DP Barcode:D154586,D166542,D160476
D160511,D160548
PC # 128501
Date out of EFGWB: 9/25/91

To: Robert Taylor
Product Manager #25
Registration Division (H7505C)

From: Akiva Abramovitch, Chief
Environmental Chemistry Review Section #3
Environmental Fate and Ground Water Branch/EFED (H7505C)

Through: Henry Jacoby, Branch Chief
Environmental Fate and Ground Water Branch/EFED (H7505C)

Attached, please find the EFGWB review of . . .

Case/Submission: 194142/S399522,051991/S389232,281967/S389239,281993/S389301
281477/S380457

Record # : 264987,264988,264675,264678,250410

Common Name : Sulfosate.

Type Product : Herbicide.

Product Name : Touchdown.

Company Name : Monsanto Agricultural Company.

Purpose : Review field dissipation and accumulation in confined rotational crops studies. Determine if available data support new uses on citrus, grapes, corn and soybeans. Review soil and water chemistry validation methods.

Date Received: 9/4/91

Date Completed 9/25/91

EFGWB # (s): 90-0680-0681
90-0594-0595
90-0784,91-0755
91-0361

Deferrals to:

_____ Ecological Effects Branch, EFED

_____ Science Integration and Policy Staff, EFED

_____ Non-Dietary Exposure Branch, HED

_____ Dietary Exposure Branch, HED

_____ Toxicology Branch I, HED

_____ Toxicology Branch II, HED

1. **CHEMICAL:** Common name:

Sulfosate.

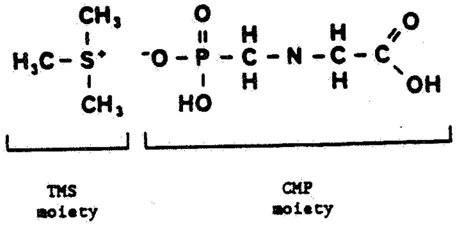
Chemical name:

Trimethylsulfonium carboxymethylaminomethylphosphonate; trimethylsulfonium N-(phosphonomethyl)glycine (1-) ion.

Trade name(s):

Touchdown, SC-0224 Concentrate, SC-0224 4-LC.

Structure:



Formulations:

LC (40.8%, 4 lb/gal); concentrate (52.2%, 5 lb/gal).

Physical/Chemical properties:

Molecular formula: $C_6H_{15}NO_5PS$.
Molecular weight: 244.23.
Physical state: Liquid.
Specific gravity: 1.27 g/cm^3.
Boiling point: 110 C at 760 Torr.
Vapor pressure: <4 x 10^{-7} Torr at 25 C.

2. **TEST MATERIAL:**

Studies 1-3: Soluble concentrate (40.8%, 4 lb/gal).
Study 4: Active ingredient; [^{14}C-anion]; labeled carboxymethylaminomethylphosphonate ion.
Study 5: Active ingredient; [^{14}C-cation]; labeled trimethylsulfonium ion.

3. **STUDY/ACTION TYPE:**

Review field dissipation and accumulation in confined rotational crops studies. Determine if available data support new uses on citrus, grapes, corn and soybeans. Review soil and water chemistry validation methods.

4. **STUDY IDENTIFICATION:**

MRID #41235906: Iwata, Y. 1989a. ICIA 0224 - Field dissipation study for terrestrial uses, California, 1987-1988. Laboratory Project ID WRC 89-37, Protocol No. RP-87-37. Unpublished study performed by Stauffer Chemical Company and ICI Americas Inc., Richmond, CA, and submitted by Monsanto Agricultural Company, St. Louis, MO.

MRID #41209921: Iwata, Y. 1989b. ICIA 0224 - Field dissipation study for terrestrial uses, Georgia, 1987-1988. Laboratory Project ID WRC 89-23, Protocol No. RP-87-27. Unpublished study performed by Stauffer Chemical

Company and ICI Americas Inc., Richmond, CA, and submitted by Monsanto Agricultural Company, St. Louis, MO.

MRID #41235907: Iwata, Y. 1989c. ICIA 0224 - Field dissipation study for terrestrial uses, Mississippi, 1987-1988. Laboratory Project ID WRC 89-40, Protocol No. RP-87-27. Unpublished study performed by Stauffer Chemical Company and ICI Americas Inc., Richmond, CA., and submitted by Monsanto Agricultural Company, St. Louis, MO.

MRID #41209920: Spillner, C.J. 1989a. [^{14}C-anion]ICIA0224 - Confined accumulation studies on rotational crops. Study No. PMS-224, Report No. WRC 89-25. Unpublished study performed by ICI Americas Inc., Richmond, CA., and submitted by Monsanto Agricultural Company, St. Louis, MO.

MRID #41209922: Spillner, C.J. 1989b. [^{14}C-cation]ICIA0224 - Confined accumulation studies on rotational crops. Study No. PMS-227, Report No. WRC 89-26. Unpublished study performed by ICI Americas Inc., Richmond, CA., and submitted by Monsanto Agricultural Company, St. Louis, MO.

No MRID #. June 26, 1991. Sulfosate: Validation data for soil and water environmental chemistry methods WRC 85-34R (determination on anions AMPA and CMP), WRC 85-33R (determination of cation TMS) Performing laboratory, ICI Western Research Center Richmond CA.

5. REVIEWED BY:

Kevin L. Poff
Chemist
EFGWB/EFED/OPP
Review Section #3

Signature: K. L. Poff

Date: 9/25/91

6. APPROVED BY:

A. Abramovitch
Chief
EFGWB/EFED/OPP
Review Section #3

Signature: Akiva Abramovitch

Date: SEP 25 1991

7. CONCLUSION:

Terrestrial Field Dissipation (164-1) (DER 1)

(1) Study MRID #41235906 does not satisfy the terrestrial field data requirement (164-1) for sulfosate at this time for the following reason:

(a) the soil samples were stored frozen for up to 366 days prior to analysis; however, adequate freezer storage stability data for sulfosate and it's degradates were not provided.

(2) The sulfosate moieties trimethylsulfonium cation (TMS) and carboxymethylaminomethylphosphonate anion (CMP) dissipated with calculated half-lives of 6 and 12 days, respectively, in the 0- to 3-inch depth of unvegetated sandy loam soil in California treated with a single application of sulfosate at 4 lb ai/A. TMS and CMP did leach to the 3- to 6-inch soil depth, but were not detected below the 6-inch soil depth. The CMP degradate aminomethylphosphonic acid (AMPA) was isolated in the 0- to 3-inch depth. Total rainfall during the first 364 days of the study totaled 11.6 inches; rainfall began at >100 days posttreatment and total irrigation for the study period was 33.74 inches.

Terrestrial Field Dissipation (164-1) (DER 2)

(1) Study MRID #41235907 does not satisfy the terrestrial field data requirement (164-1) for sulfosate at this time for the following reason:

(a) the soil samples in this study were stored frozen for up to 170 days prior to analysis; however, adequate freezer storage stability data for sulfosate and it's degradates were not provided.

(2) The sulfosate moieties trimethylsulfonium cation (TMS) and carboxymethylaminomethylphosphonate anion (CMP) dissipated with half-lives of 5 and 6 days, respectively, in the 0- to 3-inch depth of unvegetated sandy loam soil in Mississippi treated with a single application of sulfosate at 4 lb ai/A. TMS and CMP were not detected below the 3-inch soil depth, except for one sampling interval in which TMS was near the detection limit. The CMP degradate aminomethylphosphonic acid (AMPA) was isolated in the 0- to 3-inch depth. During the study, total rainfall was 38.0 inches and irrigation totaled 7.9 inches.

Terrestrial Field Dissipation (164-1) (DER 3)

(1) Study MRID #41209921 does not satisfy the terrestrial field data requirement (164-1) for sulfosate at this time for the following reason:

(a) the soil samples in this study were stored frozen for up to 133 days prior to analysis; however, adequate freezer storage stability data for sulfosate and it's degradates were not provided.

(b) the soil organic matter content, pH, and CEC were not specified.

(2) The sulfosate moieties trimethylsulfonium cation (TMS) and carboxymethylaminomethylphosphonate anion (CMP) dissipated with calculated half-lives of 10 and 4 days, respectively, from the 0- to 3-inch depth of unvegetated loamy sand soil in Georgia that was treated with a single application of sulfosate at 4 lb ai/A. In general, TMS and CMP were not detected below the 3-inch soil depth. The CMP degradate aminomethylphosphonic acid (AMPA) was isolated in the 0- to 3-inch depth. During the study period, total rainfall was 54.7 inches, and irrigation totaled 10.0 inches.

Confined Rotational Crop (165-1) (DER 4)

(1) Study MRID #41209920 does not satisfy the confined rotational crop data requirement (165-1) for sulfosate at this time for the following reasons:

(a) sulfosate residues in the crops were not identified; crops were only analyzed for total radioactivity.

(b) residues in the soil were inadequately characterized.

(c) frozen storage stability data were not provided for crop substrates.

(d) accumulation data from a leafy green vegetable (spinach, lettuce) need to be provided.

(2) [^{14}C]Carboxymethylaminomethylphosphonate (CMP) residues accumulated in wheat and turnips planted 35, 95, and 370 days after loamy sand soil was treated with anion-labeled [^{14}C]sulfosate at 4.59 ppm (0- to 7.5-cm depth). Residues in the wheat ranged from 0.06 to 0.51 ppm; residues in the turnips ranged from 0.02 to 0.09 ppm. In general, accumulation was greatest in crops from the 95-day rotation and least in the crops from the 370-day rotation.

Confined Rotational Crop (165-1) (DER 5)

(1) Study MRID #41209922 does not satisfy the confined rotational crop data requirement (165-1) for sulfosate at this time for the following reasons:

(a) two [^{14}C]compounds, isolated from the wheat leaves at up to 0.03 and 0.04 ppm, were not identified; and

(b) frozen storage stability data were not provided for crop substrates.

(2) [^{14}C]Trimethylsulfonium (TMS) residues accumulated in wheat planted 39 and 103 days after loamy sand soil was treated with cation-labeled [^{14}C]sulfosate at 0.98 ppm of TMS; [^{14}C]residues in wheat were a maximum 0.324 ppm and consisted primarily of TMS and two unidentified compounds. [^{14}C]Trimethylsulfonium (TMS) residues were <0.02 ppm in turnips at all sampling intervals.

Validation Data for Sulfosate Soil and Water Chemistry Methods

The EPA Environmental Chemistry Laboratory, Stennis Space Center Bay St. Louis, MS is validating ICI America's analytical methods WRC 85-34R (Determination of SC-0224 Anion Residues in Crops, Soil, and Water by Liquid Chromatography) and WRC 85-33R (Determination of SC-0224 Cation Residues in Crops, Soil and Water by Gas Chromatography).

The data package submitted to St. Louis contains recovery data of CMP, AMPA, and TMS from fortified water and soil samples (soil originated at the terrestrial field study sites located in CA, GA, MI, WA) as well as sample chromatograms from soil and water analysis.

After the method validation is completed by the ECL in St. Louis MS. a report will be forwarded to EFGWB to determine the impact of results. At that time an evaluation will be made and a complete report will be generated.

8. RECOMMENDATIONS:

The current status of environmental fate data requirements to support the registration of sulfosate for terrestrial food and terrestrial non-food uses is as follows:

Satisfied:
-Hydrolysis (161-1). Stable at pH 5, 7, and 9 at 25°C. EFGWB #4119, 4120 3/1/84
-Photodegradation in water (161-2). pH 5, cation stable; anion 14.6 days, pH 7, cation stable; anion 77.9 days, pH 9, cation 31.7 days; anion 41.6 days. EFGWB #4119, 4120 3/1/84.
-Photodegradation in soil (161-3). Cation stable, anion 382 hours; EFGWB # 6147, 6148, 1/21/86. EFGWB # 60707-60708,70214-70215, 3/27/87.
-Aerobic Soil Metabolism (162-1). Sandy loam, cation 49 hours, anion 13 hours. EFGWB # 6483-6486, 6/30/86; EFGWB # 70716-17, 6/26/87. However, EFGWB # 70760-61 indicates an aerobic half-life of 2-3 wks for both cation and anion.
-Anaerobic Soil Metabolism (162-2). Half-life of cation is 2 months based on CO_2 evolution. Anion exhibited a half-life similar to that of the aerobic metabolism study of 2-3 wks. EFGWB # 70760-61, 9/22/87.
-Leaching/Adsorption/Desorption (163-1). K_d values were 3-9; < 1% of the applied radiolabeled material was eluted w/ 20 inches of water. EFGWB # 70760-61, 9/22/87.

The following studies can be made acceptable by submission of supplemental information:

Confined Rotational Crop (165-1)
Terrestrial Field Dissipation (164-1)

Waived
Fish Accumulation (165-3).

Reserved
Ground Water Monitoring
166-1. Small Prospect.

Not Satisfied:
Terrestrial Field Dissipation (164-1)
Field Rotational Crop (165-2)
166-2. Small Retrosp.

The registrant needs to upgrade the confined rotational crop and terrestrial field studies as well as submit field rotational crop (165-2) studies to help to support the use of sulfosate on corn, and soybeans. EFGWB does not need crop rotation data to support the use of sulfosate on established and orchard crops (grapes and citrus), however, acceptable terrestrial field data is required.

ENVIRONMENTAL FATE ASSESSMENT

EFGWB has already evaluated the leaching potential for sulfosate (both the TMS, trimethylsulfonium and CMP, carboxymethylaminomethylphosphonate moiety) and has decided that the potential is low for ground water contamination (EFGWB #'s 70760-61). The field studies evaluated within this report seem to indicate the low potential for sulfosate to contaminate ground water. In all 3 studies TMS was not detected at depths greater than 6 inches; in 2 of the 3 studies CMP was not detected at depths greater than 6 inches and the CMP degradate (AMPA) was not detected at depths greater than 3 inches. The CMP degradate aminomethylphosphonic acid (AMPA) was not detected at depths greater than 3 inches in all 3 studies.

9. BACKGROUND:

Sulfosate is a nonselective systemic herbicide developed for postemergence weed control on terrestrial food crop and terrestrial nonfood sites. Sulfosate is comprised of two moieties: trimethylsulfonium cation (TMS) and carboxymethlaminomethylphosphate anion (CMP). Sulfosate is applied at 0.44 to 4.1 lb ai/A using either spray, wiper, or hand-directed spot application procedures. It is generally applied with a surfactant.

10. DISCUSSION OF INDIVIDUAL TESTS OR STUDIES:

Refer to attached reviews.

11. COMPLETION OF ONE-LINER:

Attached.

12. CBI APPENDIX:

All data reviewed here are considered "company confidential" by the registrant and must be treated as such.

Environmental Fate & Effects Division
PESTICIDE ENVIRONMENTAL FATE ONE LINE SUMMARY
SULFOSATE
Last Update on September 10, 1991
[V] = Validated Study [S] = Supplemental Study [U] = USDA Data

LOGOUT	Reviewer:	Section Head:	Date: SEP 24 1991

Common Name:SULFOSATE
PC Code # :128501 CAS #:81591-81-3 Caswell #:

Chem. Name :TRIMETHYLSULFONIUM CARBOXYMETHYLAMINOMETHYL-PHOSPHONATE

Action Type:Herbicide

Trade Names:TOUCHDOWN
(Formul'tn):
Physical State:

Use :NONSELECTIVE SYSTEMIC HERBICIDE FOR POSTEMERGENCE WEED
Patterns :CONTROL
(% Usage) :
:

Empirical Form: $C_3H_7NPO_5{-}\ {+}SC_3H_9$
Molecular Wgt.: 245.23 Vapor Pressure: 4.00E -7 Torr
Melting Point : °C Boiling Point: 110C@1AtmC
Log Kow : -5 pKa: @ °C
Henry's : E Atm. M3/Mol (Measured)

Solubility in ...					Comments
Water	E	ppm	@20.0	°C	very soluble
Acetone	E	ppm	@	°C	
Acetonitrile	E	ppm	@	°C	
Benzene	E	ppm	@	°C	
Chloroform	E	ppm	@	°C	
Ethanol	E	ppm	@	°C	
Methanol	E	ppm	@	°C	
Toluene	E	ppm	@	°C	
Xylene	E	ppm	@	°C	
	E	ppm	@	°C	
	E	ppm	@	°C	

Hydrolysis (161-1)
[V] pH 5.0:STABLE 25C
[V] pH 7.0:STABLE 25C
[V] pH 9.0:STABLE 25C
[ ] pH :
[ ] pH :
[ ] pH :

Environmental Fate & Effects Division
PESTICIDE ENVIRONMENTAL FATE ONE LINE SUMMARY
SULFOSATE
Last Update on September 10, 1991
[V] = Validated Study [S] = Supplemental Study [U] = USDA Data

Photolysis (161-2, -3, -4)

[V] Water:pH5 CAT. STABLE; AN. 14.6DA
[V] :pH7 CAT. STABLE; AN. 77.9DA
[V] :pH9 CAT. 31.7DA; AN. 41.6DA
[ ] :

[V] Soil :+ STABLE; ANION 382 HR
[ ] Air :

Aerobic Soil Metabolism (162-1)

[V]	SOIL	pH	%OM	(+)	(-)
[ ]	SdLm	5.6	1.1	49 HRS	13HR
[ ]	LOAM	6.9	1.9	300 "	16 "
[ ]	SAND	6.7	2.5	29 "	33 "
[ ]	LOAM	5.7	6.2		19 "
[ ]					
[ ]					

Anaerobic Soil Metabolism (162-2)

[V] T1/2 FOR (+) MOIETY=2 MONTHS
[ ] BASED ON CO2 EVOLUTION
[ ]
[ ]
[ ]
[ ]
[ ]

Anaerobic Aquatic Metabolism (162-3)

[ ]
[ ]
[ ]
[ ]
[ ]
[ ]
[ ]

Aerobic Aquatic Metabolism (162-4)

[ ]
[ ]
[ ]
[ ]
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[ ]

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Environmental Fate & Effects Division
PESTICIDE ENVIRONMENTAL FATE ONE LINE SUMMARY
SULFOSATE
Last Update on September 10, 1991
[V] = Validated Study [S] = Supplemental Study [U] = USDA Data

Soil Partition Coefficient (Kd) (163-1)

[ ] Kd VALUES FOR TMS MOIETY:

	Sd	Si	Cl	%OM	pH	Kd
[ ]	Sd	Si	Cl	%OM	pH	Kd
[V]	88	9	3	0.6	7.9	6.72
[V]	44	43	13	1.4	6.6	3.67
[V]	14	56	30	4.4	5.3	8.08
[V]			52	2.1	5.1	8.96

Soil Rf Factors (163-1)

[V]		CATION	ANION
[ ]	SdLm	.06	.20
[ ]	Lm	.01	.16
[ ]	Sd	.09	.08
[ ]	Lm	0.0	.16
[ ]			

Laboratory Volatility (163-2)

[ ]
[ ]

Field Volatility (163-3)

[ ]
[ ]

Terrestrial Field Dissipation (164-1)

[S] FIELD STUDIES CONDUCTED IN VA, CA, IO, FL; APPL 6 LBS AIA:

[ ]	STATE	CAP(-)	TMS(+)	AMPA (CAP DEGRADATE)
[ ]	VA	<7 DAYS	NON-DETECT.	VARIABLE
[ ]	CA, IO, FL	23-26 DAYS	30-50 DAYS	83-92 DAYS

[ ]
[ ]
[ ]
[ ]
[ ]
[ ]

Aquatic Dissipation (164-2)

[ ]
[ ]
[ ]
[ ]
[ ]
[ ]

Forestry Dissipation (164-3)

[ ]
[ ]

Long-Term Soil Dissipation (164-5)
[ ]
[ ]

Accumulation in Rotational Crops, Confined (165-1)
[ ]
[ ]

Accumulation in Rotational Crops, Field (165-2)
[ ]
[ ]

Accumulation in Irrigated Crops (165-3)
[ ]
[ ]

Bioaccumulation in Fish (165-4)
[ ]
[ ]

Bioaccumulation in Non-Target Organisms (165-5)
[ ]
[ ]

Ground Water Monitoring, Prospective (166-1)
[ ]
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Ground Water Monitoring, Small Scale Retrospective (166-2)
[ ]
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[ ]

Ground Water Monitoring, Large Scale Retrospective (166-3)
[ ]
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Ground Water Monitoring, Miscellaneous Data (158.75)
[ ]
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[ ]

Field Runoff (167-1)
[ ]
[ ]
[ ]
[ ]

Surface Water Monitoring (167-2)
[ ]
[ ]
[ ]
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Spray Drift, Droplet Spectrum (201-1)
[ ]
[ ]
[ ]
[ ]

Spray Drift, Field Evaluation (202-1)
[ ]
[ ]
[ ]
[ ]

Degradation Products

Aminomethylphosphonic acid (anion deg. from photolysis)

CO2 is major degradate of TMS moiety in aerobic soil study.

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SULFOSATE

Comments

Sulfosate consists of an N-(Phosphonomethyl) glycine anion and a trimethylsulfonium cation. The anion degrades to aminomethylphosphonic acid (AMPA) via photolysis (aqueous and soil).
There are discrepancies in the aerobic metabolism data; in addn. to that shown, T1/2 for (+) in loam was 192 days in one study but in another was < 1 month based on CO2 evolution.
T1/2 for (-) on soil was 382 hours, but (+) was stable.
In an anaerobic soil study, in 66 days 43% of radioactive (-) moiety was recovered as CO2.

References: EPA REVIEWS
Writer : PJH

SULFOSATE

TASK 1: REVIEW AND EVALUATION OF INDIVIDUAL STUDIES

September 10, 1991

Final Report

Contract No. 68D90058

Submitted to:
Environmental Protection Agency
Arlington, VA 22202

Submitted by:
Dynamac Corporation
The Dynamac Building
2275 Research Boulevard
Rockville, MD 20850-3262

SULFOSATE

Table of Contents

Page

Scientific Studies

DATA EVALUATION RECORD

STUDY 1

CHEM 128501	Sulfosate	§164-1

FORMULATION--15--SOLUBLE CONCENTRATE, LIQUID (SC/L)

STUDY ID 41235906
Iwata, Y. 1989a. ICIA 0224 - Field dissipation study for terrestrial uses, California, 1987-1988. Laboratory Project ID WRC 89-37, Protocol No. RP-87-37. Unpublished study performed by Stauffer Chemical Company and ICI Americas Inc., Richmond, CA, and submitted by Monsanto Agricultural Company, St. Louis, MO.

DIRECT REVIEW TIME = 24

REVIEWED BY:	L. Binari	TITLE:	Staff Scientist
EDITED BY:	T. Colvin-Snyder W. Martin	TITLE:	Staff Scientist Staff Scientist
APPROVED BY:	W. Spangler	TITLE:	Project Manager
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TEL:	301-417-9800		

APPROVED BY: A. Abramovitch
TITLE: Chief
ORG: EFGWB/EFED/OPP
TEL: 703-557-1975

SEP 24 1991

SIGNATURE:

CONCLUSIONS:

Field Dissipation - Terrestrial

1. This study cannot be used to fulfill data requirements at this time.
2. The sulfosate moieties trimethylsulfonium cation (TMS) and carboxymethylaminomethylphosphonate anion (CMP) dissipated with calculated half-lives of 6 and 12 days, respectively, in the 0- to 3-inch depth of unvegetated sandy loam soil in California treated with a single application of sulfosate at 4 lb ai/A. TMS and CMP did leach to the 3- to 6-inch soil depth, but were not detected below the 6-inch soil depth. The CMP degradate aminomethylphosphonic acid (AMPA) was isolated in the 0- to 3-inch depth.

3. This study is scientifically sound, but does not meet Subdivision N guidelines for the following reason:

   the soil samples were stored frozen for up to 366 days prior to analysis; however, adequate freezer storage stability data were not provided.

4. In order for this study to be used towards fulfillment of the terrestrial field dissipation data requirement, adequate data on the stability of TMS, CMP, and AMPA in soil stored frozen for at least 366 days must be submitted.

METHODOLOGY:

Sulfosate (Touchdown 4-LC, 4 lb/gal SC/L, source unspecified) was applied once at 4.0 lb ai/A to the surface of a fallow plot of sandy loam soil (66% sand, 21% silt, 13% clay, 0.6% organic matter, pH 7.1, CEC 7.0 meq/100 g) located in Orange Cove, California, on July 7, 1987. An untreated plot adjacent to the treated plot was used as a control. The depth to water table was 40-50 feet; the slope of the plots was <0.5%. Soil samples were collected prior to treatment, and 0, 1, 3, 7, 14, 31, 59, 205, and 366 days posttreatment. At each sampling interval, five randomly selected locations within the treated and control plots were sampled. Soil from the 0- to 3-inch depth was collected by inserting a cylinder (3-inch diameter) into the soil. The soil from the 3- to 48-inch depth was sampled by inserting a tractor-mounted hydraulic probe with an acetate liner (1-inch diameter). All soil samples were frozen, shipped to the laboratory, and stored at -20 C for up to 366 days until analysis.

The soil from the 3- to 48-inch depth was frozen, cut into segments (3- to 6-, 6- to 9-, 9- to 12-, 12- to 24-, 24- to 36-, and 36- to 48-inch depths), and composited by depth. Samples from the 0- to 3-inch depths were not composited. The soil samples were analyzed for the trimethylsulfonium (TMS) cation, the carboxymethylaminomethylphosphonate (CMP) anion, and aminomethylphosphonic acid (AMPA). To analyze for TMS, portions of the soil were extracted by shaking for 30 minutes with 10% aqueous potassium hydroxide. After extraction, the sample was either centrifuged or allowed to settle overnight before decanting the supernatant. The supernatant was evaporated almost to dryness on a hot plate, then the concentrated supernatant plus a small volume of toluene was transferred to a vial containing solid potassium hydroxide. The vial was sealed and heated at 100 C for 60 minutes to dealkylate the TMS to dimethyl sulfide (DMS); the toluene containing the DMS was analyzed by GC using flame photometric detection for sulfur. Recoveries from twelve soil samples that were fortified with TMS at 0.05 to 2.0 ppm were 85-116%; the method detection limit was 0.05 ppm.

To analyze for CMP and AMPA, portions of soil were extracted by shaking for 1 hour with 0.5 M aqueous ammonium hydroxide. The sample was centrifuged and an aliquot of the supernatant was evaporated to dryness at 50 C. The residue was dissolved in 0.05 M borate buffer, and mixed with 9-fluorenylmethyl chloroformate dissolved in acetone. After 25 minutes, ethyl acetate was added to stop the reaction and extract the excess reagent. Aliquots of the aqueous phase (containing the fluorescent derivatized compounds) were injected into a HPLC equipped with an anion-exchange column and fluorometric detection. The mobile phase was a mixture of pH 2.5 buffer (acetic acid:phosphate, 0.147 M H_3PO_4), acetonitrile, and water; the proportions of each were determined by the retention time of the peaks. Recoveries from 28 soil samples that were fortified with CMP at 0.05 to 0.5 ppm ranged from 70 to 118%; recoveries from soil samples fortified with AMPA ranged from 64 to 120%. The method detection limit for CMP and AMPA was 0.05 ppm.

DATA SUMMARY:

The sulfosate moieties trimethylsulfonium cation (TMS) and carboxymethylaminomethylphosphonate anion (CMP) dissipated with registrant-calculated half-lives of 6 and 12 days, respectively, from the upper 3 inches of unvegetated sandy loam soil in California after a single application of sulfosate (Touchdown 4-LC, 4 lb/gal SC/L) at 4 lb ai/A on July 7, 1987.

TMS in the 0- to 3-inch soil depth averaged 2.2 ppm at 0 days posttreatment and decreased to 1.4 ppm at 7 days, 0.81 ppm at 14 days, and was not detected (<0.05 ppm) by 59 days (Table 1). TMS was isolated in the 3- to 6-inch soil depth at 0.12 ppm at 3 days posttreatment and 0.21 ppm at 7 days. TMS was not detected at depths greater than 6 inches.

CMP in the 0- to 3-inch soil depth averaged 2.7 ppm at 0 days posttreatment and decreased to 1.04 ppm at 7 days, 0.71 ppm at 14 days, and was not detected (<0.05 ppm) by 120 days (Table 2). CMP was isolated in the 3- to 6-inch soil depth once, 7 days posttreatment at 0.20 ppm. CMP was not detected at depths greater than 6 inches. The CMP degradate

aminomethylphosphonic acid (AMPA)

reached a maximum concentration of 0.35 ppm at 31 days posttreatment, and was not detected at soil depths greater than 3 inches (Table 3).

Total rainfall during the first 364 days of the study totaled 11.6 inches; rainfall began at >100 days posttreatment. Irrigation was 0.56 inches at 3 days posttreatment, 0.28 inches at 7 days, 1.02 inches between 7 and 14 days, 2.8 inches between 14 and 30 days, and 4.2 inches between 30 and 59 days; total irrigation for the study period was 33.74 inches. Air temperatures ranged from 28 to 107 F during the study period.

COMMENTS:

1. The freezer storage stability data provided by the registrant were not adequate to confirm that TMS, CMP, and AMPA were stable during 366 days of frozen storage. The study author cited data from a previously reviewed freezer storage stability study (MRID 40046208, Dynamac Initial Report dated 3/27/87) as evidence that TMS, CMP, and AMPA are stable in soil during freezer storage. Although the study was scientifically valid, the experimental design was inappropriate to accurately determine the freezer storage stability of TMS, CMP, and AMPA in soil. Field plots were treated with sulfosate, and soil from the field plots was sampled at an unspecified interval and frozen for 0, 1, and 2 years. Since the application of a pesticide to a field plot tends to be erratic, and between-sample variation is often significant, using field samples for storage stability studies introduces considerable variability in the data and may confound affects resulting from frozen storage. In fact, in this terrestrial field dissipation study, the coefficients of variation of the replicate analyses for TMS, CMP, and AMPA were as high as 43% (Tables 1, 2, and 3). The study author stated that the variability between replicate samples may have been due to the use of a backpack sprayer. More typically, in order to determine freezer storage stability of a pesticide or pesticide degradate, soil samples are individually fortified in the field or laboratory with the pesticide or pesticide degradate. The soil is immediately frozen, and sampled periodically. A new freezer storage stability study must be submitted.

2. The half-lives calculated by the registrant, 6 days for TMS and 12 days for CMP, do not precisely correspond to the observed dissipation rates. The observed half-lives were 7-14 days for TMS and 3-7 days for CMP.

3. Field sample data sheets provided with the document indicate that samples were taken prior to treatment, but no analytical data were provided.

4. EFGWB prefers that residues in samples be separated by chromatographic methods (such as TLC, HPLC, or GC) with at least three solvent systems of different polarity, and that specific compounds isolated by chromatography be identified using a confirmatory method such as MS in addition to comparison to the R_f of reference standards.

   In this study, the sample extracts were analyzed using GC with two columns, or HPLC with a single column. Peaks were identified only by comparison to the location of known reference standards chromatographed on the same columns.

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5. The study author stated that AMPA has been previously identified in laboratory studies to be the only significant soil metabolite. An unidentified degradate of TMS that was present at 14-17% of the applied radioactivity at 4 days posttreatment in aerobic soil metabolism studies was not persistent.

6. In untreated control samples, CMP and AMPA were not detected (<0.05 ppm), and TMS varied from 0.01 to 0.03 ppm. The study author stated that TMS detected in the control samples was due to inteference by compounds in the soil that were coextracted with TMS.

Environmental Fate review Dated 9/25/91

Page_____ is not included in this copy.

Pages 20 through 34 are not included.

The material not included contains the following type of information:

_____ Identity of product inert ingredients.

_____ Identity of product impurities.

_____ Description of the product manufacturing process.

_____ Description of quality control procedures.

_____ Identity of the source of product ingredients.

_____ Sales or other commercial/financial information.

_____ A draft product label.

_____ The product confidential statement of formula.

_____ Information about a pending registration action.

__✓__ FIFRA registration data.

_____ The document is a duplicate of page(s) __________.

_____ The document is not responsive to the request.

The information not included is generally considered confidential by product registrants. If you have any questions, please contact the individual who prepared the response to your request.

DATA EVALUATION RECORD

STUDY 2

CHEM 128501 Sulfosate §164-1

FORMULATION--SOLUBLE CONCENTRATE, LIQUID (SC/L)

STUDY ID 41235907
Iwata, Y. 1989c. ICIA 0224 - Field dissipation study for terrestrial uses, Mississippi, 1987-1988. Laboratory Project ID WRC 89-40, Protocol No. RP-87-27. Unpublished study performed by Stauffer Chemical Company and ICI Americas Inc., Richmond, CA., and submitted by Monsanto Agricultural Company, St. Louis, MO.

DIRECT REVIEW TIME = 16

REVIEWED BY: L. Binari TITLE: Staff Scientist

EDITED BY: T. Colvin-Snyder TITLE: Staff Scientist
W. Martin Staff Scientist

APPROVED BY: W. Spangler TITLE: Project Manager

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Akiva Abramovitch

SEP 24 1991

SIGNATURE:

CONCLUSIONS:

Field Dissipation - Terrestrial

1. This study cannot be used to fulfill data requirements at this time.

2. The sulfosate moieties trimethylsulfonium cation (TMS) and carboxymethylaminomethylphosphonate anion (CMP) dissipated with half-lives of 5 and 6 days, respectively, in the 0- to 3-inch depth of unvegetated sandy loam soil in Mississippi treated with a single application of sulfosate at 4 lb ai/A. TMS and CMP were not detected below the 3-inch soil depth, except for one sampling interval in which TMS was near the detection limit. The CMP degradate

aminomethylphosphonic acid (AMPA) was isolated in the 0- to 3-inch depth.

3. This study is scientifically sound, but does not meet Subdivision N guidelines for the following reason:

> Soil samples in this study were stored frozen for up to 170 days prior to analysis; however, adequate freezer storage stability data were not provided.

4. In order for this study to be used towards fulfillment of the terrestrial field dissipation data requirement, adequate data on the stability of TMS, CMP, and AMPA in soil stored frozen for at least 170 days must be submitted.

METHODOLOGY:

Sulfosate (Touchdown 4-LC, 4 lb/gal SC/L, source unspecified) was applied at 4.0 lb ai/A to the surface of a fallow plot (50 x 40 feet) of silt loam soil (23% sand, 62% silt, 15% clay, 0.7-1.5% organic matter, pH 6.7, CEC 7.1 meq/100 g) located in Leland, Mississippi, on July 14, 1987. An untreated plot located 40 feet upslope from the treated plot was used as a control. The depth to the water table was 20 feet; the slope of the field was 0.5 to 2%. Soil samples were collected prior to treatment, and 0, 1, 3, 7, 14, 28, 57, 199, 380, and 542 days posttreatment. At each sampling interval, five randomly selected locations within the treated and control plots were sampled. Soil from the 0- to 3-inch depth was collected by inserting a cylinder (3-inch diameter) into the soil. The soil from the 3- to 48-inch depth was sampled by inserting a tractor-mounted hydraulic probe with an acetate liner (1-inch diameter). All soil samples were frozen, shipped to the laboratory, and stored at -20 C for up to 170 days until analysis.

The soil from the 3- to 48-inch depth was frozen, cut into segments (3- to 6-, 6- to 9-, 9- to 12-, 12- to 24-, 24- to 36-, and 36- to 48-inch depths), and composited by depth. Samples from the 0- to 3-inch depths were not composited. The soil samples were analyzed for the trimethylsulfonium (TMS) cation, the carboxymethylaminomethylphosphonate (CMP) anion, and aminomethylphosphonic acid (AMPA).

To analyze for TMS, portions of the soil were extracted by shaking for 30 minutes with 10% aqueous potassium hydroxide. After extraction, the sample was either centrifuged or allowed to settle overnight before decanting the supernatant. The supernatant was evaporated almost to dryness on a hot plate, then the supernatant plus a small volume of toluene was transferred to a vial containing solid potassium hydroxide. The vial was sealed and heated at 100 C for 60 minutes to dealkylate the TMS to dimethyl sulfide (DMS); the toluene containing the DMS was analyzed by GC using flame photometric detection for sulfur. Recoveries from eleven soil samples that were fortified with TMS at 0.05 to 2.00 ppm ranged from 84 to 117%; the detection limit was 0.05 ppm.

To analyze for CMP and AMPA, portions of soil were extracted by shaking for 1 hour with 0.5 M aqueous ammonium hydroxide. The sample was centrifuged and an aliquot of the supernatant was evaporated to dryness at 50 C. The residue was dissolved in 0.05 M borate buffer and mixed with 9-fluorenylmethyl chloroformate dissolved in acetone. After 25 minutes, ethyl acetate was added to stop the reaction and extract the excess reagent. Aliquots of the aqueous phase (containing the fluorescent derivitized compounds) were injected into a HPLC equipped with an anion-exchange column and fluorometric detection. Mobile phase composition was a mixture of pH 2.5 buffer (acetic acid:phosphate, 0.147 M H_3PO_4), acetonitrile, and water; the proportions of each were determined by the retention time of the peaks. Recoveries from 17 soil samples that had been fortified with CMP at 0.05 to 2.00 ppm ranged from 60 to 94%; recoveries from soil samples fortified with AMPA ranged from 74 to 108%. The method detection limit for CMP and AMPA was 0.05 ppm.

DATA SUMMARY:

The sulfosate moieties trimethylsulfonium cation (TMS) and carboxymethylaminomethylphosphonate anion (CMP) dissipated with registrant-calculated half-lives of 5 and 6 days, respectively, from the upper 3 inches of unvegetated sandy loam soil in Mississippi after a single application of sulfosate (Touchdown 4-LC; 4 lb/gal SC/L) at 4 lb ai/A on July 14, 1987.

TMS in the 0- to 3-inch soil depth averaged 1.8 ppm at 0 days posttreatment and decreased to 1.4 ppm at 3 days, 0.5 ppm at 7 days, 0.051-0.061 ppm at 28-57 days and was not detected (<0.05 ppm) at 199 days (Table 1). TMS was isolated in the 3- to 6-inch soil depth only once, 57 days posttreatment at 0.051 ppm. TMS was not detected at depths greater than 6 inches.

CMP in the 0- to 3-inch soil depth averaged 2.7 ppm at 0 days posttreatment and decreased to 2.0 ppm at 3 days, 1.11 ppm at 7 days, and was not detected (<0.05 ppm) by 28 days (Table 2). CMP was not detected at depths greater than 3 inches. The CMP degradate

aminomethylphosphonic acid (AMPA)

reached a maximum concentration of 0.32 ppm at 14 days posttreatment, and was not detected at depths greater than 3 inches (Table 3).

During the study, total rainfall was 38.0 inches. Irrigation totaled 7.9 inches during the study period. Air temperatures ranged from 12 to 101 F, and soil temperatures (2 inch depth) ranged from 31 to 111 F.

COMMENTS:

1. The freezer storage stability data provided by the registrant were not adequate to confirm that TMS, CMP, and AMPA were stable during 170 days of frozen storage. The study author cited data from a previously reviewed freezer storage stability study (MRID 40046208, Dynamac Initial Report dated 3/27/87) as evidence that TMS, CMP, and AMPA are stable in soil during freezer storage. Although the study was scientifically valid, the experimental design was inappropriate to accurately determine the freezer storage stability of TMS, CMP, and AMPA in soil. Field plots were treated with sulfosate, and soil from the field plots was sampled at an unspecified interval and frozen for 0, 1, and 2 years. Since the application of a pesticide to a field plot tends to be erratic, and between-sample variation is often significant, using field samples for storage stability studies introduces considerable variability in the data and may confound affects resulting from frozen storage. In fact, in this terrestrial field dissipation study, the coefficients of variation of the replicate analyses for TMS, CMP, and AMPA were as high as 68% (Tables 1, 2, and 3). The study author stated that the variability between replicate samples may have been due to the use of a backpack sprayer. More typically, in order to determine freezer storage stability of a pesticide or pesticide degradate, soil samples are individually fortified in the field or laboratory with the pesticide or pesticide degradate. The soil is immediately frozen, and sampled periodically. A new freezer storage stability study must be submitted.

2. The study author stated that the test material was applied July 7, 1987; however, the field data sheets state that the material was applied July 14, 1987.

3. In untreated control samples, CMP and AMPA were not detected (<0.05 ppm), and TMS varied from 0.01 to 0.06 ppm. The study author stated that TMS detected in the control samples was due to interference.

4. Field sample data sheets provided with the document indicate that samples were taken prior to treatment, but no analytical data were provided.

5. The study author stated that AMPA has been previously identified in laboratory studies to be the only significant soil metabolite. An unidentified degradate of TMS that was present at 14-17% of the applied radioactivity at 4 days posttreatment in aerobic soil metabolism studies was not persistent.

6. EFGWB prefers that residues in samples be separated by chromatographic methods (such as TLC, HPLC, or GC) with at least three solvent systems of different polarity, and that specific compounds isolated by chromatography be identified using a

confirmatory method such as MS in addition to comparison to the R_f of reference standards.

In this study, the sample extracts were analyzed using GC with two columns, or HPLC with a single column. Peaks were identified only by comparison to the location of known reference standards chromatographed on the same columns.

Environmental Fate review Dated 9/25/91

Page _____ is not included in this copy.

Pages 40 through 53 are not included.

The material not included contains the following type of information:

_____ Identity of product inert ingredients.

_____ Identity of product impurities.

_____ Description of the product manufacturing process.

_____ Description of quality control procedures.

_____ Identity of the source of product ingredients.

_____ Sales or other commercial/financial information.

_____ A draft product label.

_____ The product confidential statement of formula.

_____ Information about a pending registration action.

✓ FIFRA registration data.

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DATA EVALUATION RECORD

STUDY 3

CHEM 128501 Sulfosate §164-1

FORMULATION--SOLUBLE CONCENTRATE, LIQUID (SC/L)

STUDY ID 41209921
Iwata, Y. 1989b. ICIA 0224 - Field dissipation study for terrestrial uses, Georgia, 1987-1988. Laboratory Project ID WRC 89-23, Protocol No. RP-87-27. Unpublished study performed by Stauffer Chemical Company and ICI Americas Inc., Richmond, CA, and submitted by Monsanto Agricultural Company, St. Louis, MO.

DIRECT REVIEW TIME = 16

REVIEWED BY:	L. Binari	TITLE:	Staff Scientist
EDITED BY:	T. Colvin-Snyder K. Ferguson	TITLE:	Staff Scientist Task Leader
APPROVED BY:	W. Spangler	TITLE:	Project Manager

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APPROVED BY: A. Abramovitch
TITLE: Chief
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SEP 24 1991

SIGNATURE:

CONCLUSIONS:

Field Dissipation - Terrestrial

1. This study cannot be used to fulfill data requirements at this time.
2. The sulfosate moieties trimethylsulfonium cation (TMS) and carboxymethylaminomethylphosphonate anion (CMP) dissipated with calculated half-lives of 10 and 4 days, respectively, from the 0- to 3-inch depth of unvegetated loamy sand soil in Georgia that was treated with a single application of sulfosate at 4 lb ai/A. In general, TMS and CMP were not detected below the 3-inch soil depth. The CMP degradate aminomethylphosphonic acid (AMPA) was isolated in the 0- to 3-inch depth.

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3. This study is scientifically sound, but does not meet Subdivision N guidelines for the following reasons:

   although soil samples in this study were stored frozen for up to 133 days prior to analysis, adequate freezer storage stability data were not provided; and

   the soil organic matter content, pH, and CEC were not specified.

4. In order for this study to be used towards fulfillment of the terrestrial field dissipation data requirement, adequate data on the stability of TMS, CMP, and AMPA in soil stored frozen for at least 133 days must be submitted, and the soil organic matter content, pH, and CEC must be reported.

METHODOLOGY:

Sulfosate (Touchdown 4-LC, 4 lb ai/gal SC/L, source not specified) was applied once at 4.0 lb ai/A to the surface of a fallow plot (72 x 18 feet) of loamy sand soil (86% sand, 7.4% silt, 6.6% clay; organic matter content, pH, and CEC not specified) located in Donalsonville, Georgia, on August 12, 1987. An untreated plot located 45 feet upslope and south of the treated plot was used as a control. The depth to water table was 20 feet, and the slope of the plots was 0.5-2%. Soil samples were collected prior to treatment and 0, 2, 5, 7, 14, 33, 58, 182, and 369 days posttreatment. At each sampling interval, three randomly selected locations within the treated and control plots were sampled. Soil from the 0- to 3-inch depth was collected by inserting a cylinder (3-inch diameter) into the soil. The soil from the 3- to 48-inch depth was sampled using a tractor-mounted hydraulic probe with an acetate liner (1-inch diameter). All soil samples were frozen, shipped to the laboratory, and stored at -20 C for up to 133 days until analysis.

The soil from the 3- to 48-inch depth was frozen and cut into segments (3- to 6-, 6- to 9-, 9- to 12-, 12- to 24-, 24- to 36-, and 36- to 48-inch depths). The soil samples were analyzed for the trimethylsulfonium (TMS) cation, the carboxymethylaminomethylphosphonate (CMP) anion, and aminomethylphosphonic acid (AMPA).

To analyze for TMS, portions of the soil were extracted by shaking for 30 minutes with 10% aqueous potassium hydroxide. After extraction, the sample was either centrifuged or allowed to settle overnight before decanting the supernatant. The supernatant was evaporated almost to dryness on a hot plate, then the concentrated supernatant plus a small volume of toluene was transferred to a vial containing solid potassium hydroxide. The vial was sealed and heated at 100 C for 60 minutes to dealkylate the TMS to dimethyl sulfide (DMS); the toluene containing the DMS was analyzed by GC using flame photometric detection for sulfur. Recoveries from twelve soil samples that had been fortified with TMS at 0.05 to 1.0 ppm ranged from 80 to 124%. The detection limit was 0.05 ppm.

To analyze for CMP and AMPA, portions of soil were extracted by shaking for 1 hour with 0.5 M aqueous ammonium hydroxide. The sample was centrifuged, and an aliquot of the supernatant was evaporated to dryness at 50 C. The residue was dissolved in 0.05 M borate buffer and mixed with 9-fluorenylmethyl chloroformate dissolved in acetone. After 25 minutes, ethyl acetate was added to stop the reaction and extract the excess reagent. Aliquots of the aqueous phase (containing the fluorescent derivitized compounds) were injected into a HPLC equipped with an anion-exchange column and fluorometric detection. Mobile phase composition was a mixture of pH 2.5 buffer (acetic acid:phosphate, 0.147 M H_3PO_4), acetonitrile, and water; the proportions of each were determined by the desired retention time. Recoveries of CMP from 18 soil samples that were fortified at 0.05 to 2.0 ppm ranged from 68 to 115%, and recoveries of AMPA from fortified samples ranged from 70 to 118%. The method detection limit for CMP and AMPA was 0.05 ppm.

DATA SUMMARY:

The sulfosate moieties trimethylsulfonium cation (TMS) and carboxymethylaminomethylphosphonate anion (CMP) dissipated with registrant-calculated half-lives of 10 and 4 days, respectively, from the upper 3 inches of unvegetated sandy loam soil in Georgia after a single application of sulfosate (Touchdown 4-LC; 4 lb/gal SC/L) at 4 lb ai/A on August 12, 1987.

TMS in the 0- to 3-inch depth averaged 1.15 ppm at 0 days posttreatment, decreased to 0.59 ppm at 5 days, was 1.01 ppm at 7 days, was 0.51 ppm at 14 days, and was not detected (<0.05 ppm) by 58 days (Table 1). TMS was isolated in the 3- to 6-inch depth only once, immediately posttreatment at 0.12 ppm. TMS was not detected at depths greater than 6 inches.

CMP in the 0- to 3-inch depth averaged 1.2 ppm at 0 days posttreatment, decreased to 0.55 ppm at 2 days, 0.27 ppm at 5 days, and was not detected (<0.05 ppm) by 33 days (Table 2). CMP was isolated in the 3- to 6-inch depth once, immediately posttreatment at 0.12 ppm. CMP was not detected at depths greater than 6 inches. The CMP degradate

aminomethylphosphonic acid (AMPA)

reached a maximum concentration of 0.42 ppm at 7 days posttreatment, and was not detected at depths greater than 3 inches (Table 3).

During the study period, total rainfall was 54.7 inches, and irrigation totaled 10.0 inches. Air temperatures ranged from 21.4 to

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98.8 F, and soil temperatures (3-inch depth) ranged from 35.6 to 115 F.

COMMENTS:

1. The freezer storage stability data provided by the registrant were not adequate to confirm that TMS, CMP, and AMPA were stable during 133 days of frozen storage. The study author cited data from a previously reviewed freezer storage stability study (MRID 40046208, Dynamac Initial Report dated 3/27/87) as evidence that TMS, CMP, and AMPA are stable in soil during freezer storage. Although the study was scientifically valid, the experimental design was inappropriate to accurately determine the freezer storage stability of TMS, CMP, and AMPA in soil. Field plots were treated with sulfosate, and soil from the field plots was sampled at an unspecified interval and frozen for 0, 1, and 2 years. Since the application of a pesticide to a field plot tends to be erratic, and between-sample variation is often significant, using field samples for storage stability studies introduces considerable variability in the data and may confound affects resulting from frozen storage. In fact, in this terrestrial field dissipation study, the coefficients of variation of the replicate analyses for TMS, CMP, and AMPA were as high as 90% (Tables 1, 2, and 3). The study author stated that the variability between replicate samples may have been due to the use of a backpack sprayer. More typically, in order to determine freezer storage stability of a pesticide or pesticide degradate, soil samples are individually fortified in the field or laboratory with the pesticide or pesticide degradate. The soil is immediately frozen, and sampled periodically. A new freezer storage stability study must be submitted.

2. The test soil was not completely characterized. The soil organic matter content, pH, and CEC were not specified.

3. The actual application rate was less than the theoretical rate of 4.0 lb ai/A; concentrations of TMS and CMP (the two components of sulfosate) in the 0- to 3-inch depth immediately posttreatment were 1.15 and 1.2 ppm, respectively (Tables 1 and 2). The concentration of each sulfosate moiety (TMS and CMP) in the 0- to 3-inch depth should have been approximately 2 ppm.

4. The half-life of 4 days for CMP calculated by the registrant does not correspond to the observed dissipation rate of approximately 2 days.

5. In untreated control samples, CMP was not detected (<0.05 ppm), and TMS and AMPA varied from 0.01 to 0.04 ppm and 0.01 to 0.08 ppm, respectively. The study author stated that TMS and AMPA detection in the control samples was due to interference.

6. The study author stated that AMPA has been previously identified in laboratory studies to be the only significant soil metabolite of

sulfosate. Although an unidentified degradate of TMS was present at 14-17% of the applied radioactivity at 4 days posttreatment in aerobic soil metabolism studies, the compound was not persistent.

7. Numerous weather data recording equipment failures during the study do not permit an accurate account of the amount of precipitation or a complete report of the maximum and minimum temperatures in the air and soil.

8. EFGWB prefers that residues in samples be separated by chromatographic methods (such as TLC, HPLC, or GC) with at least three solvent systems of different polarity, and that specific compounds isolated by chromatography be identified using a confirmatory method such as MS in addition to comparison to the R_f of reference standards.

   In this study, the sample extracts were analyzed using GC with two columns, or HPLC with a single column. Peaks were identified only by comparison to the location of known reference standards chromatographed on the same columns.

9. Prior to the initiation of the study, the test plots were bahiagrass/bermudagrass pastures. After disking before test material application, the herbicides atrazine and metolachlor were applied to the plots. No fertilization or cultivation was performed during the test.

Environmental Fate review Dated 9/25/91

Page_____ is not included in this copy.

Pages 69 through 72 are not included.

The material not included contains the following type of information:

_____ Identity of product inert ingredients.

_____ Identity of product impurities.

_____ Description of the product manufacturing process.

_____ Description of quality control procedures.

_____ Identity of the source of product ingredients.

_____ Sales or other commercial/financial information.

_____ A draft product label.

_____ The product confidential statement of formula.

_____ Information about a pending registration action.

✓ FIFRA registration data.

_____ The document is a duplicate of page(s) __________.

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The information not included is generally considered confidential by product registrants. If you have any questions, please contact the individual who prepared the response to your request.

DATA EVALUATION RECORD

STUDY 4

CHEM 128501 Sulfosate §165-1

FORMULATION--00--ACTIVE INGREDIENT

STUDY ID 41209920
Spillner, C.J. 1989a. [^{14}C-anion]ICIA0224 - Confined accumulation studies on rotational crops. Study No. PMS-224, Report No. WRC 89-25. Unpublished study performed by ICI Americas Inc., Mountain View, CA, and submitted by Monsanto Agricultural Company, St. Louis, MO.

DIRECT REVIEW TIME = 20

REVIEWED BY:	L. Binari	TITLE:	Staff Scientist
EDITED BY:	T. Colvin-Snyder K. Ferguson	TITLE:	Staff Scientist Task Leader
APPROVED BY:	W. Spangler	TITLE:	Project Manager
ORG:	Dynamac Corporation Rockville, MD		
TEL:	301-417-9800		

APPROVED BY: A. Abramovitch
TITLE: Chief
ORG: EFGWB/EFED/OPP
TEL: 703-557-1975

SEP 24 1991

SIGNATURE:

CONCLUSIONS:

Confined Accumulation - Rotational Crops

1. This study cannot be used to fulfill data requirements.

2. [^{14}C]Carboxymethylaminomethylphosphonate (CMP) residues accumulated in wheat and turnips planted 35, 95, and 370 days after loamy sand soil was treated with anion-labeled [^{14}C]sulfosate at 4.59 ppm (0- to 7.5-cm depth). Residues in the wheat ranged from 0.06 to 0.51 ppm; residues in the turnips ranged from 0.02 to 0.09 ppm. In general, accumulation was greatest in crops from the 95-day rotation and least in the crops from the 370-day rotation.

3. This study is scientifically sound, but does not meet Subdivision N guidelines for the following reasons:

   residues in the crops were not identified (crops were analyzed for total radioactivity only);

   residues in the soil were inadequately characterized; and

   frozen storage stability data were not provided for crop substrates.

4. In order for this study to fulfill the accumulation in confined rotational crop data requirement, the registrant must further characterize the CMP residues in the crops and soil, and must provide freezer storage stability data for the crop substrates. In addition, accumulation data from a leafy vegetable with fibrous roots are needed.

METHODOLOGY:

Keeton loamy sand soil (79.9% sand, 13.9% silt, 6.2% clay, 0.6% organic matter, pH 6.9, CEC 12.2 meq/100 g) was mixed with 17-17-17 fertilizer at 185 g/59 kg soil, sieved (2 mm), and placed in clay pots. Glass tubes (18.75 cm long, 1 cm diameter) were placed in the center of each pot to drain added water in excess of 1 cm from the top of the soil. The upper 7.5-cm layer of soil was removed from six of the pots, combined, and treated with [^{14}C]sulfosate labeled in the methylene group of the CMP moiety (radiochemical purity 94%, specific activity 30 mCi/mmol, ICI) at a nominal rate of 6 ppm sulfosate (equivalent to 4 ppm CMP and 6 kg/ha sulfosate). Soil from six additional pots was treated with unlabeled sulfosate (purity 95.7%, ICI) at the same rate. The pots of soil were maintained outdoors in Mountain View, California. At rotation intervals of 35, 95, and 370 days posttreatment, rotational crops of wheat and turnips were each planted in one pot of soil treated with [^{14}C]sulfosate and one pot of soil treated with unlabeled sulfosate. Immediately prior to planting of rotational crops, soil from the upper and lower 7.5 cm of the pots was removed; the soil from each depth was separately mixed, and the soil was returned to the pots. Immature plant thinnings from the 35-day rotation were sampled at unspecified periods up to harvest of mature plants. The plants from all rotation intervals were harvested at maturity; the wheat and turnips planted at 35 days posttreatment were harvested 98 and 222 days postplanting, respectively, and the crops planted at 95 and 370 days posttreatment were harvested 99-100 days postplanting. The soils were sampled immediately posttreatment and prior to each planting and harvest of mature crops. Immediately prior to planting of each rotational crop, one soil core (1 cm diameter x 15 cm deep) was removed from each pot, and the cores were divided into 7.5-cm segments; soil was also sampled from each depth after mixing and prior to being returned to the pots. At crop harvest intervals, soil from the upper and lower 7.5 cm of each pot was removed and sampled. All crop and soil samples were stored frozen at -10 C until analysis (duration of storage not specified).

The wheat was separated into heads (grain and chaff) and stalks (plus leaves) clipped at ground level, then ground in a Wiley mill. The turnip leaves were clipped off the roots, frozen in liquid nitrogen, and homogenized in a mortar and pestle; the roots were washed with distilled water and ground fresh in a food processor. Tissue samples were analyzed for total radioactivity by LSC following combustion. The detection limit of [^{14}C]residues in plant tissue was calculated to be 0.002 ppm.

Soil samples were extracted three times by shaking for 1 hour with 1 M hydrochloric acid; after each extraction, the samples were centrifuged and the supernatants decanted. Aliquots of the soil extracts were analyzed for total radioactivity by LSC. The extracts were concentrated by rotary vacuum evaporation and analyzed by LSC. Extracts were passed through prerinsed C-18 bonded silica columns; radioactive residues were eluted with 1 M hydrochloric acid and the eluate concentrated by rotary vacuum evaporation. The concentrate was diluted with distilled water and mixed with Dowex AG-50-WX8 (hydrogen form) resin at 25 C for 2 hours. The resin was filtered, dried, and analyzed by LSC following combustion. The filtrate was concentrated by rotary vacuum evaporation analyzed by one- and two-dimensional TLC using silica gel plates developed in n-propanol:diethylamine:water (5:2:3, v:v:v) and n-propanol:triethylamine:water (5:2:3, v:v:v). Samples were cochromatographed with non-radiolabeled standards. Extracted soils were analyzed for total radioactivity by LSC following combustion.

DATA SUMMARY:

[^{14}C]Carboxymethylaminomethylphosphonate (CMP) residues (uncharacterized) accumulated in mature wheat and turnips planted in loamy sand soil 35, 95, and 370 days after the soil was treated with CMP-labeled [^{14}C]sulfosate (radiochemical purity 94%). In crops planted at the 35- and 95-day rotation intervals, [^{14}C]CMP residues were 0.25-0.29 ppm in mature wheat chaff and grain, 0.46-0.51 ppm in mature wheat stalks and leaves, and 0.02 ppm in mature turnip leaves and bulbs (Table V). In crops planted at the 370-day rotation, [^{14}C]CMP residues were 0.1-0.11 ppm in mature wheat chaff, stalks, and leaves; 0.06 ppm in mature wheat grain; and 0.02-0.03 ppm in mature turnip leaves and bulbs. In immature wheat and turnip thinnings from the 35-day rotation sampled at unspecified intervals, [^{14}C]CMP residues were 0.16-0.18 ppm.

Immediately posttreatment, [^{14}C]CMP residues in the upper treated layer of soil (0- to 7.5-cm) were 3.15 ppm CMP equivalents (Table IV). At the time of planting, CMP residues in the treated layer of soil were 2.4 ppm CMP equivalents for the 35-day rotation, 1.89 ppm CMP equivalents for the 95-day rotation, and 1.45 ppm CMP equivalents for the 370-day rotation; average CMP residues in the entire pots of soil (15-cm depth) were 1.33, 1.30, and 0.80 ppm, respectively (Tables III and IV). At the time of harvest of mature crops, average CMP residues in the entire pots of soil were 0.52-0.96 ppm (Table III).

Average temperatures during the study ranged from approximately 4 C to 28 C (Figure 1). Estimated rainfall was approximately 9 cm during the first 35 days of the study, 37 cm during the first 95 days, and 71 cm during the entire 370 days (Figure 1).

COMMENTS:

1. The plant samples were analyzed for total [^{14}C]residues only. The study author stated that residues in the plant samples were not characterized because of very low levels of radioactivity and the difficulty of purifying the test material from the samples; however, [^{14}C]residues accumulated to a maximum concentration of 0.51 ppm in the wheat stalks/leaves and 0.09 ppm in the turnip leaves.

2. [^{14}C]Residues in the soil were not adequately identified or quantified. The soil extracts "contained large quantities of substances, presumably dissolved soil organic matter, that interfered with TLC analysis." TLC of "purified" extracts showed that most of the radioactivity remained at the origin or did not chromatograph with any of the standards used (Figure 3), and, when soil extracts were spiked with standards, "the standards did not move from the origin." In addition, clean-up procedures (C-18 column and cation-exchange batch method) in preparation for TLC resulted in the loss of approximately 75% of the extracted radioactivity.

3. Frozen storage stability data were not provided for crop substrates. Plant tissue were stored at -10 C for unspecified lengths of time before analysis.

   Soil samples in this study were stored frozen for up to 181 days before extraction; the study author stated that "no field-treated sample was stored in excess of 366 days". Freezer storage stability data for sulfosate (MRID 40046208) were reviewed in a Dynamac document submitted 3/27/87. The study was determined to be scientifically valid; sulfosate was determined to be stable under the frozen storage conditions for at least two years.

4. A leafy vegetable crop was not included in the study. The study author stated that the turnips should be considered both a root and leafy vegetable crop since turnip greens are eaten. However, it is unlikely that the concentration of adsorbed residues in the foliage of a root crop would be similar to the concentration of residues in the foliage of a crop with fibrous roots.

5. The nominal application was 5.8 ppm of sulfosate; however, the confirmed application was 4.59 ppm (3.15 ppm CMP equivalents) for the 0- to 7.5-cm depth. The study author stated that the maximum use rate is 6 kg ai/ha, which is equivalent to approximately 6 ppm.

6. The study author stated that leachates were collected and analyzed during all the growing periods of the crops. It was reported that "the amount of radioactivity found in the leachate was insignificant"; no quantitative data were provided.

7. Throughout the report, the study author referred to notebook numbers and page numbers when discussing methods and results which were not provided for review. The descriptions of the cultural conditions during the growing periods were inadequate. No information was provided as to the dates of plant thinning, the frequency and quantity of waterings, or the rates and application dates of pesticide (allethrin).

8. The method of visualization of compounds on TLC plates was not specified

9. Immature plants were analyzed only during the 35-day rotation.

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DATA EVALUATION RECORD

STUDY 5

CHEM 128501 Sulfosate §165-1

FORMULATION--00--ACTIVE INGREDIENT

STUDY ID 41209922

Spillner, C.J. 1989b. [^{14}C-cation]ICIA0224 - Confined accumulation studies on rotational crops. Study No. PMS-227, Report No. WRC 89-26. Unpublished study performed by ICI Americas Inc., Mountain View, CA, and submitted by Monsanto Agricultural Company, St. Louis, MO.

DIRECT REVIEW TIME = 20

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SEP 24 1991

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CONCLUSIONS:

Confined Accumulation - Rotational Crops

1. This study cannot be used to fulfill data requirements.

2. [^{14}C]Trimethylsulfonium (TMS) residues accumulated in wheat planted 39 and 103 days after loamy sand soil was treated with cation-labeled [^{14}C]sulfosate at 0.98 ppm of TMS; [^{14}C]residues in wheat were a maximum 0.324 ppm and consisted primarily of TMS and two unidentified compounds. [^{14}C]Trimethylsulfonium (TMS) residues were <0.02 ppm in turnips at all sampling intervals.

3. This study is scientifically sound, but does not meet Subdivision N guidelines for the following reasons:

two [^{14}C]compounds, isolated from the wheat leaves at up to 0.03 and 0.04 ppm, were not identified; and

frozen storage stability data were not provided for crop substrates.

4. In order for this study to fulfill the accumulation in confined rotational crop data requirement, the registrant must further characterize the TMS residues in the wheat and soil, and must provide freezer storage stability data for the crop substrates. In addition, accumulation data from a leafy vegetable with fibrous roots are needed.

METHODOLOGY:

Keeton loamy sand soil (81.5% sand, 13.6% silt, 5.0% clay, 1.1% organic matter, pH 7.2, CEC 12.2 meq/100 g) was mixed with 17-17-17 fertilizer at 36 g/45 L soil, sieved (3 mm), and placed in clay pots. Glass tubes (20 cm long, 1 cm diameter) were placed in the center of each pot to drain added water in excess of 1 cm from the top of the soil. The upper 7.5-cm layer of soil was removed from six of the pots, combined, and treated with [^{14}C]sulfosate (labeled in the methylene group of the TMS moiety; radiochemical purity >97%, specific activity 20 mCi/mmol, ICI) at a nominal rate of 6.2 ppm sulfosate (equivalent to 3.9 ppm TMS and 6 kg/ha sulfosate). Soil from six additional pots was treated with unlabeled sulfosate (purity 95.7%, ICI) at the same rate. The pots of soil were maintained outdoors in Mountain View, California. At rotation intervals of 39, 103, and 364 days posttreatment, rotational crops of wheat and turnips were each planted in one pot of soil treated with [^{14}C]sulfosate and one pot of soil treated with unlabeled sulfosate. Immediately prior to planting of rotational crops, soil from the upper and lower 7.5 cm of the pots were removed, the soil from each depth was separately mixed, and the soil was returned to the pots. Immature plant thinnings from the 39-day rotation were sampled at unspecified periods up to harvest of mature plants. The plants from all rotation intervals were harvested at maturity; the wheat and turnips planted at 39 days posttreatment were harvested at 83 and 133 days postplanting, respectively, and the crops planted at 103 and 364 days posttreatment were harvested at 70-87 days postplanting. The soils were sampled immediately posttreatment and prior to each planting and harvest of mature crops. Immediately prior to planting of each rotational crop, one soil core (1 cm diameter x 15 cm deep) was removed from each pot, and the cores were divided into 7.5-cm segments; soil was also sampled from each depth after mixing and prior to being returned to the pots. At crop harvest intervals, soil from the upper and lower 7.5 cm of each pot was removed and sampled. All crop and soil samples were stored frozen at -10 C until analysis (duration of storage not specified).

The wheat was separated into heads (grain and chaff) and stalks (plus leaves) clipped at ground level, then ground in a Wiley mill. The turnip leaves were clipped off the roots, both were frozen in liquid nitrogen, and homogenized in a mortar and pestle. Tissue samples were analyzed for total radioactivity by LSC following combustion. The detection limit of [^{14}C]residues in plant tissue was calculated to be 0.003 ppm. Wheat leaves from the 39- and 103-day rotations were extracted using Scheme 3. Plant tissue was extracted sequentially by homogenization using methanol (twice), water, and 2 M ammonium chloride, each for 5 minutes. Aliquots of the extracts were analyzed for total radioactivity by LSC. The ammonium chloride fraction contained little radioactivity and was not analyzed further. The methanol and water extracts were combined, filtered, and concentrated using rotary vacuum evaporation; the concentrate was filtered through an ion-exchange column that was sequentially eluted with water, and 0.01, 0.1, 1, and 2 M HCl. Fractions containing radioactivity were combined and concentrated, then analyzed for total radioactivity using LSC. Aliquots of the concentrated solutions were analyzed by one-dimensional TLC using cation-exchange (Fixion) plates developed with either 2 M hydrochloric acid or citric acid:sodium hydroxide:sodium chloride (1.4:0.8:26.8, adjusted to pH 6). Areas of radioactivity were located by autoradiography or by linear scanning, scraped from the plates, and analyzed for total radioactivity using LSC. The extracted plant tissue was analyzed for unextracted radioactivity using LSC following combustion.

The soil collected at 0 and 39 days posttreatment was extracted using Scheme 1. A subsample of the soil was extracted three times by shaking for 2 hours with 2 M ammonium formate (1:5, w:v). The extracts were combined, and aliquots were analyzed for total radioactivity by LSC. The remaining extracts were freeze-dried; the resulting residue was then rinsed with methanolic HCl until the rinse contained only background levels of radioactivity. The rinses were combined; aliquots were analyzed for total radioactivity by LSC and the remaining solution was refrigerated to precipitate dissolved salts. The supernatant was decanted and freeze-dried, and the resulting residues were dissolved in water and analyzed using LSC. An aliquot of the solution was filtered through an ion-exchange column that was sequentially eluted with water, and 0.01, 0.1, 1, and 2 M HCl. Fractions containing radioactivity were combined; neutralized to pH 6-7 with Alamine 336; and extracted sequentially with toluene, chloroform, cyclohexane, and ether. After each extraction, aliquots of the aqueous and organic fractions were analyzed using LSC. The organic fractions were not analyzed further because they contained no radioactivity. In order to remove residual salt, the remaining aqueous solutions were combined and evaporated to dryness by rotary vacuum evaporation. The residues were redissolved in distilled water, and the resulting solution was eluted through an ion-exchange column as described previously; this purification process was done once for the day 0 and twice for the day 39 soil sample extracts. Aliquots of the eluate were analyzed for total radioactivity by LSC; additional aliquots were analyzed using one-dimensional TLC analysis on silica gel plates developed in either 20% ammonium formate:methanol (1:1, v:v) or 10% methylamine hydrochloride:methanol (1:1, v:v), and on cellulose plates developed in iso-propanol:formic acid:water (20:1:5, v:v:v). The purified extracts were cochromatographed with non-radiolabeled sulfosate. Areas of radioactivity were located using autoradiography or linear scanning, scraped from the plates, and analyzed for total radioactivity by LSC. Extracted soils were analyzed for total radioactivity by LSC following combustion.

The soil collected at later sampling intervals was extracted using Scheme 2. A subsample of the soil was extracted three times by shaking for 3.5 hours with 2 M hydrochloric acid. The extracts were combined and evaporated to dryness by rotary vacuum evaporation. The resulting residues were redissolved in water and filtered through an ion-exchange column with water; selected fractions were combined, concentrated, and refiltered. The purified solutions were concentrated, and aliquots were analyzed for total radioactivity by LSC. Additional aliquots of the solutions were analyzed using one- and two-dimensional TLC on cation-exchange (Fixion) plates developed with 2 M hydrochloric acid and citric acid:sodium hydroxide:sodium chloride (1.4:0.8:26.8, adjusted to pH 6). Areas of radioactivity were located by autoradiography or linear scanning, scraped from the plates, and analyzed for total radioactivity by LSC. The extracted soils were analyzed for total radioactivity by LSC following combustion.

DATA SUMMARY:

[^{14}C]Trimethylsulfonium (TMS) residues accumulated in mature wheat and turnips planted in loamy sand soil 39, 103, or 364 days after the soil was treated with TMS-labeled [^{14}C]sulfosate (radiochemical purity >97%) at a nominal rate of 6.22 ppm. In crops planted at the 39-day rotation interval, [^{14}C]TMS residues were 0.06 ppm in mature wheat chaff, 0.03 ppm in wheat grain, 0.05 ppm in wheat stems, 0.32 ppm in wheat leaves, and <0.02 ppm in mature turnip leaves and bulbs (Tables VIII and XII). In crops planted at the 103-day rotation interval, [^{14}C]TMS residues were 0.04 ppm in mature wheat chaff, 0.02 ppm in wheat grain, 0.03 ppm in wheat stems, 0.16 ppm in wheat leaves, and <0.02 ppm in mature turnip leaves and bulbs. In crops planted at the 364-day rotation interval, [^{14}C]TMS residues were ≤0.011 ppm in mature wheat chaff, grain, and leaves, and leaves, and <0.004 ppm in mature turnip leaves and bulbs. In immature wheat seedlings from the 39-day rotation, [^{14}C]residues were 0.166 ppm (Table VIII).

In the wheat leaves from the 39- and 103-day plantings, 57% of the recovered [^{14}C]residues were extractable (Table XI). TMS was present in the 39-day sample at 0.04 ppm and in the 103-day sample at 0.004 ppm (Table XI). Unknown A was present at 0.01 and 0.04 ppm in the 39- and 103-day samples, respectively; unknown B was 0.03 ppm in the

39-day sample (Table XI). Radioactivity in other plant tissues, including all samples from the 365-day rotation, was not characterized.

Immediately posttreatment, [^{14}C]TMS residues in the entire pots of soil (15-cm depth) were 0.98 ppm TMS equivalents (Table VI). At the time of planting, average residues were 0.42 ppm TMS equivalents for the 39-day rotation, 0.16 ppm TMS equivalents for the 103-day rotation, and 0.10 ppm TMS equivalents for the 364-day rotation (Table VI). At the times of harvest of mature crops, average TMS residues decreased from 0.22 ppm at 124 days to 0.07 ppm at 451 days (Table VI). TMS comprised 100% of the extractable soil residues at 0 and 39 days posttreatment, 83% at 103 days, and 47% at 365 days (Table VII).

Temperatures during the study ranged from 4 C to 29 C. Rainfall totaled approximately 5 cm during the first 95 days posttreatment and 83 cm during the entire 370-day study (Table IV).

COMMENTS:

1. [^{14}C]Residues in the plant tissues were not adequately characterized. Only [^{14}C]residues in the wheat leaves from the 39- and 103-day rotations were extracted, and TMS was the only compound identified in the wheat leaves. Unknowns A and B, present at maximum concentrations of 0.04 and 0.03 ppm, respectively, in the wheat leaves, were not identified. The study author stated that Unknowns A and B could not be characterized further because of insufficient amounts of purified extracts, and that "because of problems involved in obtaining metabolite data on wheat leaves, no further work was done on other plant parts that contained lower residues."

2. Frozen storage stability data were not provided for crop substrates. Plant tissue were stored at -10 C for unspecified lengths of time before analysis.

   Soil samples in this study were stored frozen before extraction. Freezer storage stability data for sulfosate (MRID 40046208) were reviewed in a Dynamac document submitted 3/27/87. The study was determined to be scientifically valid; sulfosate was determined to be stable under the frozen storage conditions for at least two years.

3. A leafy vegetable crop was not included in the study. The study author stated that the turnips should be considered both a root and leafy vegetable crop since turnip greens are eaten. However, it is unlikely that the concentration of adsorbed residues in the foliage of a root crop would be similar to the concentration of residues in the foliage of a crop with fibrous roots.

4. The study author stated that leachates were collected and analyzed during all the growing periods of the crops. It was reported that

"the amount of radioactivity found in the leachate was insignificant"; no quantitative data were provided.

5. Throughout the report, the study author referred to notebook numbers and page numbers when discussing methods and results which were not provided for review. The descriptions of the cultural conditions during the growing periods were inadequate. No information was provided as to the dates of plant thinning, the frequency and quantity of waterings, or the rates and application dates of pesticide.

6. Immature plants were analyzed only during the 35-day rotation.

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REFERENCES:

The following studies were reviewed.

Iwata, Y. 1989a. ICIA 0224 - Field dissipation study for terrestrial uses, California, 1987-1988. Laboratory Project ID WRC 89-37, Protocol No. RP-87-37. Unpublished study performed by Stauffer Chemical Company and ICI Americas Inc., Richmond, CA, and submitted by Monsanto Agricultural Company, St. Louis, MO. (41235906)

Iwata, Y. 1989b. ICIA 0224 - Field dissipation study for terrestrial uses, Georgia, 1987-1988. Laboratory Project ID WRC 89-23, Protocol No. RP-87-27. Unpublished study performed by Stauffer Chemical Company and ICI Americas Inc., Richmond, CA, and submitted by Monsanto Agricultural Company, St. Louis, MO. (41209921)

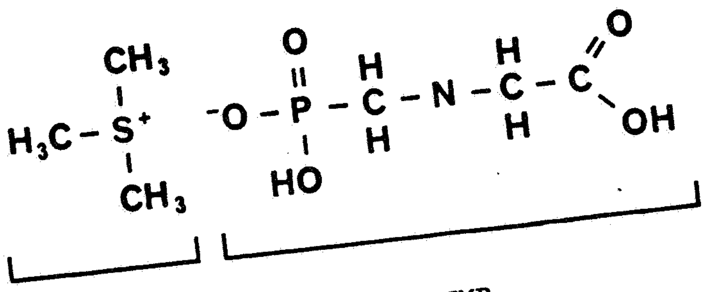
Iwata, Y. 1989c. ICIA 0224 - Field dissipation study for terrestrial uses, Mississippi, 1987-1988. Laboratory Project ID WRC 89-40, Protocol No. RP-87-27. Unpublished study performed by Stauffer Chemical Company and ICI Americas Inc., Richmond, CA., and submitted by Monsanto Agricultural Company, St. Louis, MO. (41235907)

Spillner, C.J. 1989a. [^{14}C-anion]ICIA0224 - Confined accumulation studies on rotational crops. Study No. PMS-224, Report No. WRC 89-25. Unpublished study performed by ICI Americas Inc., Richmond, CA., and submitted by Monsanto Agricultural Company, St. Louis, MO. (41209920)

Spillner, C.J. 1989b. [^{14}C-cation]ICIA0224 - Confined accumulation studies on rotational crops. Study No. PMS-227, Report No. WRC 89-26. Unpublished study performed by ICI Americas Inc., Richmond, CA., and submitted by Monsanto Agricultural Company, St. Louis, MO. (41209922)

APPENDIX

SULFOSATE



Trimethylsulfonium carboxymethylaminomethylphosphonate
Trimethylsulfonium N-(phosphonomethyl)glycine (1-) ion

Sulfosate