

Shaughnessy No.: 014506

Date out of EAB:

29 JUN 1987

To: Amy S. Rispin
Chief
Science Integration Staff (TS 767C)

From: Emil Regelman, Supervisory Chemist
Review Section #3
Exposure Assessment Branch
Hazard Evaluation Division (TS 769C)

Handwritten signature and date: 6/30/87

Attached, please find the EAB review of...

Reg./File # _____

Chemical Name: Zineb

Type Product: fungicide

Product Name: _____

Company Name: _____

Purpose: _____

Date Received: _____

Action Code: 400

Date Completed: _____

EAB # (s): 70762

Monitoring Study Requested: _____

Total Reviewing Time: _____

Monitoring Study Volunteered: _____

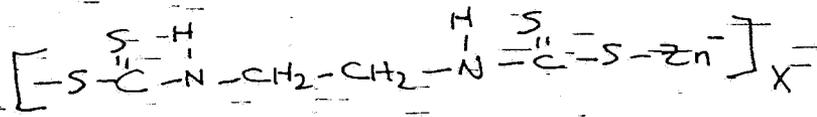
Deferrals to: _____ Ecological Effects Branch

_____ Residue Chemistry Branch

_____ Toxicology Branch

1. CHEMICAL:

chemical name: zinc ethylenebisdithiocarbamate
common name: Zineb
trade name: various
structure:



CAS # 12122-67-7
Shaughnessy #: 014506

2. TEST MATERIAL: detailed in study discussions

3. STUDY/ACTION TYPE:
evaluation of environmental fate studies in light of ground water data call-in

4. STUDY IDENTIFICATION:

Rustum, Abu M. Hydrolysis of ¹⁴C Zineb in Buffered Aqueous Solutions. [Final Report of Preliminary Study] prepared by Hazleton Laboratories America, Inc. sponsored by W.R. Landis Associates. received by EPA 4/6/87. EPA Acc. # 401492-01.

Rustum, Abu M. Hydrolysis of ¹⁴C Zineb in Buffered Aqueous Solutions. prepared by Hazleton Laboratories America, Inc. sponsored by Micro Flo Company received by EPA 6/16/87. EPA Acc. # 402346-01.

Rustum, Abu M. Artificial Sunlight Photodegradation of ¹⁴C-Zineb in a Buffered Aqueous Solution. [Final Report of Preliminary Study] prepared by Hazleton Laboratories America, Inc. sponsored by W.R. Landis Associates. received by EPA 4/6/87. EPA Acc. # 401492-02.

Rustum, Abu M. Artificial Sunlight Photodegradation of ¹⁴C-Zineb in a Buffered Aqueous Solution. prepared by Hazleton Laboratories America, Inc. sponsored by Micro Flo Company. received by EPA 6/16/87. EPA Acc. # 402346-02

Rustum, Abu M. Artificial Sunlight Photodegradation of ¹⁴C-Zineb on Soil. [Final Report of Preliminary Study] prepared by Hazleton Laboratories America, Inc. sponsored by W.R. Landis Associates. received by EPA 4/6/87. EPA Acc. # 401492-03.

Rustum, Abu M. Artificial Sunlight Photodegradation of ¹⁴C-Zineb on Soil. prepared by Hazleton Laboratories America, Inc. sponsored by Micro Flo Company. received by EPA 6/16/87. EPA Acc. # 402346-03.

Rustum, Abu M. Determination of the Mobility of Soil-Aged ¹⁴C-Zineb Residues by Soil Thin Layer Chromatography. prepared by Hazleton Laboratories America, Inc. sponsored by Micro Flo Company. received by EPA 4/6/87. EPA Acc. # 401492-06.

Lesheski, Mary Jo. Determination of the Mobility of ¹⁴C-Zineb in Selected Soils by Soil Thin Layer Chromatography. prepared by Hazleton Laboratories America, Inc. sponsored by Micro Flo Company. received by EPA 4/6/87. EPA Acc. # 401492-05.

Saxena, Adesh M. The Adsorption/Desorption of ¹⁴C-Zineb on Representative Agricultural Soils. prepared by Hazleton Laboratories America, Inc. sponsored by Micro Flo Company. received by EPA 4/6/87. EPA Acc. # 401492-04.

Nash, Ralph G. Determining Environmental Fate of Pesticides with Microagroecosystems. published in Residue Reviews, 1983, Volume 85, pp. 199-215.

Nash, Ralph G. and Beall, M. Leroy, Jr. Fate of Maneb and Zineb Fungicides in Micro-agroecosystem Chambers. published 1980 by Am. Chem. Soc. MRID 00131024.

The studies below were not reviewed since they dealt with a complex containing Zineb, but not with Zineb itself:

Fraunhofer Institut für Umweltchemie und Ökotoxikologie. Report on Water Photolysis of the EBDC Fungicide Metiram-complex. submitted to BASF Aktiengesellschaft, December 1985. Received by EPA 7/2/85. TRID # 470232-033
Fraunhofer Institut für Umweltchemie und Ökotoxikologie. Report on Hydrolysis of the EBDC Fungicide Metiram-complex. submitted to BASF Aktiengesellschaft, December 1985. Received by EPA 7/2/85. TRID # 470232-032

The study below was not reviewed since it is a position paper from the NRC of Canada:

Rose, D., Pearson, C.M., Zuker, M., Roberts, J.R.; Ethylenethiourea: Criteria for the Assessment of its Effects on Man. National Research Council of Canada, NRC Associate Committee on Scientific Criteria for Environmental Quality. TRID # 455501-017.

5. REVIEWED BY:

Typed Name: E. Brinson Conerly
Title: Chemist, Review Section 3
Organization: EAB/HED/OPP

E. Brinson Conerly
6/29/87

6. APPROVED BY:

Typed Name: Emil Regelman
Title: Supervisory Chemist, Review Section 3
Organization: EAB/HED/OPP

Emil Regelman
6/29/87

7. CONCLUSIONS:

The photolysis studies are not acceptable to satisfy data requirements, as the light source did not simulate sunlight. The final hydrolysis study is acceptable and demonstrates that the compound is stable to hydrolysis at pHs 5, 7, and 9 (no demonstrated hydrolysis over a 34 day study period). Leaching and adsorption/desorption studies indicate that the compound is of low mobility, but indicate that an unspecified impurity or degradate is of high mobility. The K_d s for adsorption ranged from 1.78 - 6.70. Percentages of compound desorbed ranged from 0.74% - 16.7% of adsorbed. In the leaching study, r_f for the parent ranged from 0.10 - 0.16, and for the degradate 0.98 - 0.99.

8. RECOMMENDATIONS:

The critical study to assess environmental fate of the compound is soil metabolism. The applicant must submit this study, and also an acceptable photolysis study for our review.

9. BACKGROUND: n.a.

10. DISCUSSION OF INDIVIDUAL TESTS OR STUDIES:

10.1 A. STUDY IDENTIFICATION

Rustum, Abu M.- Hydrolysis of ^{14}C Zineb in Buffered Aqueous Solutions. [Final Report of Preliminary Study] prepared by Hazleton Laboratories America, Inc. sponsored by W.R. Landis Associates. received by EPA 4/6/87. EPA Acc. # 401492-01.

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B. MATERIALS AND METHODS

test chemical - ^{14}C -Zineb, spec. act. 119 MBq/mmol (3.22 mCi/mmol),
radiopurity "at least 89.0%" in 0.5M NH_4OH [by HPLC analysis and solvent
system I (1 ppm aqueous ferrous sulfate:methanol 55:45 v/v). Solubility as
provided by sponsor, 10 mg/L in H_2O
test solutions - ca 5 ppm (equivalent to 5 mg/L)
test buffers -
sodium acetate - 0.02 M, pH 5
sodium borate - 0.01 M, pH 9
sodium phosphate - 0.01 M, pH 7
test protocol - filter-sterilized solutions were incubated @ $25^\circ \pm 1^\circ\text{C}$ in the
dark. Samples were analyzed by HPLC and LSC.

C. REPORTED RESULTS

The hydrolytic half-lives of Zineb ... at pH 5, 7, and 9 appeared to be
greater than 7 days. Time 0 column recoveries were below 70% at all pH
levels, but increased rapidly and were greater than 90% by study completion.
The percent of Zineb recovered from the HPLC system was below 40% at
time 0 for all pH levels. Recoveries of Zineb increased and appeared to
stabilize after about 21 hours in pH 5, 93:50 hours:minutes in pH 7, and 94:00
hours: minutes in pH 9. One additional HPLC peak [other than Zineb] was seen
at all pH levels, and another peak was seen at one time point in both pH
5 and 7.

D. STUDY AUTHOR'S CONCLUSIONS/QUALITY ASSURANCE MEASURES

Homogeneity of test solutions was verified by LSC -- each individual sample
was within 10% of the mean for all (0.8% for pH 5 and 0.2% for pH 7 and 9.)

E. REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS

This is designated by the preparer as a "preliminary study". We note the
following deficiencies:

- 1) The purity of the test compound is reported as "at least 89.0%" This means that as much as 11% impurities could be present.
- 2) No time-zero concentration is reported for pH 9.
- 3) In the earliest analyzed samples an impurity designated Peak A represented 10-50% as much radioactivity as the parent Zineb.
- 4) Apparent concentration in the pH 5 test solution increased approximately 20% during the incubation. Although the concentration was supposed to be only 50% of saturation, this observation could result from a solubilization of test material.
- 5) Recoveries of radioactivity in peak areas were as low as ca. 50% of applied material, and increased over time in all pHs. If one believes the results, Zineb is being formed over the course of the incubation.
- 6) Concentration of Zineb appeared to increase with incubation in all pHs.

This study does not appear useful either for demonstrating stability of the compound or for estimating half-lives. The observations reported may be due to artifacts of the analytical method.

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10.2 A. STUDY IDENTIFICATION

= Rustum, Abu M. Hydrolysis of ¹⁴C Zineb in Buffered Aqueous Solutions. prepared by Hazleton Laboratories America, Inc. sponsored by Micro Flo Company. received by EPA 6/16/87. EPA Acc. # 402346-01.

B. MATERIALS AND METHODS

test material - as above
test solution - ca. 5 ppm, analyzed by LSC to determine exact concentration
test buffers - as above
test protocol - samples were analyzed at 0, 6, 13, 20, 27, and 34 days by HPLC.

C. REPORTED RESULTS

The hydrolytic half-lives of Zineb under test conditions at pH 5, 7, and 9 appeared to be greater than 34 days. The HPLC column recoveries were above 90% at all time points, except day 0 (81% to 88%), for all pH levels. The percent of Zineb recovered from the HPLC system was above 90% at the final time point in all pH levels. No additional major peaks (greater than 10%) were observed in pH 5, 7, and 9 except at Day 20 for pH 5 (one replicate, 13.0%) and 9 (both replicates, 13.6% and 13.5%). One additional minor HPLC peak (approximately 1%) was observed in pH 9 at one time point (day 20).

D. STUDY AUTHOR'S CONCLUSIONS/QUALITY ASSURANCE MEASURES

Replicate aliquots of test solution counted within 3.2% of the mean for all.

E. REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS

There is no clear-cut demonstration of formation of major degradates within the time period of the study. In spite of the somewhat exotic results reported in the previous study, EAB accepts this study as fulfilling data requirements for hydrolysis.

10.3 A. STUDY IDENTIFICATION

Rustum, Abu M. Artificial Sunlight Photodegradation of ¹⁴C-Zineb in a Buffered Aqueous Solution. [Final Report of Preliminary Study] prepared by Hazleton Laboratories America, Inc. sponsored by W.R. Landis Associates, Inc. EPA Acc. # 401492-02.

B. MATERIALS AND METHODS

test compound - as described above in study 10.1
test solution - test compound dissolved in 0.5 M NH₄OH, in pH 9 buffer to a final concentration of 5 ppm
light source - commercial lamps (spectral characteristics attached)
test buffer - pH 9 as described above in study 10.1
sampling protocol - time 0, 35", 2hr 5", 3 hr 25", 19 hr 45", 24 hr 45", 44 hr 35", 90 hr 55", 164 hr 15"

C. REPORTED RESULTS

Column and Zineb recoveries ... increase[d] ... with time in both hydrolysis (dark control) and photolysis (exposed) samples. Due to this abnormal

Table 6
Distribution of Radioactivity in
pH 5 Samples*

Hydrolysis Time (Days)	HPLC Replicate	¹⁴ C as Percent of Total Applied		Column Recovery (%)
		Zineb	Peak A	
0	A-1	83.6	2.7	89.6
	B-1	81.6	2.3	86.6
Mean		82.6	2.5	88.1
6	A-1	85.1	4.4	94.5
	B-1	85.5	5.3	94.8
Mean		85.3	4.8	94.6
13	A-1	89.7	3.3	94.6
	B-1	91.8	2.7	94.9
Mean		90.8	3.0	94.8
20	A-1	83.7	13.0	102.6
	B-1	93.2	2.1	96.7
Mean		88.4	7.6	99.6
27	A-1	87.7	1.6	90.5
	B-1	95.3	0.9	97.8
Mean		91.5	1.2	94.2
34	A-1	89.6	3.9	94.0
	B-1	94.1	1.7	96.6
Mean		91.8	2.8	95.3

Note: The following retention times were found: Zineb = 2.5 minutes, and Peak A = 4.5 minutes. Retention times were representative values. Actual retention times varied due to changes in the mobile phase composition.

* For each sample, the balance of radioactivity not accounted for in the table was present as diffuse radioactivity among the HPLC fractions.

Table 7
Distribution of Radioactivity in
pH 7 Samples*

Hydrolysis Time (Days)	HPLC Replicate	¹⁴ C as Percent of Total Applied		Column Recovery (%)
		Zineb	Peak A	
0	A-1	88.7	2.9	95.8
	B-1	70.6	3.3	79.2**
Mean		79.6	3.1	87.5
6	A-1	90.2	6.1	102.7
	B-1	86.6	4.9	96.0
Mean		88.4	5.5	99.4
13	A-1	92.4	2.3	96.0
	B-1	89.3	2.3	93.4
Mean		90.8	2.3	94.7
23	A-1	92.6	2.9	97.5
	B-1	88.3	3.4	94.8
Mean		90.4	3.2	96.2
27	A-1	95.7	1.5	99.0
	B-1	92.8	1.2	95.0
Mean		94.2	1.4	97.0

* For each sample, the balance of radioactivity not accounted for in the table was present as diffuse radioactivity among the HPLC fractions.
 ** The pre- and post-HPLC injection aliquots (100 µL each), as analyzed by LSC, were determined to contain a higher dpm level than at other time points, which may have resulted in the observed lower column and Zineb recoveries for this sample.

Table 7 (Continued)
Distribution of Radioactivity in
pH 7 Samples*

Hydrolysis Time (Days)	HPLC Replicate	¹⁴ C as Percent of Total Applied		Column Recovery (%)
		Zineb	Peak A	
34	A-1	100.0	2.0	103.0
	B-1	99.5	2.3	104.2
Mean		99.8	2.2	103.6

Note: The following retention times were found: Zineb = 2.5 minutes and Peak A = 4.5 minutes. Retention times were representative values. Actual retention times varied due to changes in the mobile phase composition.

* For each sample, the balance of radioactivity not accounted for in the table was present as diffuse radioactivity among the HPLC fractions.

Table B
Distribution of Radioactivity in
pH 9 Samples*

Hydrolysis Time (Days)	HPLC Replicate	¹⁴ C as Percent of Total Applied			Column Recovery (%)
		Zineb	Peak A	Peak B	
0	A-1	72.2	3.7	NA	80.2
	B-1	71.3	3.9	NA	81.5
Mean		71.8	3.8	NA	80.8
6	A-1	88.6	5.1	NA	97.6
	B-1	84.2	4.9	NA	93.4
Mean		86.4	5.0	NA	95.5
13	A-1	90.6	2.0	NA	94.4
	B-1	89.5	1.5	NA	93.1
Mean		90.0	1.8	NA	93.8
20	A-1	73.3	13.6	1.3	90.2
	B-1	73.2	13.5	1.2	90.7
Mean		73.2	13.6	1.2	90.4
27	A-1	92.1	1.3	NA	94.5
	B-1	92.6	1.9	NA	96.5
Mean		92.4	1.6	NA	95.5
34	A-1	93.3	2.4	NA	97.5
	B-1	92.5	2.7	NA	96.9
Mean		92.9	2.6	NA	97.2

Note: The following retention times were found: Zineb = 2.5 minutes, Peak A = 4.5 minutes, and Peak B = 13.0 minutes. Retention times were representative values. Actual retention times varied due to changes in the mobile phase composition.

NA - Not applicable.

* For each sample, the balance of radioactivity not accounted for in the table was present as diffuse radioactivity among the HPLC fractions.

phenomenon, the data generated during the 7-day study were not enough to calculate the photolytic half-life of Zineb. One additional peak (Peak A) was observed in both dark control and exposed samples... [which] represented significant amounts of the applied ^{14}C at Time 0, in both dark control (14.9%) and exposed (25.0%) samples...

D. STUDY AUTHOR'S CONCLUSIONS/QUALITY ASSURANCE MEASURES

Column and Zineb recoveries found in both dark control and exposed samples ... indicated a potential difficulty since recoveries of both increased significantly with time.

E. REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS

As the preparer correctly states, the "abnormal" observations with respect to recoveries preclude use of this study to define photolytic behavior of this material. We further note that the characteristics of the light source indicate emissions in a few narrow bands rather than a broad spectrum. The light source does not simulate natural sunlight.

10.4 A. STUDY IDENTIFICATION

Rustum, Abu M. Artificial Sunlight Photodegradation of ^{14}C -Zineb in a Buffered Aqueous Solution. prepared by Hazleton Laboratories America, Inc. sponsored by Micro Flo Company. received by EPA 6/16/87. EPA Acc. # 402346-02

B. MATERIALS AND METHODS

similar to 10.3 described above, except sampling was done on days 0, 6, 13, 20, 27, and 34.

C. REPORTED RESULTS

The HPLC column recoveries were similar for exposed and dark control samples, and varied from 84.0% to 132.3%. Zineb recovery was similar for dark control and exposed samples, and varied from 62.3% to 117.1%. Beside Zineb, one significant product was seen under these experimental conditions. For both exposed and dark control samples, this product was always less than 7%, except at Day 20 (21% or less).

D. STUDY AUTHOR'S CONCLUSIONS/QUALITY ASSURANCE MEASURES

Under the test conditions of the 34-day period of the study, the degradation of Zineb was not sufficient to calculate the half-lives for both hydrolytic (dark control) and photolytic (exposed) samples.

E. REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS

- 1) The light source was not comparable to natural sunlight.
- 2) Analytical results were somewhat more erratic than would be expected given the technique used.
- 3) Zineb seemed to increase over time in both exposed samples and dark controls, although this could be an artifact related to comment 2.

This study is not acceptable to fulfill aqueous photolysis data requirements.

10.5 A. STUDY IDENTIFICATION

Rustum, Abu M. Artificial Sunlight Photodegradation of ¹⁴C-Zineb on Soil. [Final Report of Preliminary Study] prepared by Hazleton Laboratories America, Inc. sponsored by W.R. Landis Associates, Inc. received by EPA 4/6/87. EPA Acc. # 401492-03.

B. MATERIALS AND METHODS

test compound - as described in 10.1
test soil - characteristics attached
light source - commercial lamps (characteristics attached)
extraction method - soil was extracted 2x with NH₄OH 0.5 M. After LSC quantitation, the extracts were centrifuged and passed onto the HPLC system.
analytical method - as described in 10.1, LSC for total radioactivity, and HPLC for differential analyses

C. REPORTED RESULTS

No apparent degradation occurred in either the ... exposed or dark control samples during the 3-day preliminary study. Material balances from the ... light-exposed samples ranged from 93.5% on Day 0, to 99.3% on Day 1, to 97.2% on Day 3. Material balances for the dark control samples ranged from 91.1% on Days 0 and 1, to 91.3% on Day 3.

D. STUDY AUTHOR'S CONCLUSIONS/QUALITY ASSURANCE MEASURES

It appeared that under the test conditions of the preliminary study, the half-life of Zineb was greater than 3 days for both ... exposed and dark control samples.

Radioactivity in CO₂ and organic volatile traps was below detection limits.

Two different extraction techniques yielded vary similar recoveries (ca. 70%).

E. REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS

This is only a preliminary study, not intended to satisfy data requirements. It is unacceptable for this purpose, in any case, since the light source does not simulate sunlight.

10.6 A. STUDY IDENTIFICATION

Rustum, Abu M. Artificial Sunlight Photodegradation of ¹⁴C-Zineb on Soil. prepared by Hazleton Laboratories America, Inc. sponsored by Micro Flo Company. received by EPA 6/16/87. EPA Acc. # 402346-03.

B. MATERIALS AND METHODS

In general as described in 10.5, but sampling was done on days 0, 6, 13, 20, 27, and 34.

C. REPORTED RESULTS

1) No major soluble photodegradation products were observed as a result of

Table 7

Distribution of Radioactivity: pH 9 Samples
Exposed to Chroma-50 Lamps*

Time of Exposure (Days)	Sample Identification	¹⁴ C as Percent of Total Applied			Column Recovery (%)
		Zineb	Peak A	Peak B	
0	6015342BpH9-2**	117.1**	6.6**	NA**	132.3**
	6015342BpH9-3	78.7	4.7	NA	89.1
6	6015342BpH9-2	87.2	5.2	NA	96.5
	6015342BpH9-3	78.8	5.0	NA	88.5
13	6015342BpH9-2	88.2	1.6	NA	91.5
	6015342BpH9-3	83.0	1.6	NA	86.3
20	6015342BpH9-2	68.4	19.3	NA	91.1
	6015342BpH9-3	62.3	19.6	NA	84.8
27	6015342BpH9-2	90.2	1.2	NA	92.6
	6015342BpH9-3	89.3	1.4	NA	92.6
34	6015342BpH9-2	91.5	2.6	NA	95.7
	6015342BpH9-3	86.4	2.3	NA	91.3

Note: The following retention times were found: Zineb = 2.5 minutes, Peak A = 4.5 minutes. Retention times were representative values. Actual retention times varied due to changes in the mobile phase composition.

NA Not applicable.

- * For each sample, the balance of radioactivity not accounted for in the table was present as diffuse radioactivity among the HPLC fractions.
- ** Residual radioactivity possibly remained in the HPLC system from previous injections.

Table 8

Distribution of Radioactivity: pH 9 Dark Control Samples

Time of Exposure (Days)	Sample Identification	14C as Percent of Total Applied			Column Recovery (%)
		Zineb	Peak A	Peak B	
0	6015342BpH9-8	73.5	4.8	NA	84.0
	6015342BpH9-9	83.0	2.7	NA	89.6
6	6015342BpH9-8	82.1	5.2	NA	90.3
	6015342BpH9-9	83.2	4.6	NA	93.8
13	6015342BpH9-8	89.4	1.3	NA	92.2
	6015342BpH9-9	87.2	2.0	NA	91.5
20	6015342BpH9-8	65.7	21.0	2.0	92.0
	6015342BpH9-9	68.7	17.0	1.3	89.1
27	6015342BpH9-8	90.3	1.6	NA	93.5
	6015342BpH9-9	90.4	1.3	NA	93.4
34	6015342BpH9-8	103.5	4.0	NA	109.2
	6015342BpH9-9	92.4	3.3	NA	97.3

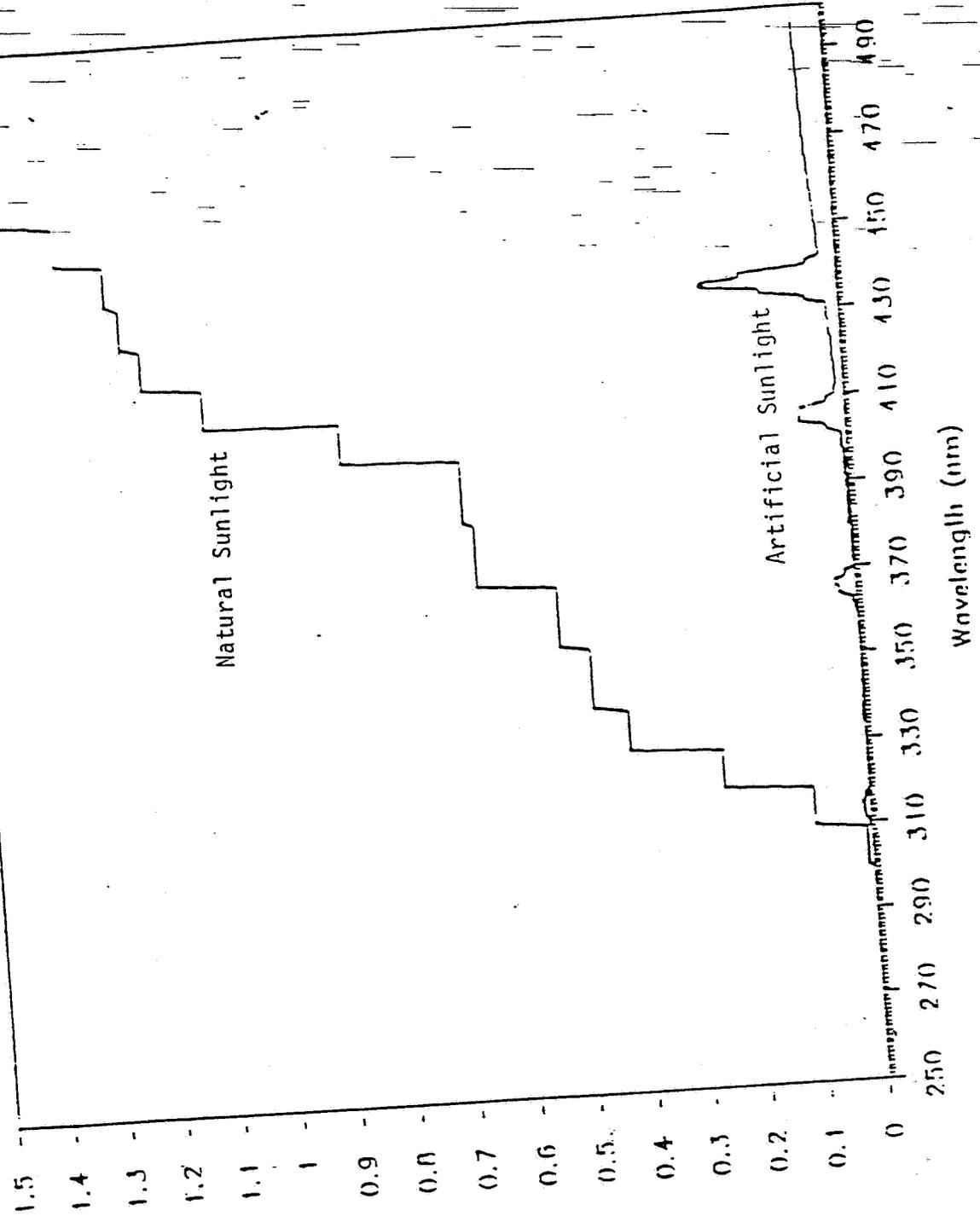
Note: The following retention times were found: Zineb = 2.5 minutes, Peak A = 4.5 minutes. Retention times were representative values. Actual retention times varied due to changes in the mobile phase composition.

NA Not applicable.

* For each sample, the balance of radioactivity not accounted for in the table was present as diffuse radioactivity among the HPLC fractions.

COMPARISON OF LIGHT SOURCES

Chroma 50 Lamps and Natural Sunlight



FLUX (W/CM/SQ M)

Table 3
Column and ¹⁴C-Zineb Recoveries by
HPLC of Exposed Samples

Time (Days)	Sample Replicate	Recovery (%)				Column Recovery (%)
		Zineb	Peak A	Peak B	Peak C	
0	A	102.4	9.4	NA	NA	113.9
	B	89.7	3.2	NA	NA	93.3
	Mean	96.0	6.3			103.6
6	L10	84.1	2.6	NA	NA	87.4
	L12	84.1	3.5	NA	NA	90.1
	Mean	84.1	3.0			88.8
13	L2	86.2	2.7	NA	NA	89.8
	L8	84.2	3.0	NA	NA	89.2
	Mean	85.2	2.8			89.5
20	L4	69.8	11.1	1.4	4.2	88.3
	L11	70.1	11.5	2.2	4.5	90.1
	Mean	70.0	11.3	1.8	4.4	89.2
27	L5	91.6	3.2	0.6	NA	96.1
	L6	88.8	3.0	0.9	NA	94.6
	Mean	90.2	3.1	0.8		95.4
34	L7	91.3	2.9	0.4	NA	95.5
	L9	87.8	2.2	0.4	NA	91.0
	Mean	89.6	2.6	0.4	NA	93.2

NA Not applicable.

Table 4
 Distribution of ¹⁴C-Zineb and Degradation Products Expressed as Percents of Radioactivity Applied to Exposed Soil Samples

Time (Days)	Sample Replicate	0.5M NH ₄ OH Extractable Fraction	Recovery (%)*				Total**
			Zineb	Peak A	Peak B	Peak C	
0	A	76.2	78.0	7.2	NA	NA	85.2
	B		68.4	2.4	NA	NA	70.8
	Mean		73.2	4.8	NA	NA	78.0
6	L10	55.3	46.5	1.4	NA	NA	47.9
	L12		46.5	1.9	NA	NA	48.4
	Mean		46.5	1.6	NA	NA	48.2
13	L2	53.6	46.2	1.4	NA	NA	47.6
	L8		45.1	1.6	NA	NA	46.7
	Mean		45.6	1.5	NA	NA	47.2
20	L4	52.3	36.5	5.8	0.7	2.2	45.2
	L11		36.7	6.0	1.2	2.4	46.3
	Mean		36.6	5.9	1.0	2.3	45.8
27	L5	53.9	49.4	1.7	0.3	NA	51.4
	L6		47.9	1.6	0.5	NA	50.0
	Mean		48.6	1.6	0.4	NA	50.7
34	L7	53.1	48.4	1.5	0.2	NA	50.1
	L9		46.6	1.2	0.2	NA	48.0
	Mean		47.5	1.4	0.2	NA	49.0

NA No peak observed.

* Values = Percent extractable fraction x HPLC fraction (percent recovery values).

** Sum of Zineb, Peak A, Peak B, and Peak C differed from 0.5M NH₄OH extractable fraction due to fluctuating column recovery.

Table 5
 Column and ¹⁴C-Zineb Recoveries for HPLC Procedure
 Dark Control Samples

Time (Days)	Sample Replicate	% Recovery				Column Recovery (%)
		Zineb	Peak A	Peak B	Peak C	
0	C	66.1	8.7	7.2	1.3	85.6
	D	68.8	7.9	8.5	1.4	89.0
	Mean	67.4	8.3	7.8	1.4	87.3
6	D3	64.0	18.1	1.0	2.7	87.4
	D12	64.4	18.2	1.1	2.8	88.1
	Mean	64.2	18.2	1.0	2.8	87.8
13	D1	64.7	17.8	0.8	2.6	86.9
	D11	66.5	19.3	0.7	3.4	91.1
	Mean	65.6	18.6	0.8	3.0	89.0
20	D2	74.7	5.6	0.3	4.2	85.7
	D9	63.4	18.9	1.1	2.6	88.5
	Mean	69.0	12.2	0.7	3.4	87.1
27	D4	64.2	19.3	1.1	1.0	87.0
	D6	64.8	18.7	1.0	1.3	87.2
	Mean	64.5	19.0	1.0	1.2	87.1
34	D5	64.2	17.8	1.3	1.4	85.9
	D10	62.2	19.4	1.4	1.1	85.9
	Mean	63.2	18.6	1.4	1.2	85.9

Table 6
Distribution of ¹⁴C-Zineb and Degradation Products Expressed as Percents of Radioactivity Applied to Dark Control Samples

Time (Days)	Sample Replicate	0.5M NH ₄ OH Extractable Fraction	Recovery (%)*			Total**	
			Zineb	Peak A	Peak B		Peak C
0	A	74.8	49.4	6.5	5.4	1.0	62.3
	B		51.5	5.9	6.4	1.0	64.8
	Mean		50.4	6.2	5.9	1.0	63.6
6	D3	55.2	35.3	10.0	0.6	1.5	47.4
	D12		35.5	10.0	0.6	1.5	47.6
	Mean		35.4	10.0	0.6	1.5	47.5
13	D1	50.3	32.5	9.0	0.4	1.3	43.2
	D11		33.4	9.7	0.4	1.7	45.2
	Mean		33.0	9.4	0.4	1.5	44.2
20	D2	47.9	35.8	2.7	0.1	2.0	40.6
	D9		30.4	9.1	0.5	1.2	41.2
	Mean		33.1	5.9	0.3	2.0	40.9
27	D4	47.2	30.3	9.1	0.5	0.5	40.4
	D6		30.6	8.8	0.5	0.6	40.4
	Mean		30.4	9.0	0.5	0.6	40.4
34	D5	48.3	31.0	8.6	0.6	0.7	40.9
	D10		30.0	9.4	0.7	0.5	40.6
	Mean		30.5	9.0	0.6	0.6	40.8

* Values = Percent extractable fraction x HPLC fraction (percent recovery value).
 ** Sum of Zineb, Peak A, Peak B, and Peak C differed from 0.5M NH₄OH extractable fraction due to fluctuating column recovery.

Table 7
Mean Percent Recoveries for
Exposed Soil Samples

<u>Exposure Time (Days)</u>	<u>0.5M NH₄OH Extractable Fraction</u>	<u>Soil Fraction</u>	<u>CO₂ Trap</u>	<u>Organic Volatiles Trap*</u>	<u>Total Recovery</u>
0	76.2	21.2	NA	NA	97.4
6	55.3	37.0	0.0	0.0	92.3
13	53.6	40.8	0.4	NA	94.8
20	52.3	43.9	1.1	0.0	97.3
27	53.9	43.5	1.1	0.0	98.5
34	53.1	42.2	1.1	0.0	96.4

NA Not applicable.

* Numbers are expressed as mean percentages of the total radioactivity applied to duplicate samples.

Table 8
Mean Percent Recoveries for Dark Control Samples

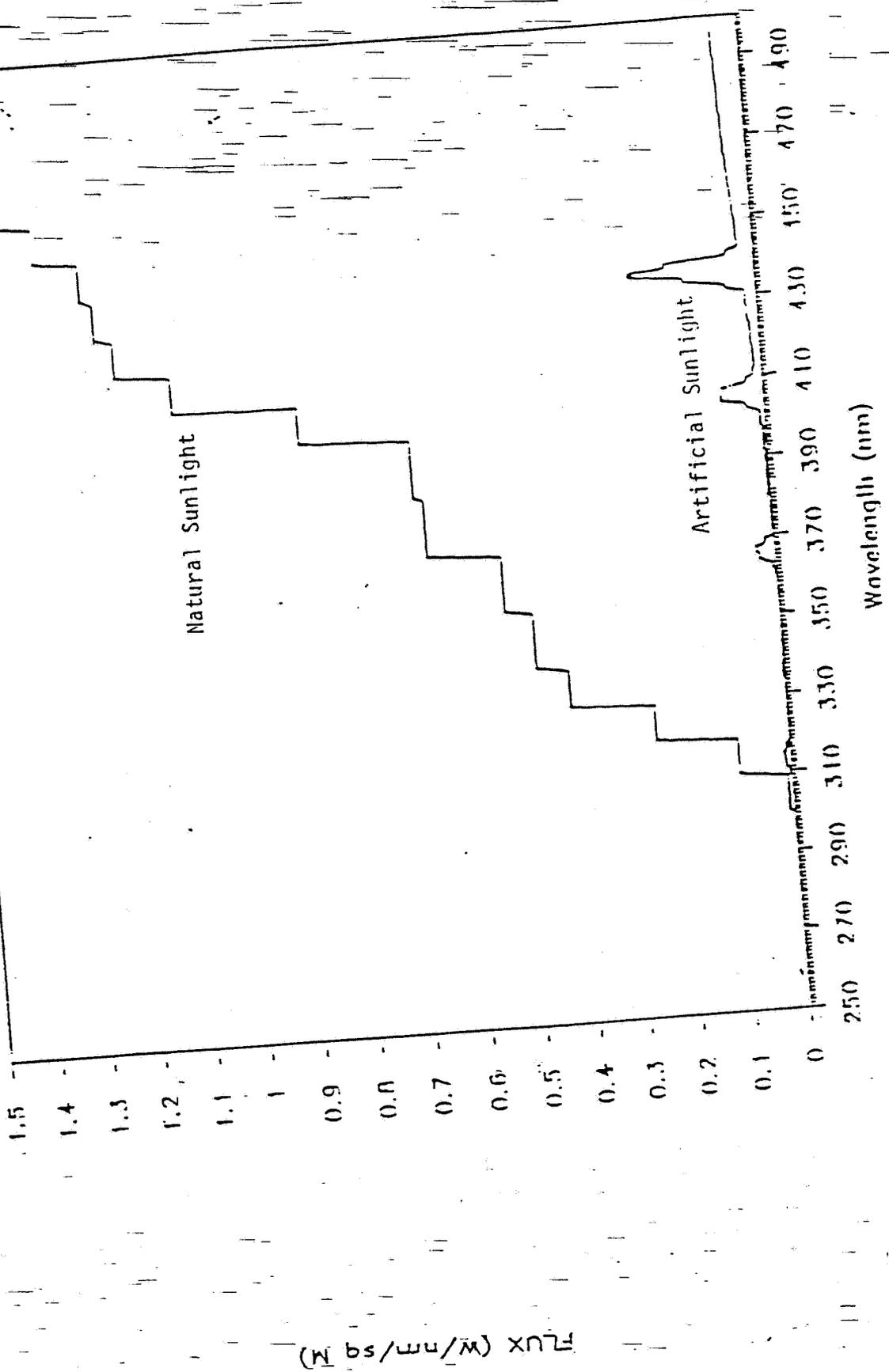
Exposure Time (Days)	0.5M NH ₄ OH Extractable Fraction*	Soil Fraction*	CO ₂ Trap*	Organic Volatiles Trap*	Total Recovery
0	74.8	21.8	NA	NA	96.6
6	55.2	42.4	0.5	0.0	98.0
13	50.3	48.4	0.5	0.0	99.2
20	47.9	47.8	0.5	0.0	96.2
27	47.2	49.2	0.5	0.0	97.0
34	48.3	51.0	0.5	0.0	99.8

NA Not applicable.

* Numbers are expressed as mean percentages of the total radioactivity applied to duplicate samples.

COMPARISON OF LIGHT SOURCES

Chromo 50 lamps and Natural Sunlight



Properties of Dickenson Sandy Loam Soil

Composition	76%
Sand	17%
Silt	7%
Clay	1.4%
Organic matter*	
Field moisture capacity**	19.0%
pH	6.9
Bulk density**	1.31 g/cm ³
Cation exchange capacity	4

* Percent organic matter is considered to be 0.1 times the organic matter value expressed in tons/acre.
 ** Determined by HLA.

- 34 days of exposure to artificial sunlight.
- 2) Material balances for the exposed samples ranged from 92.3% on day 6 to 98.5% on Day 27. Material balances for the dark control samples ranged from 96.2% on Day 20 to 99.8% on Day 34.
 - 3) Extractable radioactivity decreased from 76.2% (mean value of duplicate analyses) on Day 0 to 55.3% (mean value of duplicate analyses) at Day 6 and then remained fairly constant through Day 34 of the definitive study. The percentage of total extractable radioactivity varied similarly.
 - 4) The cumulative radioactivity found in the CO₂ and organic volatile traps of the exposed samples after Day 34 of the definitive study was 1.1% of the total applied radioactivity. The cumulative radioactivity found in the CO₂ and organic volatile traps of the dark control samples was 0.5% of the total applied radioactivity.

D. STUDY AUTHOR'S CONCLUSIONS/QUALITY ASSURANCE MEASURES

The duration of the study was insufficient to allow estimation of half-life.

E. REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS

This study is not acceptable to fulfill the requirements for soil photolysis because the light source did not simulate natural sunlight. Further, the analytical results appear somewhat erratic, and do not present a clear-cut pattern of decrease of Zineb with concomitant decrease in photoproducts-- i.e. Zineb first decreases, then increases again.

10.7 A STUDY IDENTIFICATION

Lesheski, Mary Jo. Determination of the Mobility of ¹⁴C-Zineb in Selected Soils by Soil Thin Layer Chromatography. prepared by Hazleton Laboratories America, Inc. sponsored by Micro Flo Company. received by EPA 4/6/87. EPA Acc. # 401492-05.

B. MATERIALS AND METHODS

test compound - as described in 10.1
 test solution - test compound in 0.5M NH₄OH [per preparer ca. 0.02 uCi/spot] not aged before TLC development described in test protocol
 test soils - details attached, not sterilized
 test protocol - test solution was applied to a TLC plate, together with reference 2,4-D and carbofuran. The plates were developed in H₂O at room temperature, dried, and radioactivity detected by a linear analyzer.

C. REPORTED RESULTS

Details are attached. For each soil except Plainfield sand, the Zineb showed two areas of radioactivity, the first near the origin, representing ca. 80% and the second trailing from the origin to the solvent front, representing ca. 20%.

D. STUDY AUTHOR'S CONCLUSIONS/QUALITY ASSURANCE MEASURES

The majority of the Zineb radioactivity remained at the origin of the soil TLC plate, while the remainder of the radioactivity was spread along the plate. The leading edge of the radioactivity of Zineb was in the same or higher mobility class as the reference standards of 2,4-D and carbofuran. Zineb was classified as very mobile in Plainfield sand, Mississippi silt loam, and Hagerstown silty clay loam, and mobile in Fox sandy loam. It is likely that

Table 1
Soil Physical Properties

Soil	Sand (%)	Silt (%)	Clay (%)	Organic Matter (%)*	Field Moisture Capacity (%)	pH	Cation Exchange Capacity (meq/100 g)	Bulk Density (g/mL)
Mississippi silt loam	29	58	13	1.1	20.3	7.0	13	1.18
Plainfield sand	97	1	2	0.3	2.1	5.4	1**	1.59
Fox sandy loam	61	30	9	2.3	10.6	6.8	6	1.33
Hagerstown silty clay loam	21.4	50.2	28.4	2.5	31	6.6	14.7+	1.21

Soil physical properties were analyzed by the University of Wisconsin Extension Soil and Forage Laboratory, except for Hagerstown soil for which the results as well as the soil were provided by Charles Helling of the United States Department of Agriculture. Field moisture capacity (except for Hagerstown soil) and bulk density were measured by HLA.

Mississippi silt loam was collected from a delta farm near Greenville in Washington County, Mississippi. Fox sandy loam was collected from a farm near DeForest in Dane County, Wisconsin. Plainfield sand was collected near the south shore of Pentwell Lake in Adams County, Wisconsin. Hagerstown silty clay loam was collected near Lime Kiln in Frederick County, Maryland.

* Percent organic matter is assumed to be 0.1 times the organic matter expressed as tons per acre.

** Calculated from the equation:

$$\text{Cation exchange capacity} = 0.75 \left[\frac{\text{Ca (lbs/acre)}}{400} + \frac{\text{Mg (lbs/acre)}}{243} + \frac{\text{K (lbs/acre)}}{780} \right]$$

+ Helling, C. S., Soil Sci. Soc. Amer. Proc., 35:744 (1971).

Table 2
Relative Mobility (R_f Value) of ^{14}C -Zineb
and Reference Standards in Various Soils

Determination	Frontal R_f Value*			Frontal R_f Value**		
	Zineb	2,4-D	Carbofuran	Zineb	2,4-D	Carbofuran
<u>Plainfield Sand</u>						
1	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	NA	NA	1.0	NA	1.0
Mean frontal R_f value†	1.0	1.0	1.0			
Mean mobility class††	(5)	(5)	(5)			
Mean#	0.40	0.40	0.40			
<u>Fox Sandy Loam</u>						
1	0.74	0.56	0.54	0.72	0.49	0.39
2	0.77	0.50	0.59	0.74	0.46	0.55
3	0.79	NA	NA	0.76	NA	NA
Mean frontal R_f value†	0.75	0.50	0.52			
Mean mobility class††	(4)	(3)	(3)			
Mean#	0.76	1.48	1.40			

NA Not applicable.

* As determined by measurements from linear analyzer scans.
 ** As determined by measurements from autoradiograms.
 † Determined from measurements of linear analyzer scans and autoradiograms.
 †† As defined by EPA Pesticide Assessment Guidelines, Subdivision N, Page 57 (1982), using the mean R_f value.
 (1) = Immobile (R_f = 0.0 through 0.09)
 (2) = Low mobility (R_f = 0.1 through 0.34)
 (3) = Intermediate mobility (R_f = 0.35 through 0.64)
 (4) = Mobile (R_f = 0.65 through 0.89)
 (5) = Very mobile (R_f = 0.90 through 1.0)
 # K is the sorption coefficient calculated from the mean relative mobility. The equation and sample calculation are in Appendix C.

Table-2 (Continued).
Relative Mobility (R_f Value) of ^{14}C -Zineb
and Reference Standards in Various Soils

Determination	Frontal R_f Value*			Frontal R_f Value**		
	Zineb	2,4-D	Carbofuran	Zineb	2,4-D	Carbofuran
<u>Mississippi Silt Loam</u>						
1	0.83	0.63	0.89	0.91	0.66	0.84
2	0.91	0.75	0.82	0.94	0.65	0.83
3	0.90	NA	NA	0.94	NA	NA
Mean frontal R_f value†	0.90	0.67	0.84			
Mean mobility class††	(5)	(4)	(4)			
Mean#	0.52	0.93	0.61			
<u>Hagerstown Silty Clay Loam</u>						
1	0.87	0.34	0.75	0.91	0.24	0.69
2	1.0	0.29	0.79	0.96	0.20	0.74
3	1.0	NA	NA	0.87	NA	NA
Mean frontal R_f value†	0.94	0.27	0.74			
Mean mobility class††	(5)	(2)	(4)			
Mean#	0.47	3.32	0.78			

NA Not applicable.

* As determined by measurements from linear analyzer scans.
 ** As determined by measurements from autoradiograms.
 † Determined from measurements of linear analyzer scans and autoradiograms.
 †† As defined by EPA Pesticide Assessment Guidelines, Subdivision N, Page-67 (1982), using the mean R_f value.
 (1) = Immobile (R_f = 0.0 through 0.09)
 (2) = Low mobility (R_f = 0.1 through 0.34)
 (3) = Intermediate mobility (R_f = 0.35 through 0.64)
 (4) = Mobile (R_f = 0.65 through 0.89)
 (5) = Very mobile (R_f = 0.90 through 1.0)
 # K is the sorption coefficient calculated from the mean relative mobility. The equation and sample calculation are in Appendix C.

Table 3

Percent Distribution of ¹⁴C-Zineb Radioactivity on Soil TLC Plates*

<u>Determination</u>	<u>Origin</u>	<u>Remainder of Channel</u>
<u>Mississippi Silt Loam</u>		
1	81.6	18.4
2	74.2	25.8
3	77.5	22.5
<u>Hagerstown Silty Clay Loam</u>		
1	79.5	20.5
2	78.5	21.5
3	78.2	21.8
<u>Fox Sandy Loam</u>		
1	74.5	25.5
2	66.9	33.1
3	77.0	23.0

* Quantitation of the Zineb activity was not done for the Plainfield sand plate because the radioactivity was dispersed relatively uniformly over the whole channel.

the mobile portion of the ^{14}C - zineb can be attributed to either a soil TLC degradation product or an impurity in the test material.

E. REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS

The preparer's interpretation of the data appears correct-- the major portion of radioactivity of zineb in all soils is relatively immobile, but a minor component (impurity or degradate) is mobile. The study is acceptable.

10.8 A. STUDY IDENTIFICATION

Rustum, Abu M. Determination of the Mobility of Soil-Aged ^{14}C -Zineb Residues by Soil Thin Layer Chromatography. prepared by Hazleton Laboratories America, Inc. sponsored by Micro Flo Company. received by EPA 4/6/87. EPA Acc. # 401492-06.

B. MATERIALS AND METHODS

test compound - as described in 10.1
test solution - test compound in 0.5M NH_4OH [per preparer ca. 202 ug/148 ul]
test soil - Dickenson sandy loam (details attached)
test preparation - 148 ul (202 ug) solution / 20 gm soil (10.1 ppm)
test protocol - test preparation was incubated in a biometer flask (equipped with a NaOH trap which was sampled at days 1, 4, 5, 8, 11, 18, 22, 25, 29, and 32 days for radioactivity). Following incubation, an aliquot of the soil was applied in triplicate to a prepared TLC plate, together with reference 2,4-D and unaged zineb. The plate was developed in H_2O at room temperature, dried, and radioactivity detected by a linear analyzer.

C. REPORTED RESULTS

Details are attached.

D. STUDY AUTHOR'S CONCLUSIONS/QUALITY ASSURANCE MEASURES

After 32 days of aerobic incubation of ^{14}C - zineb in Dickenson sandy loam soil, 37.6% of the applied radioactivity had been trapped in NaOH, indicating that zineb degrades on soil. The soil-aged residues of zineb were less mobile than both non soil-aged zineb and 2,4-D. ... Soil-aged zineb was classified as having low mobility. R_f for the parent was 0.10 - 0.16, and for the degradate 0.98 - 0.99

E. REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS

The starting material contains as much as ca. 10% impurities. The mobility of the major component (presumably zineb) does not appear to change from the non-aged to the aged sample. A possible interpretation of the data is that it has some minor components which are degraded, but zineb itself does not change through the course of the incubation. It would be classed as low mobility based on this study. Note that the formation of immobile degradates is not precluded by these data. This study is acceptable for defining the behavior of zineb when aged.

10.9 A. STUDY IDENTIFICATION

Saxena, Adesh M. The Adsorption/Desorption of ^{14}C -Zineb on Representative Agricultural Soils. prepared by Hazleton Laboratories America, Inc.

Table 2

Relative Mobility (Frontal R_f Value) of Soil-Aged Zineb, Nonsoil-Aged Zineb, and 2,4-D Reference Standard in Dickenson Sandy Loam Soil

Replicate	Zineb		2,4-D Reference Pesticide
	Nonsoil-Aged*	Soil-Aged	
1	0.98	0.16	0.71
2	0.99	0.10	0.76
3	NA	0.16	NA
Mean	0.99	0.14	0.74
Mobility class**	(5)	(2)	(4)
K_f	0.411	7.04	0.780

NA Not applicable.

* This value is the R_f of the leading edge of the radioactivity of the most mobile component.

** As defined by EPA Pesticide Assessment Guidelines, Subdivision N, Page 67 (1982).

- (1) = Immobile ($R_f = 0.0$ to 0.09)
- (2) = Low mobility ($R_f = 0.1$ to 0.34)
- (3) = Intermediate mobility ($R_f = 0.35$ to 0.64)
- (4) = Mobile ($R_f = 0.65$ to 0.89)
- (5) = Very mobile ($R_f = 0.90$ to 1.0)

+ K is the sorption coefficient calculated from relative mobility. Appendix D contains the equation and a sample calculation.

Properties of Dickenson Sandy Loam Soil

The sifted Dickenson sandy loam soil was reported by the University of Wisconsin-Extension Soil and Forage Laboratory as follows:

<u>Sand</u>	<u>Silt</u>	<u>Clay</u>	<u>Organic Matter*</u>	<u>pH</u>	<u>Estimated Cation Exchange Capacity</u>
76%	17%	7%	2.3%	6.9	4

* Percent organic matter is assumed to be 0.1 times the organic matter expressed as tons/acre.

Seventy-five percent of 1/3 bar FMC of the Dickenson soil was determined to be 14.3% by HLA.

This soil was collected on November 21, 1986, from a farm near Belleville in Dane County, Wisconsin.

Figure 7

Distribution of Radioactivity on Soil
TLC Plate: Nonsoil-Aged ^{14}C -Zineb
Applied to Dickenson Sandy Loam,
Channel 5, Replicate 2

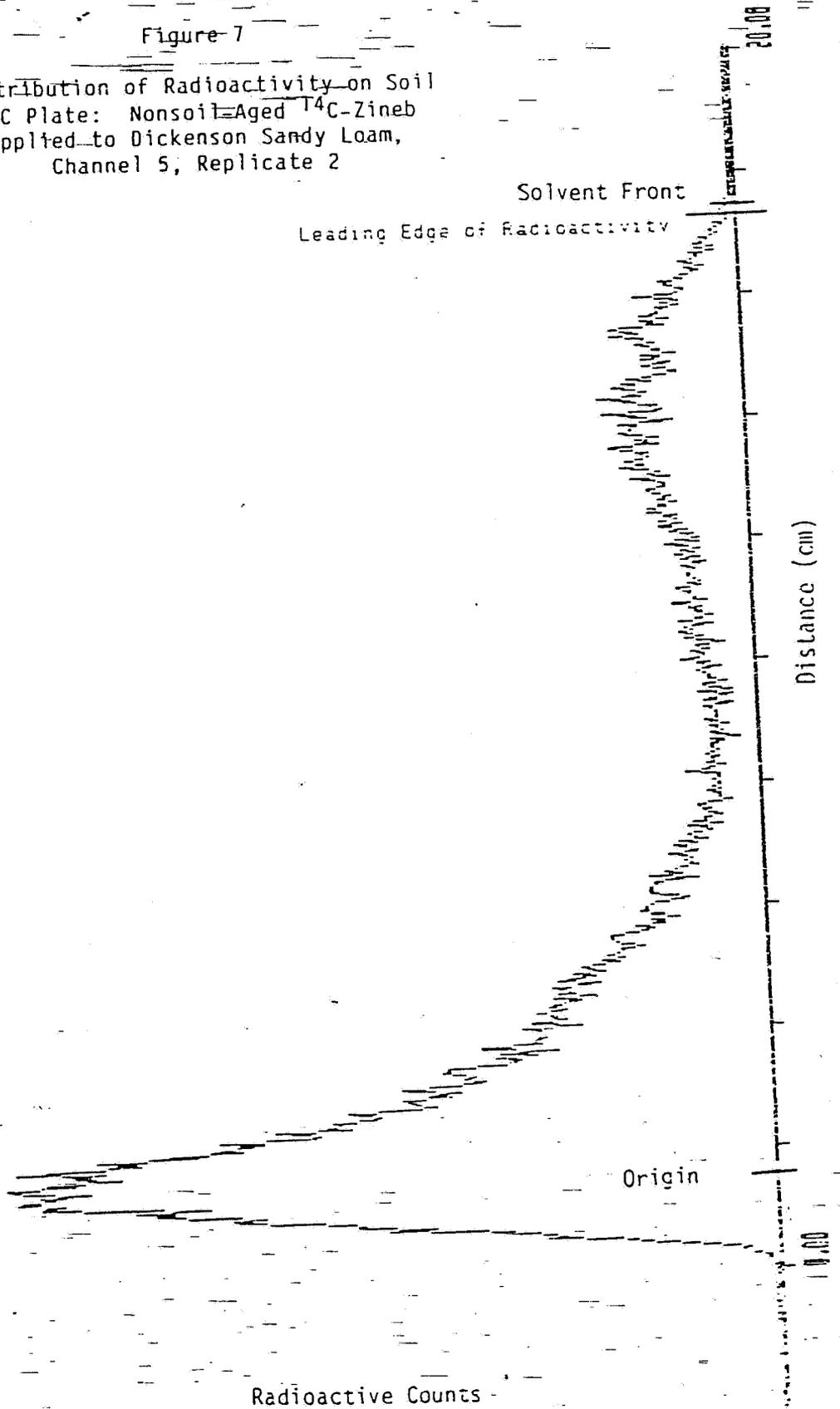


Figure 8

Distribution of Radioactivity on Soil
TLC Plate: Soil-Aged ¹⁴C-Zinc
Applied to Dickenson Sandy Loam,
Channel 6, Replicate 3

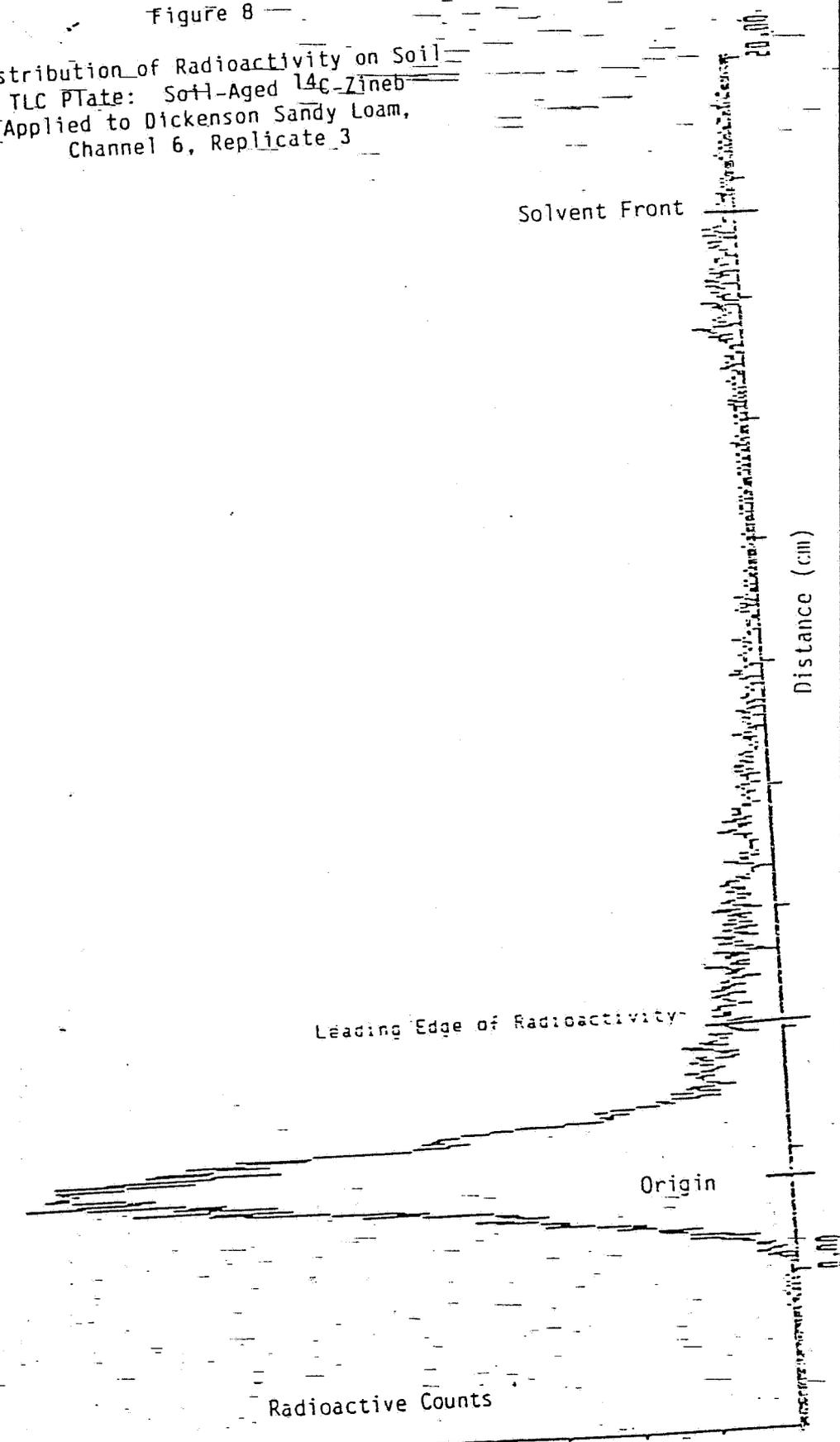


Table 1
Cumulative Percent of Applied Radioactivity Trapped
in NaOH Solution

<u>Sample Day</u>	<u>Percent Radioactivity Trapped</u>	<u>Cumulative Percent Radioactivity Trapped</u>
1	0.1	0.1
4	2.4	2.5
5	0.8	3.3
8	2.4	5.7
11	2.8	8.5
18	13.5	22.0
22	2.5	24.5
25	5.5	30.0
29	4.9	34.9
32	2.7	37.6

sponsored by W.R. Landis Associates, Inc. - received by EPA 4/6/87.
EPA Acc. # 401492-04.

B. MATERIALS AND METHODS

test compound - as described in 10.1
test solutions - the above in 0.5 M NH₄OH, diluted with 0.01 M Ca(NO₃)₂
to give 5.20, 2.06, 1.04, and 0.523 ppm (concentration verified by LSC)
test soils - details attached
test protocol - Preliminary studies were done to establish stability, solubility,
non-adsorption to glass, equilibration times, and soil/water ratio.
Soil samples (1 gm for all except Plainfield sand, which were 2 gm)
were treated with 10 ml each of the above solutions, shaken for 1 hr,
centrifuged, the supernatant removed for adsorption determination.
A fresh portion of calcium nitrate was added to the soil pellet, and
the preparation shaken for desorption determination.

C. REPORTED RESULTS

Details are attached

D. STUDY AUTHOR'S CONCLUSIONS/QUALITY ASSURANCE MEASURES

Aqueous Zineb adsorbed to some degree in all four soils studied. At 25 °C
this adsorption followed the Freundlich isotherm. The K_d values ranged from
1.78 to 6.70. Desorption of adsorbed Zineb ranged from 0.74% to 16.7%.
Based on K_d values, the potential for leaching of Zineb is greatest in the
Plainfield sand and least in the Kewaunee clay loam.

E. REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS

The conclusions are supported. The study is acceptable.

10.10 A. STUDY IDENTIFICATION

Nash, Ralph G. Determining Environmental Fate of Pesticides with Microagroecosystem
published in Residue Reviews, 1983, Volume 85. pp. 199-215.

E. REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS

This article presents some information relative to persistence of ETU and Zineb
comparing results in the field with results in a large research chamber. It
is interesting, but does not serve to fulfill any data requirements or provide
useful supplemental information since experimental detail is not included.

10.11 A. STUDY IDENTIFICATION

Nash, Ralph G. and Beall, M. Leroy, Jr. Fate of Maneb and Zineb Fungicides in
Microagroecosystem Chambers. published 1980 by American Chemical Society
MRID 00131024.

E. REVIEWER'S DISCUSSION AND INTERPRETATION OF STUDY RESULTS

This article does not speak to any formal data requirement. It does present some
information about the persistence of Maneb and Zineb when tested in a large
research chamber. Since experimental detail is not provided, this study
does not provide useful supplemental information. However, results are

Table 1
 Adsorption/Desorption and Soil Concentration
 of Aqueous Zineb: Plainfield Sand

Initial Solution Concentration (ppm)	Replicate Set	Adsorption Concentration (ppm)		Ratio of C_s to Initial Solution Concentration	Desorption (%)
		Solution (C_w)	Soil (C_s)		
0.523	A	0.271	1.256	2.17	1.91
	B	0.320	1.015		4.33
1.04	A	0.702	1.698	1.53	4.06
	B	0.743	1.490		3.29
2.08	A	1.642	2.210	1.02	1.58
	B	1.679	2.023		0.74
5.19	A	4.546	3.243	0.601	-2.22
	B	4.595	2.998		1.10

Note: Values are summarized from Appendices C-1 and C-2.

Table 2
Adsorption/Desorption and Soil Concentration
of Aqueous Zineb: Plano Silt Loam

Initial Solution Concentration (ppm)	Replicate Set	Adsorption Concentration (ppm)		Ratio of C_s to Initial Solution Concentration	Desorption (%)
		Solution (C_w)	Soil (C_s)		
0.523	A	0.327	1.955	3.72	12.2
	B	0.330	1.931		13.4
1.04	A	0.669	3.722	3.47	15.4
	B	0.691	3.502		14.9
2.08	A	1.404	6.802	3.23	15.8
	B	1.419	6.648		16.7
5.19	A	3.732	14.626	2.76	13.8
	B	3.792	14.027		13.4

Note: Values are summarized from Appendices C-1 and C-3.

Table 3
Adsorption/Desorption and Soil Concentration
of Aqueous-Zinc: Fox Sandy Loam

Initial Solution Concentration (ppm)	Replicate Set	Adsorption Concentration (ppm)		Ratio of C_s to Initial Solution Concentration	Desorption (%)
		Solution (C_w)	Soil (C_s)		
0.523	A	0.354	1.683	3.23	7.25
	B	0.353	1.695		4.19
1.04	A	0.724	3.172	3.01	6.49
	B	0.732	3.098		8.17
2.08	A	1.540	5.441	2.57	8.22
	B	1.560	5.236		7.66
5.19	A	3.997	11.977	2.16	-1.14
	B	4.154	10.408		3.31

Note: Values are summarized from Appendices C-1 and C-4.

Table 4
Adsorption/Desorption and Soil Concentration
of Aqueous Zineb: Kewaunee Clay Loam

Initial Solution Concentration (ppm)	Replicate Set	Adsorption Concentration (ppm)		Ratio of C_s to Initial Solution Concentration	Desorption (%)
		Solution (C_w)	Soil (C_s)		
0.523	A	0.258	2.645	4.76	5.33
	B	0.289	2.338		6.84
1.04	A	0.544	4.977	4.59	6.79
	B	0.583	4.580		7.34
2.08	A	1.276	8.083	3.80	6.79
	B	1.313	7.713		11.1
5.19	A	3.469	17.259	3.21	5.57
	B	3.591	16.038		6.71

Note: Values are summarized from Appendices C-1 and C-5.

Table 10-9
5

Table 5
 K_d Values for Zineb Adsorbed on
 Four Agricultural Soils

<u>Soil</u>	<u>K_d</u>	<u>1/n</u>	<u>Correlation Coefficient</u>
Plainfield sand	1.78	0.365	0.9747
Plano silt loam	4.92	0.820	0.9990
Fox sandy loam	3.84	0.765	0.9973
Kewaunee clay loam	6.70	0.725	0.9929

Note: Values are summarized from Appendices C-6 through C-9.

Physical Analysis of Soil

Soil	Sand (%)	Silt (%)	Clay (%)	Organic Matter (%)*	Field Moisture Capacity (%)**	pH	Cation Exchange Capacity (meq/100 g)	Bulk Density (g/mL)
Plainfield sand	97	1	2	0.3	2.1	5.4	1+	1.59
Plano silt loam	13	65	22	4.0	27.2	6.4	15	1.30
Fox sandy loam	61	30	9	2.3	10.6	6.8	6	1.33
Kewaunee clay loam	21	47	32	5.0	26.7	7.0	21	1.19

For all soils, physical analysis was performed by the University of Wisconsin-Extension Soil and Forage Laboratory. Field moisture capacity and bulk density were measured by HLA.

Fox sandy loam was collected from a farm in Dane County, Wisconsin. Plainfield sand was collected near the south shore of Petenwell Lake in Adams County, Wisconsin. Plano silt loam was collected at the University of Wisconsin's Arlington farm, Columbia County, Wisconsin. The Kewaunee soil was collected from Winnebago County, Wisconsin.

- * Percent organic matter is assumed to be 0.1 times the organic matter expressed as tons per acre.
- ** Field moisture capacity was determined at 0.33 bar.
- + Calculated from the equation:

$$\text{Cation exchange capacity} = 0.75 \left[\frac{\text{Ca (lb/acre)}}{400} + \frac{\text{Mg (lb/acre)}}{243} + \frac{\text{K (lb/acre)}}{780} \right]$$

consistent with the low mobility indicated in other studies reported in this review (10.7 - 10.9.)

- 11. COMPLETION OF ONE-LINER: n.a.
- 12. CBI APPENDIX: included