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Runoff of diazinon from turf:
Effect of water application, slope, and formulation

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July 2002

[1] Environmental Monitoring Branch, California Department of Pesticide Regulation
[2] Center for Irrigation Technology, Fresno State University
[3] Center for Analytical Chemistry, California Department of Food and Agriculture

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Abstract

A designed experiment was conducted to evaluate the effect of slope, water application rate, and formulation on diazinon movement off-site from sprinkler-irrigated turf plots. Each of the three factors was examined at two levels: slope at 2 ½ and 5 percent, water application rate at 3.2 and 4.9 cm hr^{-1}, and formulation using a granular and an aqueous concentrate formulation. Sufficient water was applied to generate 20 1-L sequential runoff samples from each plot after which water was turned off. There was no significant difference in total applied water due to any treatment factor. The total amount of water applied to the 0.7 m^2 plots was 6.50 cm ± 1.76 cm, and the 20 L of runoff was equivalent to 46 ± 10% of applied water. While there was no significant effect of slope or water application rate on the fraction of applied diazinon moving off-site in runoff, the effect of formulation was marked. The fraction of applied granular diazinon recovered in runoff water was 1.5 ± 0.2% of application, while 21.8 ± 4.3% of applied aqueous concentrate diazinon was recovered in runoff. Peak diazinon concentrations were also very different for the two formulations: peak diazinon runoff concentrations ranged from 274 - 426 ug L^{-1} in the 16 granular-treated plots, while peak diazinon concentrations ranged from 3770 – 11000 ug L^{-1} in the 16 aqueous concentrate-treated plots. A granular dissolution rate-limiting mechanism appears to reduce post-application off-site granular diazinon movement in runoff water relative to aqueous concentrate applications in turf.

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Introduction

Organophosphate (OP) insecticides, and particularly diazinon, have been the focus of numerous California surface water monitoring studies over the last decade. Although monitoring of urban water courses has been more limited than major rivers and tributaries (e.g. Spurlock, 2002), some urban data have demonstrated relatively high diazinon concentrations, ranging up to 1 ug L^{-1} or more (Dubrovsky et al., 1998, Scanlin and Feng, 1997, Bortelson and Davis, 1997). Mechanisms of diazinon off-site movement to surface water from some agricultural use scenarios - such as winter orchard dormant spray applications - are reasonably well understood (Foe, 1995, Kratzer, 1997, Poletika et al., 2000, Ross et al., 1996), but far less is known about the nature of diazinon off-site movement in urban environments. The objective of this study was to estimate diazinon concentrations in runoff from turf applications under typical slope and water application rate conditions.

Materials and Methods

Study overview

The effect of formulation, slope, and water application rate on off-site movement of diazinon was investigated using a 2^3 factorial randomized design (Table 1). Each of the 8 treatment combinations was replicated 4 times for a total of 32 experimental plots. The application rates used were comparable to the diazinon product label rates for turf of 5 kg active ingredient ha^{-1} (4.4 lbs $acre^{-1}$). Analysis of variance (ANOVA) was used to examine treatment effects on (a) volume of water applied to plots, (b) water runoff rate from the plots, (c) diazinon recovery, and (d) diazinon moving off-site.

Table 1. Factors/levels

Factor	Level 1	Level 2
water application rate	3.2 cm h^{-1}	4.9 cm h^{-1}
slope	2.5%	5%
formulation	aqueous concentrate 22.4% active ingredient	granular 5.0% active ingredient

Site/plot description

The study was conducted in a fallow area located on the California State University campus in Fresno, California. The soil is a Hanford sandy loam, a coarse-loamy, mixed, nonacid, thermic, Typic Xerorthorent (USDA-SCS, 1971). National Resource Conservation Service tabulated properties for a Hanford sandy loam are bulk density ranging from 1.5 to 1.6 g cm^{-3}, and a moderately rapid permeability class of 5.1 to 15.3 cm h^{-1} (USDA-SCS, 1971).

Six weeks before the first runoff experiment was initiated, 0.46 m by 1.5 m sections of tall fescue turf were placed on soil beds that had been prepared at 2.5 % and 5% slope. These plots were sprinkler irrigated daily. The turf on each plot was cut to approximately 5 cm height the day before it received a diazinon application.

Diazinon application

Prior to each application, a 0.46 m by 1.5 m metal frame fitted with a drain was placed around the turf plot and driven into the ground approximately 10 cm, leaving 10 cm above the ground (Fig.1). Each plot was divided into quadrants for the granular application, and 1.7 g of a 5.2% diazinon granular formulation (California registration number 239-2479-ZB) was scattered over each quadrant to provide an application of 5.0 kg of active ingredient $hectare^{-1}$ (4.5 lbs $acre^{-1}$). For application of the aqueous concentrate, plastic was laid on the ground adjacent to the plot and over the drain of the metal frame. An aqueous concentrate 22.4% diazinon formulation (California registration number 239-2643-AA) mixed in water was applied at a rate of 4.4 kg active ingredient $hectare^{-1}$ (4.0 lbs $acre^{-1}$) using a CO_2 pressurized backpack sprayer and spray boom outfitted with 3 low-pressure flat fan Teejet LP8010 spray nozzles with

Teejet 11750 ball check valves at 12" spacing on a 24" boom with a pressure of 24 psi at the spray boom.

The diazinon application rates were based on direct gravimetric or volumetric measurements of the formulated granular or aqueous concentrate product. Independent deposition measurements were not conducted during application due to technical problems. The diazinon application rates of 352 mg diazinon plot^{-1} (granular) and 312 mg diazinon plot^{-1} (aqueous concentrate) correspond to applications of 5.0 kg ha^{-1} and 4.5 kg ha^{-1}, approximately equal to the label application rates of 5 kg diazinon ha^{-1}.

Water application

Immediately after diazinon application to a plot, sprinkler irrigation was applied through 4 nozzles arranged in a square pattern with 76 cm spacing located 1 m above the surface of the plot. The nozzles were connected to a 13 psi water line, and were outfitted with TeeJet D1 (low application rate) or D3 (high application rate) disc type cone spray tips and DC 31 brass cores. Measured water application rates to the plots using these nozzles were 3.18 cm h^{-1} and 4.92 cm h^{-1} for the low and high water application rates, respectively.

Sampling

Water samples   Water was collected in 1-liter amber bottles at the drain as it ran off the plot (Fig. 1). Samples were labeled in the order they were collected and the time was recorded for each. Upon collection of 20 liters of runoff water, the irrigation water was turned off and no more runoff samples were taken. Samples were stored at 4 °C until analysis.

Turf/soil samples

Background turf samples   Turf samples were taken from 4 plots prior to diazinon application using a 6-cm diameter stainless steel tube that was driven into the ground approximately 2.5 cm. For each sample 3 cores were taken from each plot and composited in 1-liter jars and stored at 4 °C.

Post runoff turf samples One turf sample was taken from each plot immediately after the runoff event using the stainless steel coring device discussed above.

Chemical analysis

Diazinon analyses were performed by the California Department of Food and Agriculture Center for Analytical Chemistry, Environmental Monitoring section using gas chromatography/flame photometric detection (Appendix 1).

Matrix blanks, consisting of American River water samples, were analyzed with each extraction set, and no detections were found with the exception of the blanks analyzed on 6/18/01 and 6/19/01 (Appendix 2). Selected matrix spikes (0.08 ug L^{-1}) also exceeded upper control limits on these dates. After evaluating the data, the probable cause was determined as the extremely high diazinon sample concentrations (100 – 6000 ug L^{-1}) relative to the spikes and blanks, leading to carryover contamination during the analysis. This problem was remedied by (i) raising the reporting limit, (ii) raising the spike level, and (iii) further diluting the samples prior to analysis. Blanks yielded nondetections (<1 ug L^{-1}) on all subsequent days, and all subsequent spiked samples fell within the upper and lower control limits (Appendix 2).

Mass balance calculations

Total mass of diazinon recovered from each replicate was calculated as the sum of diazinon in runoff (ug) and post-runoff diazinon remaining on the plots (ug). Diazinon recovered in runoff water is calculated as the sum of diazinon from each sampling interval (= concentration x interval volume). Post-runoff diazinon remaining on the turf plot was calculated as

$$diazinon\ (ug) = [C\ (1+\theta)] \times \rho_b \times A \times z$$

where C = analytical diazinon concentration in post-application turf/soil core samples (mass/mass, wet wt. basis), θ = water content of soil samples (mass water/mass dry

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soil), ρ_b = mean turf/soil core bulk density (= 1.25 g cm^{-3}), A = plot area = 6968 cm^2, and z = core depth = 2.5 cm.

Data analysis

The four primary response variables were (a) volume of water applied to the plots, (b) water runoff rate from the plots, (c) diazinon recovery (mass diazinon recovered/theoretical application), and (d) fraction of applied diazinon recovered in runoff from the plots. These were analyzed to determine the presence of significant treatment effects using ANOVA. Exploratory analysis indicated that diazinon recovery and fraction diazinon off-site data were non-normal and heteroscedastic. Consequently the recommendations outlined in Zar (1996) were used to evaluate treatment effects for those two cases: ANOVA was performed on both the untransformed data and the rank-transformed data. If both analyses yielded identical conclusions then that conclusion was considered reliable. A probability level of $\alpha = 0.05$ was used for hypothesis testing. ANOVA tables are provided in Appendix 3.

Results

Water

Total water applied. The total water applied to the plots ranged from 30 to 82 L (4.3 cm to 11.8 cm), with a mean of 43 L (6.2 cm). Consequently the 20L of runoff water collected from each plot comprised 24 to 66 percent of the total water application with a mean of 46 percent (Table 2). There was no significant difference in total water applied due to the water application, slope, or formulation treatments (Appendix 3,Fig. 2).

Runoff All water runoff curves (volume runoff vs. time) displayed an initial slow runoff phase followed by an essentially constant runoff rate (e.g., Fig 3). The initial slow runoff phase corresponded roughly to the first 1-L sampling period, typically about 20 minutes. The water applied during collection of the initial samples ranged from 5 to 20 L (0.7 cm - 2.9 cm) with a mean of 9.8 L (1.4 cm). Thus, during the initial sample collection period 80 – 95 of applied water stayed on-site, either infiltrating or as hold-up in the turf.

The water runoff rates (L runoff water/time) approached a steady-state value following the intial slow runoff period. The treatment group-mean steady-state runoff rates are given by the slopes of the plots (Fig. 3), while those for the individual plots are listed in Table 2. The steady-state water runoff rates were independent of plot slope, but runoff rates for the high water application rate treatment were significantly higher than the low water application rate, 2.7 vs. 1.9 cm h^{-1}, respectively (Appendix 3).

In summary, there was no treatment effect on total water applied to the plots, so that the 20 L of runoff sampled from each plot represented 46% ± 10% of applied water regardless of slope or water application rate. However, water runoff rates were higher for the higher water application rate treatment group than for the lower water application rate.

Diazinon recoveries from the plots were variable - ranging from 43 to 150 percent of theoretical application - and displayed especially high variability for the granular formulation as compared to the liquid formulation (Fig. 4). Consequently, the high variability in the granular formulation treatment recoveries was probably at least partially attributable to the non-uniform distribution of granular diazinon across the surface area of the granular-treated plots in conjunction with the post-runoff sampling method that used small diameter (6.4 cm) cores.

Diazinon

Mass balance. Diazinon recoveries from the plots were variable - ranging from 43 to 150 percent of theoretical application – with especially high variability for the granular formulation treatments (Fig. 4). In all plots, the largest portion of recovered diazinon was that recovered post-runoff soil/turf cores as opposed to the runoff water samples. Consequently, the high variability in the granular formulation treatment recoveries was probably at least partially attributable to sampling: the non-uniform distribution of granular diazinon across the surface area of the granular-treated plots in conjunction with the small diameter cores (6.4 cm) used to sample the turf resulted in highly variable granular mass balance recoveries.

In addition to their variability, diazinon recoveries were also generally low (Table 2), with a grand median recovery of 70% of theoretical application (Fig. 5). There was no effect of water application rate, plot slope, or formulation on diazinon recovery based on an ANOVA of recovery data ranks. A substantial amount of water applied to the plots stayed "on-site" (1.4 to 8.9 cm, median = 3.4 cm) as opposed to running off the plots. Consequently, some movement of diazinon to the subsurface via leaching was likely. The post-runoff soil/turf core sampling depth was relatively shallow (2.5 cm), so that movement beyond that depth probably occurred. At least some of the unrecovered diazinon was probably attributable to diazinon leaching into deeper soil layers (> 2.5 cm depth).

<u>Diazinon runoff.</u> The fraction of diazinon moving off-site in runoff was independent of both water application rate and plot slope treatments. However, the effect of formulation was marked (Fig. 6, Appendix 3); the mean fraction of theoretical applied diazinon recovered in runoff from the liquid formulation treatments (21.9%) was 15 times greater than in the granular formulation treatments (1.45 %), and the diazinon concentration ranges in the liquid formulation runoff samples were similarly much higher than the granular formulation runoff samples. Concentrations in the initial liquid formulation runoff samples ranged from 2300 to 11,000 ug L^{-1} (mean = 5845 ug L^{-1}) while those from the granular plots ranged from 41 to 365 ug L^{-1} (mean = 126 ug L^{-1}) - this in spite of the fact that the granular plots were treated with a higher diazinon application rate (352 mg $plot^{-1}$ vs. 312 mg $plot^{-1}$).

In addition to the large effect of formulation on diazinon movement off-site, the diazinon concentration vs. time runoff profiles were qualitatively much different. The liquid formulation runoff profiles generally demonstrated high initial concentrations followed by a relatively steady decline in concentration – similar to runoff profiles previously observed for liquid formulation herbicides in runoff studies on bare-ground plots

TABLE 2. Summary of results.

TREATMENTS[A]				WATER				DIAZINON			
Plot no.	formulation	plot slope	irrigation water rate	duration (min)	applied water (cm)	fraction water runoff	steady-state runoff (L/min)	recovered on plot (mg)	recovered in runoff (mg)	total recovery fraction application	fraction in runoff
5	AC	low	low	143	7.567	0.379	0.168	133.65	60.82	0.622	0.195
16	AC	low	low	103	5.450	0.527	0.234	187.58	75.59	0.842	0.242
22	AC	low	low	106	5.609	0.512	0.204	142.65	85.43	0.730	0.273
32	AC	low	low	101	5.345	0.537	0.247	188.07	70.47	0.827	0.226
8	AC	low	high	85	6.909	0.415	0.321	150.37	55.27	0.658	0.177
14	AC	low	high	87	7.071	0.406	0.277	221.44	56.68	0.890	0.181
24	AC	low	high	82	6.665	0.431	0.295	129.11	80.47	0.671	0.258
29	AC	low	high	61	4.958	0.579	0.437	131.37	69.06	0.641	0.221
4	AC	high	low	129	6.826	0.420	0.179	169.28	69.18	0.763	0.221
11	AC	high	low	128	6.773	0.424	0.207	130.83	42.744	0.555	0.137
17	AC	high	low	83	4.392	0.653	0.273	132.51	96.89	0.734	0.310
26	AC	high	low	90	4.763	0.603	0.246	130.83	**73.543**	0.654	0.235
2	AC	high	high	72	5.852	0.490	0.349	144.40	54.53	0.637	0.175
12	AC	high	high	145	11.786	0.243	0.169	92.50	61.02	0.491	0.195
19	AC	high	high	88	7.153	0.401	0.264	130.39	78.521	0.669	0.251
28	AC	high	high	65	5.283	0.543	0.348	143.00	62.19	0.657	0.199
7	granular	low	low	211.0	11.165	0.257	0.121	248.04	4.8	0.719	0.014
13	granular	low	low	171.0	9.049	0.317	0.135	363.22	5.0	1.047	0.014
23	granular	low	low	135.0	7.144	0.402	0.188	385.53	4.5	1.109	0.013
30	granular	low	low	90.0	4.763	0.603	0.267	218.75	3.8	0.633	0.011
6	granular	low	high	113.0	9.185	0.312	0.223	143.72	6.3	0.427	0.018
15	granular	low	high	83.0	6.746	0.425	0.328	458.70	5.0	1.319	0.014
21	granular	low	high	66.0	5.364	0.535	0.372	521.34	4.7	1.496	0.013
31	granular	low	high	83.0	6.746	0.425	0.307	459.73	5.3	1.323	0.015
1	granular	high	low	120.0	6.350	0.452	0.222	408.78	7.1	1.183	0.020
10	granular	high	low	114.0	6.033	0.476	0.213	266.37	**4.2**	0.770	0.012
20	granular	high	low	91.0	**5.232**	0.216	0.247	169.39	**5.0**	0.496	0.014
25	granular	high	low	81.0	4.286	0.670	0.286	286.57	4.5	0.828	0.013
3	granular	high	high	75.0	6.096	0.471	0.348	187.55	5.2	0.548	0.015
9	granular	high	high	64.0	5.202	0.552	0.382	216.36	5.0	0.630	0.014
18	granular	high	high	73.0	5.933	0.484	0.337	144.27	**6.1**	0.428	0.017
27	granular	high	high	86.0	6.990	0.411	0.281	491.45	5.2	1.412	0.015
min	-	-	-	61	4.286	0.216	0.121	92.50	3.84	0.427	0.011
max	-	-	-	211	11.786	0.670	0.437	521.34	96.89	1.496	0.310
median	-	-	-	89	6.223	0.441	0.265	178.47	24.95	0.695	0.079
mean	-	-	-	100.75	6.521	0.455	0.265	228.99	36.69	0.794	0.117

[A] AC = aqueous concentrate; slope = 2.5%, 5%; irrigation rate = 3.18 cm h^{-1}, 4.92 cm h^{-1}

(Spurlock et al., 1997). However, the granular formulation plots exhibited low initial diazinon concentrations that gradually increased (Fig 7). This behavior, coupled with visual observation of granules on the turf plots *after water application* suggests that a dissolution rate-limited mechanism was operative in the granular-treated plots.

Evans et al. (1998) also recently investigated simulated rainfall-induced runoff of liquid and granular diazinon formulations from turf and found much lower concentrations and proportions of diazinon moving off-site than this study, especially for the liquid formulation. However, they also considered different levels of post-application incorporation, or "set", irrigations as an experimental factor. These irrigations reduce runoff potential by moving diazinon into the root zone. Consequently the lesser magnitude of diazinon off-site movement observed by Evans et al. (1998) was partially attributable to the use of set irrigations. More importantly, they utilized experimental conditions that led to very low amounts of water runoff from their simulated rainfall events. For example, mean water runoff from their liquid formulation/no set irrigation replicates was 0.09 cm, or 1% of the applied simulated rainfall. Consequently while the study of Evans et al. (1998) demonstrated certain conditions under which diazinon off-site movement from turf is minimized, the experimental conditions here are more representative of actual significant diazinon/turf runoff events.

Conclusion

A 2^3 factorial randomized design was used to examine the effect of granular vs. aqueous concentrate diazinon formulations on diazinon runoff from turf at two sprinkler irrigation water application rates and two plot slopes. The 0.7 m^2 experimental turf plots were 0.457 m x 1.52 m, and the sprinkler irrigation water application rates (3.2 cm h^{-1} and 4.9 cm h^{-1}) and slopes (2.5% and 5%) were chosen to cover a range of irrigation and/or rainfall rates and slopes that are commonly observed under actual urban turf conditions. The water runoff profiles (volume runoff vs. elapsed time) of all plots demonstrated an initial water accumulation phase characterized by a low water runoff rate, followed by a higher steady-state water runoff rate. The fraction of applied water recovered as runoff was independent of slope or water application rate.

Diazinon movement in runoff was similarly independent of the chosen irrigation water application rates and plot slopes, however a dramatic effect of formulation on diazinon off-site movement was observed. The fraction of applied diazinon recovered in runoff water differed by a factor of 15 between the two formulation treatments: 1.45% (± 0.23 % SD) of application was recovered off-site in the granular formulation treatments, whereas the diazinon recovery from runoff samples in the liquid formulation plots was 21.8% (± 4.3% SD).

The diazinon application rates of the two formulation treatments were similar: 312 mg diazinon/plot in the liquid formulation and 352 mg diazinon/plot in the granular formulation treatment. These rates correspond to 4.5 – 5 kg ha^{-1}, close to the suggested label rate. The diazinon concentration vs. volume runoff profiles for the formulation treatments were fundamentally different in magnitude and shape; the mean initial runoff concentration in the granular formulation treatments was relatively low (126 ug L^{-1}) and concentration gradually increased to a mean of 320 ug L^{-1} in the final (20^{th})1-L sample, while in the liquid formulation-treated plots the mean initial concentration was 5845 ug L^{-1} which gradually declined to 2353 ug L^{-1} in the final sample. The presence of undissolved diazinon granules was visually evident on the granular-treated plots after runoff. These data suggest that a dissolution rate-limiting mechanism may significantly reduce post-application off-site diazinon movement in runoff water from granular treated applications relative to aqueous concentrate applications in turf.

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Figures 1 – 7

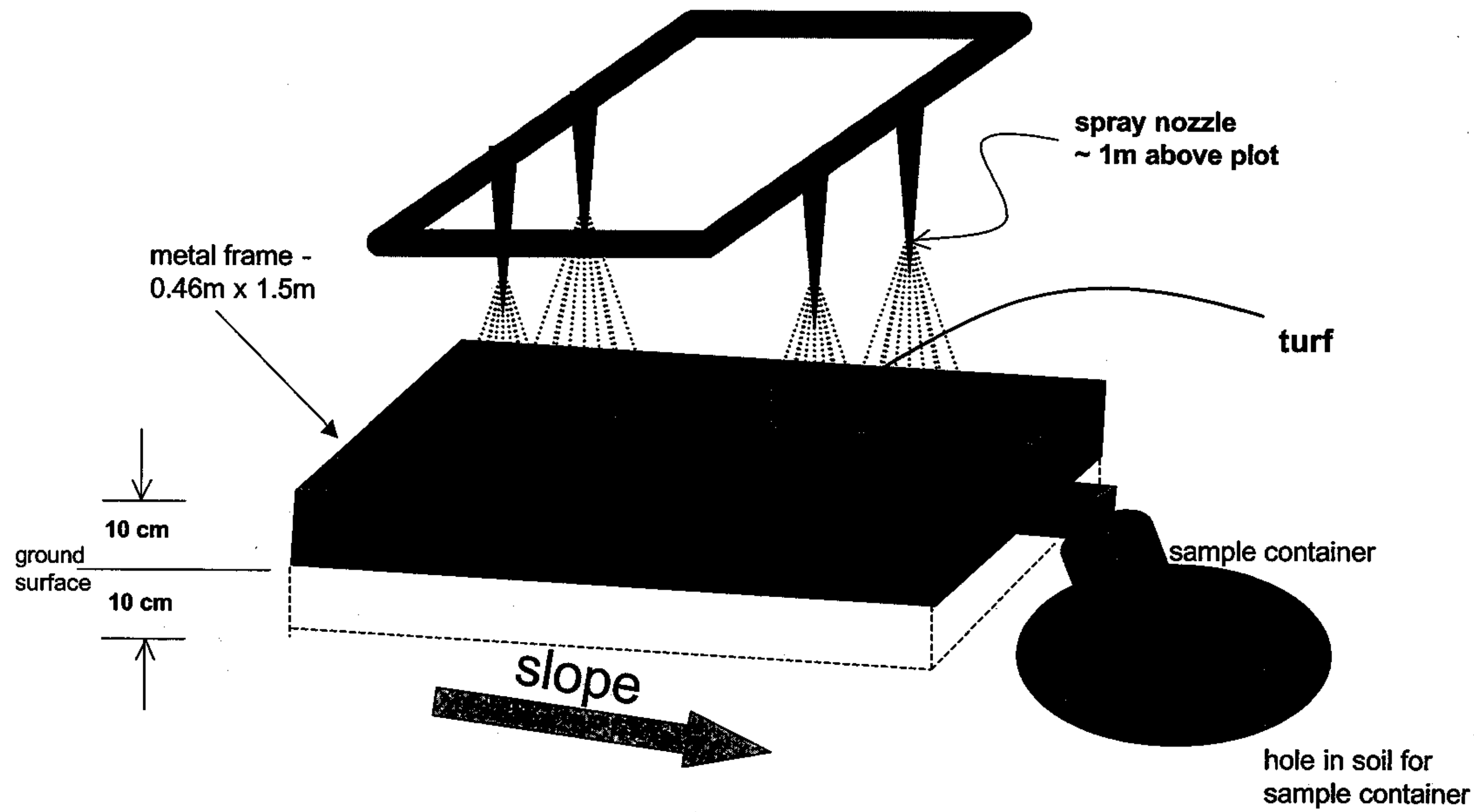
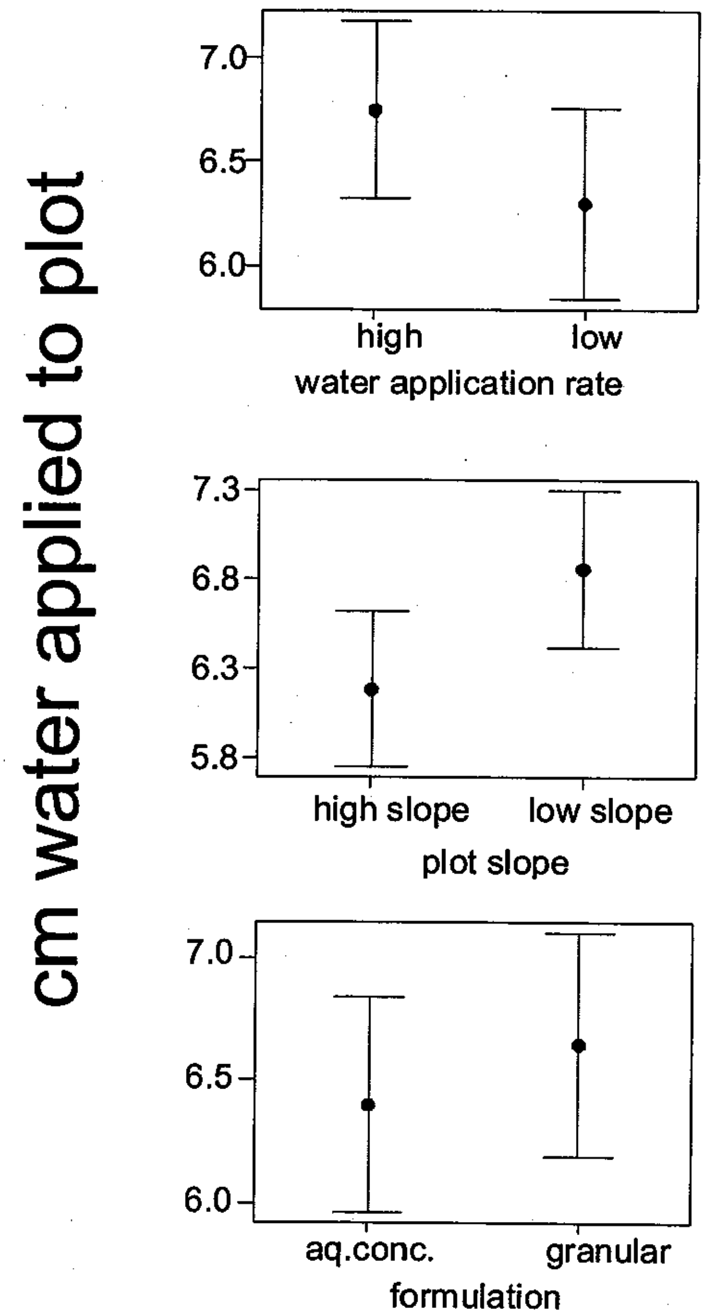


Figure 1. Plot layout schematic

Figure 2. Mean water application by treatment

(error bars ~ +/- standard error of mean)



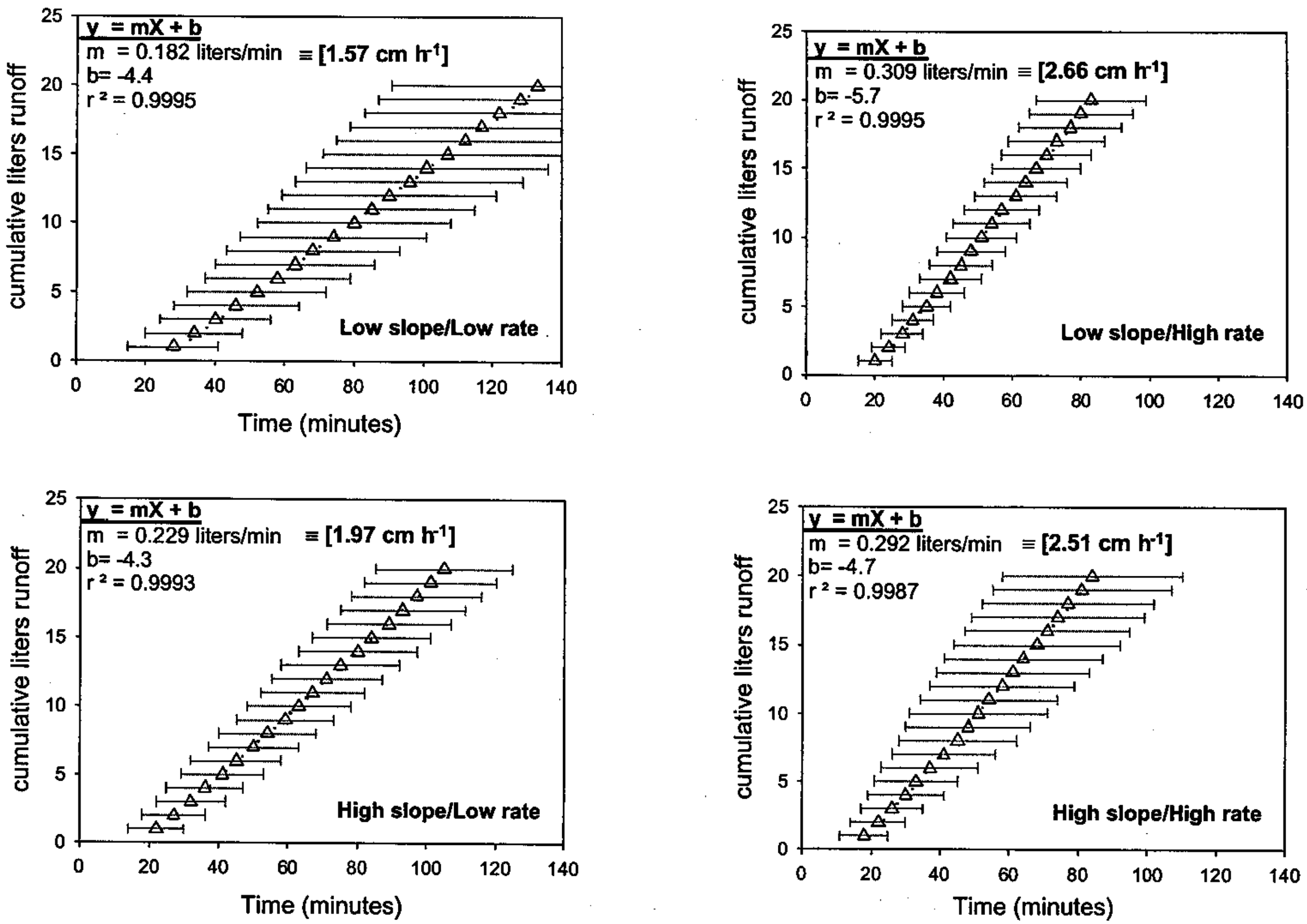


Figure 3. Treatment mean cumulative water runoff curves: cumulative runoff volume vs. mean time. Samples were collected in 1-L increments; The time (+/- SD) is the mean of all 8 plots in the respective water application rate/slope treatment group. The low and high water application rates were 3.18 cm h^{-1} and 4.88 cm h^{-1}, respectively, and the low and high slopes were 2.5% and 5%, respectively.

Figure 4. Homogeniety of variance: diazinon recovery (fraction of applied) by formulation

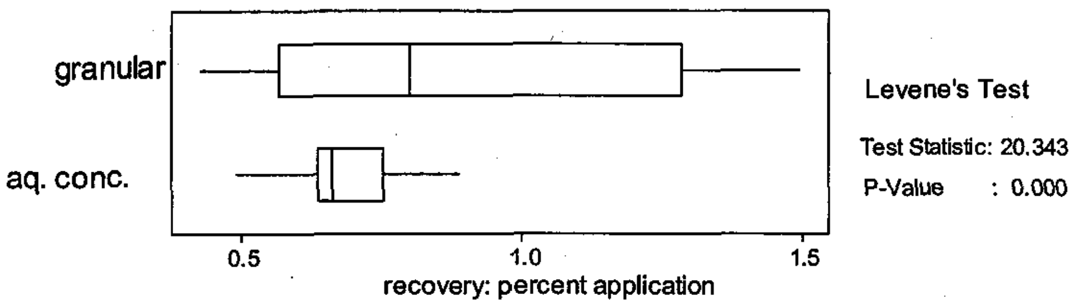
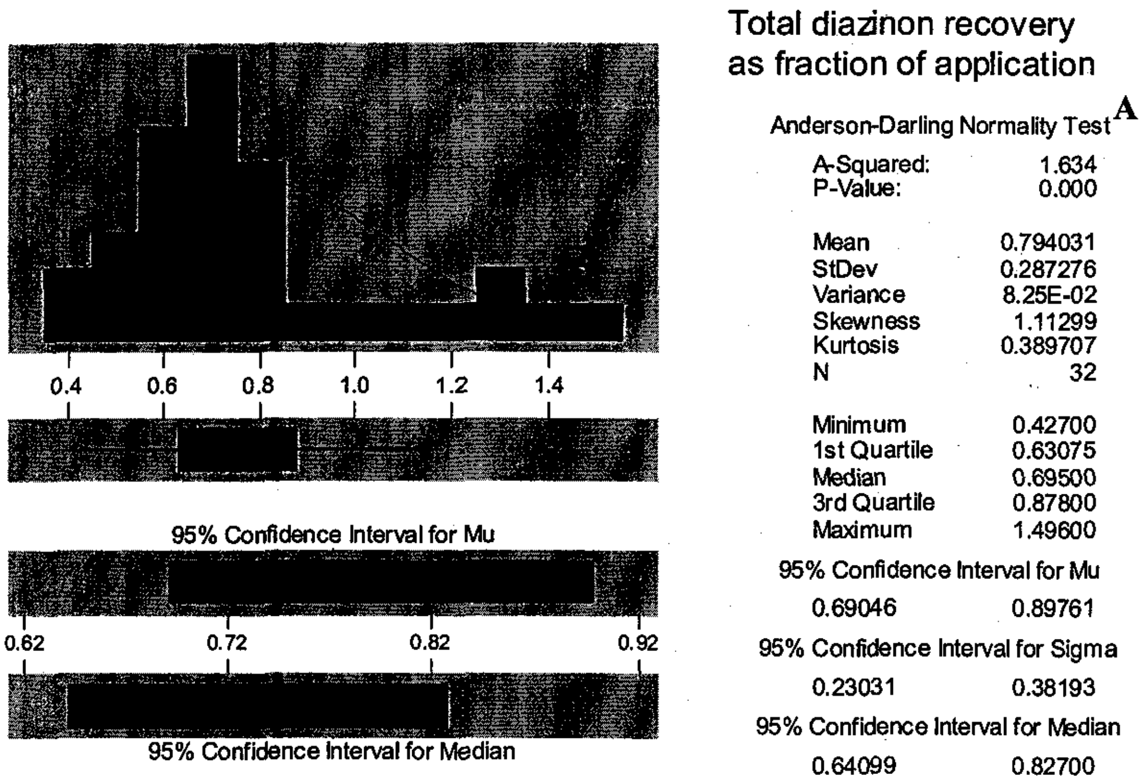


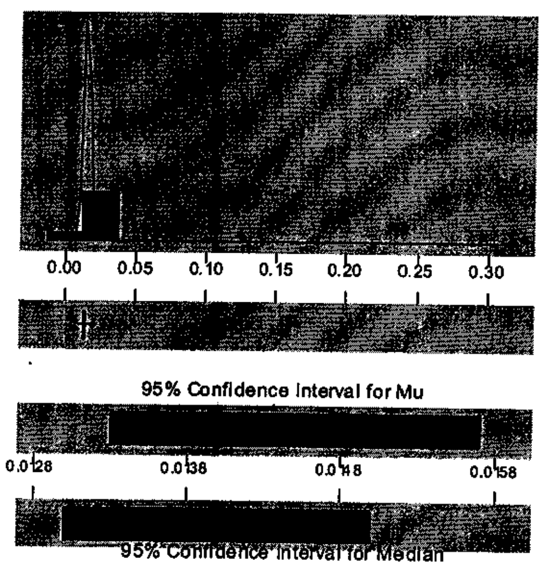
Figure 5. Distribution of recoveries



A Ho: data are normally distributed vs.
H1: data are not normally distributed;
$p < 0.05$, reject Ho

Figure 6. Fraction of applied diazinon recovered off-site by formulation group

granular formulation



Variable: frac in runoff
Group: granular

Anderson-Darling Normality Test A

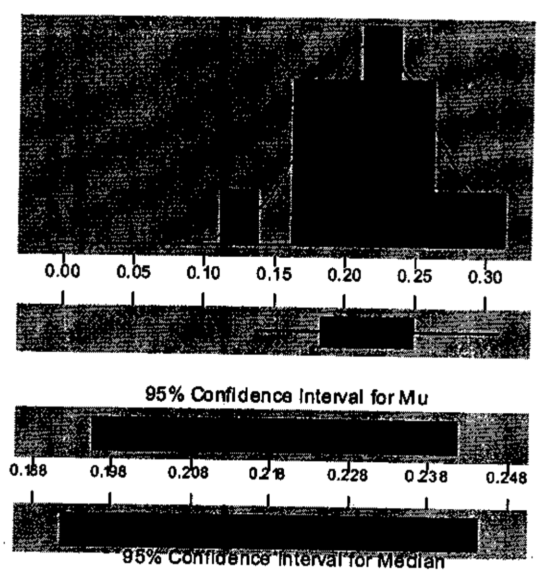
A-Squared:	0.700
P-Value:	0.054
Mean	1.45E-02
StDev	2.25E-03
Variance	5.07E-06
Skewness	1.04218
Kurtosis	1.37165
N	16
Minimum	1.10E-02
1st Quartile	1.30E-02
Median	1.40E-02
3rd Quartile	1.50E-02
Maximum	2.00E-02

95% Confidence Interval for Mu
1.33E-02 1.57E-02

95% Confidence Interval for Sigma
1.66E-03 3.48E-03

95% Confidence Interval for Median
1.30E-02 1.50E-02

aq. concentrate formulation



Variable: frac in runoff
Group: AC

Anderson-Darling Normality Test A

A-Squared:	0.164
P-Value:	0.928
Mean	0.218500
StDev	0.043205
Variance	1.87E-03
Skewness	0.246179
Kurtosis	0.187055
N	16
Minimum	0.137000
1st Quartile	0.184500
Median	0.221000
3rd Quartile	0.248750
Maximum	0.310000

95% Confidence Interval for Mu
0.195478 0.241522

95% Confidence Interval for Sigma
0.031916 0.066868

95% Confidence Interval for Median
0.191678 0.244136

A Ho: data are normally distributed vs.
H1: data are not normally distributed

Figure 7a. Mean runoff curves (mean conc. +/- sd vs. volume) AND cumulative mass vs. volume curves for granular, low slope, low water rate treatment group (plots 7, 13, 23, 30) and granular, low slope, high water rate groups (plots 6,15,21,31)

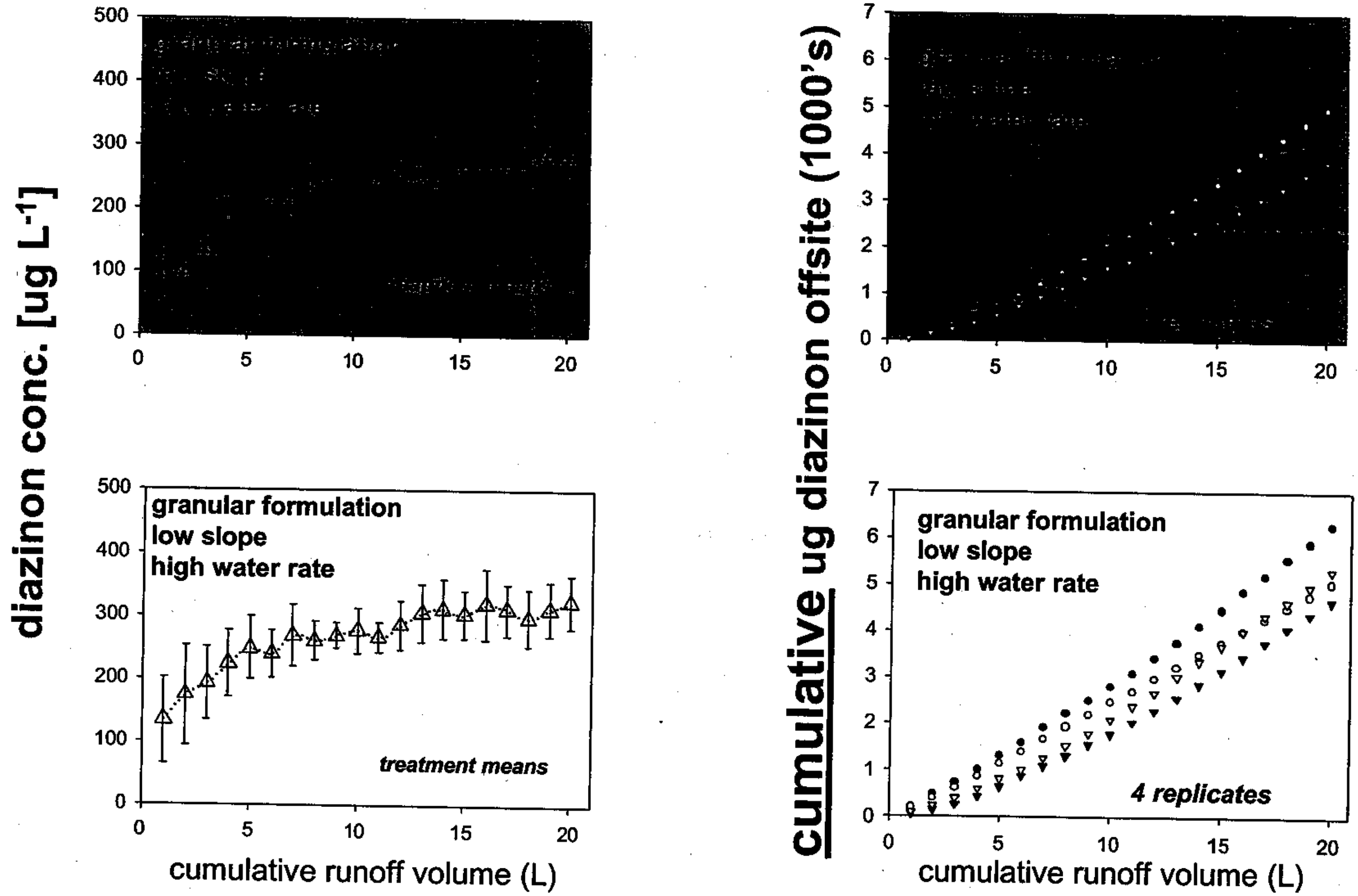


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Figure 7b. Mean runoff profiles (mean conc. +/- sd vs. volume) and cumulative mass vs. volume curves for granular, high slope, low water rate treatment group (plots 1, 10, 20, 25) and granular, high slope, high water rate groups (plots 3,9,18,27)

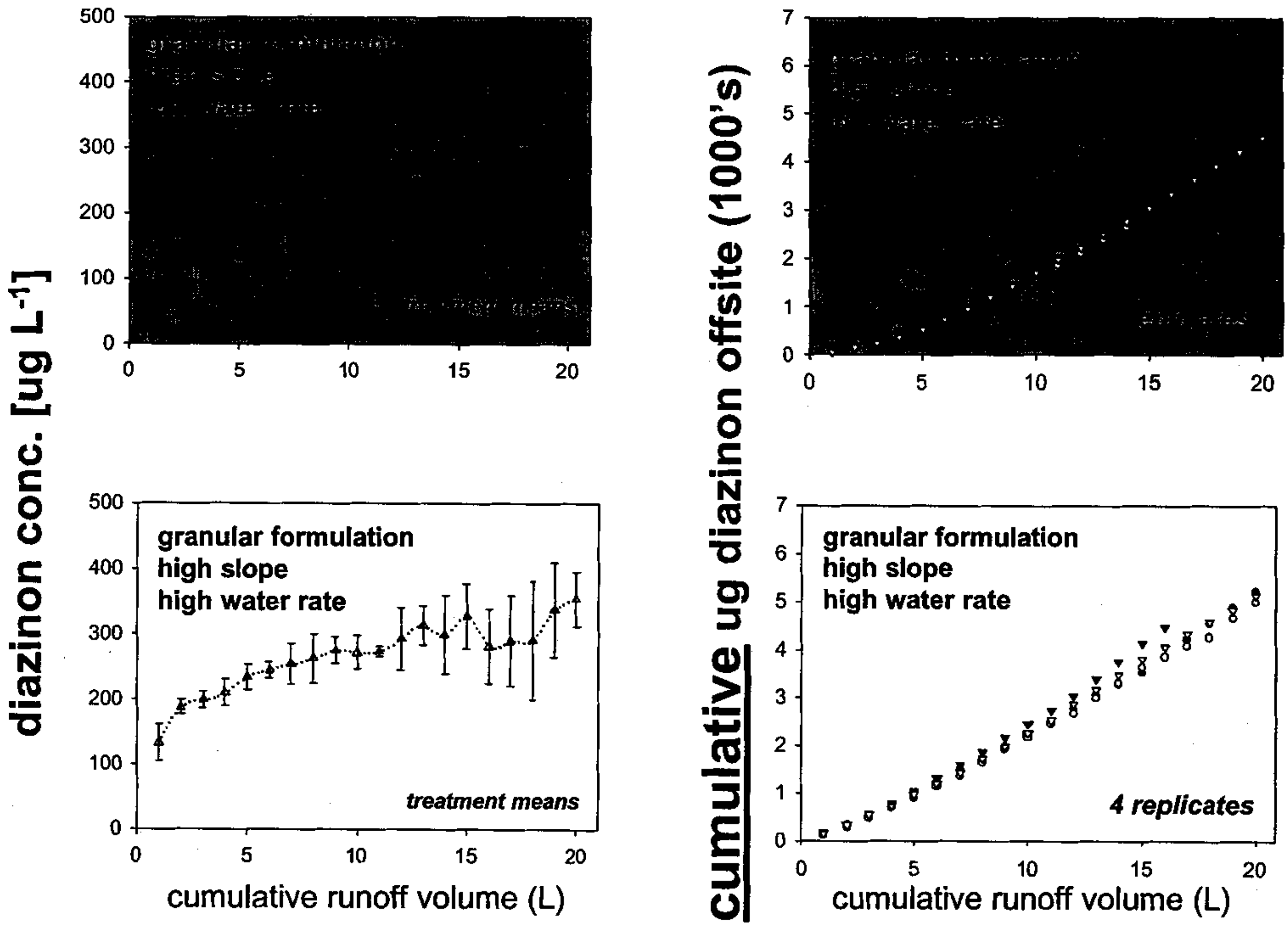

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Figure 7c. Mean runoff curves (mean conc. +/- sd vs. volume) AND cumulative mass vs. volume curves for aqueous concentrate, low slope, low water rate treatment group (plots 5, 16, 22, 32) and aqueous concentrate, low slope, high water rate groups (plots 8,14,24,29)

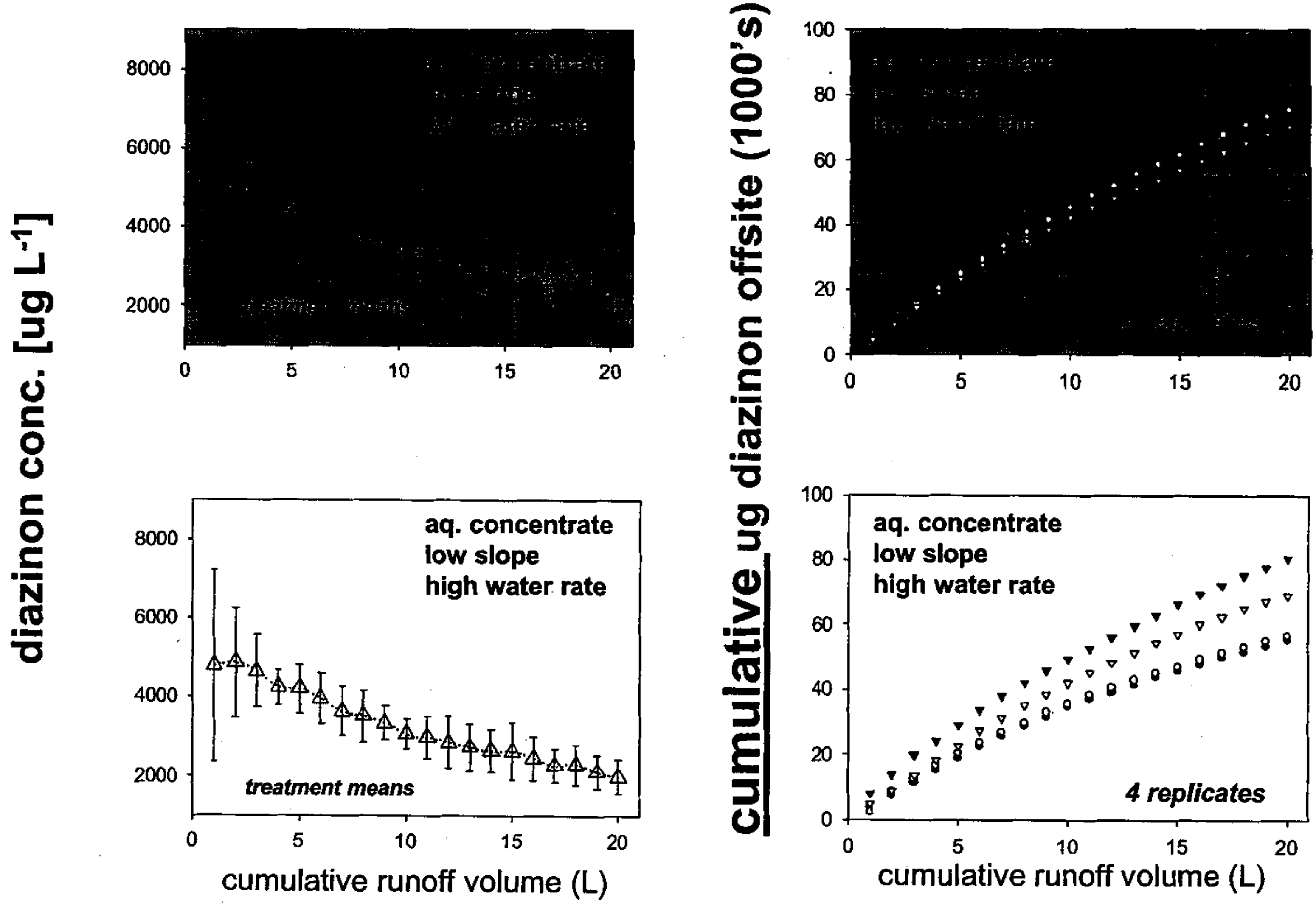
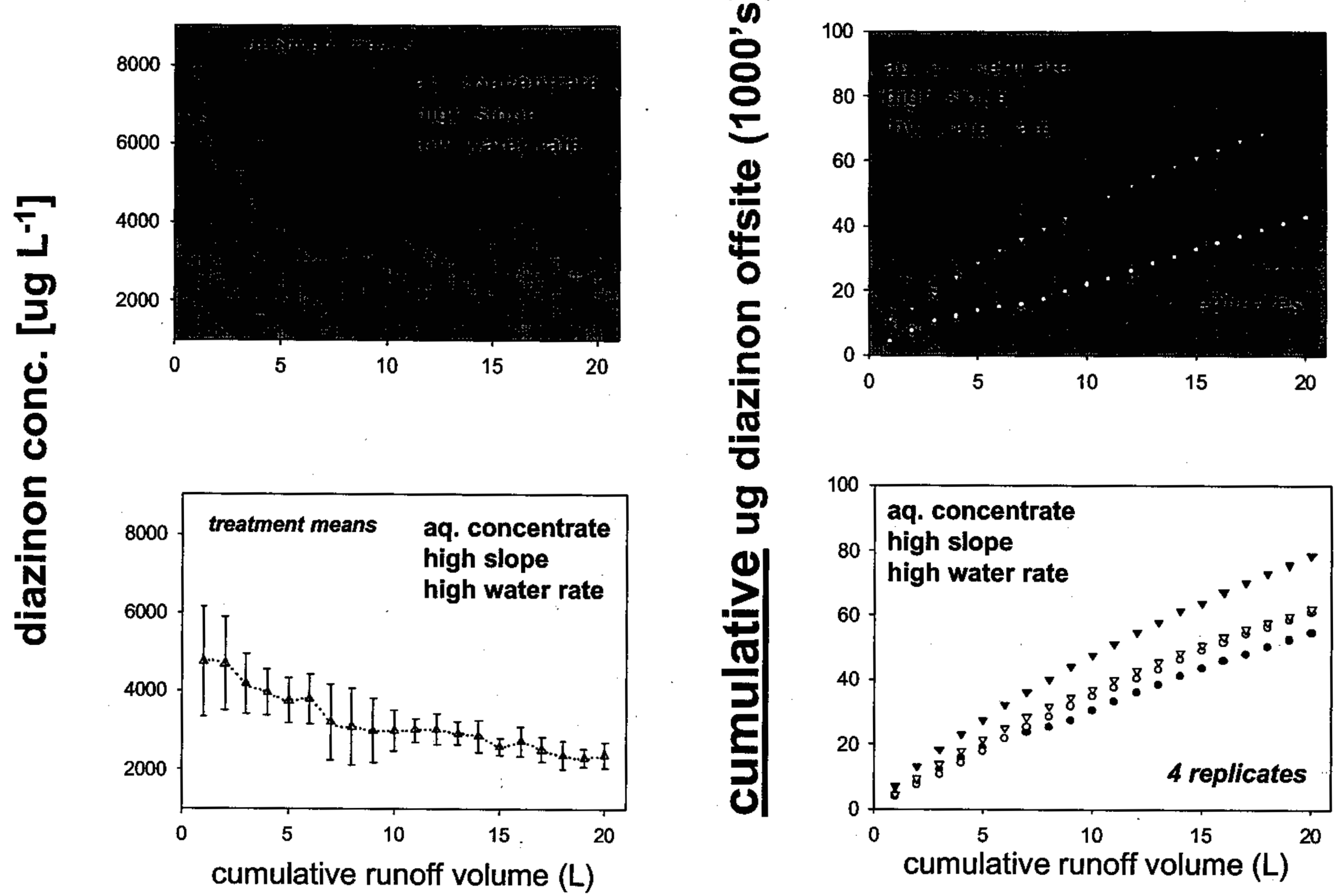


Figure 7d. Mean runoff curves (mean conc. +/- sd vs. volume) AND cumulative mass vs. volume curves for aqueous concentrate, high slope, low water rate treatment group (plots 4, 11, 17, 26) and aqueous, high slope, high water rate groups (plots 2, 12, 19, 28)



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Appendix 1

Analytical method: Analysis of diazinon by GC/FPD

CALIFORNIA DEPT. OF FOOD & AGRICULTURE
Center for Analytical Chemistry
Environmental Monitoring Section
3292 Meadowview Road
Sacramento, CA. 95832
(916) 262-2080 Fax (916) 262-1572

Determination of Organophosphate Pesticides in Surface Water using Gas Chromatography

Scope: This method is for the determination of organophosphate pesticides in surface water. The reporting limit (RL) of the method for diazinon and chlorpyrifos is 0.04 µg/L. Dichlorvos (DDVP), dimethoate, methyl parathion, malathion, ethyl parathion, methidation, phosmet, phosalone, azinphos-methyl, thimet, ethoprop and fonofos have a RL of 0.05 µg/L.

Principle: The surface water sample is extracted with methylene chloride. The extract is passed through sodium sulfate to remove residual water. The anhydrous extract is evaporated to dryness on a rotary evaporator and diluted to a final volume of 1.0 mL with acetone. The extract is then analyzed using a gas chromatograph equipped with a flame photometric detector (FPD).

Reagents, Equipment and Instruments:

Reagents:

1. Methylene Chloride (pesticide residue grade)
2. Acetone (pesticide residue grade)
3. Sodium sulfate, anhydrous
4. Organophosphate pesticide stock standard solutions (1mg/mL): Obtain standards from Center for Analytical Chemistry, CDFA

Equipment:

1. Rotary evaporator (Büchi/Brinkmann)
2. Nitrogen evaporator (Organomation Model # 112)
3. Vortex-vibrating mixer
4. Conical test tube with glass stopper, 15 mL, graduated
5. Separatory funnel, 2 L
6. Boiling flask, 500 mL
7. Whatman filter paper, #4, 15 cm
8. Funnel, long stem, 60°, 100 mm
9. Disposable Pasteur pipettes, 5.75 inches
10. Balance (Mettler PC 4400)

Instrument:

Hewlett Packard 5890 Series II GC with FPD and a HP-1, methyl silicone gum megabore column(10 m x 0.53 mm x 2.65 µm).

Analysis:

Sample Extraction:

1. Remove water samples from refrigerator and allow them to come to room temperature.
2. Record weight of water by weighing sample bottle before and after water has been transferred into a separatory funnel.
3. Extract sample by shaking with 100 mL of methylene chloride for 2 minutes. ***Vent frequently to relieve pressure.***
4. After the phases have separated, drain the lower methylene chloride layer through 20 g of anhydrous sodium sulfate, into a boiling flask.
5. Repeat steps 3 & 4 two more times using 80 mL of methylene chloride each time.
6. After draining the final extraction, rinse the sodium sulfate with 25 mL of methylene chloride.
7. Evaporate the sample extract to just dryness on a rotary evaporator using a 35 °C water bath and approximately 20 inches Hg vacuum.
8. Add 5 mL of acetone and swirl to dissolve the residue in the flask. Transfer the extract to a calibrated 15-mL graduated test tube.
9. Rinse flask 2 more times, each time with 2 mL of acetone and transfer each rinse to the same test tube.
10. Under a gentle stream of nitrogen with no heat applied, evaporate the extract to a volume slightly less than 1 mL. Then, bring to a final volume of 1.0 mL with acetone.
11. Submit extract for GC analysis.

Instrument Conditions

Primary Analysis:

Instrument: Hewlett Packard 5890 Series II GC with FPD
Column: HP-1, methyl silicone gum, 10 m x 0.53 mm x 2.65 µm
Carrier gas: helium, column flow rate 20 mL/min.
Injector temperature: 220 °C
Detector temperature: 250 °C
Injection volume: 3 µL
Column oven temperature:

Initial temperature:	150 °C held for 1 minute
Ramp rate 1:	10 °C/min.
Final temperature:	200 °C held for 2 minutes
Ramp rate 2:	20 °C/min.
Final temperature:	250 °C held for 5 minutes

Confirmation Analysis:

Instrument: Hewlett Packard 5890 Series II GC with FPD
Column: HP-17, 50% phenyl methyl silicone gum, 10 m x 0.53 mm x 2.0µm
Injector temperature: 220 °C
Detector temperature: 250 °C
Injection volume: 3 µL
Column oven temperature:
Same as primary analysis conditions.

Analysis: continued

Chemicals	Retention times: HP-1	HP-17
DDVP	0.68	1.10
Dimethoate	3.25	6.22
Diazinon	4.10	5.36
Methyl Parathion	4.75	7.50
Malathion	5.51	8.21
Chlorpyrifos	5.75	7.93
Methidathion	6.67	10.36
Phosmet	10.16	13.71
Azinphos-Methyl	10.72	15.14
Ethoprop	2.67	3.96
Thimet	3.16	4.56
Fonofos	3.89	5.62
Ethyl parathion	5.70	8.38
Phosalone	10.81	13.49

Calculations:

$$\mu g/L = \frac{\text{(peak ht of sample) (std. conc.) (std. vol. injected) (final vol. sample, mL) (1000 } \mu L/mL)}{\text{(peak ht. std) (sample vol. injected) (sample wt., g)}}$$

Method Performance:

Quality Control:

A three point calibration curve (0.04 ng/µL, 0.08 ng/µL and 0.2 ng/µL) was obtained at the beginning and the end of each set of samples. Each samples shall be injected two times to insure reliability of the analysis. If a sample signal is greater than the highest standard, dilute the sample. Reinject the diluted sample and standards twice more.

Recovery Data:

Method validation was made by spiking 1000 g of American River water with five different levels of spikes (0.08, 0.2, 0.5, 1.0, and 5.0 µg/L) and a blank for five different days (see appendix I). Recoveries of the analytes are summarized below:

Recovery of Organophosphate Pesticides in Surface Water

Organophosphate Pesticides	Spike level (µg/L)	# Spike (n)	Mean Recovery (%)	Standard Deviation (Based on % Recovery)
DDVP	0.08	5	90.5	6.94
	0.2	5	90.3	6.19
	0.5	5	85.0	10.4
	1.0	5	82.9	3.83
	5.0	5	87.6	8.64

Method Performance: continued

Organophosphate Pesticides	Spike level (µg/L)	# Spike (n)	Mean Recovery (%)	Standard Deviation (Based on % Recovery)
Dimethoate	0.08	5	102	3.14
	0.2.	5	98.0	9.15
	0.5	5	103	5.11
	1.0	5	96.9	9.03
	5.0	5	96.2	5.58
Diazinon	0.08	5	95.5	5.77
	0.2	5	88.4	8.86
	0.5	5	90.7	4.40
	1.0	5	85.9	4.55
	5.0	5	89.6	4.24
Methyl Parathion	0.08	5	97.8	9.50
	0.2	5	101	8.62
	0.5	5	97.8	6.16
	1.0	5	93.7	4.36
	5.0	5	94.0	5.44
Malathion	0.08	5	96.3	8.79
	0.2	5	95.1	9.67
	0.5	5	95.4	3.25
	1.0	5	92.0	4.41
	5.0	5	94.3	3.83
Ethyl parathion	0.08	5	101	13.5
	0.2	5	97.0	4.65
	0.5	5	91.0	6.82
	1.0	5	93.7	8.55
	5.0	5	93.2	5.52
Chlorpyrifos	0.08	5	95.8	7.58
	0.2	5	96.7	9.39
	0.5	5	93.8	1.67
	1.0	5	90.8	6.18
	5.0	5	92.6	2.71
Methidathion	0.08	5	102	7.23
	0.2	5	104	9.50
	0.5	5	93.0	2.26
	1.0	5	96.1	5.66
	5.0	5	95.4	4.49

Method Performance: continued

Organophosphate Pesticides	Spike level (µg/L)	# Spike (n)	Mean Recovery (%)	Standard Deviation (Based on % Recovery)
Phosmet	0.08	5	95.8	8.13
	0.2	5	103	8.36
	0.5	5	97.2	3.64
	1.0	5	99.9	9.30
	5.0	5	97.3	4.66
Azinphos-Methyl	0.08	5	96.0	2.05
	0.2	5	103	7.55
	0.5	5	98.2	4.32
	1.0	5	110	6.03
	5.0	5	98.4	3.20
Phosalone	0.08	5	98.3	4.42
	0.2	5	103	6.96
	0.5	5	92.4	5.65
	1.0	5	102	5.89
	5.0	5	101	5.30
Thimet	0.08	5	90.0	7.86
	0.2	5	83.6	5.19
	0.5	5	82.7	4.12
	1.0	5	86.7	9.07
	5.0	5	82.9	9.45
Ethoprop	0.08	5	92.8	7.26
	0.2	5	89.9	6.69
	0.5	5	88.9	4.13
	1.0	5	90.6	10.1
	5.0	5	92.5	6.15
Fonofos	0.08	5	91.0	10.1
	0.2	5	89.4	5.59
	0.5	5	85.2	4.28
	1.0	5	86.7	9.81
	5.0	5	89.7	7.09

Method Performance: continued

Method Detection Limit:

Data used to calculated the method detection limit (MDL) is in appendix II. The MDL is as follows:

Compound	STDEV (µg/L)	MDL (µg/L)
DDVP	0.003	0.009
Ethoprop	0.005	0.016
Dimethoate	0.003	0.009
Thimet	0.005	0.016
Fonofos	0.004	0.013
Diazinon	0.003	0.009
M. Parathion	0.003	0.009
Malathion	0.004	0.013
E. Parathion	0.003	0.009
Chlorpyrifos	0.004	0.013
Methidathion	0.008	0.025
Phosmet	0.004	0.013
Azinphos methyl	0.008	0.025
Phosalone	0.004	0.013

These are the minimum concentrations of the above compounds that can be reported with 99% confidence. The method detection limit (MDL) was computed based on the following procedure:
a) Prepared 7 replicates of the analytes at 0.05 µg/L using American River water.
b) Compute the MDL as follows:

$$MDL = t \times S$$

where;
t is the Student 't' value for the 99% confidence level with n-1 degrees of freedom ($n-1$, $1-\alpha = 0.99$). n represents the number of replicates.
S denotes the standard deviation obtained from replicate analyses.

Reporting Limit

The reporting limits (RL) for diazinon and chlorpyrifos are 0.04 µg/L. For the remaining compounds, the RL is 0.05 µg/L. The MDL is used as a guide to determine the RL for this method. The RL is 1 - 5 times the MDL.

Discussion:

Methidathion, phosmet, azinphos methyl and phosalone compounds were enhanced by the matrix used in the validation. To eliminate the matrix problem, spike samples at level of 0.08, 0.2 and 0.5 ppb were calculated using standards prepared in blank matrix extract. The 0.08 and 0.2 µg/mL standards were prepared by pipetting 1 mL of background matrix into different test tubes and evaporating them to dryness in a nitrogen evaporator at 40 °C. Then, 1 ml of the working

Discussion: continued

standard was pipetted into the test tube separately and mixed well. These standards were used to calculate the 0.08 and 0.2 µg/L spikes. The 0.5 µg/mL standard was prepared by pipetting 0.2 mL of background matrix extract into a test tube and evaporating it to dryness in a nitrogen evaporator at 40 °C. Then, 1 mL of 0.5 µg/mL working standard was pipetted into the test tube and mixed well. This standard was used to calculate the 0.5 µg/L spikes. The 1.0 and 5.0 µg/L spikes were calculated using standards without addition of background matrix extract.

Several peaks were noted in the chromatograms of the blank and samples that had the same retention times as those of phosmet, phosalone and azinphos-methyl. These interferences may have been caused by impurities in the sodium sulfate used. The interfering peaks disappeared after the sodium sulfate used in extraction had been washed with methylene chloride. To avoid these interferences, it is recommended that the sodium sulfate should be washed with methylene chloride prior to use.

Reference:

1. *SOP QAQC001.0,* California Department of Pesticide Regulation, Environmental Hazards Assessment Program, 1995.

2. *Method 8141, Organophosphorus Pesticides, Capillary Colum*n. EPA Test Methods for Evaluating Solid Waste. Revised Methods, 1987.

3. *EPA Method 507, Pesticides, Capillary Column.* EPA Test Method for Drinking water and raw source water, 1987.

Written By: Jean Hsu

Title: Agricultural Chemist II

Updated By: Jorge L. Hernandez

Title: Agricultural Chemist I

Approved By: Catherine Cooper

Title: Agricultural Chemist III

Appendix I

Day 1 - OP's Method Validation						
	Results in ug/L					
Analyte	Blank	0.08 ng/uL	0.2 ng/uL	0.5 ng/uL	1.0 ng/uL	5.0 ng/uL
DDVP	ND	0.064	0.164	0.437	0.817	4.57
Cygon	ND	0.085	0.201	0.527	0.918	4.88
Diazinon	ND	0.072	0.164	0.459	0.830	4.69
M. Parathion	ND	0.085	0.209	0.541	0.970	5.12
Malathion	ND	0.074	0.180	0.482	0.860	4.80
Dursban	ND	0.072	0.178	0.467	0.816	4.66
Supracide	ND	0.082	0.208	0.475	0.892	4.67
Imidan	ND	0.073	0.215	0.485	0.861	5.20
Guthion	ND	0.076	0.203	0.502	1.07	4.79
Ethoprop	ND	0.078	0.200	0.447	1.00	4.88
Timet	ND	0.074	0.184	0.394	0.938	4.63
Fonofos	ND	0.075	0.194	0.409	0.959	4.75
E. Parathion	ND	0.080	0.204	0.425	1.02	4.92
Zolone	ND	0.072	0.225	0.413	1.01	5.21

Day 2 - OP's Method Validation						
	Results in ug/L					
Analyte	Blank	0.08 ng/uL	0.2 ng/uL	0.5 ng/uL	1.0 ng/uL	5.0 ng/uL
DDVP	ND	0.079	0.198	0.500	0.879	5.01
Cygon	ND	0.080	0.169	0.544	1.09	5.22
Diazinon	ND	0.080	0.198	0.487	0.937	4.68
M. Parathion	ND	0.084	0.211	0.490	0.959	4.79
Malathion	ND	0.085	0.207	0.499	0.972	4.86
Dursban	ND	0.085	0.212	0.480	0.921	4.61
Supracide	ND	0.091	0.232	0.467	1.03	5.10
Imidan	ND	0.072	0.196	0.466	1.09	4.99
Guthion	ND	0.075	0.208	0.519	1.15	5.08
Ethoprop	ND	0.073	0.186	0.433	0.768	4.12
Timet	ND	0.069	0.168	0.411	0.710	3.83
Fonofos	ND	0.069	0.186	0.420	0.701	3.98
E. Parathion	ND	0.072	0.187	0.430	0.803	4.21
Zolone	ND	0.073	0.195	0.470	0.932	4.68

Appendix I (cont)

Day 3 - OP's Method Validation						
	Results in ug/L					
Analyte	Blank	0.08 ng/uL	0.2 ng/uL	0.5 ng/uL	1.0 ng/uL	5.0 ng/uL
DDVP	ND	0.075	0.177	0.422	0.783	4.07
Cygon	ND	0.080	0.205	0.477	0.851	4.64
Diazinon	ND	0.078	0.187	0.447	0.824	4.41
M. Parathion	ND	0.079	0.203	0.466	0.863	4.55
Malathion	ND	0.082	0.202	0.482	0.895	4.77
Dursban	ND	0.080	0.206	0.472	0.878	4.83
Supracide	ND	0.080	0.196	0.474	0.913	4.83
Imidan	ND	0.079	0.183	0.490	0.962	4.85
Guthion	ND	0.079	0.209	0.464	1.01	4.71
Ethoprop	ND	0.065	0.166	0.416	0.848	4.61
Timet	ND	0.066	0.165	0.393	0.876	3.53
Fonofos	ND	0.066	0.172	0.404	0.898	4.52
E. Parathion	ND	0.071	0.185	0.448	0.927	4.63
Zolone	ND	0.074	0.213	0.484	1.07	4.87

Day 4 - OP's Method Validation						
	Results in ug/L					
Analyte	Blank	0.08 ng/uL	0.2 ng/uL	0.5 ng/uL	1.0 ng/uL	5.0 ng/uL
DDVP	ND	0.073	0.179	0.409	0.811	3.91
Cygon	ND	0.079	0.188	0.517	1.02	4.49
Diazinon	ND	0.081	0.154	0.447	0.847	4.18
M. Parathion	ND	0.066	0.171	0.467	0.933	4.41
Malathion	ND	0.067	0.161	0.457	0.923	4.38
Dursban	ND	0.070	0.169	0.457	0.961	4.45
Supracide	ND	0.075	0.183	0.447	0.984	4.49
Imidan	ND	0.087	0.213	0.514	1.01	4.66
Guthion	ND	0.076	0.183	0.494	1.16	4.98
Ethoprop	ND	0.075	0.174	0.457	1.00	4.66
Timet	ND	0.082	0.163	0.432	0.898	4.18
Fonofos	ND	0.086	0.176	0.446	0.905	4.31
E. Parathion	ND	0.098	0.204	0.510	1.01	4.69
Zolone	ND	0.075	0.201	0.477	1.08	5.29

Appendix I (cont)

Day 5 - OP's Method Validation						
	Results in ug/L					
Analyte	Blank	0.08 ng/uL	0.2 ng/uL	0.5 ng/uL	1.0 ng/uL	5.0 ng/uL
DDVP	ND	0.071	0.185	0.356	0.857	4.34
Cygon	ND	0.083	0.217	0.501	0.974	4.83
Diazinon	ND	0.071	0.181	0.427	0.859	4.45
M. Parathion	ND	0.077	0.212	0.480	0.960	4.61
Malathion	ND	0.077	0.201	0.466	0.949	4.75
Dursban	ND	0.076	0.202	0.469	0.962	4.62
Supracide	ND	0.082	0.218	0.463	0.985	4.76
Imidan	ND	0.072	0.225	0.475	1.08	4.65
Guthion	ND	0.078	0.225	0.476	1.10	5.03
Ethoprop	ND	0.080	0.173	0.469	0.911	4.86
Timet	ND	0.069	0.156	0.437	0.914	4.56
Fonofos	ND	0.068	0.166	0.451	0.874	4.87
E. Parathion	ND	0.081	0.190	0.462	0.934	4.84
Zolone	ND	0.081	0.191	0.466	1.01	5.21

Apendix II

MDL - OP's Method

Analyte	Blank	Spk 1	Spk 2	Spk 3	Spk 4	Spk 5	Spk 6	Spk 7	STDEV	MDL (ug/L)	RL (ug/L)
	Results in ppb										
DDVP	0.000	0.040	0.035	0.046	0.040	0.040	0.042	0.039	0.003	0.009	0.05
ETHOPROP	0.000	0.043	0.049	0.036	0.043	0.051	0.043	0.047	0.005	0.016	0.05
CYGON	0.000	0.053	0.050	0.052	0.047	0.046	0.050	0.047	0.003	0.009	0.05
TIMET	0.000	0.038	0.050	0.038	0.044	0.049	0.041	0.047	0.005	0.016	0.05
FONOFOS	0.000	0.040	0.044	0.036	0.043	0.049	0.044	0.046	0.004	0.013	0.05
DIAZINON	0.000	0.052	0.044	0.050	0.045	0.043	0.047	0.045	0.003	0.009	0.04
M. PARATHION	0.000	0.053	0.048	0.046	0.046	0.045	0.050	0.044	0.003	0.009	0.05
MALATION	0.000	0.054	0.048	0.051	0.044	0.043	0.049	0.044	0.004	0.013	0.05
E. PARATHION	0.000	0.046	0.052	0.045	0.047	0.052	0.048	0.049	0.003	0.009	0.05
DURSBAN	0.000	0.052	0.046	0.051	0.043	0.042	0.050	0.043	0.004	0.013	0.04
SUPRACIDE	0.000	0.069	0.052	0.055	0.049	0.046	0.052	0.045	0.008	0.025	0.05
IMIDAN	0.000	0.079	0.073	0.080	0.073	0.068	0.071	0.071	0.004	0.013	0.05
GUTHION	0.000	0.071	0.061	0.078	0.061	0.058	0.057	0.056	0.008	0.025	0.05
ZOLONE	0.000	0.044	0.052	0.052	0.050	0.056	0.055	0.056	0.004	0.013	0.05

Appendix 2

QA/QC data
matrix blanks and spikes

Study 194 - QC for Diazinon Turf Runoff Study Summer 2001 - Matrix Spikes

Analyte: Diazinon | QC Matrix: American river water
Reporting Limit: .04g/L | Method: GC
Lab: CDFA | Spike Level: 0.08ug/L

Extraction Date	CDFA Lab No.	Spike Level	Result in ppb	% Recovery	RPD rel. % difference
6/18/01	137	0.08	0.074	93.0	3.6
	138	0.08	0.072	89.8	
6/18/01	140	0.08	0.069	85.6	7.7
	141	0.08	0.074	92.5	
6/18/01	143	0.08	[redacted]	[redacted]	50
	144	0.08	[redacted]	[redacted]	
6/19/01	146	0.08	[redacted]	[redacted]	61
	147	0.08	0.071	88.3	
6/19/01	149	0.08	0.077	95.6	13
	150	0.08	0.087	109	
6/19/01	152	0.08	0.066	82.9	24
	153	0.08	0.084	105	
6/19/01	155	0.08	0.064	80.0	18
	156	0.08	0.076	95.5	
6/19/01	158	0.08	0.076	95.3	0.3
	159	0.08	0.076	95.0	
6/19/01	161	0.08	0.077	95.9	8.6
	162	0.08	0.084	105	
6/20/01	164	0.08	0.099	124	39
	165	0.08	[redacted]	[redacted]	
6/20/01	167	0.08	[redacted]	[redacted]	18
	168	0.08	0.092	115	
6/20/01	170	0.08	0.072	89.6	6.9
	171	0.08	0.077	96.0	
6/20/01	173	0.08	0.075	93.9	8.6
	174	0.08	0.069	86.1	
6/20/01	176	0.08	0.085	106	22
	177	0.08	0.068	84.8	

* Matrix blanks on 6/18 and 6/19 had reportable levels of diazinon.
* Matrix spikes on 6/18 and 6/20 had recoveries that were out of control limits.
* This was believed to be due to contamination (carry-over) from the high levels
* of diazinon in the samples.
* The samples contained levels at the 100 to 6000 ppb range.
* Contamination was at .04 to .3 ppb levels.
* For subsequent samples the spike level and RL were raised and samples diluted

	Mean	124
	spike min	80.0
Control Limits	LCL	61.0
	UCL	125
	spike max	498

LCL = Lower Control Limit : Method Validation Mean minus 3 X SD
UCL = Upper Control Limit : Method Validation Mean plus 3 X SD

Study 194 - QC for Diazinon Turf Runoff Study Summer 2001 - Matrix Spikes

Analyte: Diazinon	QC Matrix: American river water
Reporting Limit: 1ug/L	Method: GC
Lab: CDFA	Spike Level: 5.000ug/L

Extraction Date	CDFA Lab No.	Spike Level	Result in ppb	% Recovery	RPD rel. % difference
6/25/01	196	5.0	4.757	95.1	4.8
	197	5.0	4.989	100	
6/25/01	199	5.0	5.497	110	12
	200	5.0	4.870	97.4	
6/25/01	202	5.0	4.980	100	6.9
	203	5.0	5.337	107	
6/25/01	205	5.0	5.206	104	6.2
	206	5.0	5.541	111	
6/26/01	208	5.0	3.984	79.7	0.3
	209	5.0	3.995	79.9	
6/26/01	211	5.0	5.221	104	3.2
	212	5.0	5.059	101	
6/26/01	214	5.0	4.986	100	1.3
	215	5.0	5.050	101	
6/26/01	217	5.0	5.146	103	0.8
	218	5.0	5.188	104	
6/27/01	220	5.0	4.914	98.3	8.7
	221	5.0	4.506	90.1	
6/27/01	223	5.0	4.364	87.3	1.7
	224	5.0	4.440	88.8	
6/27/01	226	5.0	4.620	92.4	5.8
	227	5.0	4.360	87.2	
6/27/01	229	5.0	4.434	88.7	0.3
	230	5.0	4.419	88.4	
6/27/01	232	5.0	4.610	92.2	2.6
	233	5.0	4.732	94.6	
6/27/01	235	5.0	4.855	97.1	3.8
	236	5.0	4.675	93.5	
6/28/01	238	5.0	5.008	100	0.5
	239	5.0	5.032	101	
6/28/01	241	5.0	5.246	105	4.9
	242	5.0	5.507	110	

	Mean	97.2
	spike min	79.7
Control Limits	LCL	61.0
	UCL	125
	spike max	111

LCL = Lower Control Limit : Method Validation Mean minus 3 X SD
UCL = Upper Control Limit : Method Validation Mean plus 3 X SD

One matrix blank was run with each extraction set, no detections were found.

Study 194 - QC for Diazinon Turf Runoff Study Summer 2001 - Matrix Spikes

Analyte: Diazinon | QC Matrix: American river water
Reporting Limit: 1ug/L | Method: GC
Lab: CDFA | Spike Level: 5.000ug/L

Extraction Date	CDFA Lab No.	Spike Level	Result in ppb	% Recovery	RPD rel. % difference
6/29/01	244	5.0	5.102	102	0.4
	245	5.0	5.121	102	
6/29/01	247	5.0	5.012	100	0.7
	248	5.0	4.975	100	
7/9/01	556	5.0	4.976	100	0.6
	557	5.0	4.946	98.9	
7/9/01	559	5.0	4.507	90.1	0.6
	560	5.0	4.535	90.7	
7/9/01	562	5.0	4.112	82.2	1.6
	563	5.0	4.046	80.9	
7/9/01	565	5.0	4.270	85.4	0.2
	566	5.0	4.277	85.5	
7/9/01	567	5.0	4.460	89.2	2.2
	568	5.0	4.560	91.2	
7/10/01	570	5.0	4.412	88.2	6.4
	571	5.0	4.704	94.1	
7/10/01	573	5.0	4.775	95.5	4.5
	574	5.0	4.995	100	
7/10/01	576	5.0	4.392	87.8	6.0
	577	5.0	4.135	82.7	
7/10/01	579	5.0	4.607	92.1	1.4
	580	5.0	4.674	93.5	
7/11/01	582	5.0	4.675	93.5	3.4
	583	5.0	4.835	96.7	
7/11/01	585	5.0	4.653	93.1	10
	586	5.0	4.204	84.1	
7/11/01	588	5.0	4.431	88.6	3.0
	589	5.0	4.298	86.0	
7/11/01	591	5.0	4.281	85.6	9.4
	592	5.0	3.898	78.0	
7/12/01	594	5.0	4.335	86.7	7.4
	595	5.0	4.025	80.5	
7/12/01	597	5.0	4.055	81.1	5.5
	598	5.0	4.284	85.7	
7/12/01	600	5.0	4.107	82.1	0.6
	601	5.0	4.083	81.7	

	Mean	89.9
	spike min	78.0
Control Limits	LCL	61.0
	UCL	125
	spike max	102

LCL = Lower Control Limit : Method Validation Mean minus 3 X SD
UCL = Upper Control Limit : Method Validation Mean plus 3 X SD

One matrix blank was run with each extraction set, no detections were found.

Study 194 - QC for Diazinon Turf Runoff Study Summer 2001 - Matrix Spikes

Analyte: Diazinon — QC Matrix: American river water
Reporting Limit: 1ug/L — Method: GC
Lab: CDFA — Spike Level: 5.000ug/L

Extraction Date	CDFA Lab No.	Spike Level	Result in ppb	% Recovery	RPD rel. % difference
7/16/01	614	5.0	4.641	92.8	6.5
	615	5.0	4.952	99.0	
7/16/01	617	5.0	5.214	104	5.4
	618	5.0	4.941	98.8	
7/16/01	620	5.0	5.123	102	15
	621	5.0	4.412	88.2	
7/16/01	623	5.0	4.523	90.5	13
	624	5.0	5.164	103	
7/17/01	626	5.0	4.439	88.8	7.0
	627	5.0	4.137	82.7	
7/17/01	629	5.0	4.938	98.8	0.2
	630	5.0	4.948	99.0	
7/17/01	632	5.0	4.366	87.3	1.8
	633	5.0	4.287	85.7	
7/17/01	632	5.0	4.366	87.3	1.8
	633	5.0	4.287	85.7	
7/17/01	635	5.0	5.224	104	1.3
	636	5.0	5.294	106	
7/18/01	638	5.0	4.423	88.5	1.7
	639	5.0	4.348	87.0	
7/18/01	641	5.0	4.634	92.7	0.8
	642	5.0	4.596	91.9	
7/18/01	644	5.0	4.089	81.8	6.5
	645	5.0	3.830	76.6	
7/18/01	647	5.0	5.130	103	5.4
	648	5.0	4.858	97.2	
7/19/01	650	5.0	4.293	85.9	1.9
	651	5.0	4.377	87.5	
7/19/01	653	5.0	4.975	100	13
	654	5.0	4.365	87.3	
7/19/01	656	5.0	4.412	88.2	0.4
	657	5.0	4.394	87.9	
7/19/01	659	5.0	4.598	92.0	2.7
	660	5.0	4.477	89.5	

	Mean	92.4
	spike min	76.6
Control Limits	LCL	61.0
	UCL	125
	spike max	106

LCL = Lower Control Limit : Method Validation Mean minus 3 X SD
UCL = Upper Control Limit : Method Validation Mean plus 3 X SD

One matrix blank was run with each extraction set, no detections were found.

Appendix 3

Analysis of Variance

APPENDIX 3. ANOVA TABLES

3A. Response variable = Total water applied (cm)
Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values	
formulat	fixed	2	gran	EC
slope	fixed	2	hs	ls
water	fixed	2	hw	lw

gran = granular
EC = emulsifiable concentrate
hs = high slope = 5%
ls = low slope = 2.5%
hw = high water application rate = 4.9 cm h^{-1}
lw = low water application rate = 3.2 cm h^{-1}

Analysis of Variance for cm total water applied

Source	DF	SS	MS	F	P
formulat	1	0.471	0.471	0.16	0.694
slope	1	3.636	3.636	1.22	0.280
water	1	1.616	1.616	0.54	0.468
formulat*slope	1	9.346	9.346	3.14	0.089
formulat*water	1	3.586	3.586	1.21	0.283
slope*water	1	4.566	4.566	1.53	0.227
formulat*slope*water	1	0.016	0.016	0.01	0.942
Error	24	71.398	2.975		
Total	31	94.635			

Anderson-Darling Normality Test: residuals
H0: data follow a normal distribution vs. H1: data do not follow a normal distribution
A-Squared: 0.367
P-Value: 0.411

3B. Response variable = Runoff rate (l min^{-1})
Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values	
slope	fixed	2	hs	ls
water	fixed	2	hw	lw

hs = high slope = 5%
ls = low slope = 2.5%
hw = high water application rate = 4.9 cm h^{-1}
lw = low water application rate = 3.2 cm h^{-1}

Analysis of Variance for runoff rate l min^{-1}

Source	DF	SS	MS	F	P
slope	1	0.001632	0.001632	0.51	0.482
water	1	0.080210	0.080210	24.96	[redacted]
slope*water	1	0.004790	0.004790	1.49	0.232
Error	28	0.089984	0.003214		
Total	31	0.176615			

Anderson-Darling Normality Test: residuals
H0: data follow a normal distribution vs. H1: data do not follow a normal distribution
A-Squared: 0.244
P-Value: 0.744

3C. Response variable = Fraction of applied diazinon recovered
Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values	
formulat	fixed	2	gran	EC
slope	fixed	2	hs	ls
water	fixed	2	hw	lw

gran = granular
EC = emulsifiable concentrate
hs = high slope = 5%
ls = low slope = 2.5%
hw = high water application rate = 4.9 cm h^{-1}
lw = low water application rate = 3.2 cm h^{-1}

1. untransformed data

Analysis of Variance for recovery

Source	DF	SS	MS	F	P
formulat	1	0.34590	0.34590	4.55	[redacted]
slope	1	0.19516	0.19516	2.57	0.122
water	1	0.00463	0.00463	0.06	0.807
formulat*slope	1	0.03491	0.03491	0.46	0.504
formulat*water	1	0.04583	0.04583	0.60	0.445
slope*water	1	0.06186	0.06186	0.81	0.376
formulat*slope*water	1	0.04689	0.04689	0.62	0.440
Error	24	1.82315	0.07596		
Total	31	2.55834			

Anderson-Darling Normality Test: residuals
H0: data follow a normal distribution vs. H1: data do not follow a normal distribution
A-Squared: 0.502
P-Value: 0.191

2. rank-transformed data

Analysis of Variance for rank_recovery

Source	DF	SS	MS	F	P
formulat	1	105.12	105.12	1.14	0.296
slope	1	242.00	242.00	2.63	0.118
water	1	45.12	45.12	0.49	0.491
formulat*slope	1	3.12	3.12	0.03	0.855
formulat*water	1	0.50	0.50	0.01	0.942
slope*water	1	91.12	91.12	0.99	0.330
formulat*slope*water	1	32.00	32.00	0.35	0.561
Error	24	2209.00	92.04		
Total	31	2728.00			

Anderson-Darling Normality Test: residuals
H0: data follow a normal distribution vs. H1: data do not follow a normal distribution
A-Squared: 0.469
P-Value: 0.233

3D. Response variable = Fraction of applied diazinon recovered in runoff
Analysis of Variance (Balanced Designs)

Factor	Type	Levels	Values	
formulat	fixed	2	gran	EC
slope	fixed	2	hs	ls
water	fixed	2	hw	lw

gran = granular
EC = emulsifiable concentrate
hs = high slope = 5%
ls = low slope = 2.5%
hw = high water application rate = 4.9 cm h^{-1}
lw = low water application rate = 3.2 cm h^{-1}

1. untransformed data

Source	DF	SS	MS	F	P
formulat	1	0.332928	0.332928	309.45	[redacted]
slope	1	0.000055	0.000055	0.05	0.823
water	1	0.000925	0.000925	0.86	0.363
formulat*slope	1	0.000105	0.000105	0.10	0.757
formulat*water	1	0.001152	0.001152	1.07	0.311
slope*water	1	0.000003	0.000003	0.00	0.957
formulat*slope*water	1	0.000015	0.000015	0.01	0.907
Error	24	0.025821	0.001076		
Total	31	0.361004			

Anderson-Darling Normality Test: residuals
H0: data follow a normal distribution vs. H1: data do not follow a normal distribution
A-Squared: 2.400
P-Value: [redacted]

2. rank-transformed data

Source	DF	SS	MS	F	P
formulat	1	2048.00	2048.00	90.81	[redacted]
slope	1	2.00	2.00	0.09	0.768
water	1	4.50	4.50	0.20	0.659
formulat*slope	1	18.00	18.00	0.80	0.381
formulat*water	1	98.00	98.00	4.35	0.048
slope*water	1	0.13	0.13	0.01	0.941
formulat*slope*water	1	1.13	1.13	0.05	0.825
Error	24	541.25	22.55		
Total	31	2713.00			

Anderson-Darling Normality Test: residuals
H0: data follow a normal distribution vs. H1: data do not follow a normal distribution
A-Squared: 0.235
P-Value: 0.772

Appendix 4

Concentration/Volume/Time Data
by plot

Study 194 - Results for Surface Water Runoff for Diazinon Turf Runoff Study Summer 2001

Analyte: Diazinon | Date of Sampling: 6/01 - 7/01
Reporting Limit: 1ug/L | Matrix: Runoff Water
Method: GC/FPD | Lab: CDFA

	Granular - Low Slope - Low Water											
Runoff Order	Plot 7 ug/L	time in minutes	water (inches)	Plot 13 ug/L	time in minutes	water (inches)	Plot 23 ug/L	time in minutes	water (inches)	Plot 30 ug/L	time in minutes	water (inches)
1	136	54	1.13	95.7	34.0	0.71	114	32	0.67	40.9	18.0	0.38
2	171	9	0.19	72.0	9.0	0.19	72.1	6.0	0.13	86.1	6	0.13
3	201	9	0.19	136	8	0.17	97.5	6.0	0.13	109	4	0.08
4	208	9	0.19	192	9	0.19	209	6	0.13	138	4	0.08
5	244	9	0.19	215	8	0.17	216	6	0.13	162	4	0.08
6	270	6	0.13	230	9	0.19	186	6	0.13	186	5	0.10
7	197	9	0.19	252	7	0.15	223	5	0.10	196	3	0.06
8	210	9	0.19	256	8	0.17	278	4	0.08	207	4	0.08
9	255	9	0.19	260	9	0.19	273	5	0.10	209	4	0.08
10	259	8	0.17	204	10	0.21	239	6	0.13	226	4	0.08
11	250	7	0.15	310	6	0.13	272	5	0.10	140	3	0.06
12	243	9	0.19	290	7	0.15	253	6	0.13	215	4	0.08
13	250	9	0.19	262	8	0.17	265	5	0.10	214	4	0.08
14	250	9	0.19	254	7	0.15	260	5	0.10	210	3	0.06
15	259	7	0.15	327	7	0.15	256	5	0.10	228	4	0.08
16	261	8	0.17	318	5	0.10	291	5	0.10	203	3	0.06
17	265	8	0.17	342	4	0.08	221	5	0.10	253	4	0.08
18	270	7	0.15	314	7	0.15	266	5	0.10	244	3	0.06
19	280	9	0.19	312	5	0.10	266	6	0.13	288	3	0.06
20	289	7	0.15	329	4	0.08	242	6	0.13	281	3	0.06
Totals	4768	211	4.40	4971	171	3.56	4500	135	2.81	3836	90	1.88

	Mean of Total Diazinon Runoff in ug	Mean of Total Time in minutes	Mean of Total Water (inches)
Mean	4519	152	3.16
SD	494	52	1.07
CV	11	34	34

Samples are 1 liter surface water samples taken as they drained from the plot.
Liquid and granular formulations were applied at 4.0 and 4.5 lbs ai per acre, respectively.
Low Slope = ~ 2.5% Low water = 1.25"/hour
High Slope = ~5% High water = 1.92"/hour

Study 194 - Results for Surface Water Runoff for Diazinon Turf Runoff Study Summer 2001

Analyte: Diazinon	Date of Sampling: 6/01 - 7/01
Reporting Limit: 1ug/L	Matrix: Runoff Water
Method: GC/FPD	Lab: CDFA

	Granular - Low Slope - High Water											
Runoff Order	Plot 6 ug/L	time in minutes	water (inches)	Plot 15 ug/L	time in minutes	water (inches)	Plot 21 ug/L	time in minutes	water (inches)	Plot 31 ug/L	time in minutes	water (inches)
1	200	27	0.86	181	25	0.80	56.4	14.0	0.45	100	20	0.64
2	261	6	0.19	213	4	0.13	82.0	3.0	0.10	140	4	0.13
3	257	4	0.13	222	3	0.10	127	3	0.10	164	4	0.13
4	279	5	0.16	258	3	0.10	170	4	0.13	189	3	0.10
5	310	5	0.16	268	3	0.10	209	2	0.06	208	4	0.13
6	281	5	0.16	257	4	0.13	228	2	0.06	195	4	0.13
7	326	5	0.16	278	3	0.10	207	3	0.10	263	2	0.06
8	300	4	0.13	254	3	0.10	224	2	0.06	267	3	0.10
9	298	4	0.13	257	3	0.10	253	3	0.10	266	3	0.10
10	304	4	0.13	277	3	0.10	226	2	0.06	302	3	0.10
11	257	4	0.13	241	3	0.10	266	3	0.10	298	3	0.10
12	338	5	0.16	270	2	0.06	245	3	0.10	290	4	0.13
13	344	5	0.16	257	3	0.10	274	3	0.10	344	3	0.10
14	364	4	0.13	257	3	0.10	290	3	0.10	335	3	0.10
15	338	4	0.13	253	4	0.13	294	2	0.06	328	3	0.10
16	395	5	0.16	263	3	0.10	295	3	0.10	321	4	0.13
17	346	4	0.13	252	3	0.10	316	3	0.10	331	3	0.10
18	354	5	0.16	247	3	0.10	301	2	0.06	290	4	0.13
19	350	4	0.13	256	3	0.10	303	3	0.10	338	3	0.10
20	367	4	0.13	281	2	0.06	294	3	0.10	350	3	0.10
Totals	6269	113	3.62	5042	83	2.66	4660	66	2.11	5319	83	2.66

	Mean of Total Diazinon Runoff in ug	Mean of Total Time in minutes	Mean of Total Water (inches)
Mean	5323	86	2.76
SD	686	20	0.63
CV	13	23	23

Samples are 1 liter surface water samples taken as they drained from the plot.
Liquid and granular formulations were applied at 4.0 and 4.5 lbs ai per acre, respectively.

Low Slope = ~ 2.5% Low water = 1.25"/hour

High Slope = ~5% High water = 1.92"/hour

Study 194 - Results for Surface Water Runoff for Diazinon Turf Runoff Study Summer 2001

Analyte: Diazinon
Reporting Limit: 1ug/L
Method: GC/FPD

Date of Sampling: 6/01 - 7/01
Matrix: Runoff Water
Lab: CDFA

	Granular - High Slope - Low Water											
Runoff Order	Plot 1 ug/L	time in minutes	water (inches)	Plot 10 ug/L	time in minutes	water (inches)	Plot 20 ug/L	time in minutes	water (inches)	Plot 25 ug/L	time in minutes	water (inches)
1	365	32	0.67	82.6	23.0	0.48	59.2	19.0	0.40	49.9	14	0.29
2	382	7	0.15	88.8	5.0	0.10	111	5	0.10	88.9	4	0.08
3	323	6	0.13	135	4	0.08	138	5	0.10	100	4	0.08
4	344	6	0.13	156	5	0.10	168	4	0.08	115	4	0.08
5	339	5	0.10	162	4	0.08	196	4	0.08	157	3	0.06
6	316	4	0.08	182	4	0.08	150	5	0.10	220	4	0.08
7	335	5	0.10	177	4	0.08	141	4	0.08	232	3	0.06
8	360	4	0.08	220	5	0.10	245	4	0.08	230	3	0.06
9	356	5	0.10	217	5	0.10	257	5	0.10	245	4	0.08
10	426	4	0.08	224	4	0.08	265	4	0.08	264	3	0.06
11	336	4	0.08	226	4	0.08	303	4	0.08	285	4	0.08
12	338	5	0.10	242	4	0.08	325	4	0.08	255	3	0.06
13	358	4	0.08	265	4	0.08	317	4	0.08	276	3	0.06
14	348	4	0.08	274	6	0.13	335	4	0.08	257	4	0.08
15	364	5	0.10		5	0.10	332	4	0.08	282	4	0.08
16	331	4	0.08		6	0.13	330	5	0.10	276	3	0.06
17	383	4	0.08		5	0.10	339	3	0.06	300	4	0.08
18	354	4	0.08	255	5	0.10	346	4	0.08	285	3	0.06
19	382	4	0.08	257	6	0.13			0.00	304	4	0.08
20	409	4	0.08	267	6	0.13			0.00	283	3	0.06
Totals	7149	120	2.50	3430	114	2.38	4357	91	1.90	4505	81	1.69

	Mean of Total Diazinon Runoff in ug	Mean of Total Time in minutes	Mean of Total Water (inches)
Mean	4860	102	2.11
SD	1598	19	0.39
CV	33	18	18

Samples are 1 liter surface water samples taken as they drained from the plot.
Liquid and granular formulations were applied at 4.0 and 4.5 lbs ai per acre, respectively.

Low Slope = ~ 2.5% Low water = 1.25"/hour
High Slope = ~5% High water = 1.92"/hour

Study 194 - Results for Surface Water Runoff for Diazinon Turf Runoff Study Summer 2001

Analyte: Diazinon
Reporting Limit: 1ug/L
Method: GC/FPD

Date of Sampling: 6/01 - 7/01
Matrix: Runoff Water
Lab: CDFA

	[illegible]											
Runoff Order	Plot 3 ug/L	time in minutes	water (inches)	Plot 9 ug/L	time in minutes	water (inches)	Plot 18 ug/L	time in minutes	water (inches)	Plot 27 ug/L	time in minutes	water (inches)
1	123	20	0.64	100	14	0.45	170	16	0.51	138	17	0.54
2	201	3	0.10	183	3	0.10	176	3	0.10	192	4	0.13
3	195	3	0.10	184	3	0.10	202	4	0.13	215	4	0.13
4	209	3	0.10	221	3	0.10	226	3	0.10	182	4	0.13
5	228	3	0.10	210	2	0.06	258	3	0.10	241	3	0.10
6	243	4	0.13	235	2	0.06	264	3	0.10	237	4	0.13
7	281	3	0.10	231	4	0.13	282	3	0.10	223	4	0.13
8	210	3	0.10	266	3	0.10	280	3	0.10	293	3	0.10
9	277	2	0.06	277	2	0.06	296	3	0.10	248	4	0.13
10	256	3	0.10	245	3	0.10	296	2	0.06	291	3	0.10
11	270	2	0.06	277	3	0.10	280	3	0.10	263	3	0.10
12	277	3	0.10	237	2	0.06	308	3	0.10	351	4	0.13
13	279	3	0.10	316	3	0.10	352	4	0.13	306	3	0.10
14	220	3	0.10	319	2	0.06	362	2	0.06	294	4	0.13
15	264	3	0.10	326	2	0.06	386	4	0.13	334	3	0.10
16	321	3	0.10	214	3	0.10	335	2	0.06	257	4	0.13
17	365	3	0.10	227	3	0.10		3	0.10	279	4	0.13
18	323	2	0.06	192	2	0.06	399	3	0.10	249	3	0.10
19	325	3	0.10	394	2	0.06	393	3	0.10	240	4	0.13
20	347	3	0.10	335	3	0.10	414	3	0.10	318	4	0.13
Totals	5214	75	2.40	4989	64	2.05	5679	73	2.34	5151	86	2.75

	Mean of Total Diazinon Runoff in ug	Mean of Total Time in minutes	Mean of Total Water (inches)
Mean	5258	75	2.38
SD	296	9	0.29
CV	6	12	12

Samples are 1 liter surface water samples taken as they drained from the plot.
Liquid and granular formulations were applied at 4.0 and 4.5 lbs ai per acre, respectively.
Low Slope = ~ 2.5% Low water = 1.25"/hour
High Slope = ~5% High water = 1.92"/hour

Study 194 - Results for Surface Water Runoff for Diazinon Turf Runoff Study Summer 2001

Analyte: Diazinon
Reporting Limit: 1ug/L
Method: GC/FPD

Date of Sampling: 6/01 - 7/01
Matrix: Runoff Water
Lab: CDFA

	Liquid - Low Slope - High Water											
Runoff Order	Plot 5 ug/L	time in minutes	water (inches)	Plot 16 ug/L	time in minutes	water (inches)	Plot 22 ug/L	time in minutes	water (inches)	Plot 32 ug/L	time in minutes	water (inches)
1	6790	28	0.58	6180	19	0.40	5720	13	0.27	4380	22	0.46
2	4890	7	0.15	4500	6	0.13	5810	4	0.08	5090	6	0.13
3	4280	7	0.15	4990	5	0.10	5870	4	0.08	4840	5	0.10
4	3650	7	0.15	4650	5	0.10	5700	4	0.08	4740	4	0.08
5	3720	6	0.13	4600	4	0.08	5550	4	0.08	4220	5	0.10
6	3320	6	0.13	4360	4	0.08	4960	4	0.08	4320	5	0.10
7	3160	6	0.13	4340	4	0.08	4860	5	0.10	4070	4	0.08
8	3100	6	0.13	4030	4	0.08	4740	5	0.10	3450	3	0.06
9	2830	6	0.13	3940	4	0.08	4420	4	0.08	3480	5	0.10
10	2610	5	0.10	3640	4	0.08	3730	5	0.10	3620	4	0.08
11	2610	6	0.13	3600	4	0.08	4340	5	0.10	3130	3	0.06
12	2580	7	0.15	3440	4	0.08	3880	5	0.10	2980	4	0.08
13	2520	5	0.10	3260	4	0.08	3740	6	0.13	2880	4	0.08
14	2390	6	0.13	3140	4	0.08	4010	5	0.10	2740	4	0.08
15	2150	6	0.13	3130	5	0.10	3060	5	0.10	2960	4	0.08
16	2230	6	0.13	3050	4	0.08	3120	5	0.10	2690	3	0.06
17	2080	5	0.10	2930	5	0.10	2780	5	0.10	2830	4	0.08
18	2060	6	0.13	2940	5	0.10	3150	6	0.13	2830	4	0.08
19	1940	6	0.13	2830	5	0.10	2970	6	0.13	2780	4	0.08
20	1910	6	0.13	2040	4	0.08	3020	6	0.13	2440	4	0.08
Totals	60820	143	2.98	75590	103	2.15	85430	106	2.21	70470	101	2.10

	Mean of Total Diazinon Runoff in ug	Mean of Total Time in minutes	Mean of Total Water (inches)
Mean	73078	113	2.36
SD	10262	20	0.42
CV	14	18	18

Samples are 1 liter surface water samples taken as they drained from the plot.
Liquid and granular formulations were applied at 4.0 and 4.5 lbs ai per acre, respectively.
Low Slope = ~ 2.5%   Low water = 1.25"/hour
High Slope = ~5%   High water = 1.92"/hour

Study 194 - Results for Surface Water Runoff for Diazinon Turf Runoff Study Summer 2001

Analyte: Diazinon
Reporting Limit: 1ug/L
Method: GC/FPD

Date of Sampling: 6/01 - 7/01
Matrix: Runoff Water
Lab: CDFA

[illegible]

Runoff Order	Plot 8 ug/L	time in minutes	water (inches)	Plot 14 ug/L	time in minutes	water (inches)	Plot 24 ug/L	time in minutes	water (inches)	Plot 29 ug/L	time in minutes	water (inches)
1	3970	24	0.77	2300	19	0.61	8070	17	0.54	4910	17	0.54
2	3570	5	0.16	6340	3	0.10	5750	4	0.13	3830	3	0.10
3	3840	4	0.13	4100	4	0.13	5880	4	0.13	4800	3	0.10
4	3840	3	0.10	4020	3	0.10	4360	4	0.13	4840	2	0.06
5	3680	3	0.10	3760	5	0.16	5000	4	0.13	4400	2	0.06
6	3700	4	0.13	3190	3	0.10	4490	4	0.13	4470	2	0.06
7	3170	4	0.13	3060	4	0.13	4320	3	0.10	4010	2	0.06
8	3150	2	0.06	2820	5	0.16	4190	4	0.13	3930	2	0.06
9	2790	4	0.13	3460	4	0.13	3850	3	0.10	3310	2	0.06
10	3060	3	0.10	2540	3	0.10	3240	4	0.13	3440	2	0.06
11	2380	3	0.10	2670	3	0.10	3460	3	0.10	3370	2	0.06
12	2250	2	0.06	2360	4	0.13	3560	3	0.10	3260	3	0.10
13	2280	3	0.10	2300	4	0.13	3520	3	0.10	2860	3	0.10
14	2190	4	0.13	2210	3	0.10	3260	3	0.10	2920	2	0.06
15	2020	2	0.06	2110	3	0.10	3560	3	0.10	2840	2	0.06
16	1970	3	0.10	2020	3	0.10	2870	4	0.13	2990	3	0.10
17	1890	3	0.10	1990	4	0.13	2850	3	0.10	2380	2	0.06
18	1850	3	0.10	1940	3	0.10	2950	3	0.10	2450	3	0.10
19	1760	3	0.10	1820	3	0.10	2660	3	0.10	2230	2	0.06
20	1910	3	0.10	1670	4	0.13	2630	3	0.10	1820	2	0.06
Totals	55270	85	2.72	56680	87	2.78	80470	82	2.62	69060	61	1.95

	Mean of Total Diazinon Runoff in ug	Mean of Total Time in minutes	Mean of Total Water (inches)
Mean	65370	79	2.52
SD	11820	12	0.38
CV	18	15	15

Samples are 1 liter surface water samples taken as they drained from the plot.
Liquid and granular formulations were applied at 4.0 and 4.5 lbs ai per acre, respectively.
Low Slope = ~ 2.5% Low water = 1.25"/hour
High Slope = ~5% High water = 1.92"/hour

Study 194 - Results for Surface Water Runoff for Diazinon Turf Runoff Study Summer 2001

Analyte: Diazinon
Reporting Limit: 1ug/L
Method: GC/FPD

Date of Sampling: 6/01 - 7/01
Matrix: Runoff Water
Lab: CDFA

	[redacted]											
Runoff Order	Plot 4 ug/L	time in minutes	water (inches)	Plot 11 ug/L	time in minutes	water (inches)	Plot 17 ug/L	time in minutes	water (inches)	Plot 26 ug/L	time in minutes	water (inches)
1	7940	24	0.50	4020	33	0.69	9190	13	0.27	11000	14	0.29
2	7250	6	0.13	3280	7	0.15	6920	4	0.08	3250	4	0.08
3	6750	6	0.13	3060	7	0.15	7080	3	0.06	4750	4	0.08
4	2650	7	0.15	1570	5	0.10	6470	3	0.06	4960	4	0.08
5	2870	5	0.10	1600	5	0.10	5750	4	0.08	4600	5	0.10
6	2750	6	0.13	1270	6	0.13	4450	3	0.06	4040	4	0.08
7	2680	6	0.13	991	5	0.10	5680	4	0.08	3250	5	0.10
8	3080	5	0.10	1560	5	0.10	5060	3	0.06	3190	5	0.10
9	2680	6	0.13	2270	5	0.10	4500	3	0.06	3490	5	0.10
10	2000	6	0.13	2230	5	0.10	4180	4	0.08	3310	5	0.10
11	3540	6	0.13	1890	4	0.08	4490	3	0.06	3500	4	0.08
12	3150	5	0.10	2150	5	0.10	4030	4	0.08	3090	3	0.06
13	2710	6	0.13	2520	4	0.08	4000	4	0.08	2940	3	0.06
14	3220	6	0.13	1973	4	0.08	4030	4	0.08	3060	4	0.08
15	2890	5	0.10	2300	4	0.08	3760	4	0.08	2480	4	0.08
16	2920	5	0.10	1890	4	0.08	3720	4	0.08	2590	3	0.06
17	3000	5	0.10	2060	6	0.13	3530	4	0.08	2640	3	0.06
18	1630	5	0.10	1980	5	0.10	3360	4	0.08	2220	4	0.08
19	2810	4	0.08	2060	4	0.08	3400	4	0.08		3	0.06
20	2660	5	0.10	2070	5	0.10	3290	4	0.08	2672	4	0.08
Totals	69180	129	2.69	42744	128	2.67	96890	83	1.73	71032	90	1.88

	Mean of Total Diazinon Runoff in ug	Mean of Total Time in minutes	Mean of Total Water (inches)
Mean	69962	108	2.24
SD	22119	24	0.51
CV	32	23	23

Samples are 1 liter surface water samples taken as they drained from the plot.
Liquid and granular formulations were applied at 4.0 and 4.5 lbs ai per acre, respectively.

Low Slope = ~ 2.5% Low water = 1.25"/hour
High Slope = ~5% High water = 1.92"/hour

Study 194 - Results for Surface Water Runoff for Diazinon Turf Runoff Study Summer 2001

Analyte: Diazinon
Reporting Limit: 1ug/L
Method: GC/FPD

Date of Sampling: 6/01 - 7/01
Matrix: Runoff Water
Lab: CDFA

	Topical High Slope High Water											
Runoff Order	Plot 2 ug/L	time in minutes	water (inches)	Plot 12 ug/L	time in minutes	water (inches)	Plot 19 ug/L	time in minutes	water (inches)	Plot 28 ug/L	time in minutes	water (inches)
1	4210	18	0.58	3730	35	1.12	6830	15	0.48	4280	10	0.32
2	3950	3	0.10	3570	7	0.22	6220	5	0.16	5040	4	0.13
3	3850	3	0.10	3310	6	0.19	5100	4	0.13	4460	3	0.10
4	3460	3	0.10	3550	7	0.22	4750	4	0.13	4100	3	0.10
5	3240	3	0.10	3640	8	0.26	4570	4	0.13	3540	3	0.10
6	3090	3	0.10	3770	8	0.26	4640	4	0.13	3650	3	0.10
7	1840	3	0.10	3650	7	0.22	4020	4	0.13	3320	3	0.10
8	1700	3	0.10	3320	8	0.26	3980	3	0.10	3360	3	0.10
9	1950	3	0.10	3220	6	0.19	3910	4	0.13	2850	3	0.10
10	3080	3	0.10	2840	6	0.19	3660	4	0.13	2410	2	0.06
11	2720	2	0.06	2890	5	0.16	3410	3	0.10	2990	3	0.10
12	2770	3	0.10	2900	5	0.16	3620	4	0.13	2800	3	0.10
13	2580	3	0.10	2830	5	0.16	3300	3	0.10	2970	3	0.10
14	2530	3	0.10	2870	5	0.16	3410	4	0.13	2580	3	0.10
15	2460	3	0.10	2880	6	0.19	2571	4	0.13	2450	3	0.10
16	2320	3	0.10	2660	5	0.16	3220	4	0.13	2650	2	0.06
17	2260	2	0.06	2400	4	0.13	2960	4	0.13	2400	3	0.10
18	2200	3	0.10	2380	4	0.13	2850	4	0.13	2020	3	0.10
19	2210	3	0.10	2280	4	0.13	2640	4	0.13	2100	3	0.10
20	2110	2	0.06	2330	4	0.13	2860	3	0.10	2220	2	0.06
Totals	54530	72	2.30	61020	145	4.64	78521	88	2.82	62190	65	2.08

	Mean of Total Diazinon Runoff in ug	Mean of Total Time in minutes	Mean of Total Water (inches)
Mean	64065	93	2.96
SD	10209	36	1.16
CV	16	39	39

Samples are 1 liter surface water samples taken as they drained from the plot.
Liquid and granular formulations were applied at 4.0 and 4.5 lbs ai per acre, respectively.

Low Slope = ~ 2.5% Low water = 1.25"/hour
High Slope = ~5% High water = 1.92"/hour