

**MONITORING THE PESTICIDE TREATMENTS OF THE
JAPANESE BEETLE PROJECT
SACRAMENTO COUNTY, CALIFORNIA , 1983-1986
VOLUME II: ISOFENPHOS**

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Environmental Hazards Assessment Program



**STATE OF CALIFORNIA
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EH 89-3

Memorandum

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Date : March 14, 1989

Place : Sacramento

From : **Department of Food and Agriculture** Randall Segawa, Sr. Env. Hazards Scientist
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Subject : Executive Summary for Report EH 89-3: "Monitoring the Pesticide Treatments of the Japanese Beetle, Sacramento County, California, 1983-86 - Volume II: Isofenphos

In the summer of 1983, the Sacramento County Agriculture Department and the California Department of Food and Agriculture (CDFA) initiated a program to eradicate an infestation of the Japanese beetle in Orangevale, California. Part of the eradication program consisted of one application of the pesticide isofenphos to turf areas during the fall of 1983.

The Environmental Hazards Assessment Program of the CDFA monitored isofenphos concentrations in turf, thatch, soil, air, fruit, surface water, and ground water. The majority of isofenphos was confined to turf, thatch, and the upper layers of soil, and was virtually undetectable by week 30. Little off-target movement occurred since very low residues were found in air, surface water runoff, or deeper soil layers. No detectable residues were found in ground water or fruit.

The pesticides carbaryl and diazinon were also used during this eradication program. Monitoring results for these pesticides will be reported separately.

MONITORING THE PESTICIDE TREATMENTS OF THE
JAPANESE BEETLE ERADICATION PROJECT,
SACRAMENTO COUNTY, CALIFORNIA, 1983 - 1986
VOLUME II: ISOFENPHOS

BY

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ENVIRONMENTAL HAZARDS ASSESSMENT PROGRAM

ABSTRACT

The Japanese beetle has the potential of being a serious agricultural pest if it becomes established in California. Therefore, the Sacramento County Agriculture Department and the California Department of Food and Agriculture conducted a program to eradicate an infestation found in the Orangevale area. This program was initiated during the summer of 1983 and continued through the spring of 1986. Part of the eradication program consisted of one application of isofenphos to turf areas during the fall of 1983. Monitoring was conducted by the Environmental Hazards Assessment Program to determine the environmental distribution and fate of isofenphos in turf, thatch, soil, air, fruit, and water.

Turf, thatch and soil were monitored at four locations, for 40 weeks. The highest concentrations in turf and thatch were measured during the week that followed application. The mean concentrations at that time were 68.9 mg/m² in turf and 81.5 mg/m² in thatch, corresponding to 31 and 36 percent of the 224 mg/m² of isofenphos applied, respectively. Concentrations declined to nondetectable levels by week 20 for turf and week 30 for thatch.

Surface soil samples (0-2.5 cm depth) as well as deeper soil core samples (0-15 cm and 15-30 cm depths) were collected. Surface soil was sampled inconsistently until week 8. At that time the mean concentration was 58.4 mg/m² or (3.18 ppm fresh weight), representing 26 percent of the applied isofenphos. For the 0-15 cm depth the highest concentration, 1.15 ppm (fresh weight), occurred during week 8 and declined to nondetectable levels by week 30. For the 15-30 cm depth the highest concentration, 0.64 ppm (fresh weight), occurred during week 1 and declined to nondetectable levels by week 8.

Air concentrations were monitored before, during, and after application at the same four locations as the turf, thatch and soil. Concentrations just before application ranged from none detected to 0.46 ng/m³. Concentrations during application ranged from 21 to 46 ng/m³. Concentrations immediately after application ranged from 9.4 to 32 ng/m³. These concentrations were very low compared to concentrations reported for broadcast applications of other pesticides.

Fruit samples were collected from trees planted in treated turf areas. Eight different types of fruit were collected: almonds, apples, figs, grapes, grapefruit, oranges, persimmons, and walnuts. None of the collected samples contained a detectable amount of isofenphos. In addition, an experimental application to tomato plants by the University of California, Davis, also showed no residues as the result of translocation of isofenphos through roots.

Water monitoring occurred at nine creek sites during rain runoff periods and at two well sites. The highest concentration detected at any of the creek sites was 43.6 ppb on November 10, 1983. The amount of isofenphos leaving

the treatment area through runoff, or mass discharge rate, was estimated by multiplying the water concentration by the flow rate. The highest mass discharge rate measured for all creeks combined was 31 g/hr on December 23, 1983. Even if this rate continued for five days, the total amount discharged would be less than one percent of the 186 kg of isofenphos applied. Samples collected from the American River by the California Department of Fish and Game showed no detectable isofenphos in all samples. Samples collected from the two wells also showed no detectable residue.

The variability of residue concentrations in turf, thatch, and soil made it very difficult to estimate true concentrations, distribution in the different media, and dissipation rates. However, it appears that the majority of isofenphos was confined to turf, thatch, and the upper layers of soil and was virtually undetectable by week 30. It also appears that little off-target movement occurred, since very low or no detectable residue was found in air, fruit, surface runoff, ground water, or deeper soil layers.

PREFACE

This report is the second of three volumes describing the environmental monitoring of the pesticide treatment program to eradicate the Japanese beetle infestation in Sacramento County, California, 1983-1986. This program consisted of nine separate treatments (summer 1983, fall 1983, spring 1984, summer 1984, fall 1984, spring 1985, summer 1985, fall 1985, spring 1986), with multiple applications of pesticides during each treatment. Three different pesticides were used during the program, carbaryl, isofenphos, and diazinon. This report presents the monitoring of the pesticide isofenphos, Volume I describes the carbaryl monitoring and Volume III describes the diazinon monitoring.

Each volume also has two companion documents. The first is a short executive summary which explains the monitoring program in lay terms. The second document is a supplement which contains the raw data summarized in the main report. Both of these documents are available on request.

ACKNOWLEDGMENTS

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We are indebted to the other individuals and agencies which provided cooperative monitoring and/or chemical analyses including the California Department of Fish and Game, the California Department of Health Services, the State Water Resources Control Board, the Central Valley Regional Water Quality Control Board, and the University of California.

Thanks are also extended to the Japanese Beetle Project personnel, and the Sacramento County Agriculture Department for their assistance.

DISCLAIMER

The mention of commercial products, their source or use in connection with material reported herein is not to be construed as an actual or implied endorsement of such product.

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INTRODUCTION

The Japanese beetle, Popillia japonica Newman, has the potential of being a serious agricultural pest if it becomes established in California. Damage occurs as the result of both larval and adult feeding. The larvae feed on the roots of plants, primarily grasses, while adult beetles can feed on the leaves, fruit, and flowers of over 300 plant species (Dowell, 1983). Areas in California with irrigated turf, and host plants for adults to feed on would be a suitable environment for the Japanese beetle.

Knowledge of the life cycle is crucial to the detection and eradication of Japanese beetle. During the summer the insect is in the adult stage and feeds on above ground portions of host plants. Also at this time, adults lay eggs in the soil. When eggs hatch in late summer the larvae feed on roots of plants, continue to feed through fall, and then become inactive in the winter. In the spring the larvae begin to feed again, pupate, and emerge as adults in early summer.

Detection and eradication activities were conducted by the Japanese Beetle Eradication Project, a cooperative effort of the Sacramento County Agriculture Department and the Pest Detection/Emergency Projects Branch of the California Department of Food and Agriculture (CDFA). Detection surveys were conducted in the summer when the adults could be trapped. This was the only time when a population could be detected and the area of the infestation determined. During the summer, the adult population was reduced

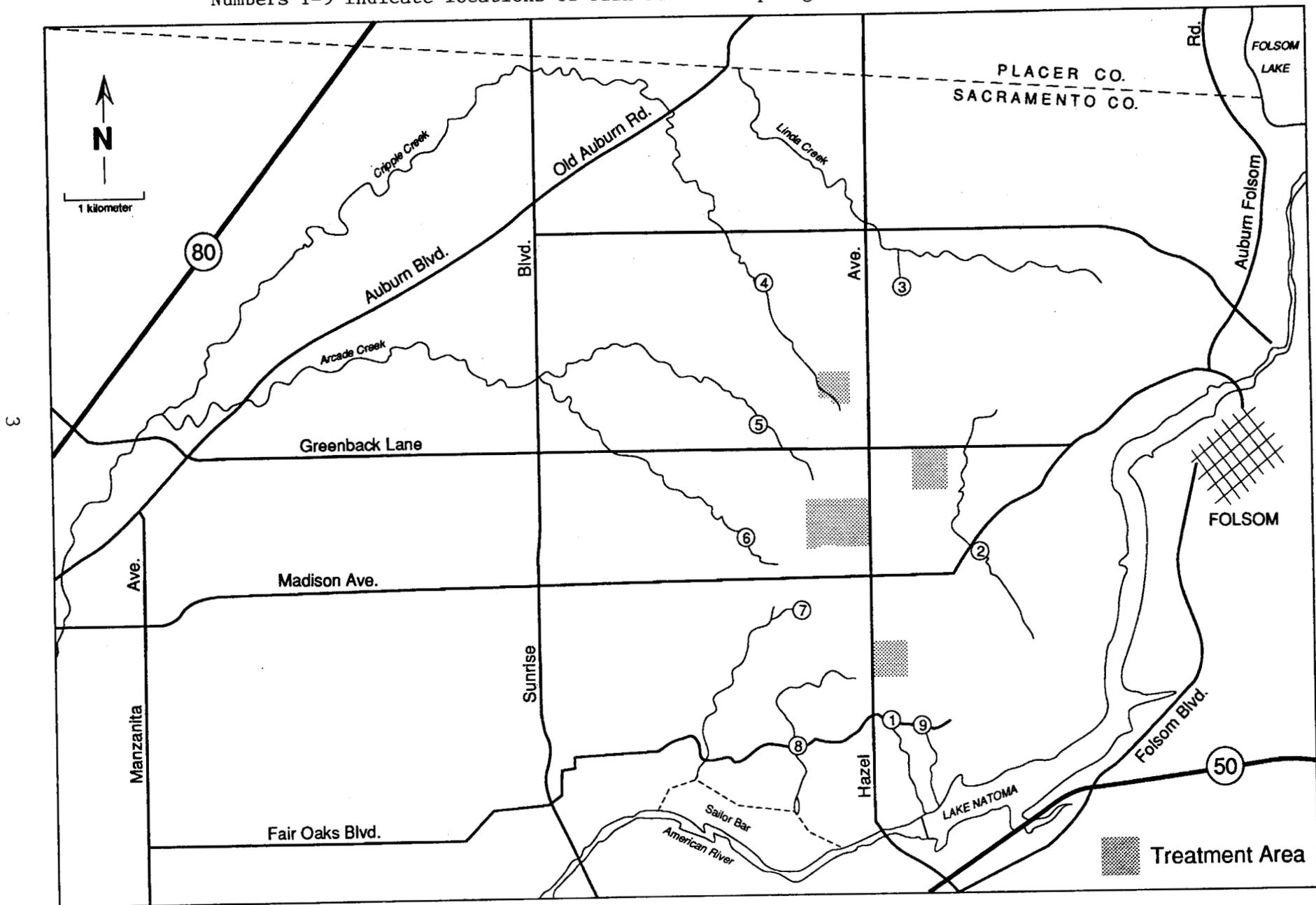
by treating the foliage of host plants in the infested area with the pesticide carbaryl. During the fall and spring, soil pesticide applications of isofenphos and/or diazinon were made to turf, pasture, and fallow garden areas to reduce the larval populations. This two-phase treatment program was successful in eradicating the Japanese beetle infestation. This report describes the monitoring for isofenphos, Volumes I and III describe the monitoring for carbaryl and diazinon, respectively.

The monitoring of the isofenphos treatment was conducted by the Environmental Hazards Assessment Program (EHAP) of the CDFR. The specific objectives of the isofenphos monitoring program were to determine the environmental concentrations and fate of isofenphos. Isofenphos concentrations were measured in turf, thatch, soil, water, air, and fruit.

TREATMENT PROGRAM

The infestation was confined to the northern part of Sacramento County. The majority of the isofenphos treatment area was located in Orangevale. The boundaries are shown in Figure 1. Size of the treatment area and location of the boundaries were crucial only to the water runoff monitoring of creeks.

Figure 1. Isofenphos treatment area, Japanese Beetle Project, Sacramento, 1983-6.
 Numbers 1-9 indicate locations of rain runoff sampling sites.



Oftanol 5G® was the formulated product used by the Japanese Beetle Project. This product is a granular formulation which contains 5% isofenphos as the active ingredient. The product was sampled at the beginning of the program and found to contain 5.23% isofenphos. Isofenphos is an insecticide belonging to the organophosphate family with the following characteristics (Worthing, 1979):

Chemical name: 1-methylethyl 2-[[ethoxy[(1-methylethyl)amino]phosphinothioyl]oxy-benzoate

Chemical Abstracts number: 25311-71-1

Chemical formula: $C_{15}H_{24}NO_4PS$

Molecular weight: 345.4

Water solubility: 23.8 ppm

Vapor pressure: 4×10^{-6} torr at 20°C

LD50: 28 - 38.7 mg/kg, rat, oral

Trade names: Oftanol, Amaze, Pryfon

Isofenphos was used only during the first soil treatment, August 5 through September 23, 1983. The pesticide was a granular formulation and applied with a variety of fertilizer spreaders only to turf areas of residential properties, golf courses, schools, parks, and commercial properties. One application was made to each property at a rate of 2.24 kilograms active ingredient per hectare (2 lb/ac). Immediately after application the turf was watered so the pesticide would penetrate into the lower thatch and surface soil areas where the larvae feed. A total of 186 kg (409 lb) of isofenphos was applied to 83 ha (205 ac), which encompassed 2,050 properties.

MATERIALS AND METHODS

Turf and Thatch Methods

Turf and thatch monitoring occurred at four locations, three residential properties (Locations 01, 03, 04) and one school (Location 06). The sampling locations were selected based on the amount and condition of turf, ease of access, and permission of the owner. The sampling schedule was designed to determine the maximum concentration and dissipation rate for each media. Background samples were collected prior to application; post application samples were collected on the day of application and 1, 2, 4, 8, 12, 20, 30, and 40 weeks after treatment.

Samples were collected from an area of at least 150 square meters at each location. The area to be sampled was divided into a number of sampling "cells" with each cell 1.5 by 1.5 meter. For each sampling date nine cells were randomly selected for sampling. Each sample was a composite of material collected from three of the cells, and three samples were collected on each date. Turf and thatch were collected using a 6.0 centimeter diameter stainless steel tube. The cylinder was inserted into the turf and soil to a depth of approximately 7 cm and the plug of turf and soil was removed from the ground with the cylinder. The plug was pushed out of the cylinder and the turf (defined as the green, growing portion of the grass) was clipped into a glass jar. After the turf was cut off the scissors were cleaned and the thatch (defined as the dead vegetation directly below the turf) was clipped off into a second glass jar. The glass jars were sealed

with a foil-lined lid and kept cold until they were analyzed by the laboratory.

The turf and thatch chemical analyses were conducted by California Analytical Laboratories, Inc. (CAL). All samples were analyzed for isofenphos and its toxic oxygen analog (oxon). For turf and thatch both dislodgable (surface) and internal residue concentrations were determined. The analytical procedure for turf and thatch were the same. Two grams were extracted with a Sur-ten® solution to remove the dislodgable residue. Both the Sur-ten® solution and the leftover vegetation were then extracted with ethyl acetate. The ethyl acetate extracts were analyzed with a gas chromatograph (GC) containing a nitrogen/phosphorous detector (NPD), and a 1.2 meter by two millimeter glass column packed with 10% SP-2250. The detection limit for dislodgable isofenphos was 0.5 ppm, 1.0 ppm for dislodgable oxon, 2.5 ppm for internal isofenphos, and 5.0 ppm for internal oxon.

Analytical quality control included the analysis of spiked samples to determine the amount recovered when known quantities of isofenphos were added to samples. In addition, selected samples were analyzed by the California Department of Health Services, Sanitation and Radiation Laboratory (CDHS). Three turf and three thatch samples were individually homogenized and "split" between CAL and CDHS for comparative analysis.

Turf and thatch laboratory results were reported on a parts per million (ppm) basis. For the purposes of this report the concentrations shown are dislodgable and total (dislodgable + internal) residue. Also, by multiplying the concentration (ppm) by the sample weight (grams) and dividing by the ground surface area (square meters) sampled, the results can be expressed as micrograms of pesticide per square meter of ground area. By expressing the results in this manner the residue concentrations can be related to the application rate (kilograms per hectare) by a simple conversion. Therefore, the results of the turf and thatch as well as the application rate are expressed as milligrams per square meter (mg/m^2) throughout the report.

The statistical analysis consisted of determining the mean for each site and sampling date, and then calculating a grand mean from the site means. Standard deviations and standard errors were also calculated. Regression analysis was then used to estimate a linear model for concentration versus time. Details of these analyses are given in the Results and Discussion Section and Appendix I.

In addition to the normal monitoring, a small scale test was conducted prior to the initiation of the isofenphos treatment. This test, described in Appendix II, examined the amount of dislodgable residue on turf.

Soil Methods

Soil concentrations were monitored at the same locations and used the same time schedule as turf and thatch. Two types of soil samples were collected, surface and core. Surface soil samples were not included in the original monitoring plan, so they were collected infrequently through the week 4 sampling period. Beginning with week 8 period, surface samples were collected every sampling period. Surface soil samples were collected from the same plugs as the turf and thatch. After the turf and thatch were cut off, the top 2.5 cm of soil was placed into a glass jar. Soil core samples from 0-15 and 15-30 cm depths were collected from the same cells as the other samples. Again, three samples were collected from each property and date, with each sample a composite of three subsamples. The core subsamples were collected with a steel Veihmeyer tube, 2.2 cm in diameter. Core samples were placed in glass jars with foil-lined lids. All soil samples were kept cold until they were analyzed by the laboratory.

The soil samples were analyzed by CAL for isofenphos and isofenphos oxon. Five grams of soil were extracted with two 100 ml portions of ethyl acetate. The extracts were analyzed by GC-NPD using the same conditions as the turf and thatch. For quality control spiked soil samples were analyzed. Three split samples were also analyzed by CDHS. The detection limit for isofenphos was 0.1 ppm (fresh weight basis), and 0.2 ppm (fresh weight basis) for the oxon.

Results were reported on a ppm, fresh weight basis. In this report the surface soil concentrations are expressed on both a ppm basis and mg/m² basis just like the turf and thatch. The soil core concentrations are expressed on a ppm basis only. Because so many of the sample concentrations were near or below the detection limit parametric analysis of this data was not possible. Therefore, a contingency table analysis was performed on the occurrence of isofenphos in soil. A complete explanation of the data analysis appears in the Results and Discussion Section and Appendix I.

Air Methods

Air concentrations were monitored at the same four locations as turf, thatch, and soil. A series of three air samples was collected at each location. Samples were collected for six hours the day before application, during the application and watering period, and for six hours immediately after application and watering.

Air samples were collected with General Metal Works® high volume air samplers, calibrated at a rate of 0.85 cubic meters per minute. The samplers pumped air through a cartridge containing Rohm and Haas XAD-2® resin to trap the pesticide. One air sampler was placed as close as possible to the center of the treated area at a height of 50 cm above the turf. After sampling was completed, the cartridges were frozen until they were analyzed by the laboratory.

The air samples were analyzed by the University of California, Davis, Environmental Toxicology Department (UCD) for isofenphos and isofenphos oxon. The XAD-2[®] resin was extracted with two 100 ml portions of ethyl acetate. The extracts were analyzed with a GC equipped with a flame photometric detector (FPD) and a 6 foot by 1/8 inch column containing 1.5% SP-2250 and 1.95% SP-2401. The detection limit for both the isofenphos and the oxon was 50 ng per sample. Air results were reported on a nanograms per sample basis. By dividing the amount of pesticide in the sample (nanograms) by the volume of air sampled (cubic meter), the air concentration (ng/m³) was calculated.

The high volume air samplers can create artificially high values of isofenphos oxon because the large volume of air passed through the XAD-2[®] trapping resin converts the parent isofenphos to the oxon. To determine the amount of conversion and the efficiency of the XAD-2[®] resin in collecting the isofenphos from air, a trapping efficiency test was conducted by UCD.

Fruit Methods

Fruit samples were collected from a number of properties. Since no drift was expected with a granular formulation, fruit residue could only occur by translocation of the isofenphos through the roots. Therefore, only trees planted in turf were sampled. Samples of almonds, apples, figs, grapefruit, grapes, oranges, persimmons, and walnuts were collected from one to three different properties. Fruit samples were collected at two

periods, preharvest and harvest. Depending on the type of fruit this varied from four to 122 days after application.

Composite samples of fruit were collected from all areas of the tree using fruit pickers to collect fruit out of reach. One sample per tree was collected. Approximately one-half kilogram of material was placed in a paper bag for each sample. The samples were kept cold until they were analyzed by the laboratory.

Fruit samples were analyzed by the CDFA Chemistry Laboratory Services Branch for isofenphos and isofenphos oxon. The preparation and analysis for each type of fruit sample was different because of the large matrix differences. Results were reported on a ppm, fresh weight basis. The detection limit for both isofenphos and the oxon was 0.1 ppm (fresh weight basis).

In addition to the normal monitoring, a small scale test was conducted by UCD. This test, described in Appendix III, examined the uptake of isofenphos by tomato plants.

Water Methods

Water samples were collected from nine creek locations and two well locations. The creek sampling sites were located where the highest concentrations were expected, just downstream of the treatment areas. Only one well could be found inside the isofenphos treatment area. However,

since the property did not have any turf, it was not treated. That well and and a second well outside the treatment area were sampled.

Monitoring was conducted during rain runoff events since these were the periods when the highest concentrations were expected. Samples were collected during the first five rain storms. For each rain storm, sampling was initiated when rain runoff could be observed flowing into storm drains. Well samples were collected on January 26, 1984.

Grab samples of water were collected from creeks by dipping with one liter amber glass bottles. The collected samples were kept cold until they were analyzed by the laboratory. Water flow rates were estimated by determining the depth, width, and velocity of the creek at the sampling point. Rainfall was measured using a rain gauge placed in the treatment area. Well samples were collected after a minimum of 15 minutes pumping. Water was collected from Schrader® valves located near the wellhead and before water entered the storage tank. These samples were also collected in one-liter amber glass bottles and stored on ice until analysis.

Water monitoring was also conducted by the California Department of Fish and Game's Pesticide Investigations Unit (CDFG). They collected water samples from the American River area to determine possible impacts to fish, particularly those located in their fish hatchery near Nimbus Dam.

Water samples were analyzed by CAL and the CDFG Water Pollution Control Laboratory for isofenphos and isofenphos oxon using their standard organophosphate methods. Two split samples were also analyzed by the CDHS laboratory. The detection limit for both isofenphos and the oxon was 0.1 ppb.

The concentrations were reported on a parts per billion basis (ppb). The amount of isofenphos leaving the treatment area through runoff, or mass discharge rate ($\mu\text{g}/\text{sec}$), was estimated by multiplying the concentration (ppb or $\mu\text{g}/\text{l}$) by the creek flow rate (l/sec). By adding the discharge rates of all sampling points and making a simple conversion, a total mass discharge rate (g/hr) was calculated.

RESULTS AND DISCUSSION

This section contains the results of the isofenphos monitoring only. The results of the diazinon monitoring and its comparison to the isofenphos results are given in Volume III.

Turf and Thatch

Isofenphos turf and thatch data reported previously in a series of memorandums do not agree with the data presented here for two reasons. First, the results reported previously were calculated assuming negative samples were zeros. The results presented here were calculated assuming the concentrations of negative samples were one-half the detection limit. A detailed explanation for making this assumption is given in Appendix I. Briefly, all that is known about these samples is that they lie somewhere between zero and the detection limit. In the absence of any other information, the value half-way between zero and the detection limit is a more reasonable approximation than simply using zero. Second, the units used previously were mg/ft^2 , while the units used here are mg/m^2 . To convert one to the other the concentrations in mg/ft^2 are multiplied by 10.76 to obtain concentrations in mg/m^2 .

The quality control analyses were inconclusive because when the analytical standard was added to the sample most of the isofenphos penetrated the turf and thatch tissue. When spiked in this manner it was not possible to quantify how much was spiked into the dislodgable fraction and how much was

spiked into the internal fraction. In addition, due to miscommunication, the split samples described in the Materials and Methods Section were analyzed incorrectly, precluding analysis of the split data.

A summary of the turf results is given in Table 1 and Figures 2 and 3, thatch results are given in Table 2 and Figures 4 and 5. For simplicity, the concentration has been reported as the sum of isofenphos and isofenphos oxon. Each mean shown in Tables 1 and 2 is the mean of the four site means for that week, with the standard deviations based on the site means. The standard error of the overall mean was calculated using Formula 10.15 in Cochran (1977), which takes into account the two-stage nature of the sampling. As expected, the maximum concentrations occurred during week 0. The dislodgeable residue constituted only a small fraction of the total amount applied. The 14.0 mg/m^2 found on turf, and 22.8 mg/m^2 found on thatch represent only 6% and 10% of the 224 mg/m^2 theoretical application rate. The amount of dislodgeable residue found on turf agrees with the findings of the preliminary test conducted prior to the program (Appendix II). Total isofenphos concentration (dislodgeable + internal) in turf was 31% of the amount applied, while 36% was contained in the thatch. The dislodgeable concentrations were approaching the detection limit at week 4; therefore, the dislodgeable analysis was discontinued. Total isofenphos concentrations reached the nondetectable level at week 20 for turf and week 30 for thatch.

Table 1. Summary statistics for isofenphos concentrations in turf, Japanese Beetle Project, Sacramento, 1983-6. Concentrations shown represent isofenphos + isofenphos oxon. Statistics are calculated on the four (Locations 01, 03, 04, 06) site means. Values below the detection limit are treated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

	Weeks After Application	N	Isofenphos Concentration, mg/m ²				
			Mean	Standard Deviation	Standard Error	Max	Min
Dislodgable	0	3	14.0	10.4	6.03	26.0	7.06
Dislodg + Internal	0	3	68.9	51.4	29.7	128	31.6
Dislodgable	1	4	9.35	7.21	3.60	19.7	4.20
Dislodg + Internal	1	4	37.2	24.6	12.3	67.0	13.5
Dislodgable	2	4	7.13	5.77	2.88	15.1	2.86
Dislodg + Internal	2	4	18.6	13.6	6.82	37.6	6.93
Dislodgable	4	4	3.10	3.64	1.82	8.54	0.83
Dislodg + Internal	4	4	14.0	17.9	8.93	40.7	3.60
Dislodg + Internal	8	4	21.8	26.8	13.4	60.2	ND (2.56) ^a
Dislodg + Internal	12	4	5.35	1.29	0.64	6.93	ND (3.98)
Dislodg + Internal	20	4	ND (6.78)	0.65	0.32	ND (7.37)	ND (5.98)
Dislodg + Internal	30	4	ND (3.02)	0.76	0.38	ND (3.92)	ND (2.08)
Dislodg + Internal	40	4	ND (2.18)	0.48	0.24	ND (2.89)	ND (1.86)

a ND - None Detected, with the value indicating 1/2 the detection limit. The detection limit changes because of variation in sample weights.

Figure 2. Dislodgeable Isofenphos in Turf Samples.

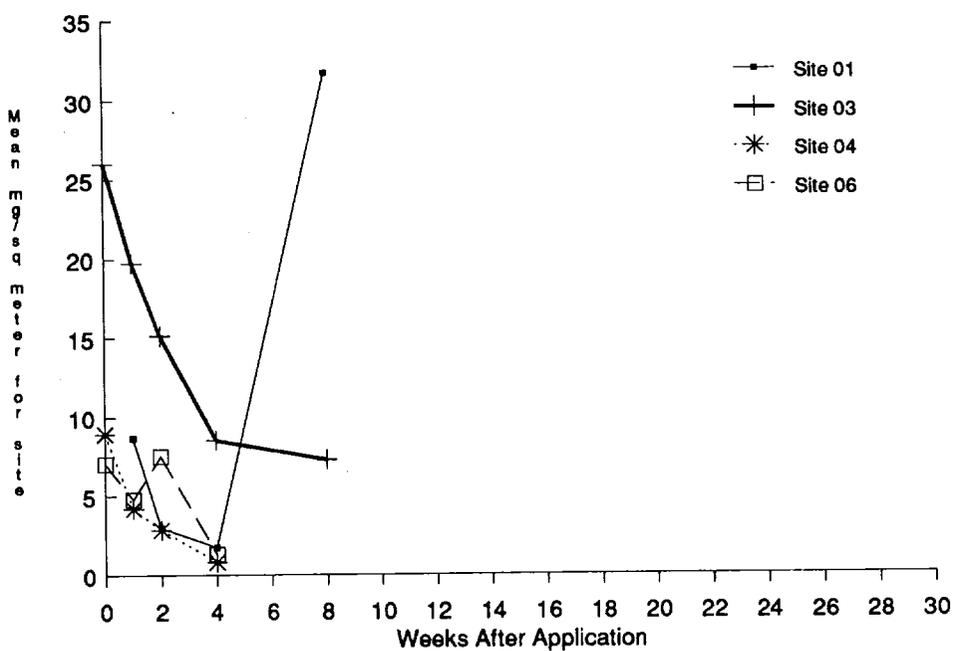


Figure 3. Total Isofenphos in Turf Samples.

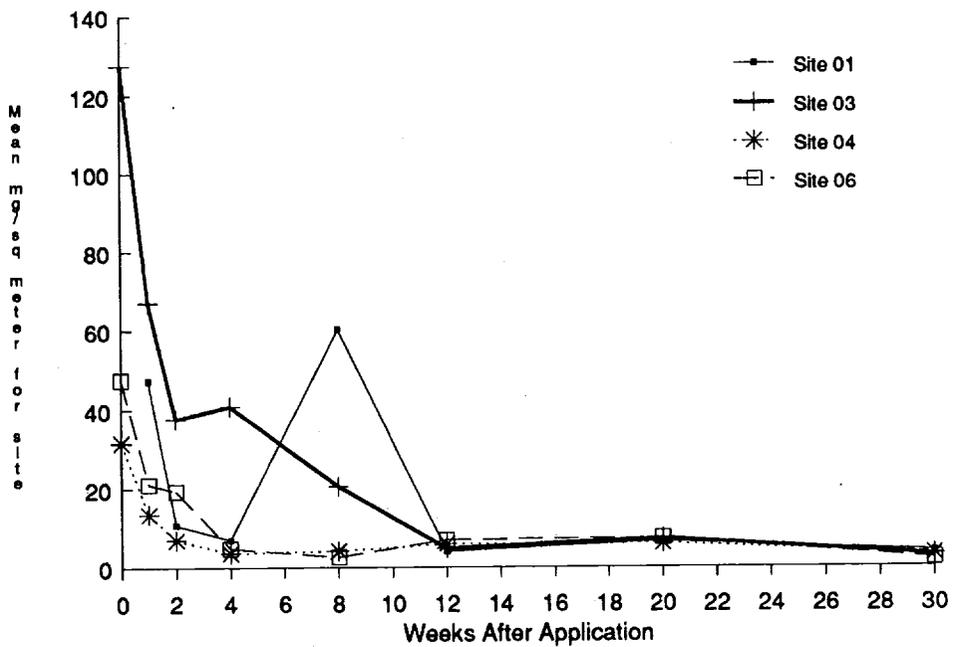


Table 2. Summary statistics for isofenphos concentrations in thatch, Japanese Beetle Project, Sacramento, 1983-6. Concentrations shown represent isofenphos + isofenphos oxon. Statistics are calculated on the four (Locations 01, 03, 04, 06) site means. Values below the detection limit are treated as 1/2 the detection limit. Standard error is calculated based on 2-stage sampling.

	Weeks After Application	N	Isofenphos Concentration, mg/m ²				
			Mean	Standard Deviation	Standard Error	Max	Min
Dislodgable	0	3	22.8	10.5	6.04	33.0	12.1
Dislodg + Internal	0	3	81.5	18.2	10.5	100	64.0
Dislodgable	1	4	15.8	3.97	1.99	21.2	12.7
Dislodg + Internal	1	4	51.9	4.83	2.49	56.3	45.1
Dislodgable	2	4	15.4	8.40	4.20	26.1	8.16
Dislodg + Internal	2	4	53.8	31.1	15.5	95.1	29.3
Dislodgable	4	4	9.40	5.83	2.91	14.3	1.64
Dislodg + Internal	4	4	33.5	19.1	9.56	49.6	8.80
Dislodg + Internal	8	4	46.7	45.7	22.8	109	11.6
Dislodg + Internal	12	4	19.2	11.4	5.72	30.8	ND (8.02) ^a
Dislodg + Internal	20	4	13.7	5.57	2.78	21.3	ND (8.34)
Dislodg + Internal	30	4	ND (3.66)	2.04	1.02	ND (6.60)	ND (1.86)
Dislodg + Internal	40	4	ND (3.38)	1.12	0.56	ND (4.40)	ND (2.39)

a ND - None Detected, with the value indicating 1/2 the detection limit. The detection limit changes because of variation in sample weights.

Figure 4. Dislodgeable Isufenphos in Thatch Samples.

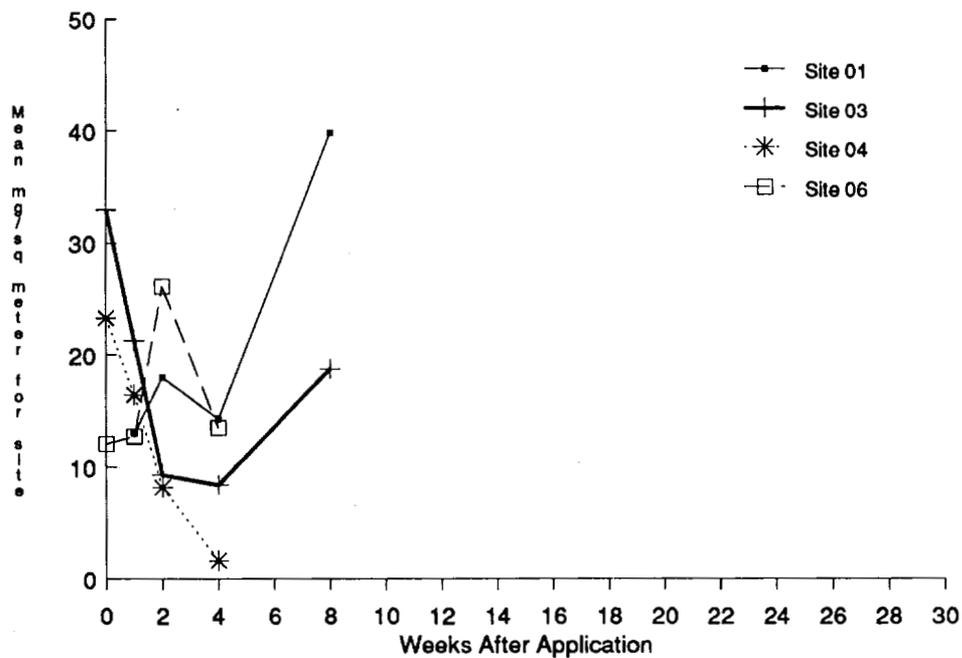
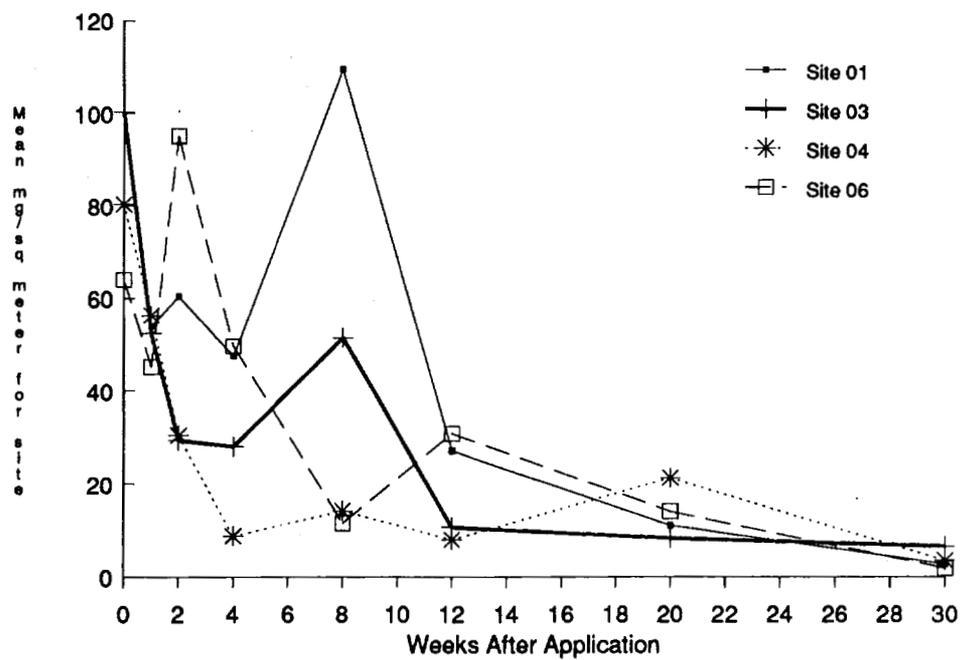


Figure 5. Total Isufenphos in Thatch Samples.



The standard deviations and standard errors show that the variation was very high. Most of the variation was probably due to the variation inherent in granular applications. Theoretical spatial distribution of the granules was 0.20 granules/cm² and each sample was comprised of 114 cm², or 23 granules (calculated by weighing and counting several hundred granules to obtain the mean granule weight). With each granule representing approximately 5% of the residue in each sample, small variations in the spatial distribution of the granules created large variations in pesticide concentration of the samples. Caro and Taylor (1976) also found high variation associated with granular applications. The large variation made it difficult to estimate true concentrations and rates of dissipation.

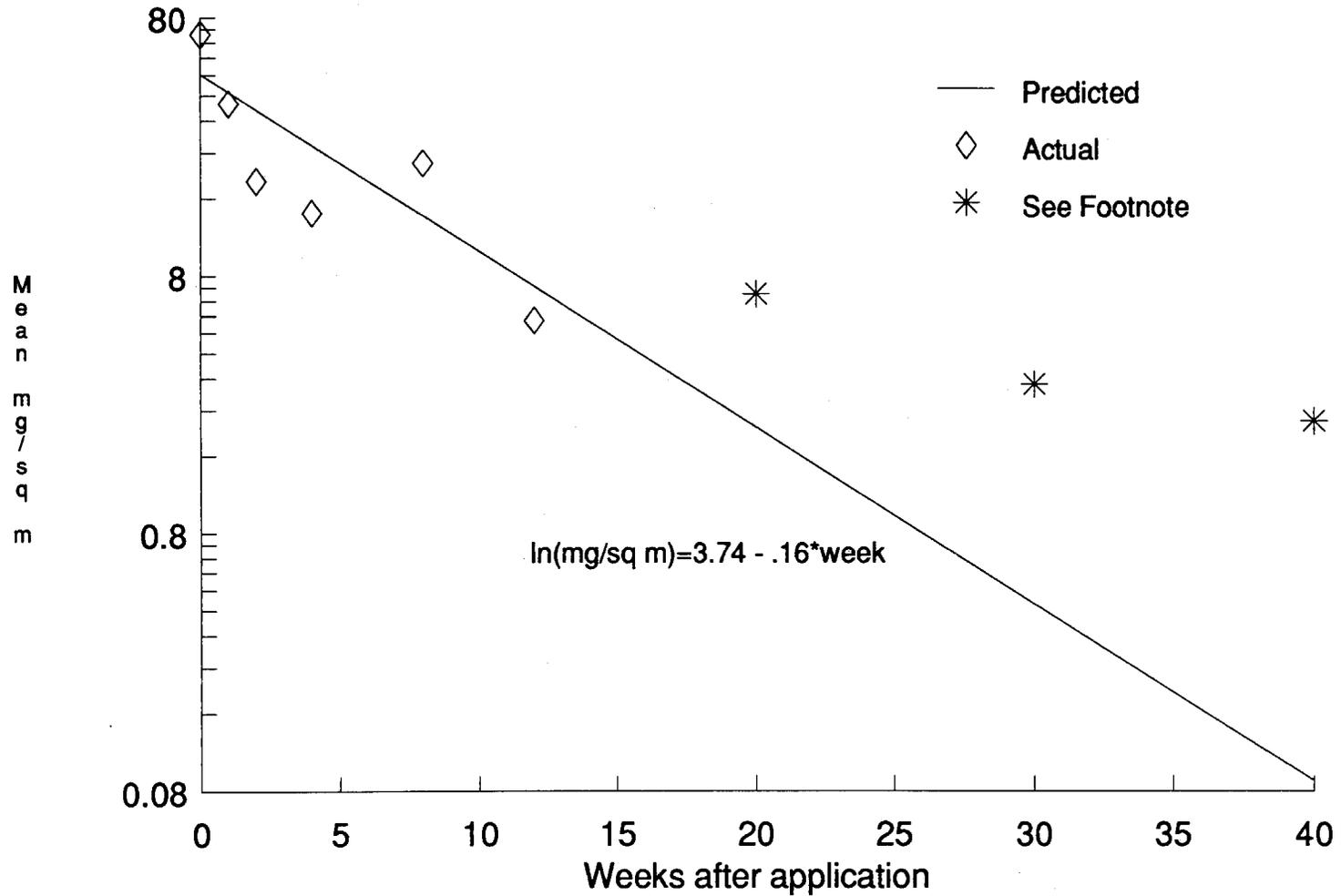
Concentrations of isofenphos oxon in turf and thatch were low. Oxon was not detected in the internal fraction of any turf sample, only the dislodgable fraction. For thatch, only one sample had detectable oxon from the internal fraction. The highest site mean concentration measured in turf was 10.5 mg/m² during week 2. Residues declined to nondetectable levels by week 12. For thatch, the highest oxon site concentration, 8.51 mg/m², was reached at week 4 and declined to nondetectable levels by week 20. While the absolute concentrations for the oxon peaked and then declined, the proportion of oxon to total isofenphos (parent and oxon combined) continually increased over time, indicating that the parent compound was breaking down to the oxon. For turf, the proportion of isofenphos as oxon increased from 6.1% at week 0 to 67% at week 12. Weeks 20 - 40 had no detectable levels for either parent or

oxon. For thatch, the proportion of isofenphos as oxon increased from 7.5 to 58% between weeks 0 and 20.

For turf and thatch linear models relating isofenphos concentration to time were used to estimate dissipation rates. For these analyses the four site mean concentrations for each week were averaged to give a single value for the week. In computing the average, any sample concentration below the detection limit was given the value of one-half the detection limit. The natural logarithm of the mean isofenphos concentration was then used as the dependent variable in the regression analysis. Weeks 30 and 40 (and 20 for turf), when all samples were below the detection limits, were not used in fitting the regression models, but the fitted models were used to predict concentrations for those weeks. The regression analyses are explained in greater detail in Appendix I.

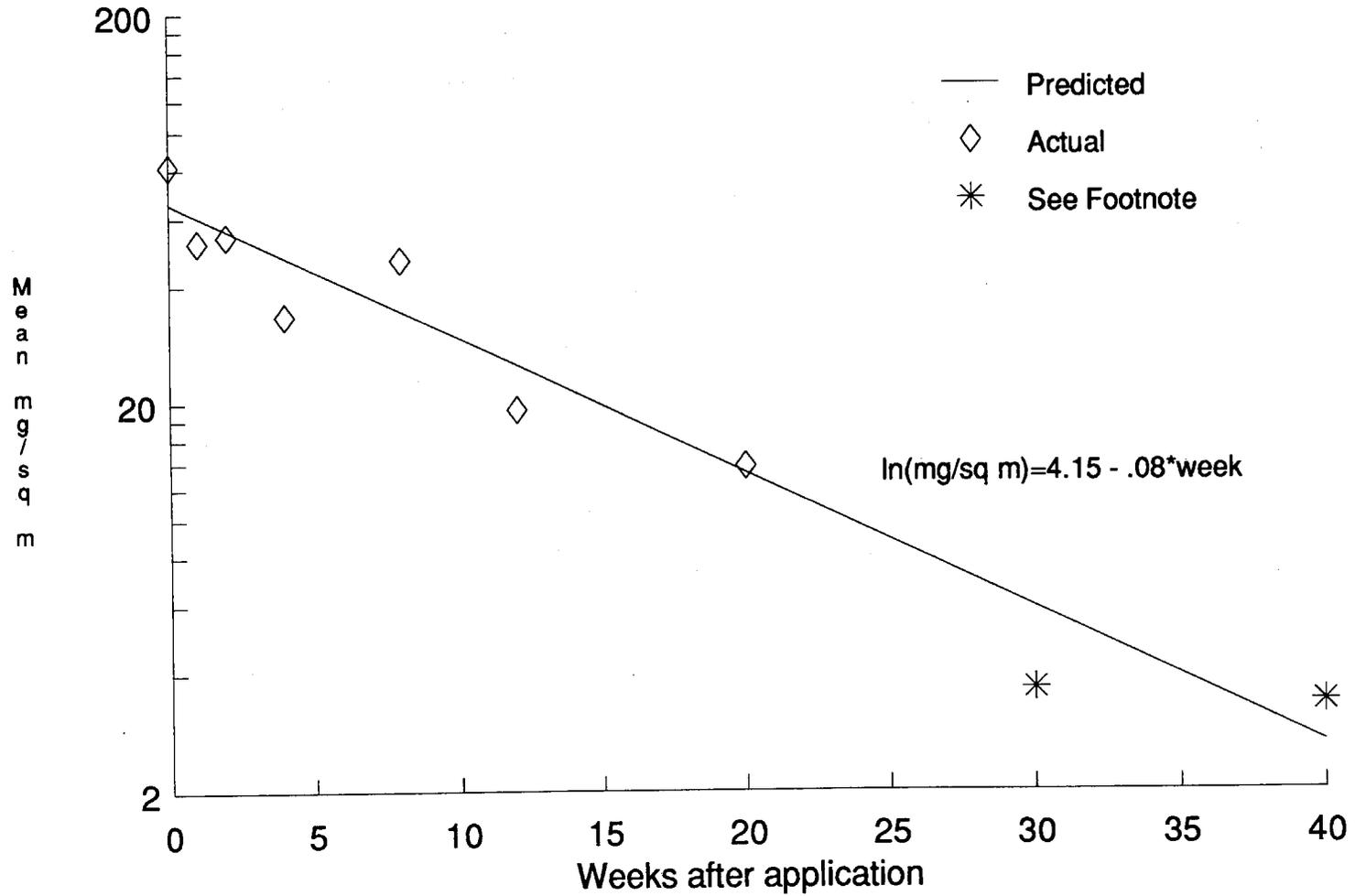
The linear relationship of log concentration to time is shown in Figure 6 for turf and Figure 7 for thatch. Actual log concentrations can be found in Tables 3 and 4. The models fit the data reasonably well, since they accounted for 70.5% of the variation for turf and 85.1% of the variation for thatch. The remaining variability was probably due to other unmeasured factors such as adsorption to plant surfaces, watering, mowing and foot traffic.

Figure 6. Predicted Isofenphos Turf Dissipation



* All samples were below the MDL. Plotted point is half of mean MDL. These points were not used in fitting the line.

Figure 7. Predicted Isofenphos Thatch Dissipation



* All samples were below the MDL. Plotted point is half of mean MDL. These points were not used in fitting the line.

The linear model for turf indicated that a period of about 4.5 weeks was required for mean isofenphos concentrations to be reduced by half. Given a predicted initial mean concentration of 48.3 mg/m², the predicted mean concentration at 20 weeks is 2.06 mg/m², with 95% confidence that it was between 1.23 and 6.42 mg/m² (Table 3). For thatch, the period required for raw mean concentrations to be reduced by half was about 9 weeks. With an initial mean concentration of 65.5 mg/m², the predicted mean concentration at 20 weeks was 13.2 mg/m², with 95% confidence that it was between 10.4 and 18.8 mg/m² (Table 4).

The conclusions regarding rates of dissipation in turf and thatch apply only to conditions like those of the present study, including the initial concentration levels. It cannot be determined from this study whether the dissipation functions would have the same forms given different conditions and different initial concentrations.

It is important to note that the disappearance of isofenphos over time in this study is dissipation, not degradation. Chemical degradation is a contributing factor in dissipation, but not the only factor. Other processes which influenced the dissipation rate of isofenphos in turf and thatch include volatilization, leaching, runoff, turf growth, traffic and mowing.

Table 3. Predicted mean isofenphos concentrations in turf samples, Japanese Beetle Project, Sacramento, 1983-6. Concentrations shown represent isofenphos + isofenphos oxon. Values below the detection limit are treated as 1/2 the detection limit.

Week	Log Mean Concentration (mg/m ²)		Raw Mean Concentration, mg/m ²		
	Actual	Predicted	Actual	Predicted ^a	95% Confidence Limits for Predicted Mean Concentration ^b
0	4.23	3.74	68.9	48.3	28.9 , 151
1	3.62	3.58	37.2	41.3	24.7 , 129
2	2.92	3.42	18.6	35.2	21.1 , 110
4	2.64	3.11	14.0	25.7	15.4 , 80.2
8	3.08	2.48	21.8	13.7	8.18, 42.6
12	1.68	1.84	5.35	7.27	4.35, 22.7
20	1.91	0.58	6.78	2.06	1.23, 6.42
30	1.11	-0.10	3.02	0.42	0.25, 1.32
40	0.78	-2.57	2.18	0.09	0.05, 0.27

a Predicted value $\hat{z} = e^{\hat{y}} e^{0.5s^2}$, where $y = \ln z$. See Appendix I for a detailed explanation.
b Limits calculated according to Land (1975).

Table 4. Predicted mean isofenphos concentrations in thatch samples, Japanese Beetle Project, Sacramento, 1983-6. Concentrations shown represent isofenphos + isofenphos oxon. Values below the detection limit are treated as 1/2 the detection limit.

Week	Log Mean Concentration (mg/m ²)		Raw Mean Concentration, mg/m ²		
	Actual	Predicted	Actual	Predicted ^a	95% Confidence Limits for Predicted Mean Concentration ^b
0	4.40	4.15	81.5	65.5	51.5 , 93.3
1	3.95	4.07	51.9	60.4	47.5 , 86.1
2	3.98	3.99	53.8	55.8	43.8 , 79.5
4	3.51	3.83	33.5	47.5	37.4 , 67.7
8	3.84	3.50	46.7	34.5	27.1 , 49.1
12	2.95	3.18	19.2	25.0	19.7 , 35.7
20	2.62	2.54	13.7	13.2	10.4 , 18.8
30	1.30	1.74	3.66	5.92	4.60, 8.40
40	1.22	0.94	3.38	2.66	2.10, 3.80

a Predicted value $\hat{z} = e^{\hat{y}} e^{0.5s^2}$, where $y = \ln z$. See Appendix I for a detailed explanation.
b Limits calculated according to Land (1975).

Another way to evaluate these data is by observing the proportion of samples below the detection limit over time. For turf at week 0, 100% of the samples had detectable concentrations, week 1 had 92% positive, week 2 had 75% positive, week 4 had 75% positive, week 8 had 58% positive, week 12 had 8% positive, and weeks 20, 30 and 40 had no positives. Thatch at week 0 and 1 had 100% positive, week 2 had 83% positive, week 4 had 92% positive, week 8 had 75% positive, week 12 had 33% positive, week 20 had 8% positive, and weeks 30 and 40 had no positives.

Very little work of this type has been done previously. Most of the work with isofenphos turf applications concerned efficacy, which was measured as percent mortality of larvae. Niemczyk (1987) did measure isofenphos in thatch after application to two different plots. Concentration in thatch on the first plot 5 days after application was 29.37 ppm and 4.76 ppm on the second plot, 6 days after application. Concentrations between 35 and 116 days after application ranged from 0.19 to 1.66 ppm. Our thatch concentration 1 week after application was 35.4 ppm, 29.5 ppm on week 8, and 8.0 on week 12. This indicates that initial concentrations were approximately the same, but dissipation in Sacramento was much slower. Sears, et al (1987) examined dislodgeable residues on turf and total residues in thatch. They found less turf dislodgeable on the day of application (4.7 mg/m^2) than was found here (14 mg/m^2) and found more rapid dissipation (no detectable by week 2) than here (no detectable by week 20). However, they did find higher thatch residues ($97\text{-}173 \text{ mg/m}^2$ during the first two weeks) than this study ($54\text{-}82 \text{ mg/m}^2$ during the first two weeks).

Soil

Isofenphos soil data reported previously in a series of memorandums do not agree with the data presented here. As with turf and thatch, the data contained in previous memorandums were calculated assuming negative samples were zero when statistical tests were conducted. The data presented here were calculated assuming negative samples were one-half the detection limit for reasons discussed in the turf and thatch section. In addition, the units used previously were mg/ft^2 and parts per million, on a fresh weight basis. The concentrations in ppm are unchanged, the concentrations in mg/ft^2 were changed to mg/m^2 . To convert one to the other, the concentrations in mg/ft^2 are multiplied by 10.76 to obtain concentrations in mg/m^2 .

Quality control data for soil showed that spiked recoveries for isofenphos averaged 97% and 103% for isofenphos oxon. Since the split soil samples were submitted at the same time as the turf and thatch, they were also analyzed incorrectly and also precluded analysis.

Results of the soil monitoring are summarized in Tables 5 - 7 and Figures 8 - 11. As expected, the highest concentrations were found in the 0-2.5 cm depth, with decreasing amounts in the 0-15 cm and 15-30 cm depths. The site mean concentrations ranged from 15.3 ppm to no detectable concentration, with a detection limit of 0.1 ppm. Because there were so many samples below the detection limit for the 0-15 and 15-30 cm depths, individual site means

at these depths were not averaged to give overall means by weeks. Instead, only the ranges of the site means for each week are given.

The 0-2.5 cm depth was sampled inconsistently until week 8 because these samples were not included in the original monitoring plan. Higher concentrations were anticipated at the 0-15 cm depth. However, when no detectable residues were found as early as week 1, sampling of the 0-2.5 cm depth was initiated. Detectable concentrations were found at the 0-2.5 cm depth for all the periods sampled between week 8 and week 40 (Table 5), although by week 40 only one of the four sites was positive. Summarizing the data from this depth is very difficult because these samples were not collected consistently. It appears that between weeks 8 and 20 concentrations were fairly constant, with mean concentrations ranging from 0.41 to 3.18 ppm or 20.9 to 58.4 mg/m², indicating that 9 to 26% of the 224 mg/m² of isofenphos applied was contained in these samples.

Concentrations at the 0-15 and 15-30 cm depths were much less than the 0-2.5 cm depth. This can best be seen by observing the maximum and minimum values for these depths (Tables 5 and 6). Except for week 0, all sampling dates had at least one of the four sites with no detectable residues at the deeper depths. The highest concentrations found were 1.15 ppm at the 0-15 cm depth and 0.64 ppm at the 15-30 cm depth.

Table 5. Summary statistics for isofenphos concentrations in soil (0-2.5 cm), Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated from the site means (Locations 01, 03, 04, 06). Concentrations shown represent isofenphos + isofenphos oxon. Values below the detection limit are treated as 1/2 the detection limit.

Weeks After Application	N	Isofenphos, mg/m ²				Isofenphos, ppm			
		Mean	Standard Error	Max	Min	Mean	Standard Error	Max	Min
0	1	314	----	----	----	15.3	----	----	----
1	0 ^a	----	----	----	----	----	----	----	----
2	0	----	----	----	----	----	----	----	----
4	1	5.92	----	----	----	0.38	----	----	----
8	3	58.4	25.2	107	22.9	3.18	1.30	4.70	0.58
12	4	41.4	24.2	114	15.5	1.39	0.98	4.33	0.28
20	4	20.9	9.88	50.0	6.13	0.41	0.17	0.90	0.15
30	4	6.88	1.00	9.42	4.88	0.16	0.02	0.22	0.13
40	4	4.46	0.99	6.97	ND (2.10) ^b	0.11	0.01	0.13	ND (0.10)

a Not sampled

b ND - None Detected, with the value indicating 1/2 the detection limit

Figure 8. Isufenphos in Soil Samples (0-2.5 cm, mg/sq m).

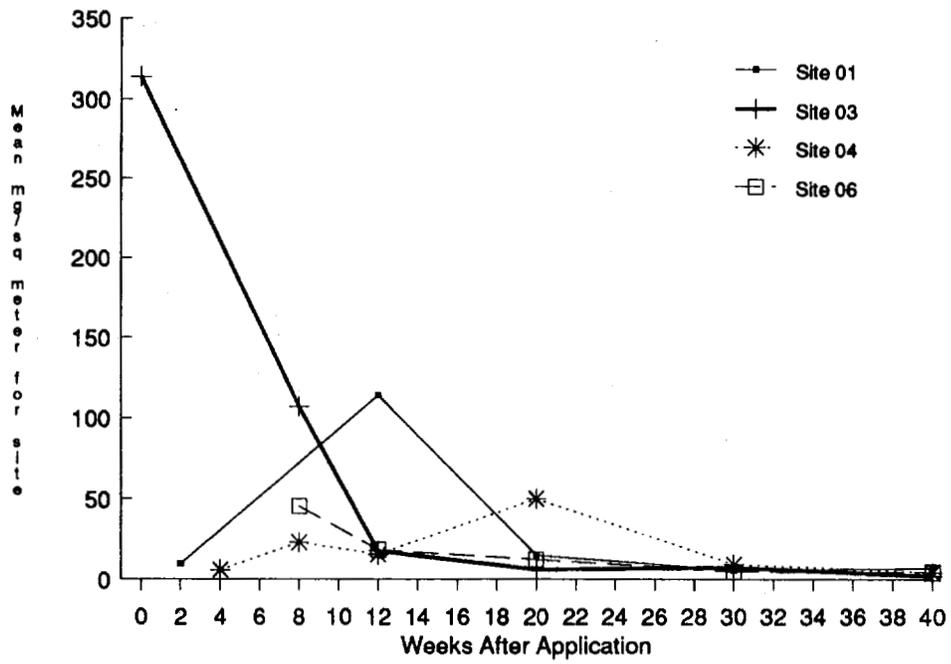


Figure 9. Isufenphos in Soil Samples (0-2.5 cm, ppm).

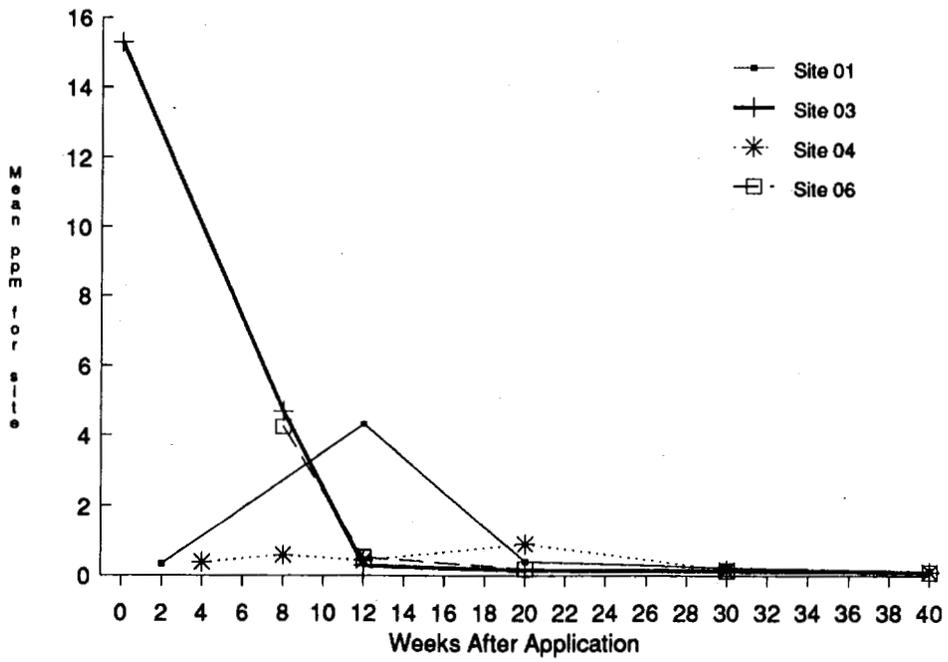


Table 6. Summary statistics for isofenphos concentrations in soil (0-15 and 15-30 cm), Japanese Beetle Project, Sacramento, 1983-6. Statistics are calculated from the site means (Locations 01, 03, 04, 06). Concentrations shown represent isofenphos + isofenphos oxon. Values below the detection limit are treated as 1/2 the detection limit.

Weeks After Application	N	<u>Isofenphos (0-15 cm), ppm</u>		<u>Isofenphos (15-30 cm), ppm</u>	
		Max	Min	Max	Min
0	3	0.66	0.14	ND (0.10) ^a	ND (0.10)
1	4	0.67	ND (0.10)	0.64	ND (0.10)
2	4	0.36	ND (0.10)	0.22	ND (0.10)
4	4	0.50	ND (0.10)	0.13	ND (0.10)
8	4	1.15	ND (0.10)	ND (0.10)	ND (0.10)
12	4	0.25	ND (0.10)	ND (0.10)	ND (0.10)
20	4	0.32	ND (0.10)	ND (0.10)	ND (0.10)
30	4	ND (0.10)	ND (0.10)	ND (0.10)	ND (0.10)
40	4	ND (0.10)	ND (0.10)	ND (0.10)	ND (0.10)

a ND - None Detected, with the value indicating 1/2 the detection limit

Figure 10. Isofenphos in Soil Samples (0-15 cm).

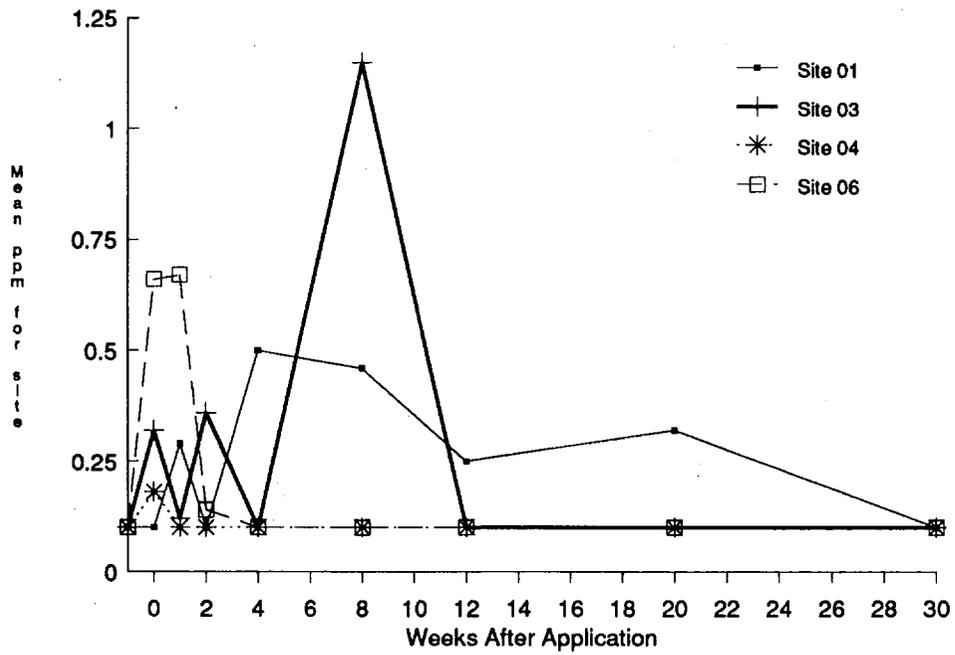
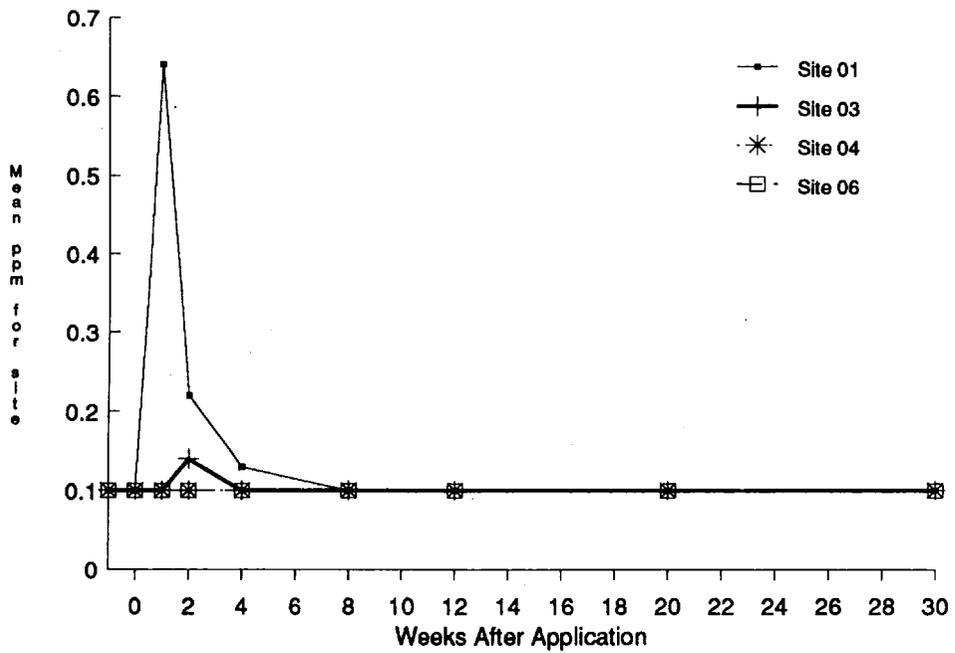


Figure 11. Isofenphos in Soil Samples (15-30 cm).



As in the turf and thatch, the high, nonhomogeneous variability was probably due to the inherent variation of the granular application. The granular formulation concentrated the isofenphos in a small number of granules, and even small variations in applying the granules created large variations in residue concentrations.

An alternative way of looking at these data is to examine the percentage of positive samples (samples with isofenphos concentration above the detection limit) at each week and depth (Table 7). It can be seen that the percentage of positive samples decreased over time and with depth.

A loglinear model was fit to the 2 X 4 X 2 contingency table shown in Table 8 (Table 8 is a reduced version of Table 7. Note that the 15-30 cm samples were not included in this analysis). Details of the loglinear analysis are given in Appendix I. The analysis showed that the percentage of positive samples was dependent on time and on depth, with fewer positives at the later weeks and at the lower depth. Furthermore, the relationship between time and presence/absence of isofenphos did not depend on depth. That is, the relative change in percent positive over time was the same at the 0-2.5 and 0-15 cm depths.

Table 7. Percentages of soil samples with isofenphos detected for Locations 01, 03, 04, and 06, Japanese Beetle Project, Sacramento, 1983-6.

Weeks After Application	% Positive		
	0-2.5 cm	0-15 cm	15-30 cm
0	100	29.4	0.0
1	not sampled	26.7	20
2	not sampled	20.0	21.4
4	66.7	20.0	6.7
8	88.9	30.8	0.0
12	58.3	16.7	0.0
20	41.7	8.3	0.0
30	33.3	0.0	0.0
40	8.3	0.0	0.0

Table 8. Frequency of isofenphos occurrence in soil by time and depth for Locations 01, 03, 04, and 06, Japanese Beetle Project, Sacramento, 1983-6.

Time Interval	Isofenphos (0-2.5 cm)		Isofenphos (0-15 cm)	
	Positive	Negative ^a	Positive	Negative
Weeks 0,1	3	0	9	23
Weeks 2,4	3	1	6	24
Weeks 8,12	15	6	6	19
Weeks 20,30	9	15	1	23

a Negative occurrences are samples below the detection limit

Additional soil core samples were collected to check for lateral or horizontal movement away from treated areas. Core samples were collected from depths of 0-15 cm and 15-30 cm at a 15 cm distance from treated turf areas. Sampling occurred on Weeks 0, 1, 2, and 4 at Locations 01, 03, 04, and 06. None of the samples contained detectable residues of isofenphos or oxon (detection limit 0.1 ppm), indicating that very little lateral movement of isofenphos occurred.

Additional soil cores were collected when it appeared that isofenphos was moving downward through soil. For example, the week 2 samples for Location 01 showed higher concentrations at the 15-30 cm depth than the 0-15 cm depth. Deeper core samples collected at this location during week 4 indicated that no further migration had occurred. None of the samples collected from the 30-45, 45-60, or 60-75 cm depths had detectable residue. In addition, only one of the three samples collected from the 15-30 cm depth during week 4 had detectable residue. It is possible that the isofenphos found during week 2 at the 15-30 cm depth may have been due to contamination from surface residue.

Generally, isofenphos oxon was found in much smaller amounts in relation to the parent isofenphos. Isofenphos oxon averaged 20% of total isofenphos, but this proportion was highly variable, ranging from 0 to 100%. On only two occasions was the oxon concentration greater than the parent concentration. Trends over time paralleled the parent compound.

Comparison of these data with other work is difficult because of sample variability. Concentrations found by Niemczyk (1987) at the 0-2.5 cm depth ranged from 0.55 ppm five days after application to 0.16 ppm 116 days after application. These concentrations were lower than those found here, but that may be due our assumption that negative samples contained one-half the detection limit. Chapman and Harris (1982) measured the half-life of isofenphos in sand as two weeks and four to eight weeks in muck. However, these were experimental applications directly to soil, with no turf covering.

Air

Results of the trapping efficiency tests conducted by UCD indicated that a considerable amount of isofenphos was converted to the oxon during sampling. Sampling for four hours at one cubic meter per minute showed that 83% of the amount spiked was trapped by the resin, and 75% of the total isofenphos collected was in the oxon form. To simplify presentation, the air data concentrations are expressed as total isofenphos (parent plus oxon).

The air concentrations (Table 9) were very low compared to broadcast applications of other pesticides (Ross and Sava, 1984). The highest concentration measured was 46 ng/m³. The low concentrations were probably due to the low vapor pressure of isofenphos, 4×10^{-6} torr at 20° C (Worthing, 1979). Since air concentrations were so low, volatilization would probably not be a major dissipation process for isofenphos.

Table 9. Results of the isofenphos air monitoring, Japanese Beetle Project, Sacramento, 1983-6. Isofenphos concentrations are expressed as the total of isofenphos plus the oxon.

Location	Isofenphos Concentration, ng/m ³		
	Background	Application	Post Application
01	ND ^a	37	22
03	ND	37	32
04	ND	21	25
06	0.46	46	9.4

a None Detected, with a detection limit of 0.16 ng/m³.

Fruit

No isofenphos or oxon was detected in any of the fruit samples, with a detection limit of 0.1 ppm. Table 10 shows the number and types of fruit samples collected, and the sampling periods. The study conducted by UCD to determine the amount of uptake by tomato plants also showed no detectable isofenphos residues even when applied at five times the label rate (Appendix III).

Table 10. Number of sites and sampling periods for the isofenphos fruit monitoring, Japanese Beetle Project, Sacramento, 1983-6. All samples had no detectable residue, with a detection limit of 0.1 ppm.

	Number of Properties Sampled	Sampling Period, Days After Treatment	
		Preharvest	Harvest
Almonds	1	4	18
Apples	3	4-36	18-77
Figs	3	7-8	18-22
Grapes	3	7-8	22
Grapefruit	1	108	122
Oranges	1	99	113
Persimmons	2	56	18-73
Walnuts	1	4	18

Although previous studies have shown that isofenphos does have slight systemic action, little or no uptake was expected under the Japanese Beetle Project conditions. Several factors mitigated the translocation of isofenphos, such as application to turf rather than bare soil. The greatest proportion of isofenphos was found in turf and thatch, and not available for uptake. The isofenphos found in soil was mainly confined to the top few centimeters, which was also not available for uptake. Additionally, trees

in general must translocate more pesticide than other plants in order for the pesticide to reach the fruit.

The Food and Agricultural Organization (FAO) has compiled the most extensive literature regarding isofenphos residues in food (FAO, 1982). Previous studies have shown that isofenphos can be taken up by certain plants. Results of experimental applications have shown concentrations generally less than one part per million in cabbage, califlower, onions, potatoes, and the forage of maize and corn. Experimental applications to Brussels sprouts, celery, rapeseed, celeriac, swedes, and turnips showed no detectable residues. The FAO has also compiled information showing that isofenphos can be taken up by rotational crops when first applied at high rates (5.6 kg/ha).

Water Results and Discussion

Quality control data showed that the isofenphos was readily converted to the oxon. When spiked with both isofenphos and oxon only 28% of the parent was recovered, but 340% of the oxon was recovered. The split samples showed some agreement. CAL found 21 and 17 ppb of total isofenphos in samples 1 and 2, respectively; while CDHS found 25 and 37 ppb in samples 1 and 2, respectively. However, CAL found mostly oxon, while CDHS found only parent.

Surface water samples were collected from creeks during the first five rain runoff periods of the season. These results are shown in Table 11. Locations of the sampling sites are shown in Figure 1. Samples were collected just outside the treatment area, where the total amount of isofenphos leaving the area could be measured. The chemical analyses showed that most of the isofenphos detected was in the oxon form. To simplify the results the data are presented as total isofenphos (parent + oxon). The data indicate that the highest concentration (43.6 ppb) and mass discharge rate (6800 $\mu\text{g}/\text{sec}$) occurred in one of the creeks leading to the American River. The highest amount of isofenphos measured in the runoff from all sites combined was 31 grams per hour on December 23rd, although this is an underestimate because not all sites were sampled on this date. If the 31 g/hr rate continued for five days the total amount discharged would be less than one percent of the 186 kg of isofenphos applied, indicating these discharges were low.

The CDFG monitoring results of the American River area showed no detectable concentrations in any of their samples. Samples were collected from the American River at the Nimbus Fish Hatchery (near Hazel Ave.) and Sunrise Bridge, and from Sailor Bar (Figure 1) on October 5, November 2, November 15, 1983 and January 13, 1984.

Table 11. Results of the isofenphos rain runoff monitoring, Japanese Beetle Project, Sacramento, 1983-6. Concentrations shown represent isofenphos + isofenphos oxon. Sampling locations are shown in Figure 1.

Site	Isofenphos Concentration, ppb (Isofenphos Flux, $\mu\text{g}/\text{sec}$)				
	Date: 9/30/83 ^a Rainfall: 1.2 cm	10/29/83 ^a 0.84 cm	11/9/83 0.71 cm	11/10/83 4.2 cm	12/23/83 0.81 cm
1	16	<2.0 ^b	4.0 (76)	43.6 (1700)	29.4 (6800)
2	<2.0	broken	<1.0 (0)	2.8 (450)	not sampled
3	not sampled	broken	<1.0 (0)	<0.1 (0)	not sampled
4	not sampled	<2.0	<1.0 (0)	1.4 (280)	not sampled
5	not sampled	<2.0	<1.0 (0)	3.4 (190)	not sampled
6	not sampled	broken	1.0 (99)	2.6 (990)	not sampled
7	not sampled	broken	<1.0 (0)	0.7 (29)	not sampled
8	not sampled	<2.0	<1.0 (0)	<0.1 (0)	not sampled
9	not sampled	broken	<1.0 (0)	38.6 (50)	43.1 (1800)

a Samples collected on 9/30 and 10/29 were collected at night, water flow could not be measured.

b "<" indicates no detectable concentration and the detection limit.

Ground water samples were collected from two wells. Neither well contained a detectable residue of isofenphos, with a detection limit of 0.1 ppb. Only two wells could be found within the treatment area, one 120 feet deep and the other with depth unknown. Neither well property was treated with isofenphos. Both wells were sampled on January 26, 1984. No ground water contamination was expected because the amount of isofenphos applied, 186 kg over 83 ha, was so small compared to areas where ground water contamination by pesticides is a problem. In addition, most of the isofenphos was confined to the turf, thatch, and top soil layers.

CONCLUSIONS AND RECOMMENDATIONS

The data from this monitoring program was highly variable, primarily due to the type of pesticide application and to the sampling methods used. The granular formulation of isofenphos used by the Japanese Beetle Project was such that one granule contained approximately 5% of the residue in any one sample. This meant that even small spatial variations in application created large differences in residue concentration. If better estimates of true concentrations and dissipation rates in any future monitoring programs are desired, this variability must be decreased or a much greater number of samples must be collected.

Even though true concentrations were difficult to estimate, apparently very little off-target movement of isofenphos occurred. Very low or no detectable concentration was found in air, fruit, surface runoff, ground

water, and deeper soil layers. The only other fraction of isofenphos that was available for off-target movement was the dislodgable turf residue. The highest amount of dislodgable isofenphos found on turf was only 6% of that applied. In addition, a major proportion of the isofenphos was accounted for in turf, thatch and the upper soil layer (Table 12). However, there is the potential for uptake by rotational crops, as discussed earlier. It is possible that uptake could occur with later crops if fallow garden areas were treated, as was done with diazinon.

The high variability made the estimation of dissipation rates problematic. However, the data indicate that virtually no isofenphos was detected by week 30 (Table 12). Since natural off-target movement was minimal, other factors must have been involved in the dissipation of isofenphos. Besides chemical degradation, the other major dissipation mechanism was probably the removal of grass clippings after mowing. The dissipation documented here is from one application, because use of isofenphos was discontinued after the fall of 1983. If use of isofenphos had continued it is possible that the rate of dissipation may have increased after several applications. Studies have shown that enhanced degradation of isofenphos can occur with repeated applications (Niemozyk and Chapman, 1987; Chapman, et al, 1986).

Table 12. Isofenphos concentrations and proportions in turf, thatch, and soil (0-2.5 cm), Japanese Beetle Project, Sacramento, 1983-6. Concentrations shown represent isofenphos + isofenphos oxon for Locations 01, 03, 04, and 06. The application rate was 224 mg/m².

Week	<u>Isofenphos, mg/m² (Proportion of App Rate, %)</u>		
	Turf	Thatch	Soil
0	68.9 (31)	81.5 (36)	Data Not Used ^a
1	37.2 (17)	51.9 (23)	No Data
2	18.6 (8.3)	53.8 (24)	No Data
4	14.0 (6.2)	33.5 (15)	Data Not Used
8	21.8 (9.7)	46.7 (21)	58.4 (26)
12	5.35 (2.4)	19.2 (8.6)	41.4 (18)
20	None Detected	13.7 (6.1)	20.9 (9.3)
30	None Detected	None Detected	6.88 (3.1)
40	None Detected	None Detected	4.46 (2.0)

a Data were not used when only one location was sampled

LITERATURE CITED

- Bradu, D. and Y. Mundlak. Estimation in Log Normal Models. Journal of the American Statistical Association. 65: 198-211. 1970.
- Caro, J.H. and A.W. Taylor. Analysis of Pesticide Residues in Field Soil: Optimizing Soil Sampling and Pesticide Extraction. International Conference on Environmental Sensing and Assessment. 1976.
- Chapman, R.A., C.R. Harris, P. Moy and K. Henning. Biodegradation of Pesticides in Soil: Rapid Degradation of Isofenphos in a Clay Loam After Previous Treatment. Journal of Environmental Science and Health. B21(3), 269-276. 1986.
- Chapman, R.A. and C.R. Harris. Persistence of Isofenphos and Isazophos in a Mineral and Organic Soil. Journal of Environmental Science and Health. B17(4), 355-361. 1982.
- Cochran, W. G. Sampling Techniques, third edition. John Wiley and Sons, New York. 1977.
- Dixon, W. J. (ed). BMDP Statistical Hardware. University of California Press, Berkeley. 1981.
- Dowell, R.V. Environmental Assessment of Japanese Beetle & Its Eradication in California. California Department of Food and Agriculture. 1983.
- Food and Agriculture Organization. Pesticide Residues in Food: 1981 Evaluations. 1982.
- Gilbert, R.O. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Co., New York. 1987.
- Helwig, J.T. and K.A. Council (ed). SAS User's Guide. SAS Institute, Raleigh, NC. 1979.
- Land, C.E. Tables of Confidence Limits for Linear Functions of the Normal Mean and Variance, in Selected Tables in Mathematical Statistics, Vol 3. American Mathematical Society, Providence, R. I. 1975.
- McCool, P.M., T. Younglove, R.C. Musselman and R.R. Teso. Plant Injury Analysis: Contingency Tables as an Alternative to Analysis of Variance. 1986.
- Niemczyk, H.D. The Influence of Application Timing and Posttreatment Irrigation on the Fate and Effectiveness of Isofenphos for Control of Japanese Beetle (Coleoptera: Scarabaeidae) Larvae in Turfgrass. Journal of Economic Entomology. 80: 465-470. 1987.

- Niemczyk, H.D. and R.A. Chapman. Evidence of Enhanced Degradation of Isofenphos in Turfgrass Thatch and Soil. Journal of Economic Entomology. 80: 880-882. 1987.
- Ross, L.J. and R.J. Sava. Fate of Thiobencarb and Molinate in Rice Fields. Journal of Environmental Quality. Vol. 15, no. 3, 220-225. 1986.
- Sears, M.K., C. Bowhey, H. Braun, and G.R. Stephenson. Dislodgeable Residues and Persistence of Diazinon, Chlorpyrifos, and Isofenphos Following Their Application to Turfgrass. Pesticide Science. Vol. 20, 223-231. 1987.
- Sokal, R.R. and F.J. Rohlf. Introduction to Biostatistics. W.H. Freeman and Company, San Francisco. 1973.
- Worthing, C.R. (ed). The Pesticide Manual: A World Compendium. 6th Ed. British Crop Protection Council. 1979.

APPENDIX I

STATISTICAL ANALYSIS OF TURF, THATCH AND SOIL DATA

Turf and Thatch Statistical Analysis

The results presented here were calculated assuming the concentrations of negative samples were one-half the detection limit. More sophisticated statistical methods exist for estimating the values of samples below the detection limit. However, these methods require that a large proportion of the data be above the limit. In this study, there were no samples above the detection limit after week 12 for turf and week 20 for thatch, so those methods could not be applied. All that is known about these samples is that they lie somewhere between zero and the detection limit. In the absence of any other information, the value half-way between zero and the detection limit is a more reasonable approximation than simply using zero. Furthermore, it would be impossible to use zeros for nondetects when regression analyses requiring logarithmic transformation of the data were done.

Within each medium, the regression of isofenphos concentration on weeks after application was estimated. In each case the dependent variable was the natural log of the overall mean concentration (mean of four sites) for each week, excluding weeks 30 and 40 (and also week 20 for turf). The log transformation was used for two reasons. First, the raw plots of concentration over time (Figures 3 and 5 in the main text) suggest a first-order exponential decay. Second, it is reasonable to expect concentrations over time to be lognormally distributed. Tables I-1 and I-2 give the analysis of variance tables for the regression models.

For both media, the estimated slope, or rate of dissipation, was significantly different from zero ($p=0.0359$ for turf; $p=0.0031$ for thatch), and the linear model accounted for a large proportion of the variance. The r^2 values were 0.707 for turf and 0.851 for thatch, meaning these models accounted for 70.7% of the variation for turf and 85.1% for thatch. The close fit of the linear model to the actual log mean concentration, especially for thatch, can be seen in Figures 6 and 7 of the main text.

Table I-1. Analysis of Variance and estimated regression coefficients for log mean isofenphos + isofenphos oxon concentration in turf samples, Japanese Beetle Project, Sacramento, 1983-6.

Source	DF	Sum of Squares	Mean Square	F Value	Prob > F
Model	1	2.678	2.678	9.663	0.0359
Error	4	1.109	0.277		
		$r^2 = 0.707$	$Adj\ r^2 = 0.634$		
<u>Parameter Estimates</u>					
Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
Intercep	1	3.739	0.314	11.92	0.0003
Week	1	-0.158	0.051	-3.11	0.0359

Table I-2. Analysis of Variance and estimated regression coefficients for log mean isofenphos + isofenphos oxon concentration in thatch samples, Japanese Beetle Project, Sacramento, 1983-6.

Source	DF	Sum of Squares	Mean Square	F Value	Prob > F
Model	1	2.013	2.013	28.64	0.0031
Error	7	0.352	0.070		
		$r^2 = 0.851$	$Adj\ r^2 = 0.822$		
<u>Parameter Estimates</u>					
Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
Intercep	1	4.147	0.142	29.21	0.0001
Week	1	-0.080	0.015	-5.35	0.0031

A linear relationship of log concentration to time reflects a first-order exponential rate of dissipation of the raw concentration (that is, the concentration before taking logs). While such a decay function might reasonably be expected under laboratory conditions, in the field many uncontrolled factors can disrupt the dissipation process, causing it to deviate from the theoretical model. Adsorption to plant surfaces, watering, mowing, and foot traffic can all affect dissipation. Since these factors were unmeasured, their influences could not be incorporated into a statistical model. Thus, some variability not explained by the linear regression models is undoubtedly due to such factors. It might also be noted that while a higher r^2 for turf could have been achieved by adding higher-order terms to the model (or by fitting a nonlinear model), there was no theoretical justification for doing so, and the simpler linear model was judged to be adequate for predictive purposes.

The regression equation predicts the log mean concentration at a given week. For practical purposes however it is the raw mean concentration that one wishes to predict. The simple antilog of the predicted log concentration is known to underestimate the expected value of the raw concentration and several methods for correcting this bias have been proposed in the literature (for a general discussion, see Gilbert, 1987). The simplest of the proposed correction methods calculates the predicted raw concentrations as

$$\hat{z} = e^{\hat{y}} e^{s^2/2}$$

where \hat{z} denotes the predicted raw concentration, y is the log concentration predicted by the regression, s^2 is the mean squared error from the regression analysis, and $e^{\hat{y}}$ is the antilog of the predicted log concentration. Note that $e^{s^2/2}$ is always greater than one, so \hat{z} is always greater than the simple antilog $e^{\hat{y}}$. Thus, $e^{s^2/2}$ serves as a correction factor for the downward bias of $e^{\hat{y}}$. This method overestimates the expected value of \hat{z} , but is less biased than the simple antilog. An unbiased, but much more computationally involved method is due to Bradu and Mundlak (1970). Predicted concentrations for the present study were computed by both methods. Since the resulting values were very similar (by inspection), the first method was used because of its logical computational simplicity. Tables 3 and 4 give the actual log mean concentrations for each week and the predicted concentrations computed by the first method.

Confidence intervals for the predicted concentrations were calculated by the method given by Land (1975). Upper (UL) and lower limits (LL) for a 95% confidence interval are calculated as

$$UL = \hat{z} e^{sH.975 / \sqrt{m}}$$

and

$$LL = \hat{z} e^{sH.025 / \sqrt{m}}$$

where \hat{z} is the predicted concentration defined previously, s is the root mean squared error and m is the error degrees of freedom from the regression analysis. The quantities $H.025$ and $H.975$ are obtained from the table

provided by Land (1975). The 95% confidence intervals are given in Tables 3 and 4.

Soil Statistical Analysis

To examine dissipation and vertical movement a contingency table analysis was performed on the frequency of isofenphos residues in soil over time and depth. An analysis of variance was not appropriate for these data because variances were not homogeneous and the error terms were not normally distributed, violating two assumptions of this parametric test.

Table 7 may be regarded as the basic contingency table to be analyzed, if each entry is replaced with two entries: the number of positive occurrences in the category and the number of negative occurrences. Thus the basic table was 9 (weeks) X 3 (depths) X 2 (isofenphos positive or negative). It was necessary to reduce the basic table in order to create cells with sufficient numbers of observations to perform the analysis. First, the 15-30 cm depth was excluded because most weeks had 0 positive occurrences. Next, weeks were grouped into four categories: weeks 0 and 1, weeks 2 and 4, weeks 8 and 12, and weeks 20 and 30. The grouping was chosen to be logical and at the same time to give sufficient cell frequencies. Week 40 was excluded because it did not have enough occurrences to stand alone as a category, yet seemed too different from weeks 20 and 30 to group with them (including it with them, however, made virtually no difference in the results). The resulting contingency table is shown in Table 8 of the main text. There was one cell that had 0 observations, which is considered

reasonable if the table contains more than 10 cells (Dixon, 1980). The dependency between samples taken the same day at the same location was ignored for the purpose of this analysis.

Once the contingency table was developed, the next step was to select the best loglinear model to fit the table (McCool et al, 1986). The loglinear analysis was run using the SAS CATMOD procedure. Since the cell with 0 observations was not a structural zero, a small positive value (10^{-6}) was substituted for the zero as suggested in the SAS User's Guide (Helwig and Council, 1979). A structural zero is a cell in which it is not possible for observations to occur, rather than one in which observations simply happened not to occur, as in the present case. Table I-3 contains a summary of the model selection analysis showing which terms were significant. The model selected was the model containing all three two-way interactions, but not the three-way interaction. The analysis of variance table (Table I-3) shows that the model fit since the likelihood ratio test for lack of fit was nonsignificant. Furthermore, the smallest likelihood ratio statistic for any model omitting a two-way interaction was 16.09, compared to 1.49 for the chosen model. The table also shows that all the two-way interactions were significant.

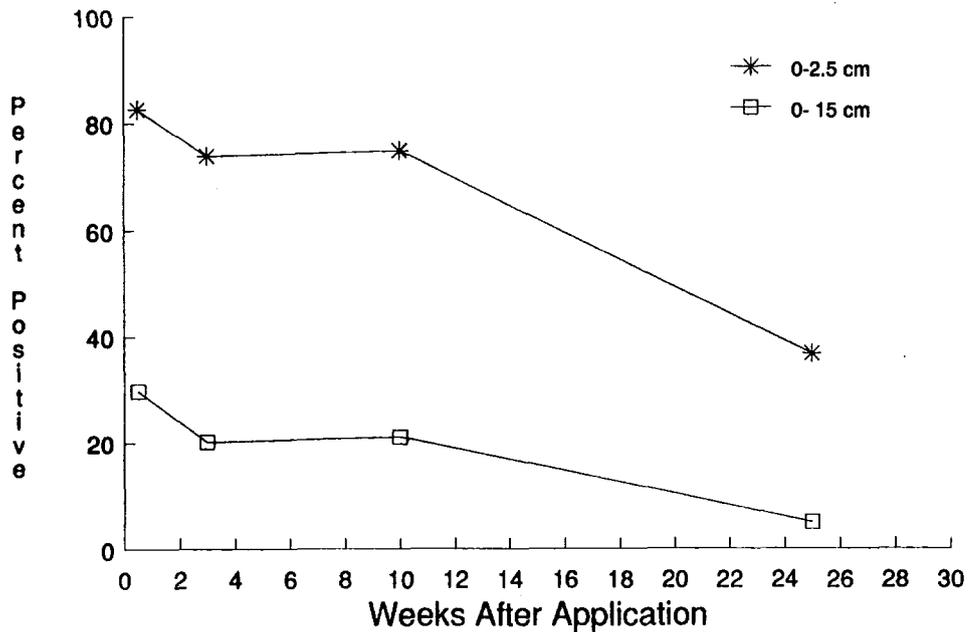
The model is interpreted to mean that the occurrence of isofenphos does depend on time and on depth, but that the dependency on one is the same at all levels of the other. That is, the relationship of isofenphos occurrence to time is the same at both depths (and similarly, the relationship of

isofenphos occurrence to depth is the same in each time category). Figure I-1 shows the occurrence of isofenphos predicted by the model for each depth and time category. There is significant decline in the occurrence of isofenphos over time, and there are significantly more occurrences at the 0-2.5 cm depth. The fact that occurrences decline at the same relative rate at both depths suggests that there is not downward movement of the material over time; such movement would be suggested by an increase at the lower depth at the same time as a decrease at the upper depth. Instead, the plot suggests that whatever downward movement there is occurs immediately and the material then declines over time at both depths.

Table I-3. Maximum likelihood analysis of variance for isofenphos occurrence in soil, Japanese Beetle Project, Sacramento, 1983-6.

Source	Degrees of Freedom	Chi-Square	Probability
Depth	1	14.95	0.0001
Week	3	10.29	0.0163
Depth X Week	3	24.98	0.0000
Isofenphos Occurrence	1	4.36	0.0368
Depth X Iso Occur	1	23.57	0.0000
Week X Iso Occur	3	11.97	0.0075
Likelihood Ratio	2	1.49	0.6851

Figure I-1. Percent of Soil Samples Positive for Isofenphos by Depth and Week, Predicted by Loglinear Model.



APPENDIX II

PRELIMINARY TURF RESIDUE TEST

INTRODUCTION

This turf test was a small study conducted to evaluate isofenphos residues on turf. When the Japanese beetle infestation was discovered in Sacramento County the most effective soil treatment pesticides (chlordan and isofenphos) were not registered in California. Department scientists requested this test to assist them in evaluating isofenphos for registration. The specific objective of this test was to determine the initial concentration and short term dissipation of dislodgable isofenphos on turf.

MATERIALS AND METHODS

Two, 2.4 by 2.4 meter (8 by 8 ft) experimental plots were established at a commercial sod farm in Sacramento. The plots were treated with Oftanol 5G[®], a granular formulation containing five percent isofenphos by weight. The Oftanol was applied with a salt shaker type device. The pesticide was applied at two rates, label rate and two times label rate (2.24 and 4.48 kg/ha active ingredient, or 2 and 4 lb/ac). Approximately 2.5 cm of water was applied to the plots immediately after application, as recommended by the label.

The plots were treated on July 20, 1983 and samples were collected at 6, 12, 28, 48, 52, 96, and 192 hours after application. The plots were irrigated at 2, 24, 49, 92, and 188 hours after application. Five replicate samples

of turf were collected from each plot, at each sampling period. Samples were collected and analyzed using the procedures described in the Materials and Methods Section of the main report. Samples were analyzed for both dislodgable and internal residue. Concentrations of isofenphos and isofenphos oxon were determined.

RESULTS AND DISCUSSION

Results of the test are summarized in Tables II-1 and II-2. As expected, the concentrations were highly variable for both plots. This was probably due to the inherent variability of granular applications. The concentrations found in the dislodgable fraction for the 1X plot ranged from 4.07 to 34.6 mg/m², 1.8 to 15% of the 224 mg/m² applied. The dislodgable concentrations from the 2X plot ranged from 5.26 to 65.7 mg/m², 1.1 to 14% of the 448 mg/m² applied. The average proportion of residue in the dislodgable fraction was 18% of the total amount for the 1X plot and 20% for the 2X plot. These proportions were fairly constant throughout the study. No discernible dissipation was observed during the study period for either plot, and there did not appear to be any correlation between irrigation events and turf concentration. As expected, the concentrations from the two plots were fairly comparable, with the 2X plot having concentrations approximately twice as high.

Table II-1. Summary statistics of isofenphos concentrations in turf for the 1X label rate plot, preliminary turf residue test, Japanese Beetle Project, Sacramento, 1983-6. Concentrations shown represent isofenphos + isofenphos oxon. Values below the detection limit are treated as 1/2 the detection limit.

	Hours After Application	N	Isofenphos Concentration, mg/m ²				
			Mean	Standard Deviation	Standard Error	Max	Min
Dislodgable	6	5	18.9	12.8	5.71	29.7	ND (1.13) ^a
Dislodg + Internal	6	5	89.8	67.2	30.1	164	11.5
Dislodgable	12	5	14.4	8.21	3.67	24.3	2.37
Dislodg + Internal	12	5	85.6	69.1	30.9	173	20.8
Dislodgable	28	5	34.6	40.2	18.0	104	ND (1.35)
Dislodg + Internal	28	5	114	81.9	36.7	236	43.2
Dislodgable	48	5	12.0	15.4	6.87	38.4	ND (1.30)
Dislodg + Internal	48	5	134	180	80.5	443	12.7
Dislodgable	52	5	19.6	14.5	6.49	41.5	3.93
Dislodg + Internal	52	5	89.6	47.7	21.3	117	22.5
Dislodgable	96	5	4.07	3.92	1.75	10.0	ND (0.63)
Dislodg + Internal	96	5	39.6	35.1	15.7	84.4	4.29
Dislodgable	192	5	12.3	4.92	2.20	19.1	7.10
Dislodg + Internal	192	5	77.1	29.7	13.3	102	30.9

a ND, None Detected with the number indicating the value for 1/2 the detection limit. The detection limit changes because of variation in sample weights.

Table II-2. Summary statistics of isofenphos concentrations in turf for the 2X label rate plot, preliminary turf residue test, Japanese Beetle Project, Sacramento, 1983-6. Concentrations shown represent isofenphos + isofenphos oxon. Values below the detection limit are treated as 1/2 the detection limit.

	Hours After Application	N	Isofenphos Concentration, mg/m ²				
			Mean	Standard Deviation	Standard Error	Max	Min
Dislodgable	6	5	65.7	52.8	23.6	137	16.2
Dislodg + Internal	6	5	261	234	105	663	120
Dislodgable	12	5	27.9	25.3	11.3	59.6	2.0
Dislodg + Internal	12	5	118	117	52.4	310	11.3
Dislodgable	28	5	55.3	33.5	15.0	95.3	23.9
Dislodg + Internal	28	5	351	212	95.0	606	166
Dislodgable	48	5	30.0	12.5	5.58	50.2	15.9
Dislodg + Internal	48	5	258	168	75.2	524	112
Dislodgable	52	5	50.5	20.4	9.14	76.4	20.2
Dislodg + Internal	52	5	188	75.7	33.9	290	76.5
Dislodgable	96	5	5.26	4.44	1.99	10.4	ND (0.81) ^a
Dislodg + Internal	96	5	36.5	32.0	14.3	75.5	15.5
Dislodgable	192	5	55.3	42.4	19.0	117	13.4
Dislodg + Internal	192	5	230	238	107	638	40.9

a ND, None Detected with the number indicating the value for 1/2 the detection limit. The detection limit changes because of variation in sample weights.

APPENDIX III
TOMATO TRANSLOCATION TEST

INTRODUCTION

Evidence in the literature indicated that isofenphos has slight systemic action, that is translocated through the roots of plants (see Fruit Results and Discussion Section). However, no studies had been done in California. The objective of this study was to determine the translocation potential of isofenphos in food crops under "worst case" conditions. The study was conducted by James Seiber and Michael McChesney of the University of California, Davis, Environmental Toxicology Department. The only food crops that were treated by the Japanese Beetle Project were fruit and nut trees planted in turf. Since these plants were expected to translocate very little isofenphos and would do so very slowly, tomato plants were selected as a worst case.

MATERIALS AND METHODS

The tomato plants were located at the Vegetable Crops field house near the airport at UCD. One row, approximately 150 m in length, was selected to be used for the study. The row consisted of two beds and each bed had two varieties of tomatoes planted, 82 VF-9 and 82 VF-10 f6 generation. Fifty meters of the row was used for the study. Each row was irrigated on every other Monday during the growing season.

Three plots comprised of five plants each were established. Each of the three plots were treated with a different application rate, label rate (2.24 kg/ha), five times label rate (11.2 kg/ha), and a control (untreated). The

surrounding area of each plant selected was staked out and the area measured. The amount of material to be applied was calculated based on the area and the material used was Oftanol 5G®.

The Oftanol was applied on August 28, 1983 with a salt shaker type jar. Each plant was carefully lifted off the ground before applying the formulation to the soil. The plots were irrigated after application with 75 l of water.

Air, soil, and tomato samples were taken on September 4, 1983, seven days after application. Two 3-hour high volume air samples were taken from the 5X plot plus one from the control plot. The air samplers were placed 36 cm above the soil. Each soil sample was comprised of 25, 2.5 X 2.5 X 2.0 cm subsamples, and three replicate samples were collected from each plot. Five tomato samples were collected from each plot, one sample from each plant. Each sample consisted of four tomatoes at least 2.5 cm in diameter. Soil and tomato samples were collected again on October 28, 1983, 61 days after application.

Air and soil samples were analyzed for isofenphos and isofenphos oxon. Tomato samples were also analyzed for des-N-isopropyl isofenphos and des-N-isopropyl isofenphos oxon in addition to the other two compounds. Air and soil samples were analyzed as previously described. The tomato samples were first rinsed with methanol to remove any dislodgable residue, and then chopped and extracted to recover the internal residue.

RESULTS AND DISCUSSION

No residues were found on the whole tomatoes indicating that none was translocated from the soil. Two other points should be made regarding the results. First, no parent or oxon was found in the three hour air samples taken on 9/4/83. At first glance, it would appear that this is in error. However, considering the small size of the sample area, the results seem reasonable. Had the area been larger one could have expected to see some residue in the air.

The second point is the surface rinse of the tomatoes. The 5X treatment did show the largest amount of parent and oxon (Table III-1). This could come from volatilization of the chemicals from the soil, but a better explanation is that as the fruit ripens the weight of the fruit increases, causing it to come in contact with the ground. It was those samples that had some soil adhering to the fruit that showed the highest residues. Considering that the average surface area of the tomatoes used was 500 cm², the amount of residue contained on one tomato is minimal.

The 7-day soil samples from this study ranged from 2.5 to 3.9 ppm. The 5X samples did show degradation with time, while the oxon did show an increase with time. One point to be noted is that the amount of oxon is not in the same proportion to the amount of parent when the 1X and 5X treatments are compared (Table III-3). That is, the ratio of oxon to parent for the 5X is less than that for the ratio of 1X for the samples on the same day. This

assumes that the recoveries for the oxon are comparable at the higher levels.

Table III-1. Results of isofenphos tomato dislodgable residue analyses, tomato translocation test, Japanese Beetle Project, Sacramento, 1983-6.

Sample	Date	<u>Isofenphos (pg/cm²)</u>				<u>Isofenphos Oxon (pg/cm²)</u>			
		1	2	3	\bar{x}	1	2	3	\bar{x}
1X	9/4/83	0.04	0.06	0.04	0.05	0.06	0.07	ND ^a	0.04
5X	9/4/83	0.45	0.12	0.12	0.22	0.24	0.21	0.06	0.17
1X	10/28/83	ND	ND	ND	ND	ND	ND	ND	ND
5X	10/28/83	ND	ND	ND	ND	0.07	1.9	ND	0.66

a None Detected, detection limit 0.04 picograms per square centimeter

Table III-2. Results of isofenphos soil residue analyses, tomato translocation test, Japanese Beetle Project, Sacramento, 1983-6.

Sample	Date	<u>Isofenphos (ppm)</u>				<u>Isofenphos Oxon (ppm)</u>			
		1	2	3	\bar{x}	1	2	3	\bar{x}
1X	9/4/83	1.7	1.7	2.3	1.9	0.76	0.88	1.6	1.1
5X	9/4/83	14	15	13	14	0.96	0.96	0.84	0.92
5X	10/28/83	15	7.7	9.7	11	2.6	3.0	2.0	2.5