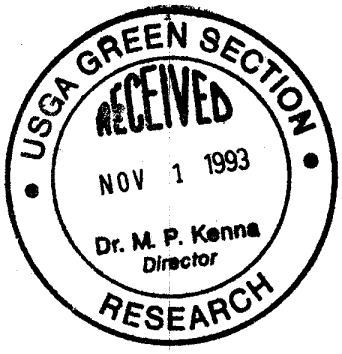

Determination of Volatile and Dislodgeable Residues on Pesticide-Treated Turfgrass

May 1, 1993 through November 1 1993

Semi-Annual Report

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EXECUTIVE SUMMARY

On June 6, 1993, trichlorfon was applied at a rate of 3.75 oz/3 gal/ 1000 ft^2 at 8 AM and on August 22, 1993, isazofos was applied at 1.5 oz/3 gal/1000 ft^2 at 8 AM. Both applications were followed by 1.27 cm (0.5 inches) of irrigation water. The methods of sampling and analysis have been presented in the May and November 1992 reports, respectively.

The watering-in process after application reduced the dislodgeable and volatile residues on day 1 post-application, except for DDVP volatile residues. Trichlorfon dislodgeable residues were reduced by approximately 500-fold (105,653 ug/m^2 immediately after application before irrigation to 138 ug/m^2 8 hr post-application, day 1) and isazofos dislodgeable residues decreased by 650-fold (3,921 ug/m^2 immediately after application before irrigation to 6 ug/m^2 8 hr post-application, day 1). Trichlorfon volatile residues were reduced 5-fold (1,153 ug/m^2/hr during application to 225 ug/m^2/hr at 15:00 to 19:00, day 1), DDVP volatile residues increased 2-fold (174 ug/m^2/hr during application to 385 ug/m^2/hr at 15:00 to 19:00, day 1), and isazofos decreased 10-fold (4164 ug/m^2/hr during application to 398 ug/m^2/hr at 15:00 to 19:00, day 1).

The practice of irrigating the treated plot after application attenuated the residues for day 1 only. Over time, the turf surface dries through evapotranspiration processes. Subsurface water moves upward translocating polar pesticides to the surface. These more water-soluble pesticides are now available as dislodgeble and volatile residues. Consequently, trichlorfon, DDVP, and isazofos residues were significantly higher on days 2 and 3 at mid-day than at the end of day 1.

The dislodgeable and volatile residues were used to assess golfer exposure and possible toxicity. The estimated dermal and inhaltion exposures were compared to LD_{50} (mg/kg), LC_{50} (mg/m^3), "no-effect" levels (inhalation and dermal, mg/m^3 and mg/kg, respectively), and maximum 8-hr exposure limit (mg/m^3) values. Assuming the golfer is not exposed to the treated area until after the irrigation process, the herbicide, MCPP, and fungicide, triadimefon, appear to be at safe levels. However, the more toxic insecticides may be at levels to cause concern. DDVP volatile residues were only 30 and 60-times below the inhalation "no-effect" levels on days 2 and 3, respectively. Isazofos dermal exposure estimates were 30 and 85-times below the "no-effect" levels on days 3 and 5, respectively.

I. MATERIALS AND METHODS.

The sampling schedule, sampling technique, extraction of residues from matrices, sample preparation, and instrumentation parameters for analysis of trichlorfon and isazofos have been presented in the May and November 1992 reports, respectively.

Application of Pesticides of Interest.

On June 6, 1993, the non-systemic insecticide, trichlorfon (trade name, Proxol 80SP), was applied at a rate of 3.75 oz/3 gal/ 1000 ft^2. At this rate, the concentration of the compound on the turf is 9155 g/ha. Approximately 30 min after application, the sprayed plot received 0.5 inches of irrigation water.

On August 22, 1993, the contact and systemic insecticide, isazofos (trade name, Triumph 4E), was applied at 1.5 oz/3 gal/1000 ft^2. The isazofos concentration on the turf at this application rate is 2142 g/ha. Approximately 30 min post-application, the treated plot received 0.5 inches of irrigation water.

II. DATA REDUCTION.

All data reduction calculations follow the protocols outlined in the reports of May and November of 1992.

Estimation of Golfer Exposure to Volatile and Dislodgeable Residues.

A. Inhalation exposure to volatile pesticide residues. The air concentrations determined at height of 70 cm from the treated surface were compared to 8-hour exposure limits (mg/m^3), rat "no-effect" levels (mg/m^3), and the acute toxic LC_{50} values (mg/m^3). Below is an example of how inhalation exposure was calculated.

LC_{50} value (8-hr exposure limit or "no-effect" level)	/	maximum volatile residues at 70 cm	=	times below LC_{50}
(mg/m^3)	/	(mg/m^3)	=	times below LC_{50}

3500 mg/m^3 / (0.33 ug/m^3 X 1 mg/1000 ug) = 10,606,061

B. Exposure to dislodgeable residues. Two methods were used to estimate dermal exposure from dislodgeable residues (Zweig *et al.*, 1985, and Ross *et al.*, 1990). Zweig compared foliar dislodgeable residues on citrus foliage to harvesters' dermal exposure. The dislodgeable residues were determined by extracting leaf discs with a soap solution. The dermal exposure was estimated by harvesters wearing surgical gauze pads from which pesticide residues per area of skin were determined. The transfer coefficient (i.e., 5 X 10^3 cm^2/hr) between dislodgeable residues and human dermal exposure has been determined to be constant for a variety of field experiments (7) and different pesticides (5).

Ross *et al.*(1990) treated a carpeted room with a insecticide defogger (i.e. active ingredient chlorpyrifos). The amount of pesticide residues that reached the carpet surface were estimated by the residues on a aluminum fallout sheet. Two hours after defogger activation, the room was vented for 30 min. Five subjects dressed in cotton socks, T-shirt, gloves and spandex tights performed Jazzercise^R routines for 20 min at 0, 6, and 12.5 hour post-venting. The ratio of pesticide residue on each article of clothing (ug/cm^2) to the residues on the carpet as determined by the fallout sheets (ug/cm^2) is termed the transfer coefficient. The established transfer coefficient of the hands was used to estimate golfer exposure. The transfer coefficients estimated at 0 and 6 hour post-venting are not statistically different and the average of the two (i.e., 17.5) was used to calculate dermal exposure from our study at 0 and 3 hr post-application. Assuming the change in the transfer coefficient is linear with time, a line from 6 to 12.5 hr was used to interpolate the transfer coefficient at 8 hr post-application (i.e., 14.9). Below are sample calculations of the two methods.

METHOD 1: Zweig *et al.*'s method (1985).

1.Conversion of dislodgeable residues in mg/m^2 to ug/cm^2:

Dislodgeable residues (mg/m^2) X 1 m^2/10000 cm^2 X 1000 ug/mg = ug/cm^2

3.67 mg/m^2 X 1 m^2/10000 cm^2 X 1000 ug/mg = 0.367 ug/cm^2

2. Incorporating into Zweig's *et al.* (1985) model:

Dislodgeable residues	X	Zweig's transfer coefficient	= Estimated human exposure
(ug/cm^2)	X	(5×10^3 cm^2/hr)	= (ug/hr)
0.367	X	(5×10^3 cm^2/hr	= 1835 ug/hr
1835 ug/hr	X	1 mg/1000 ug	= 1.84 mg/hr

3. Adjusting exposure to a 4 hour round of golf:

1.84 mg/hr X 4 hr = 7.34 mg

4. Assuming exposure is to 70 kg golfer (EPA Exposure Factors Handbook, 1989):

7.34 mg /70 kg = estimated dermal exposure

5. Adjustment of the LD_{50} and the "no-effect" levels for 70 kg person:

LD_{50} X 70 kg = LD_{50}/ 70 kg

2000 mg/kg X 70 kg = 140,000 mg/70 kg

6. Calculation of ratios of LD_{50} to estimated human exposure:

(LD_{50}/ 70 kg) / estimated dermal exposure = times below LC_{50}

(140,000 mg/70 kg) / (7.34 mg /70 kg) = 19,073.6 times

Method 2: Ross *et al.*'s method (1990).

1. Conversion of field application rate into ug/cm^2:

field application rate X 1 m^2/10000 cm^2 X 1000 ug/mg = ug/cm^2
(mg/m^2)

152.6 mg/m^2 X 1 m^2/10000 cm^2 X 1000 ug/mg = 15.26 ug/cm^2

2. Multiplication of field application rate by hand transfer coefficient:

15.26 ug/cm^2 X transfer coefficient at 0 hr = estimated dermal exposure

15.26 ug/cm^2 X 0.1714 = 2.65 ug/cm^2

3. Convert exposure from ug/cm^2 to mg/person:

average adult hands = 840 cm^2 (EPA Exposure Factors Handbook, 1989).

average adult human weighs 70 kg

2.65 ug/cm^2 X 840 cm^2 X 1 mg/ 1000 ug = 2.23 mg/ 70 kg

4. Calculation of ratios of dermal LD_{50} to estimated human exposure:

(LC_{50}/ 70 kg) / estimated dermal exposure = times below LC_{50}

(140,000 mg/70 kg) / (2.23 mg /70 kg) = 62,780.3 times

III. RESULTS.

Tables 1-4 contain the dislodgeable and volatile pesticide residues from the application of trichlorfon and isazofos in the Summer of 1993. The results from these tables are depicted graphically in Figures 1 and 2.

Tables 5-17 contain the estimated dermal and inhalation exposure for isazofos, MCPP, triadimefon, trichlorfon and DDVP.

IV. DISCUSSION.

The dislodgeable and volatile residues from pesticide-treated turfgrass, in general, dissipate with time. Surface temperature and irrigation practices are two factors which may contribute to deviation from this trend. As the surface temperature increases the inherent vapor pressure of the pesticide increases. The result is more volatilization. The diurnal effects of temperature are clearly seen in Figures 1 and 2, panels B. The volatile residues in the middle of days 2 and 3 post-application are greater than those earlier or later in the day.

The practice of irrigating the treated plot after application greatly reduces the available residues initially. Over time, the surface dries through evapotranspiration processes. Subsurface water moves upward which brings more polar pesticides to the surface of the turfgrass. Pesticides translocated to the surface are now available as a volatile or dislodgeable residues. The concentration of residues on days 2,3, or 5 post-application can be greater than those immediately after the irrigation on day 1. This is the case for trichlorfon volatile and dislodgeables on day 2 and 3 post-application.

In addition to reducing the initial amount of available residues, irrigation may enhance the chemical transformation of parent compounds. In slightly acidic to alkaline media, trichlorfon under-goes a dehydrochlorination reaction to form DDVP (Akhtar, 1982). DDVP is more volatile and more toxic than the parent insecticide, trichlorfon. It was found that irrigating the trichlorfon-treated plot resulted in the production of more DDVP than in the absense of irrigation. As seen in Figure 1, panel B , DDVP volatile residues are equivalent to or greater than the trichlorfon volatile residues at least one sampling period each day.

The purpose for measuring dislodgeable and volatile residues is to assess human exposure and possible toxicity. Triadimefon and MCPP have been assessed to have dislodgeable and volatile turf residues at least 1000-times below any LD_{50} (mg/kg), LC_{50} (mg/m^3), "no-effect" levels (inhalation and dermal, mg/m^3 and mg/kg, respectively), or maximum 8-hr exposure limit (mg/m^3) values. The two insecticides, trichlorfon and isazofos, are more toxic and the levels of residues found in the field post-application may be of concern.

As volatile residues, isazofos and trichlorfon, appear to be within safe levels. However, DDVP is of most concern with volatile residues at levels of less than 100-times below the inhalation no effect level through day 3 post-application (Table 17).

Incorporating dislodgeable residue field data into two models resulted in the estimation of dermal exposure. These models may not accurately represent golfer dermal exposure but are the best estimations available. DDVP and trichlorfon are at least 1000-times below the dermal "no-effect" levels when irrigation followed the application. Isazofos dislodgeable residues are less than 100-times below the dermal "no-effect" level through day 4 post-aplication and may be of concern.

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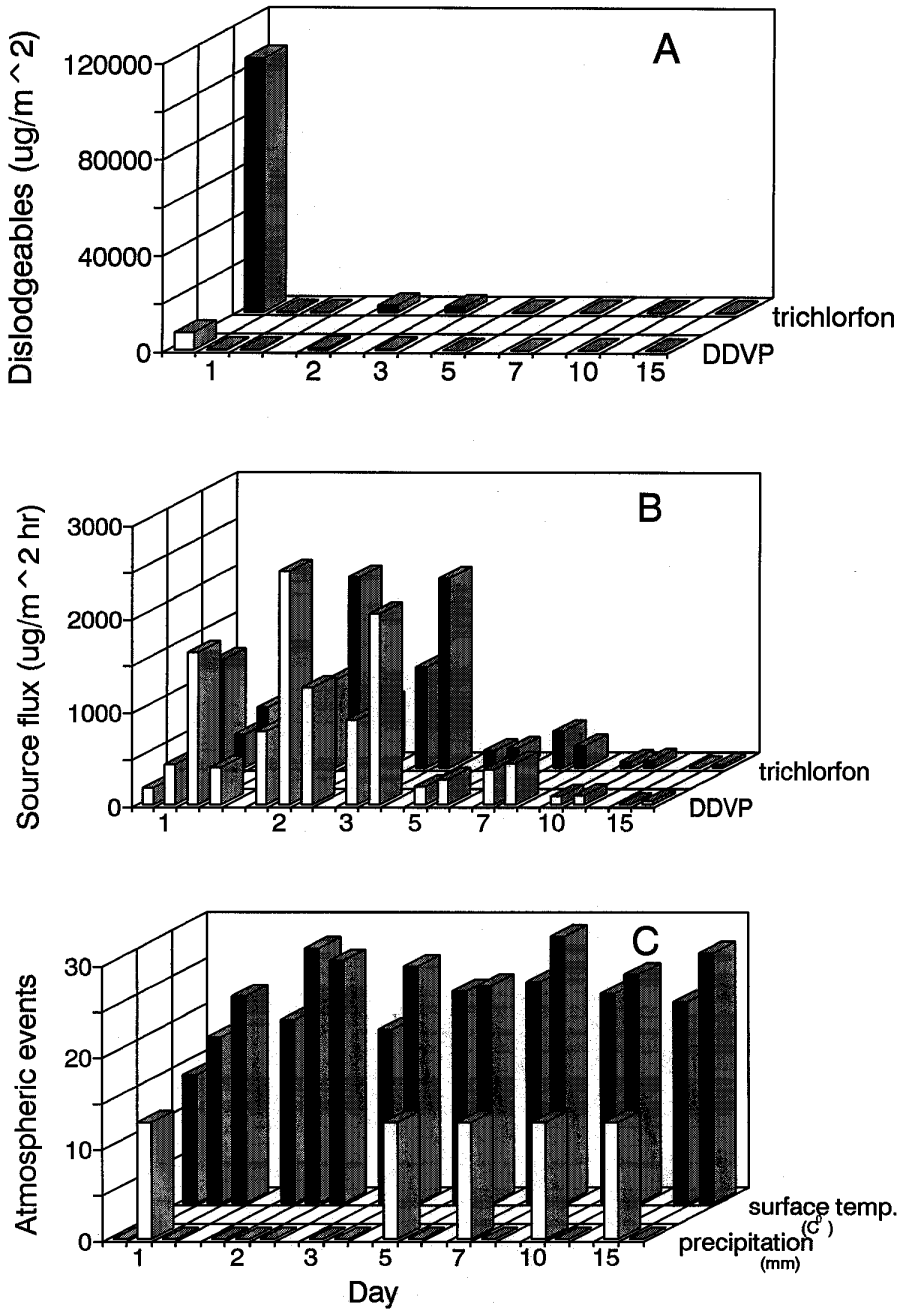

Figure 1. Trichlorfon applied at 9155 g/ha: (A) dislodgeable residues; (B) volatile residues; (C) atmospheric events. Each bar represents one sampling period.

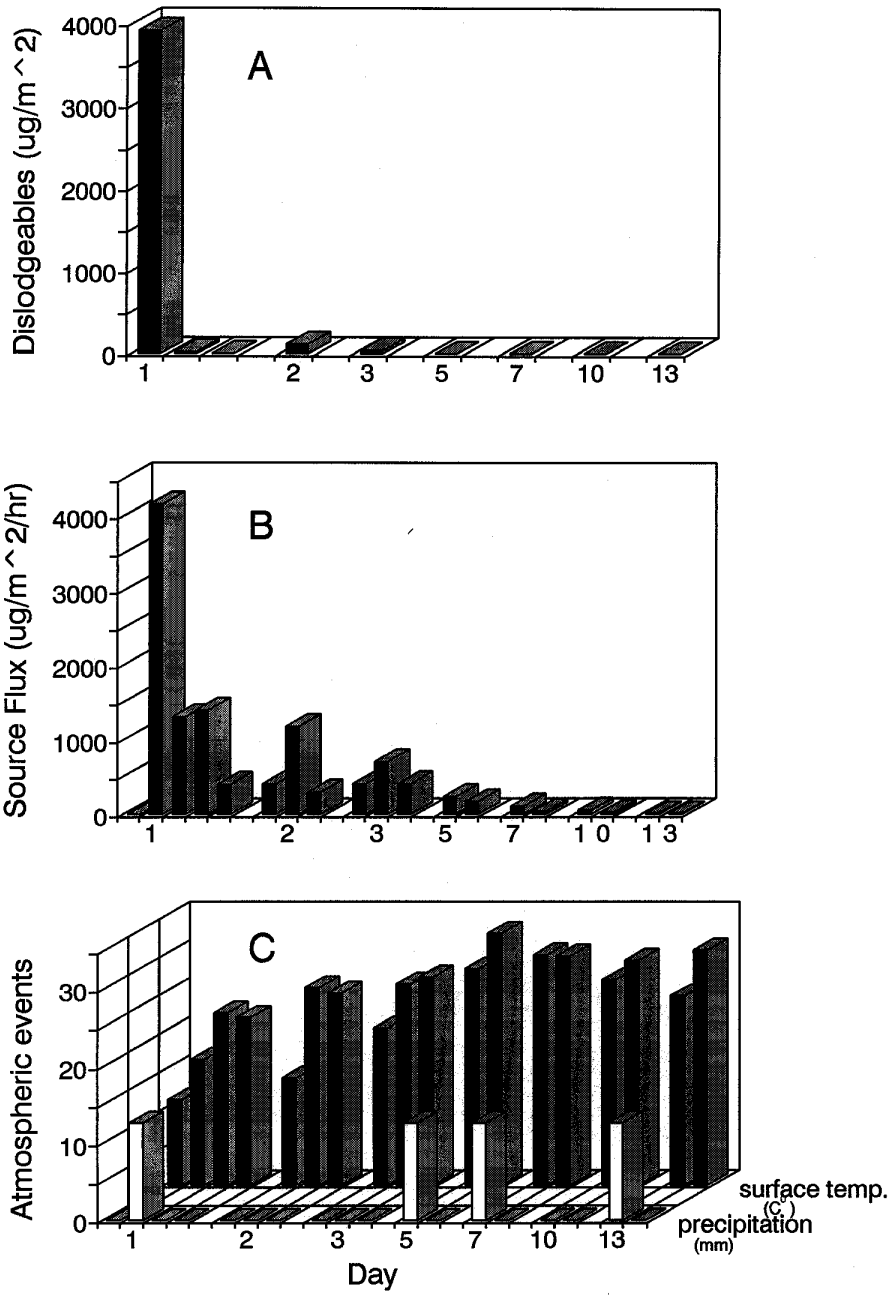

Figure 2. Isazofos applied at 2142 g/ha: (A) dislodgeable residues; (B) volatile residues; (C) atmospheric events. Each bar represents one sampling period.

Table 1. Dislodgeable trichlorfon and DDVP residues applied at 9155g/ha.

Sampling period	Trichlorfon Replicate #1 (ug/m^2)	Trichlorfon Replicate #2 (ug/m^2)	Trichlorfon Replicate #3 (ug/m^2)	DDVP Replicate #1 (ug/m^2)	DDVP Replicate #2 (ug/m^2)	DDVP Replicate #3 (ug/m^2)	Average trichlorfon	DDVP	Precipitation events (cm)	Percent of applied (%)
Day 1									a	
15 min post app	108646.4	107294.1	101020.5	8155.0	6749.8	7072.3	105653.7	7325.7	1.27	12.461
3 hr post appl.	81.4	299.6	165.5	83.6	53.7 b	34.9	182.2	57.4	nd	0.027
8 hr post appl.	211.0	84.0	118.4	30.5	nd	nd	137.8	10.2	nd	0.016
Day 2										
12 noon	1603.5	3204.0	3375.5	524.5	826.3	1003.9	2727.7	784.9	nd	0.397
Day 3										
12 noon	2787.3	2703.9	1668.5	492.2	510.0	427.3	2386.6	476.5	nd	0.321
Day 5	c	c							a	
12 noon	40.9	32.1	45.0	nd	nd	nd	39.3	------	1.27	0.004
Day 7									a	
12 noon	192.0	74.9	138.5	nd	nd	nd	135.1	------	1.27	0.015
Day 10	c	c	d							
12 noon	21.8	24.9	nd	nd	nd	nd	15.6	------	nd	0.002
Day 15	c	c							a	
12 noon	43.4	39.5	nd	nd	nd	nd	27.6	------	1.27	0.003

a. Preceded by irrigation for one half hour.
b. Nondetectable at the limit of detection (0.1 ug/ml) as determined by a 5 to 1 signal to noise ratio.
c. Estimated amount extrapolated from standard curve due to detector response falling below the limit of detection (0.5 ug.ml) as determined by a 5 to 1 siganal to noise ratio.
d. Nondetectable at the limit of detection (0.5 ug/ml) as determined by a 5 to 1 signal to noise ratio.

Table 2. Dislodgeable isazofos residues applied at 2142 g/ha.

Sampling period	Replicate #1 (ug/m^2)	Replicate #2 (ug/m^2)	Replicate #3 (ug/m^2)	Average	Standard deviation	Precipitation events (cm)	Percent of applied (%)
Day 1							
15 min post appl.	4100.8	4178.8	3484.1	3921.3	380.6	nd [a]	1.830
3 hr post appl.	12.4	16.9	15.8	22.5	2.3	1.27	0.011
8 hr post appl.	10.2643	12.8	6.3	6.3	6.4		0.003
Day 2							
12 noon	139.5	116.9	94.9	117.1	22.3	nd	0.055
Day 3							
12 noon	48.5	43.8	31.7	41.3	8.7	nd	0.019
Day 5	[b]					[a]	
12 noon	nd	nd	nd	------	------	1.27	------
Day 7						[a]	
12 noon	nd	nd	nd	------	------	1.27	------
Day 10							
12 noon	nd	nd	nd	------	------	nd	------
Day 13						[a]	
12 noon	nd	nd	nd	------	------	1.27	------

a. Preceded by irrigation for one half hour.
b. Nondetectable at the limit of detection (0.1 ug/ml) as determined by a 5 to 1 signal to noise ratio.

Table 3. Volatile trichlorfon and DDVP residues applied at 9155 g/ha.

Sampling period	Ug on resin trichlorfon (ug)	Ug on resin DDVP (ug)	Minutes air sampled (min)	M^3 of air per smp. pd. (m^3/smp)	Ug per m^3 of air trichlorfon (ug/m^3)	Ug per m^3 of air DDVP (ug/m^3)	Average surface temperature (C)	Solar radiation (kj/m^2)	Wind speed (m/s)	Precipitation events (cm)	Source flux trichlorfon (ug/m^2 hr)	Source flux DDVP (ug/m^2 hr)	Percent of applied (%)
Day 1													
8:11 – 8:47	23.89	3.61	36	22.617	1.056	0.159	13.9	762.0	0.9	nd	1153.8	174.2	0.09
										a			
9:28 – 11:00	30.16	35.42	92	59.883	0.504	0.591	18.0	2043.0	0.6	1.27	353.9	415.6	0.14
11:00 – 15:00	38.26	96.01	240	163.008	0.235	0.589	22.5	1637.8	2.2	nd	645.7	1620.2	1.10
15:00 –19:00	14.43	24.65	212	143.99	0.1	0.171	21.4	604	1.8	nd	225.3	384.9	0.26
Day 2													
7:00 – 11:00	140.49	116.15	240	183.384	0.766	0.633	19.9	2111.0	1.0	nd	937.2	774.8	0.80
11:00 – 15:00	212.52	258.67	240	142.632	1.490	1.814	27.8	3384.0	1.1	nd	2046.1	2490.5	2.15
15:00 –19:00	43.03	77.49	214	121.124	0.355	0.640	26.4	928.7	1.6	nd	693.9	1249.6	0.83
Day 3													
7:00 – 11:00	61.82	52.09	240	149.424	0.414	0.349	18.9	649.9	1.4	nd	1070.0	901.5	0.92
11:00 – 15:00	152.67	153.36	240	163.008	0.937	0.941	25.7	2449.0	1.7	nd	2028.8	2038.0	1.91
Day 5										a			
9:00 – 13:00	6.71	6.84	240	166.404	0.040	0.041	23.1	2140.0	3.7	1.27	183.1	186.6	0.17
13:00 – 17:00	6.96	8.98	240	149.424	0.047	0.060	23.6	1683.6	3.5	nd	204.9	264.6	0.22
Day 7										a			
9:00 – 13:00	42.17	39.88	240	129.048	0.327	0.309	24.1	2892.3	1.0	1.27	389.1	368.0	0.35
13:00 – 17:00	24.73	47.03	250	155.650	0.159	0.302	29.1	2786.8	1.2	nd	228.9	435.4	0.33
Day 10		b								a			
9:00 – 13:00	2.22	3.29	240	142.632	0.016	0.023	22.8	2599.0	3.2	1.27	61.2	90.6	0.07
		b											
13:00 – 17:00	2.97	3.73	240	169.800	0.017	0.022	24.9	2765.3	3.4	nd	73.4	92.3	0.08
Day 15		c	d							a			
9:00 – 13:00	nd	nd	233	131.878	-----	-----	21.9	954.2	0.9	1.27	-----	-----	----
		b											
13:00 – 17:00	2.19	2.69	240	151.462	0.014	0.018	27.3	1384.5	1.5	nd	26.5	32.7	0.03
											total percent loss		9.45

a. Preceded by irrigation for one half hour.
b. Estimated amount extrapolated from standard curve due to detector response falling below the limit of detection (0.5 ug/ml) as determined by a 5 to 1 signal to noise ratio.
c. Nondetectable at the limit of detection (0.5 ug/ml) as determined by a 5 to 1 signal to noise ratio.
d. Nondetectable at the limit of detection (0.1 ug/ml) as determined by a 5 to 1 signal to noise ratio.

Table 4. Volatile isazofos residues applied at 6427 g/ha.

Sampling period	Ug on resin (ug)	Minutes air sampled (min)	M^3 of air per smp. pd. (m^3/smp)	Ug per m^3 of air (ug/m^3)	Average surface temperature (C)	Solar radiation (kj/m^2)	Wind speed (m/s)	Precipitation events (cm)	Source flux (ug/m^2 hr	Percent of applied (%)
Day 1										
7:00–7:40	88.815	44	53.5	1.659	13.9	342.4	1.7	nd	3397.3	0.388
								a		
9:00–11:00	141.815	120	139.2	1.019	17.7	1922.5	2.4	1.27	3060.6	0.952
11:00–15:00	410.316	240	292.1	1.405	21.7	3016.5	2.0	nd	3452.9	2.149
15:00–19:00	273.176	240	258.0	1.059	22.9	2260.8	1.1	nd	1419.6	0.883
Day 2								b		
8:00–11:00	61.423	180	219.1	0.280	14.7	198.3	1.1	0.90	560.2	0.262
11:00–13:00	47.253	126	142.6	0.331	16.1	581.7	1.6	nd	954.1	0.312
16:00–19:00	26.256	180	229.3	0.114	15.5	136.5	0.8	nd	158.7	0.074
Day 3										
7:00–11:00	52.452	240	292.1	0.180	14.7	702.3	1.9	nd	432.5	0.269
11:00–15:00	142.840	220	267.7	0.534	22.8	3052.8	1.7	nd	1125.9	0.642
15:00–19:00	34.770	240	258.0	0.135	24.3	2011.0	1.9	nd	314.5	0.196
Day 4										
9:00–13:00	76.556	240	271.7	0.282	19.2	2144.8	1.3	nd	440.8	0.274
13:00–17:00	46.092	240	258.0	0.179	25.5	3068.0	1.8	nd	397.0	0.247
Day 5								b		
9:00–13:00	34.403	240	265.0	0.130	20.2	1429.0	1.5	0.10	245.0	0.152
13:00–17:00	22.011	240	265.0	0.083	23.3	1231.3	2.2	nd	221.7	0.138
Day 7								b		
9:00–13:00	8.124	234	284.8	0.029	22.4	2273.8	3.2	0.10	114.7	0.070
13:00–17:00	10.650	240	244.6	0.044	24.1	2783.3	3.1	nd	166.0	0.103
Day 12								b		
9:00–13:00	4.600	240	258.0	0.018	23.4	2199.5	1.2	0.52	26.6	0.017
13:00–17:00	2.392	240	258.0	0.009	27.6	2885.8	2.4	nd	28.1	0.017
								total percent loss		7.146

a. Preceded by irrigation for one half hour.
b. Rainfall.

Table 5. Estimated dermal exposure to isazofos applied at 6427 g/ha.

compound	application rate	maximum dislodgeable residues	LD 50 dermal	no effect level (dermal rats)	estimated exposure by carpet study	level below LD 50	level below no effect level	estimated exposure by strawberry harvesters	level below LD 50	level below no effect level
	(mg/m^2)	(mg/m^2)	(mg/70 kg)	(mg/70kg)	(mg/70 kg person)	(times)	(times)	(mg/70 kg person)	(times)	(times)
isazofos	642.7		39970[a]	7[a]						
day 1[b]										
15 min post		34.9			92.6	431.7	0.08	69.8	572.6	0.1
3 hour post		0.096			92.6	431.7	0.08	0.192	208177	36
8 hour post		0.053			76.6	521.8	0.09	0.106	377075	66
day 2		0.031			na[c]	na	na	0.062	644677	113
day 3		0.002			na	na	na	0.004	9992500	1750
day 4		0.046			na	na	na	0.092	434457	76
day 5		0.021			na	na	na	0.042	951667	167

a. Sumner (1993).
b. Followed by 1.27 cm of water.
c. Not applicable. Model only estimates exposure up to 8 hrs.

Table 6. Estimated dermal exposure to isazofos applied at 2142 g/ha.

compound	application rate	maximum dislodgeable residues	LD 50 dermal	no effect level (dermal rats	estimated exposure by carpet study	level below LD 50	level below no effect level	estimated exposure by strawberry harvesters	level below LD 50	level below no effect level
	(mg/m^2)	(mg/m^2)	(mg/70 kg)	(mg/70kg)	(mg/70 kg person)	(times)	(times)	(mg/70 kg person)	(times)	(times)
isazofos	214.2		39970[a]	7[a]						
day 1[b]										
15 min post		3.92			30.9	1295.3	0.23	7.84	5098.2	0.9
3 hour post		0.023			30.9	1295.3	0.23	0.046	868913	152
8 hour post		0.006			25.5	1565.5	0.27	0.012	3330833	583
day 2		0.117			na[c]	na	na	0.234	170812	30
day 3		0.041			na	na	na	0.082	487439	85

a. Sumner (1993).
b. Followed by 1.27 cm of water.
c. Not applicable. Model only estimates dermal exposure up to 8 hrs.

Table 7. Estimated inhalation exposure to isazofos applied at 6427 g/ha and 2142 g/ha.

compound	LC 50 (mg/m^3)	exposure limit (8hr/day) (mg/m^3)	no effect level (inhalation rats) (mg/m^3)	maximum volatiles (ug/m^3)	level below LC 50 (times)	level below exposure limit (times)	level below no effect level (times)
		a	b	c			
isazofos	2450		na	< 3.0			
			recommended rate				
day 1							
during application				1.56	1.6E+06	------	1900
11:00 – 15:00				0.85	2.9E+06	------	3500
day 2							
11:00 – 15:00				0.63	3.9E+06	------	4800
day 3							
11:00 – 15:00				0.22	1.1E+07	------	14000
day 5							
13:00 – 17:00				0.09	2.7E+07	------	33000
			three times the recommended rate				
day 1							
during application				1.66	1.5E+06	------	1800
11:00 – 15:00				1.4	1.8E+06	------	2100
day 2							
11:00 – 15:00				0.33	7.4E+06	------	9000
day 3							
11:00 – 15:00				0.53	4.6E+06	------	5700
day 5							
13:00 – 17:00				0.08	3.1E+07	------	37500

a. Sumner (1993). Male and female rats exposed for 4 hours.
b. Information not referenced in current literature.
c. Sumner (1993). 21 day rat subchronic inhalation study.

Table 8. Estimated dermal exposure to MCPP applied at 2211 g/ha.

compound and time post-application	application rate (mg/m^2)	maximum dislodgeable residues (mg/m^2)	LD 50 dermal (mg/70 kg)	no effect level (dermal rats) (mg/70kg)	estimated exposure by carpet study (mg/70 kg person)	level below LD 50 (times)	level below no effect level (times)	estimated exposure by strawberry harvesters (mg/70 kg person)	level below LD 50 (times)	level below no effect level (times)
MCPP	221.2		280000 [a]	na [b]						
15 min		1.33			31.9	8786.8	--------	2.66	105263.2	--------
3 hour		0.314			31.9	8786.8	--------	0.628	445859.9	--------
8 hour		0.311			26.4	10619.7	--------	0.622	450160.8	--------

a. Okkari (1993).
b. Information not referenced in current literature.

Table 9. Estimated inhalation exposure to MCPP applied at 2211 g/ha.

compound	LC 50	exposure limit (8hr/day)	no effect level (inhalation rats)	maximum volatiles	level below LC 50	level below exposure limit	level below no effect level
	(mg/m^3)	(mg/m^3)	(mg/m^3)	(ug/m^3)	(times)	(times)	(times)
	[a]	[b]	[c]				
MCPP	12500	na	350				
day 1							
during application				0.09	1.4E+08	-----	3.6E+06
13:00 - 17:00				0.03	4.2E+08	-----	1.1E+07
day 2							
13:00 - 17:00				0.05	2.5E+08	-----	7.0E+06

a. Okkari (1993). Rats exposed for 4 hours.
b. Information not referenced in current literature.
c. Armbruster (1993). 6 hr/day x 10 days (subacute inhalation study) of the Na-salt.

Table 10. Estimated dermal exposure to triadimefon applied at 1526 g/ha.

compound and time post-application	application rate (mg/m^2)	maximum dislodgeable residues (mg/m^2)	LD 50 dermal (mg/70 kg)	no effect level (dermal rats) (mg/70kg)	estimated exposure by carpet study (mg/70 kg person)	level below LD 50 (times)	level below no effect level (times)	estimated exposure by strawberry harvesters (mg/70 kg person)	level below LD 50 (times)	level below no effect level (times)
			a	b						
triadimefon	152.6		> 350000	21000						
15 min		3.67			22.0	15921.0	955.3	7.34	47683.9	2861.0
3 hour		2.23			22.0	15921.0	955.3	4.46	78475.3	4708.5
8 hour		1.54			18.2	19242.1	1154.5	3.08	113636	6818.2

a. Mobay (1991).
b. Eberhart (1993).

Table 11. Estimated inhalation exposure to triadimefon applied at 1526 g/ha.

compound	LC 50	exposure limit (8hr/day)	no effect level (inhalation rats)	maximum volatiles	level below LC 50	level below exposure limit	level below no effect level
	(mg/m^3)	(mg/m^3)	(mg/m^3)	(ug/m^3)	(times)	(times)	(times)
	a	b	c				
triadimefon	3500	1.0	78.7				
day 1							
during application				0.33	1.0E+06	3000	238000
11:00 – 15:00				0.313	1.1E+07	3000	251000
day 2							
11:00 – 15:00				0.221	1.6E+07	5000	356000
day 3							
11:00 – 15:00				0.142	2.5E+07	7000	554000

a. Mobay (1991). Male rats exposed to formulation dust for 4 hours
b. Mobay (1991). This value is recommended for Mobay operations only.
c. Mobay (1991). Rats exposed 6 hr/day X 5 days/week X 3 weeks (21 day inhalation study).

Table 12. Estimated dermal exposure to trichlorfon applied at 9155 g/ha..

compound and time post– application	application rate (mg/m^2)	maximum dislodgeable residues (mg/m^2)	LD 50 dermal (mg/70 k	no effect level (dermal rats) (mg/70kg)	exposure estimated by carpet study (mg/70 kg person)	level below LD 50 (times)	level below no effect level (times)	exposure estimated by strawberry harvesters (mg/70 kg person)	level below LD 50 (times)	level below no effect level (times)
			a	b						
trichlorfon	915.5		> 14000	7000						
day 1										
15 min post		47.57			131.9	1062	53	95.14	1472	74
3 hour post		18.62			131.9	1062	53	37.24	3759	188
8 hour post		10.18			109.1	1283	64	20.36	6876	344
					c					
day 2		9.33			na	na	na	18.66	7503	375
day 3		6.07			na	na	na	12.14	11532	577
day 5		2.57			na	na	na	5.14	27237	1362
day 7		1.1			na	na	na	2.2	63636	3182

a. Mobay (1990).
b. Eberhart (1993).
c. Not applicable. Model only estimates dermal exposure up to 8 hrs.

Table 13. Estimated dermal exposure to trichlorfon applied at 9155 g/ha and watered in.

compound and time post-application	application rate	maximum dislodgeable residues	LD 50 dermal	no effect level (dermal rats)	estimated exposure by carpet study	level below LD 50	level below no effect level	estimated exposure by strawberry harvesters	level below LD 50	level below no effect level
	(mg/m^2)	(mg/m^2)	(mg/70 kg)	(mg/70kg)	(mg/70 kg person)	(times)	(times)	(mg/70 kg person)	(times)	(times)
			[a]	[b]						
trichlorfon	915.5		> 140000	7000						
day 1										
[c]										
15 min post		105.6			131.9	1062	53	211.2	663	33
3 hour post		0.182			131.9	1062	53	0.364	384615	19231
8 hour post		0.137			109.1	1283	64	0.274	510949	25547
					[d]					
day 2		2.73			na	na	na	5.46	25641	1282
day 3		2.39			na	na	na	4.78	29289	1464
day 5		0.039			na	na	na	0.078	1794872	89744
day 7		0.135			na	na	na	0.27	518519	25926

a. Mobay (1990).
b. Eberhart (1993).
c. Followed by 1.27 cm of water.
d. Not applicable. Model only estimates dermal exposure up to 8 hrs.

Table 14. Estimated inhalation exposure to trichlorfon applied at 9155 g/ha.

compound	LC 50 (mg/m^3)	exposure limit (8hr/day) (mg/m^3)	no effect level (inhalation rats) (mg/m^3)	maximum volatiles (ug/m^3)	level below LC 50 (times)	level below exposure limit (times)	level below no effect level (times)
		a	b	c				
trichlorfon	20000		0.5	12.7			
			with out watering in				
day 1							
during application				2.08	9.6E+06	240	6000
11:00 – 15:00				1.22	1.5E+07	400	10000
day 2							
11:00 – 15:00				1.32	1.5E+07	380	9600
day 3							
11:00 – 15:00				1.47	1.3E+07	340	8600
day 5							
13:00 – 17:00				0.47	4.3E+07	1100	27000
			with watering in				
day 1							
during application				1.01	1.9E+07	500	13000
11:00 – 15:00				0.24	8.3E+07	2000	53000
day 2							
11:00 – 15:00				1.49	1.3E+07	330	8500
day 3							
11:00 – 15:00				0.94	2.1E+07	530	13000
day 5							
13:00 – 17:00				0.06	3.3E+08	8300	210000

a. Mobay (1990). Male rats exposed to formulation for 24 hours.
b. Hu (1986). Maximum allowable concentration (MAC) for trichlorfon as suggested by a field study of workers in a packing shop.
c. Mobay (1990). 21 day subchronic inhalation study.

Table 15. Estimated dermal exposure to DDVP when trichlorfon applied at 9155 g/ha.

compound and time post-application	application rate (mg/m^2)	maximum dislodgeable residues (mg/m^2)	LD 50 dermal (mg/70 kg)	no effect level (dermal rats) (mg/70kg)	estimated exposure by carpet study (mg/70 kg person)	level below LD 50 (times)	level below no effect level (times)	estimated exposure by strawberry harvesters (mg/70 kg person)	level below LD 50 (times)	level below no effect level (times)
			a	b						
DDVP	--------		10000	na						
					c					
day 1										
15 min		0.03			na	na	na	0.06	1.7E+05	--------
3 hour		0.01			na	na	na	0.02	5.0E+05	--------
8 hour		0.007			na	na	na	0.014	7.1E+05	--------
day 2		0.006			na	na	na	0.012	8.3E+05	--------
day 3		0.004			na	na	na	0.008	1.3E+06	--------
day 5		0.002			na	na	na	0.004	2.5E+06	--------

a. Worthing (1987).
b. Not available information. Stewart (1993).
c. Not applicable. Exposure estimates are based on the amount of compound applied. Trichlorfon was applied and DDVP is a breakdown product.

Table 16. Estimated dermal exposure to DDVP when trichlorfon applied at 9155 g/ha and watered in.

compound and time post-application	application rate (mg/m^2)	maximum dislodgeable residues (mg/m^2)	LD 50 dermal (mg/70 kg)	no effect level (dermal rats) (mg/70kg)	estimated exposure by carpet study (mg/70 kg person)	level below LD 50 (times)	level below no effect level (times)	estimated exposure by strawberry harvesters (mg/70 kg person)	level below LD 50 (times)	level below no effect level (times)
DDVP	--------		10000 [a]	na [b]						
day 1 [c]					[d]					
15 min		7.3			na	na	na	14.6	685	--------
3 hour		0.057			na	na	na	0.114	87719	--------
8 hour		0.01			na	na	na	0.02	500000	--------
day 2		0.784			na	na	na	1.568	6378	--------
day 3		0.476			na	na	na	0.952	10504	--------

a. Worthing (1987).
b. Information not available. Stewart (1993).
c. Followed by 1.27 cm water.
d. Not applicable. Exposure estimates are based on the amount of compound appied. Trichlorfon was applied and DDVP is a breakdown product.

Table 17. Estimated inhalation exposure to DDVP when trichlorfon applied at 9155 g/ha.

compound	LC 50 (mg/m^3)	exposure limit (8hr/day) (mg/m^3)	no effect level (inhalation rats) (mg/m^3)	maximum volatiles (ug/m^3)	level below LC 50 (times)	level below exposure limit (times)	level below no effect level (times)
	a	b	c				
DDVP	200	1.0	0.05				
		with out watering in					
day 1							
during application				0.09	2.2E+06	11000	560
11:00 - 15:00				0.167	1.2E+06	6000	300
day 2							
11:00 - 15:00				0.48	4.2E+05	2100	100
day 3							
11:00 - 15:00				0.87	2.3E+05	1500	60
day 5							
13:00 - 17:00				0.23	8.7E+05	4300	220
		with watering in					
day 1							
during application				0.159	1.3E+06	6300	320
11:00 - 15:00				0.59	3.4E+05	1700	90
day 2							
11:00 - 15:00				1.81	1.1E+05	620	30
day 3							
11:00 - 15:00				0.94	2.1E+05	1000	60
day 5							
13:00 - 17:00				0.06	3.3E+06	17000	840

a. Worthing (1987). Rats exposed for 4 hours.
b. American Conference of Governmental Industrial Hygienists (1971). Threshold limit value for dichlorvos.
c. EPA (1987).