503.91	

*N/S - No sample taken

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