Degradation and Mobility of Sulfometuron-methyl (Oust Herbicide) in Field Soil

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The degradation and mobility of sulfometuron-methyl and potential degradates were evaluated under actual field conditions in the United States following application of Oust herbicide to bare ground at the maximum labeled rate. Sulfometuron-methyl degraded rapidly at the four test sites; calculated half-life ($t_{1/2}$) values ranged from 12 to 25 days. Sulfometuron-methyl residues were below the limit of quantitation (10 ppb) beyond 90 days after treatment (DAT) at all test sites. The highest degradate concentration present at the end of the study (359 DAT) was 40 ppb (the herbicidally inactive 2-amino-4,6-dimethylpyrimidine). Sulfometuron-methyl and its degradates were immobile under field conditions.

Keywords: *Sulfometuron-methyl; degradation; mobility; half-life; soil*

INTRODUCTION

Sulfometuron-methyl (methyl 2-[[[[(4,6-dimethyl-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]benzoate), the active ingredient of Oust herbicide, has been shown to control a broad range of herbaceous species. It is used for vegetation management along roadsides, within railroad right-of-ways, and on industrial, noncrop sites. In addition, it can be used for selective weed control in forest site preparation for release of pines. The wide use pattern of this product justifies the study of its dissipation and mobility in field soil.

Studies of the soil metabolism and degradation of sulfometuron-methyl (Anderson and Dulka, 1985; Beyer et al., 1988; Brown, 1990; Cambon et al., 1992; Brown et al., 1998) have identified methyl 2-(aminosulfonyl)-benzoate, 2-amino-4,6-dimethylpyrimidine, and saccharin as the primary products of aerobic processes (Figure 1). Anaerobic processes, evaluated in other studies (Dulka and Anderson, 1982; Fallon, 1989; Berger and Wolfe, 1996; Brown et al., 1998), were found to be primarily responsible for the appearance of sulfometuron-methyl (free acid) and 2-(aminosulfonyl)-benzoic acid soil degradates. Half-lives (first-order kinetics model) for the disappearance of sulfometuron-methyl generally were 1−4 weeks for these aerobic or anaerobic laboratory studies.

In addition to microbial activity, chemical hydrolysis (Harvey et al., 1985; Beyer et al., 1988; Berger and Wolfe, 1996; Brown et al., 1998) has been determined to be a very important degradative mechanism for sulfometuron-methyl. While photochemical reactions can occur at the soil surface (Brown et al., 1998), this degradative process is much less significant than is hydrolysis.

Previous terrestrial field soil dissipation studies (Anderson and Dulka, 1985; Michael and Neary, 1993), carried out at seven widely varying sites, have shown sulfometuron-methyl to dissipate at rates similar to those for the laboratory soil metabolism studies (Table 1).

Contrary to laboratory studies, these field studies show that sulfometuron-methyl and its degradates are only slightly mobile under realistic environmental conditions: No residues were ever found at depths below 30 cm. If data from only nonforestry sites are examined, no residues are found below a depth of 24 cm.

This study was designed to provide data to evaluate the degradation and mobility of sulfometuron-methyl in soil under noncrop field conditions. It was conducted on bare soil at sites that are typical of locations where sulfometuron-methyl might be used.

MATERIALS AND METHODS

Chemicals. The test substance, Oust herbicide formulated as a dispersible granule containing 75% sulfometuron-methyl, was supplied by E. I. du Pont de Nemours and Co., DuPont Agricultural Products, Wilmington, DE. Analytical standards of sulfometuron-methyl (99.7% purity) and degradates (all >90% purity) were also obtained from DuPont. HPLC grade solvents (Omnisolv, EM Science) were used for soil extractions and for LC/MS analysis. All other chemicals used were of reagent grade (CMS).

Treatment and Sampling at Test Sites. Four test sites were established at locations where Oust Herbicide is typically used (Table 2). Weather data from the sites are presented in Figure 2.

For the three treated plots at each site, sulfometuron-methyl [630 g, active ingredient (ai)/ ha (equivalent to 9.0 oz of ai/ acre)] was applied once to bare soil as a soil-directed spray. Applications were made with either a CO_2 plot sprayer, a CO_2 backpack sprayer, or a CO_2 tractor sprayer. An additional plot at each site remained untreated, serving as a study control plot.

Plots at the Madera, CA, site were irrigated, primarily to allow workers to harvest soil cores at the designated intervals. Because in actual field use Oust herbicide is not used in irrigated settings, plots were not irrigated at any of the other test sites.

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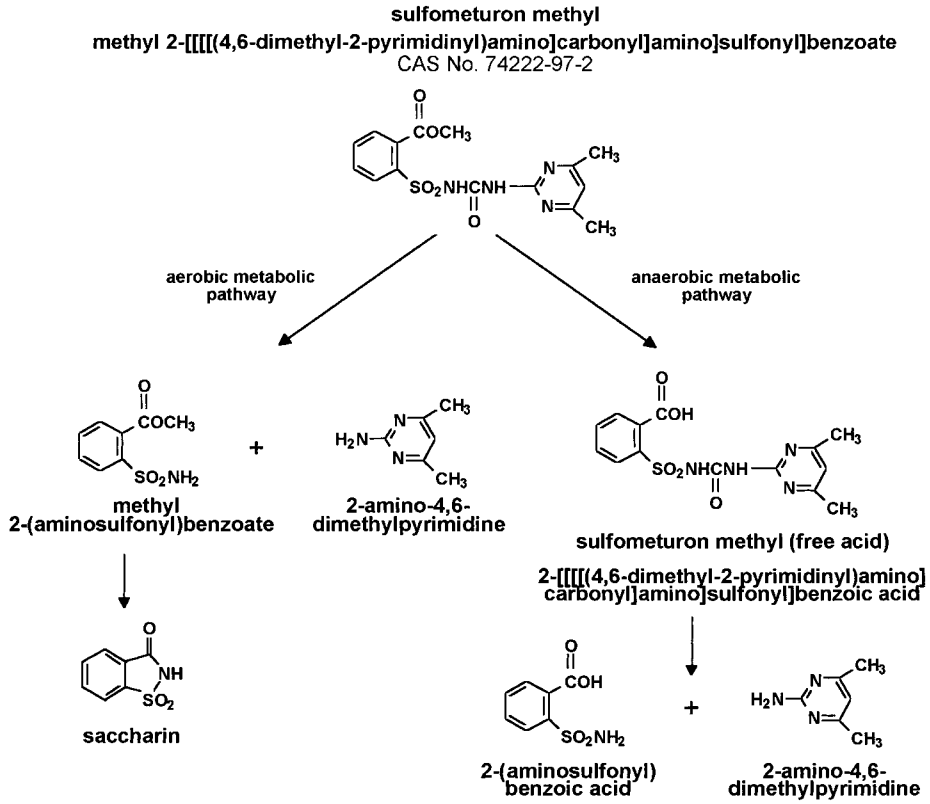

Figure 1. Metabolic pathway of sulfometuron-methyl in soil.

Table 1. Locations, Characteristics, and Half-Life Determinations for Sites Where Field Soil Dissipation Studies Have Been Conducted

test location	field type	treatment date	$t_{1/2}$ (weeks)	reference
Newark, DE	bare ground	July 3, 1980	2−3	Anderson and Dulka (1985)
Raleigh, NC	bare ground	July 18, 1980	2−3	Anderson and Dulka (1985)
Rosetown, SK	bare ground	July 29, 1980	5	Anderson and Dulka (1985)
Pendleton, OR	bare ground	Sept 8, 1980	13	Anderson and Dulka (1985)
Fort Collins, CO[a]	bare ground	Nov 14, 1980	21	Anderson and Dulka (1985)
Gainesville, FL	pine forest	June 13, 1985	0.7	Michael and Neary (1993)
Wahalak, MS	pine forest	April 9, 1985	4.7	Michael and Neary (1993)

[a] At the Fort Collins, CO, site, application was made to frozen ground in November.

Table 2. Test Site Information and Soil Characterization Information Taken from 0−30-cm Samples from Treated Plots

	Greenville, MS	Rochelle, IL	Uvalde, TX	Madera, CA
approximate location	9 mi SSE of Greenville, MS	1/8 mi W of Rochelle, IL	2 mi W of Uvalde, TX	8 mi W and 1 mi S of Madera, CA
application date	May 13, 1991	May 15, 1991	May 15, 1991	April 3, 1991
plot dimensions (m)	4.0 × 15	6.1 × 14	3.7 × 9.1	2.0 × 37
slope (%)	1	0	0.5	<0.5
soil identification	Commerce silty clay loam	Drummer silty clay loam	Uvalde silty clay loam	Chino sandy loam
sand (%)	19.6	15.6	21.2	53.6
silt (%)	45.6	49.6	36.0	29.6
clay (%)	34.8	34.8	42.8	16.8
organic matter (%)	1.7	3.1	2.3	1.2
pH	6.7	6.3	7.9	7.8
cation exchange capacity (mequiv/100 g)	23.19	31.38	26.14	18.53
moisture content (%)	22.61	19.85	16.68	14.84
moisture capacity, 0.33 bar (%)	30.48	28.21	27.49	23.42
moisture capacity, 15 bar (%)	17.92	16.87	20.18	12.10

Soil samples were collected before application, within 6 h after application, and approximately 14, 30, 60, 90, 120, 150, 180, 210, 240, 270, 300, 330, and 360 days after treatment (DAT).

Soil samples were taken to a depth of 90 cm using a zero-contamination soil probe with a plastic liner. On each sampling day at each site, five replicate 90-cm cores were taken from each of the three treated plots, and five replicate 90-cm cores were obtained from the control plot. All cores (2.5-cm diameter) were divided at the field sites into 0−45- and 45−90-cm segments.

Sample Processing. Soil cores were further sectioned in the laboratory into 0−15-, 15−30-, 30−45-, 45−60-, and 60−90-cm sections. Cores were combined by plot number,

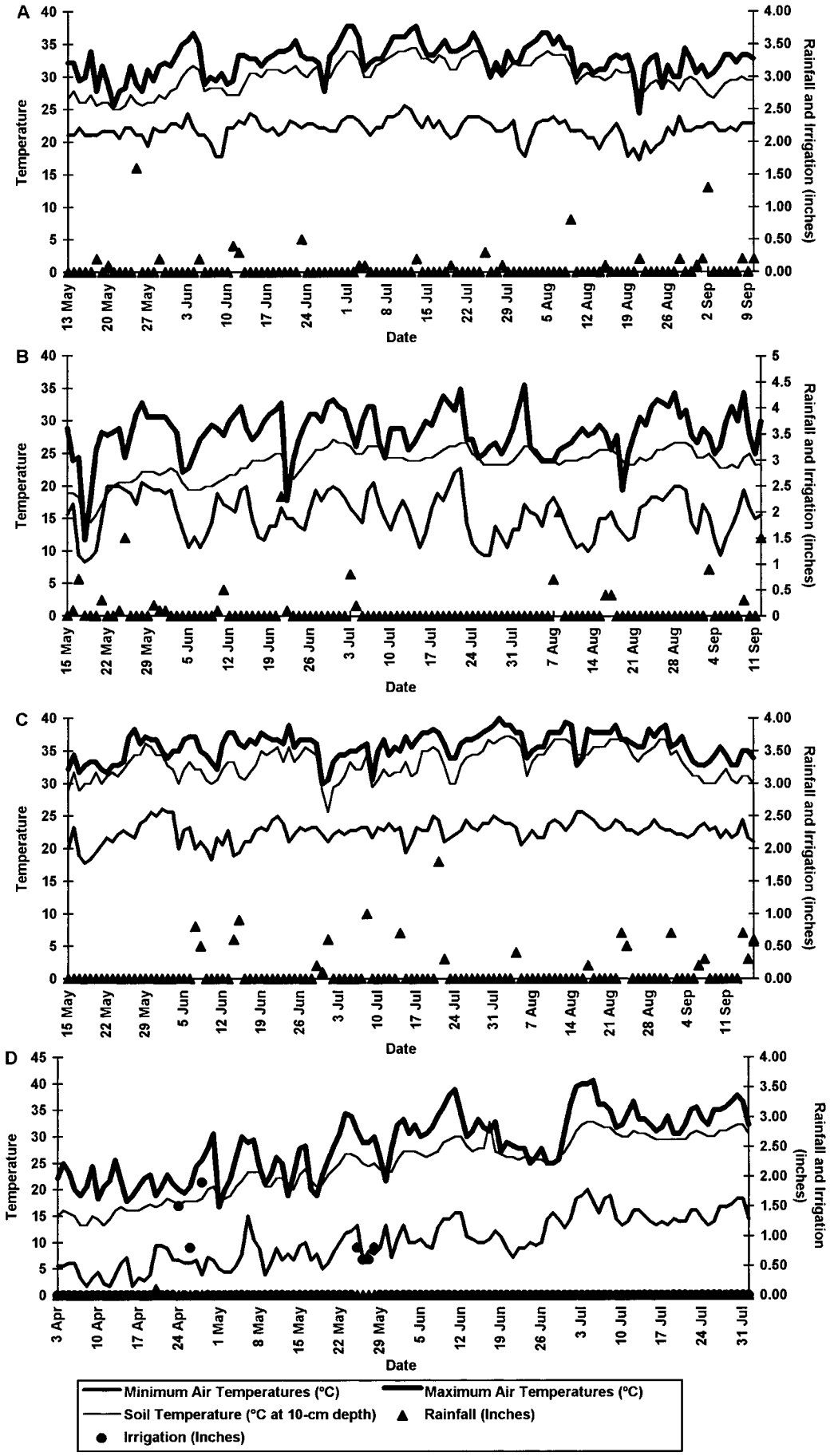

Figure 2. Air temperatures, soil temperatures, and rainfall at test sites from the day the test substance was applied until the first <10 ppb value was found: (A) Greenville, MS; (B) Rochelle, IL; (C) Uvalde, TX; (D) Madera, CA.

Table 3. Ions Used for the Determination of Sulfometuron-methyl and Degradates

Analytical Method 1

analyte	MW	precursor ion (*m*/*z*)	product ion (*m*/*z*)	approx RT (min)
sulfometuron-methyl (free acid)	201	124	107	4.7
2-amino-4,6-dimethyl-pyrimidine	350	124	107	5.1
methyl 2-(aminosul-fonyl)benzoate	214	233	199	6.7
sulfometuron-methyl	364	124 233	107 199	8.1

Analytical Method 2

analyte	MW	monitored ion (*m*/*z*)	approx RT (min)
2-(aminosulfonyl)-benzoic acid	201	182	12
saccharin	183	182	13.5

sampling date, and sampling depth (i.e., replicates from within the same plot were combined according to depth) and were homogenized using a food processor.

Analytical Method 1. Soil samples were analyzed for sulfometuron-methyl and its possible soil degradates sulfometuron-methyl (free acid), 2-amino-4,6-dimethylpyrimidine, and methyl 2-(aminosulfonyl)benzoate (Figure 1) as follows.

Soil (10 g, contained in 40-mL glass vials) was extracted with 10 mL of 80:20 acetonitrile (ACN)/(0.2 M ammonium acetate, 0.1% formic acid), by vortex-mixing for several seconds, ultrasonic mixing for 10 min (Branson 1200 ultrasonic cleaning bath, Branson Cleaning Equipment Co., Shelton, CT), vortex-mixing for several seconds, ultrasonic mixing for 5 min, and then vortex-mixing for several seconds. Vials were centrifuged for 15 min (≈1000 rpm), and supernatants were decanted into 50-mL graduated cylinders. Soil samples were re-extracted two additional times, using the same procedure (extracts combined in the 50-mL graduated cylinders). Extracts were diluted to 30 mL with extraction solution and mixed well by hand. Aliquots (6 mL) were filtered (Gelman Acrodisc CR syringe filters, 0.45 μm) into 10-mL (graduated) glass centrifuge tubes, concentrated under nitrogen (to ≈0.5 mL) at room temperature, and diluted to final volume (typically 1.0 mL) with 10:90 ACN/(0.2 M ammonium acetate, 0.1% formic acid). Samples were ultrasonically mixed for 1 min and then vortex-mixed for 30 s. Samples were filtered (same filters as before) into HPLC autosampler vials and stored in a freezer until analysis.

Standards and sample extracts were injected onto a Waters HPLC system (model 600-MS HPLC gradient pump and WISP 712 autosampler from Waters Corp., Milford, MA) connected to a Finnigan TSQ700 triple-stage quadrupole mass spectrometer (positive ion MS/MS mode, Finnigan MAT Corp., San Jose, CA) via a thermospray interface (Finnigan model TSP2). The column used was a Waters Nova-Pak C_{18}, 3.9 × 150 mm. Operating conditions for HPLC were as follows: injection volume, 20−100 μL; solvent A, 0.2 M ammonium acetate and 0.1% (v/v) formic acid; solvent B, acetonitrile; mobile phase flow rate, 1.20 mL/min. The gradient program was a follows: initial conditions, 95% A, 5% B; 5.00 min, 70%A, 30% B; 5.10 min, 55% A, 45% B; 7.50 min, 95% A, 5% B. The HPLC column was cleaned with 45% acetonitrile, as needed. Operating conditions for MS were as follows: vaporizer temperature, 125 °C (typical); source block temperature, 270 °C (typical); repeller, −10 V.

Detection was based on selected reaction monitoring (see Table 3 for relevant ions). The limit of quantitation (LOQ) was 10 ppb for each analyte.

Analytical Method 2. Soil samples were analyzed for the possible soil degradates 2-(aminosulfonyl)benzoic acid and saccharin (Figure 1) as follows.

Soil (2 g, contained in 10-mL sample cartridges) was extracted using an ISCO supercritical fluid extraction (SFE) system (model 2300, ISCO Inc., Lincoln, NE), which was configured for two extraction cells. Operating parameters were as follows: pump A, model 260D, constant pressure mode (5000 psi); pump B, model 100D, constant flow mode (2.00 mL/min); extractor temperature, 60 °C; extraction fluid (pump A), SFE grade, liquid CO_2. Pump B, containing 25:75 methanol/water as an SFE fluid modifier, was used to add 6 mL of modifier to each extraction cell. Pump A was then used to pressurize the extraction cells with CO_2 to a pressure of 5000 psi. Extraction was sustained in a static mode for 5 min. Sample extracts were then collected in test tubes. Soil samples were re-extracted (same procedure) a second time (extracts combined in the test tubes). A final collection was performed after the cells were pressurized with CO_2 for 30−60 s (no modifier added), as a flush to the system. Extracts were transferred to 10-mL, graduated, glass centrifuge tubes. Small volumes of methanol (≈1 mL) were used to rinse the collection tubes at least two times (rinses were added to centrifuge tubes). Samples were concentrated under nitrogen (to dryness) at 50 °C and diluted to final volume (typically 1.0 mL) with 0.1% (v/v) aqueous ammonium hydroxide. Samples were ultrasonically mixed for 1 min and then vortex-mixed for 30 s. Samples were acidified by addition of 1 drop of glacial acetic acid for every 1 mL of ammonium hydroxide that had been added. Sample tubes were briefly swirled by hand (to mix); extracts were filtered (same filters as in analytical method 1) into HPLC autosampler vials and stored in a freezer until analysis.

Standards and sample extracts were injected onto a Waters HPLC system [model 600-MS HPLC gradient pump, model 590-MS isocratic pump (for postcolumn addition), and WISP 712 autosampler from Waters Corp., Milford, MA] connected to a Finnigan TSQ700 triple-stage quadrupole mass spectrometer (negative ion MS mode, Finnigan MAT Corp., San Jose, CA) via a thermospray interface (Finnigan model TSP2). The column used was a Whatman Spherisorb 5 ODS-3, 4.6 × 250 mm. Operating conditions for HPLC were as follows: injection volume, 20−100 μL; solvent A, 5 mM ammonium acetate and 0.06% (v/v) formic acid; solvent B, acetonitrile; mobile phase flow rate, 1.00 mL/min. The gradient program was as follows: initial conditions, 100% A, 0% B; 5.00 min, 90%A, 10% B; 10.00 min, 90% A, 10% B; 12.00 min, 55% A, 45% B; 13.00 min, 100% A, 0% B. A postcolumn addition of 0.5 M ammonium acetate [containing 1% (v/v) acetonitrile] at 0.3 mL/min was made. The HPLC column was cleaned with 100% acetonitrile, as needed. Operating conditions for MS were as follows: vaporizer temperature, 100 °C (typical); source block temperature, 270 °C (typical); repeller, −10 V.

Detection was based on selected ion monitoring (see Table 3 for relevant ions). The LOQ was 10 ppb for each analyte.

For recovery determinations, control samples were fortified by adding standards of sulfometuron-methyl, sulfometuron-methyl (free acid), 2-amino-4,6-dimethylpyrimidine, and methyl 2-(aminosulfonyl)benzoate in acetonitrile or 2-(aminosulfonyl)-benzoic acid and saccharin in methanol directly onto the preprocessed sample prior to the addition of extraction solvent. Determinations of these fortified samples were performed throughout the study to monitor the performance of the analytical methods. Mean recoveries are presented in Table 4.

Degradation Data Analysis. Degradation curves for sulfometuron-methyl were analyzed using simple linear regression statistics (Figure 3). The dependent variable was natural log(sulfometuron-methyl concentration), and the independent variable was time (days after treatment).

The soil half-life ($t_{1/2}$) was calculated from the slope of the best fit line using the equation (first-order, linear kinetics model)

$$t_{1/2} = -0.693/\text{slope}$$

where $t_{1/2}$ is the time for the sulfometuron-methyl residue level to decline to 50% of the original concentration. This equation implies that the rate of sulfometuron-methyl degradation is directly proportional to the instantaneous concentration of sulfometuron-methyl residues.

Table 4. Mean Recovery Data for the Four Test Sites

analyte	recovery (%) ± SD			
	Greenville, MS	Rochelle, IL	Uvalde, TX	Madera, CA
sulfometuron-methyl	95 ± 9 $n = 27$	90. ± 8 $n = 17$	90. ± 7 $n = 13$	95 ± 9 $n = 28$
sulfometuron-methyl (free acid)	55 ± 9 $n = 10$	50 ± 4 $n = 6$	51 ± 11 $n = 8$	93 ± 15 $n = 6$
2-amino-4,6-dimethyl-pyrimidine	91 ± 10 $n = 10$	87 ± 9 $n = 6$	86 ± 10 $n = 8$	94 ± 6 $n = 7$
methyl 2-(aminosul-fonyl)benzoate	104 ± 15 $n = 10$	117 ± 12 $n = 6$	99 ± 14 $n = 9$	108 ± 10 $n = 7$
saccharin	91 ± 13 $n = 15$	86 ± 12 $n = 11$	95 ± 8 $n = 14$	94 ± 8 $n = 21$
2-(aminosulfonyl)-benzoic acid	86 ± 10 $n = 15$	82 ± 10 $n = 11$	86 ± 9 $n = 15$	89 ± 7 $n = 15$

RESULTS AND DISCUSSION

Degradation of Sulfometuron-methyl. Analysis of the soil samples showed that, at all sites, the soil concentration of sulfometuron-methyl declined rapidly. As the level of sulfometuron-methyl concentrations declined, the concentrations of the degradates 2-amino-4,6-dimethylpyrimidine, methyl 2-(aminosulfonyl)benzoate, and saccharin increased, consistent with chemical hydrolysis and aerobic metabolism operating as key degradative mechanisms. The absence of significant findings of sulfometuron-methyl (free acid) and 2-(aminosulfonyl)benzoic acid—sulfometuron-methyl (free acid) was detected once, and 2-(aminosulfonyl)benzoic acid was undetected—suggests minimal anaerobic activity.

The following sections describe the degradation pattern within the 0−15-cm soil depth (migration below this depth was insignificant) of sulfometuron-methyl (and its degradates) at each site (Figure 4).

Greenville, MS. The highest average soil concentration of sulfometuron-methyl was 79 ppb at DAT 0. By DAT 60, sulfometuron-methyl residues had degraded to below the LOQ. Linear regression analysis of natural log(sulfometuron-methyl concentration) versus time indicates a soil half-life of 14 days.

Degradate concentrations reached maximum values at DAT 60 (consistent with the disappearance of sulfometuron-methyl). On average, the degradate residues showed a general slow decline during the following 6 months (180 days). At DAT 359, only 2-amino-4,6-dimethylpyrimidine was quantifiable, with a value of 17 ppb.

An unusual occurrence at this site was the detection of sulfometuron-methyl (free acid) at DAT 15 (44 ppb, average). This was the only detection of sulfometuron-methyl (free acid) at a treated field site in this study. As expected, this degradate degraded rapidly.

Rochelle, IL. The highest average soil concentration of sulfometuron-methyl was 157 ppb at DAT 0. By DAT 60, sulfometuron-methyl residues had degraded to below the LOQ. Linear regression analysis of natural log(sulfometuron-methyl concentration) versus time indicates a soil half-life of 12 days.

Methyl 2-(aminosulfonyl)benzoate and saccharin concentrations reached maximum values at DAT 30 (consistent with the disappearance of sulfometuron-methyl). 2-Amino-4,6-dimethylpyrimidine reached a peak concentration of 55 ppb at DAT 120. On average, the degradate residues showed a general slow decline during the period of DAT 30 through DAT 362. At DAT 362, methyl 2-(aminosulfonyl)benzoate, 2-amino-4,6-dimethylpyrimidine, and saccharin were still quantifiable at low levels (<30 ppb), probably due to cessation of degradative processes during the cold winter months at this site.

Because of frozen ground, soil samples could not be obtained at the Illinois site during the period DAT 210 through DAT 300. As Figure 4B shows, degradate residue concentrations apparently remained constant during this period, with dissipation continuing with the onset of the spring thaw.

Uvalde, TX. The highest average soil sulfometuron-methyl concentration was 330 ppb, found at DAT 0. By DAT 61, sulfometuron-methyl residues had degraded to below the LOQ. Linear regression analysis of natural log(sulfometuron-methyl concentration) versus time indicates a soil half-life of 15 days.

Degradate concentrations reached maximum values during the period DAT 14 through DAT 61 (consistent with the disappearance of sulfometuron-methyl). Degradate dissipation was quite rapid during the period of DAT 14 through DAT 148. By DAT 281, all residues were below the LOQ.

Madera, CA. The highest average soil sulfometuron-methyl concentration was 175 ppb, found at DAT 0. By DAT 120, sulfometuron-methyl residues had degraded to below the LOQ. Linear regression analysis of natural log(sulfometuron-methyl concentration) versus time indicates a soil half-life of 25 days. This is longer than for the other sites, probably due to this site being considerably drier than the other three tests sites (as noted in the Introduction, chemical hydrolysis is an important degradative mechanism for sulfometuron-methyl).

The concentration of methyl 2-(aminosulfonyl)benzoate reached a maximum value (40 ppb) at DAT 61 (consistent with the disappearance of sulfometuron-methyl). This degradate was not detected after DAT 120. Degradates 2-amino-4,6-dimethylpyrimidine and saccharin reached a maximum concentration at approximately DAT 180. The concentration of 2-amino-4,6-dimethylpyrimidine was constant (at ≈40 ppb) through DAT 359. Saccharin was barely detectable by DAT 359.

Mobility of Sulfometuron-methyl and Degradates. Sulfometuron-methyl was determined to be immobile (i.e., confined to the upper soil depth, 0−15 cm) at all field test sites throughout the course of this study.

The Madera, CA, site produced the only samples in which sulfometuron-methyl was found below a depth of 15 cm (Table 5). The quantifiable sulfometuron-methyl concentrations at lower depths occurred at DATs 0 and 14. There was no rainfall or irrigation during this period, so these results are almost certainly spurious. No natural environmental process adequately explains the data at these DATs. These results are reasonably attributable to an artifact of the sampling procedure—since a single core is obtained initially (0−90 cm), residues from the top portion of the core almost certainly contaminated the lower depth segments. The even distribution of sulfometuron-methyl concentrations within lower depth segments is further evidence for a sampling problem at these intervals (i.e., the sulfometuron-methyl residue appears to have migrated fairly evenly throughout the complete core).

Soil degradates of sulfometuron-methyl were determined to be immobile (i.e., confined to the upper soil depth, 0−15 cm) at all field test sites throughout the

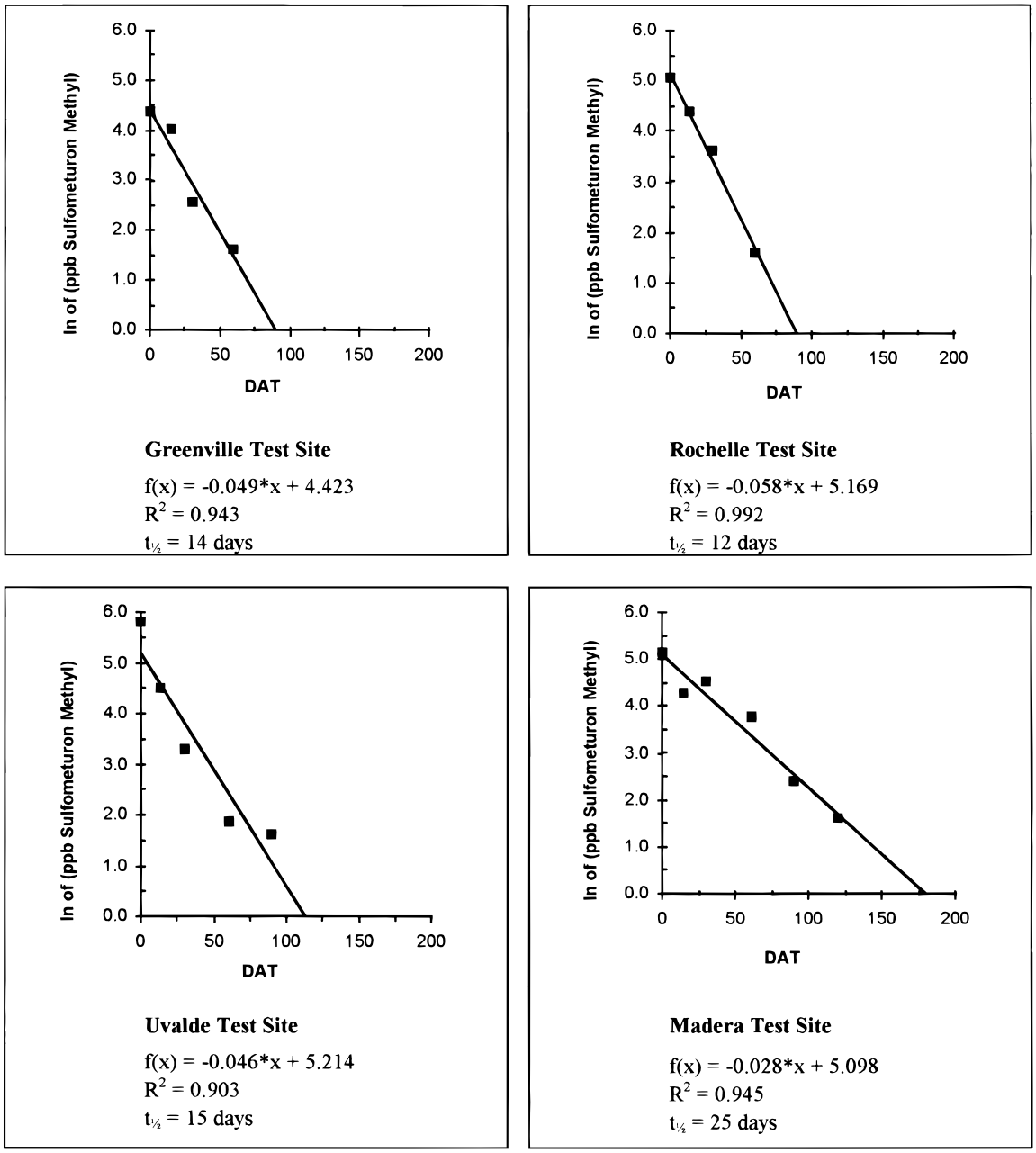

Figure 3. Plots to evaluate the half-life of sulfometuron-methyl in soil at the 0−15-cm level. Data are taken from the mean concentrations of sulfometuron-methyl and degradate residues found at the 0−15-cm level at each site. The final data point used for these figures was the first <10 ppb value found at each site. For these data points, ln 5 ppb (corresponding to LOQ/2) was plotted.

course of this study. No reliably quantifiable determinations of degradates were found below the 0−15-cm depth. (Soil cores were generally analyzed for degradates down to the 45-cm depth.) Madera soil replicate 1 for DAT 180 (30−45-cm depth) showed an apparent 2-amino-4,6-dimethylpyrimidine concentration of 15 ppb. However, the absence of 2-amino-4,6-dimethylpyrimidine in replicates 2 and 3 and the absence of any other detections of 2-amino-4,6-dimethylpyrimidine below 15 cm suggest that this result is an artifact.

Conclusion. Sulfometuron-methyl degraded rapidly under actual field-use conditions at all four test sites. At Greenville, MS, Rochelle, IL, and Uvalde, TX, the soil half-lives ranged from 12 to 15 days. At Madera, CA, the soil half-life was somewhat longer (25 days). This is probably attributable to this site being considerably drier than the other three test sites.

These soil half-lives are consistent with the results of the previous seven field soil dissipation studies cited in the Introduction. These earlier studies had a median half-life of 4.7 weeks. (At the Colorado test site, the soil was treated in November when the ground was already frozen. If the Colorado data are omitted, the median and mean half-lives from the other sites were 3.6 and 5 weeks, respectively.) The median and mean soil half-lives for this study (all four test sites) were 2.0 and 2.3 weeks, respectively.

Of the five potentially important degradates identified in sulfometuron-methyl soil metabolism studies (see Introduction), only methyl 2-(aminosulfonyl)benzoate, 2-amino-4,6-dimethylpyrimidine, and saccharin were detected to any significant extent in this study. Where there were significant differences (Greenville, MS, and Madera, CA), 2-amino-4,6-dimethylpyrimidine was the

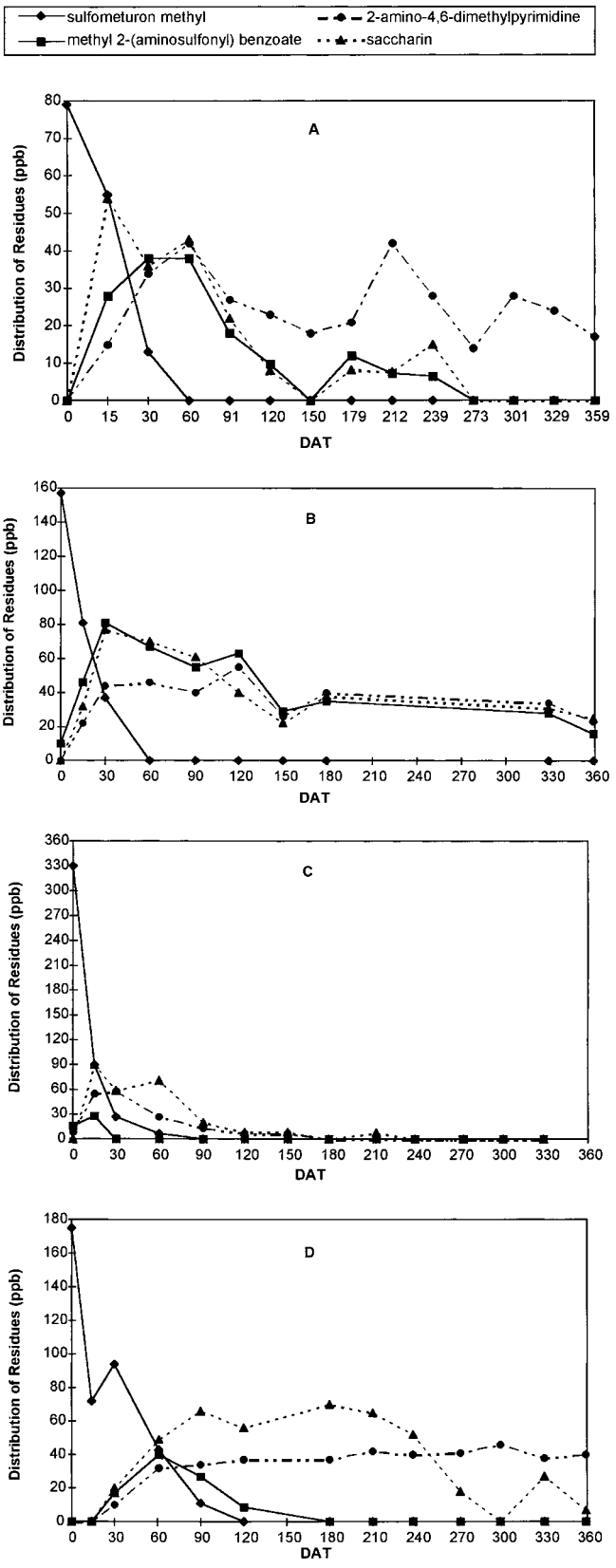

Figure 4. Mean residues of sulfometuron-methyl and degradates in the 0−15-cm level at each test site: (A) Greenville, MS; (B) Rochelle, IL; (C) Uvalde, TX; (D) Madera, CA. Data are taken from the mean concentrations of sulfometuron-methyl and degradate residues found at the 0−15-cm level. For the purpose of calculating average values, 5 ppb (corresponding to LOQ/2) was used for individual data determined to be <LOQ (unless all three replicate subplots produced values of <LOQ, in which case 0 ppb was plotted).

Table 5. Sulfometuron-methyl Residues from the Madera, CA, Site[a]

DAT	control or replicate no.	depth (cm)	sulfometuron-methyl residues found (ppb)
−1	control	0−15	<10
	rep 1	0−15	<10
		0−15	<10
	rep 2	0−15	<10
	rep 3	0−15	<10
0	control	0−15	<10
		15−30	<10
		30−45	<10
		45−60	<10
		60−90	<10
	rep 1	0−15	180
		15−30	19
		30−45	17
		45−60	13
		60−90	<10
	rep 2	0−15	96
		15−30	12
		30−45, dup A*	14
		30−45, dup B*	<10
		45−60, dup A*	<10
		45−60, dup B*	<10
		60−90	<10
	rep 3	0−15	250
		15−30	12
		30−45	11
		45−60	<10
		60−90	<10
14	control	0−15	<10
		15−30	<10
		30−45	<10
		45−60	<10
		60−90	<10
	rep 1	0−15	78
		15−30	12
		30−45	15
		45−60	14
		60−90, dup A*	<10
		60−90, dup B*	<10
	rep 2	0−15, dup A*	75
		0−15, dup B*	79
		15−30	21
		30−45	30
		45−60	13
		60−90	21
	rep 3	0−15	57
		15−30, dup A*	<10
		15−30, dup B*	<10
		30−45	<10
		45−60	<10
		60−90	<10
30	control	0−15	<10
		15−30	<10
		30−45	<10
	rep 1	0−15	120
		15−30	<10
		30−45	<10
	rep 2	0−15	65
		15−30	<10
		30−45	<10
	rep 3	0−15	97
		15−30, dup A*	<10
		15−30, dup B*	<10
		30−45	<10

[a] Asterisk (*) indicates duplicate analyses.

longest-lived degradate. The highest 2-amino-4,6-dimethylpyrimidine residue concentration remaining at DAT 359 (the last sampling date) was 40 ppb at Madera, CA. The total concentration of degradate residues declined considerably by the end of 1 year.

This study shows sulfometuron-methyl and its soil degradates to be immobile (i.e., generally confined to the upper soil depth, 0−15 cm). This result is consistent with previously published field soil dissipation studies. Although laboratory studies suggest the potential for these compounds to be mobile in sandy or loamy soils, when sulfometuron-methyl is applied to soil under field conditions, these compounds are seen to be quite immobile.

Therefore, one can reasonably conclude that, under actual field-use conditions, sulfometuron-methyl degrades rapidly and sulfometuron-methyl and its soil degradates are immobile.

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