Shaughnessy No.: 009001

Date Out of EAB: JUL 14 1987

To: George La Rocca
Product Manager 15
Registration Division (TS-767)

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

Attached, please find the EAB review of...

Reg./File # : 52904-C

Chemical Name: Lindane

Type Product : Insecticide/acaricide

Product Name : Exagama, Gallogama, Gammophele Fog, Lindafor, Lindagrain

Company Name : Rhone-Poulenc, Inc.

Purpose : Flagged data in response to Registration Standard.

70047

Action Code(s): 660

Date Received: 12/26/86

Date Completed: JUL 14 1987

Total EAB Reviewing Time: 3.5 days

EAB #(s) : 7047,7048,7054,7056,7072

TAIS CODE: 104

Monitoring submitted: _____

Monitoring requested: _____

Deferrals to:

_____ Ecological Effects Branch

_____ Residue Chemistry Branch

_____ Toxicology Branch

1. CHEMICAL: Common name:

Lindane

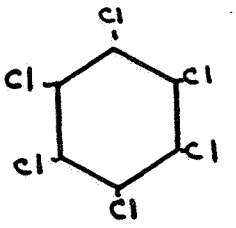
Chemical name:

Gamma isomer of 1,2,3,4,5,6-hexachlorocyclohexane

Trade name(s):

Exagama, Gallogama, Gammophele Fog, Lindafor, Lindagrain, Lindagranox, Lindalo, Lindamul, Lindapoudre, Lindaterra

Structure:



Formulations:

0.75 and 1% D; 6-75% WP; 1-75% WP/D; 0.27-11.2% Impr; 0.35-1.75 lb/gal and 0.45-40% EC; 1.65 lb/gal and 20% SC/L; 2.67 and 4.0 lb/gal and 0.095-25% RTU; 0.75 and 3% PrL; 1-40% FlC

Physical/Chemical properties:

Molecular formula: $C_6H_6Cl_6$
Molecular weight: 290.85
Physical state: White crystalline solid.
Melting point: 112-113°C.
Vapor pressure of ai: 0.06 mm Hg at 40°C.
Solubility: In water - 7.3 ppm at 25°C, 12 ppm at 35°C, 14 ppm at 45°C; slightly soluble in mineral oil; soluble in acetone, aromatic, and chloronated hydrocarbons.

2. TEST MATERIAL:

Studies 1-4: Ring-labeled [^{14}C]lindane (radiochemical purity 97-98%); Study 5: 20% EC.

3. STUDY/ACTION TYPE:

Response for expedited data requested under the Lindane Registration Standard.

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4: STUDY IDENTIFICATION:

Jordan, E.G. and F.A. Norris. 1986. Lindane-^{14}C-photodegradation on soil by natural sunlight. Pesticide Assessment Guideline 161-3. Report No. 86/BHL/605/AG. Unpublished study prepared and submitted by Rhone-Poulenc, Inc., Monmouth Junction, NJ. Acc. No. 265725. MRID # 00~~159488~~ 164546

Mirfakhrae, K.D. 1986. The hydrolysis of lindane at pH levels of 5, 7, and 9. Report No. 86/BHL/405/AG. Unpublished study prepared and submitted by Rhone-Poulenc, Inc., Monmouth Junction, NJ. Acc. No. 263945.

Norris, F.A. and K.D. Mirfakhrae. 1986. Lindane-^{14}C-photodegradation in aqueous solution by natural sunlight. Report No. 86/BHL/AG. Unpublished study prepared and submitted by Rhone-Poulenc, Inc., Monmouth Junction, NJ. Acc. No. 265726. MRID # 00164547

Norris, F.A. 1986a. Lindane-^{14}C-photodegradation in aqueous solution by natural sunlight using acetone as a photosensitizer. Report No. 86/BHL/596/AG. Unpublished study prepared and submitted by Rhone-Poulenc, Inc., Monmouth Junction, NJ. Acc. No. 265724. MRID # 00168545

Norris, F. 1986b. The volatilization of lindane from soil. Prepared by Agrisearch Incorporated, Frederick, MD, and submitted by Rhone-Poulenc, Inc., Monmouth Junction, NJ. Acc. No. 265721.

5. REVIEWED BY:

Paul Mastradone, Ph.D.
Chemist
EAB/HED/OPP

Signature: Paul J. Mastradone
Date: JUL 10 1987

6. APPROVED BY:

Emil Regelman,
Supervisory Chemist
Review Section #3, EAB/HED/OPP

Signature: Emil Regelman
Date: JUL 14 1987

7. CONCLUSIONS:

1. Insufficient data exist to assess the processes involved and the fate of Lindane in the environment. Additional data have been submitted as required under the Registration Standard. These data are in the review process at this time. Because the Registration Standard requires expedited review of the submitted studies EAB is forwarding these completed reviews.

2. Five studies requested under the Lindane Registration Standard and designated for priority review were included in this package. These were Hydrolysis (161-1), two Photodegradation in water (161-2), Photodegradation on soil (161-3), and Laboratory volatility (163-1).

3. The hydrolysis study was marginally acceptable and fulfilled the data requirements for (161-1) required under the Registration Standard.

The study indicated that ring-labelled ^{14}C- Lindane hydrolysed with a half-life of 115-173 days at pH 5, 281-309 days at pH 7 and 35-36 days at pH 9. At pH 9 the hydrolytic products were identified as pentachlorocyclohexene, 1,2,4-trichlorobenzene and 1,2,3-trichlorobenzene by TLC techniques utilizing autoradiography and cochromatographic techniques. Quantitation was by LSC.

4. The first Photodegradation in water study reviewed in this package (Norris and Mirfakhrae, 1986) was scientifically valid but was not acceptable because the test solutions were not buffered and the incubation temperatures were not reported. These data may be considered as supplemental and indicate that ring-labelled ^{14}C Lindane was not degraded. Reported data indicate that 96.9% of the parent lindane (0.642 ppm) remained 28 days after treatment. The dark control contained 92.8 % of parent Lindane at the 28 days post-treatment.

5. The second photodegradation in water study reviewed in this package (Norris, 1986a) was considered to be scientifically valid but was not acceptable to fulfill the guideline requirements for 162-1 because the study was conducted for 14 days only, the test solutions were not buffered and the incubation temperatures were not reported. The results must be considered as supplemental and indicate that ring-labelled ^{14}C-Lindane was stable to natural sunlight for 14 days with 97.7% of initial added Lindane (1.282 ppm) present.

6. The photodegradation on soil study was considered to be scientifically invalid and unacceptable as the materials balance left >40% of the initial applied radiolabelled compound unaccounted for.

7. The laboratory volatility study (Norris, 1986b) was considered to be scientifically valid but not acceptable in fulfillment of guideline requirement (163-2). These data are considered to be supplemental because the vapor pressure at 25°C, the K_d of the soil and the water solubility of Lindane were not reported. Data presented indicate that Lindane volatilized at a rate of 1.19 ug/cm^2/hour from a sandy loam soil purged with 100% relative humidity N_2. The flow rate was 0.432 m^3/day and the lindane concentration in the air reported to be 11.9 ug/m^3/day. Lindane was not reported as volatilized in 0% relative humidity conditions.

8. RECOMMENDATIONS:

1. The Hydrolysis study reviewed in this action is considered to be marginally acceptable in fulfillment of guideline requirement (161-1). No additional hydrolysis data are required.

2. Although the data presented in the two photodegradation in water studies appear to indicate that Lindane is stable to photodegradation in water the lack of control and/or monitoring of pH and temperature has made these studies unacceptable. A study should be conducted as described in the guidelines. The solution should be buffered and the incubation temperatures reported. The registrant should also keep the dark controls at the temperature of the test solution. The study report should include complete data on the intensity of the sunlight and any atmospheric or climatic conditions that might affect the intensity or time of exposure of the test substance.

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3. The soil photolysis study reviewed in this data package was not considered to be scientifically valid because the materials balance was unacceptably low. Less than 60% of the ^{14}C-Lindane initially applied was accounted for at the end of the study. A new soil photolysis study must be conducted according to guideline requirements. This study should employ extraction and analysis techniques that allow acceptable recoveries and identification of ^{14}C-Lindane or related degradates,

5. The volatility study reviewed in this package was considered only supplemental because insufficient data were provided in the report. The study could possibly be made acceptable with inclusion of the data noted in section 8.1. of this document and further explanation of the sharply contrasting results of the 0% and 100% relative humidity data. EAB suggests that this study be resubmitted if the appropriate supportable data can be included in that report. EAB further suggests that if the registrant repeats the study, the N_2 purge be replaced with an air purge.

9. BACKGROUND:

A. Introduction

Lindane has been previously reviewed by Dyanamc for the Standard.

The Registration Standard requests all environmental fate data be submitted on an expedited basis and flagged this data for expedited review. These are some of the data requested under the Standard.

B. Directions for Use

Lindane is an insecticide/acaricide registered for use on a variety of terrestrial food crop (field and vegetable crops including seed treatment), terrestrial nonfood (ornamentals and tobacco), greenhouse food crop (vegetables), greenhouse nonfood (ornamentals), forestry, domestic outdoor and indoor (pets and household), commercial indoor (food/feed storage areas and containers, and animal premises), and wood or wooden structure sites. Of the total amount of lindane applied in the United States in 1982, 48, 20, and 19% was used for seed treatment, livestock, and hardwood lumber, respectively. Application rates range from 0.25 to 2.25 oz/100 lb of seed for seed treatment; 0.2 to 2.06 lb/A for foliar and soil treatment; 0.8 to 1.5 oz/50,000 ft^3 for greenhouse; 0.006 to 0.11 lb/gal for bark; 0.023 to 3% sprays, dips, and dusts for indoor and animal treatment; 0.01 lb/1000 ft^2 for animal premises; and 4 lb/1000 ft^2 (14.64% solutions) for wood and wooden structures. Lindane may be formulated with captan, methoxychlor, sulfur, maneb, zineb, carbaryl, terrachlor, orthodichlorobenzene, kerosene, heavy aromatic naphtha, toxaphene, DDVP, malathion, pine oil, piperonyl butoxide, pyrethrins, naled, dicofol, tetrachlorophenols, methylated napthalenes, dinocap, benzyl benzoate, rotenone, diazinon, basic copper sulfate, and mancozeb. Single active ingredient formulations consist of 0.75 and 1% D, 6-75% WP, 1-75% WP/D, 0.27-11.2% Impr, 0.35-1.75 lb/gal and 0.45-40% EC, 1.65 lb/gal and 20% SC/L, 2.67 and 4 lb/gal and 0.097-25% RTU-L, 0.75 and 3% PrL, and 1-40% FlC.

Lindane is generally surface applied using ground equipment but may be incorporated. Applicators must be certified or under the direct supervision of applicators certified to apply lindane products registered for the following uses: commercial ornamentals, pecans, livestock, forestry, Christmas trees, structural treatments, dog shampoos, and dog dusts.

10. DISCUSSION OF INDIVIDUAL TESTS OR STUDIES:

See attached reviews of individual studies.

11. COMPLETION OF ONE-LINER:

One-liner not complete to date.

12. CBI APPENDIX:

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

DYNAMAC CORPORATION

LINDANE

Final Report

Task 1: Review and Evaluation of Individual Studies

Task 2: Environmental Fate and Exposure Assessment

Contract No. 68-02-4250

JUNE 8, 1987

Submitted to:
Environmental Protection Agency
Arlington, VA 22202

Submitted by:
Dynamac Corporation
The Dynamac Building
11140 Rockville Pike
Rockville, MD 20852

LINDANE

Table of Contents

INTRODUCTION

Lindane is an insecticide/acaricide registered for use on a variety of terrestrial food crop (field and vegetable crops including seed treatment), terrestrial nonfood (ornamentals and tobacco), greenhouse food crop (vegetables) and nonfood (ornamentals), forestry, domestic outdoor and indoor (pets and household), commercial indoor (food/feed storage areas and containers, and animal premises including manure), and wood or wooden structure sites. Of the total amount of lindane applied in the United States in 1982, ~48, 20, and 19% was used for seed treatment, livestock, and hardwood lumber, respectively. Application rates range from 0.25 to 2.25 oz/100 lb of seed for seed treatment; ~0.2 to 2.06 lb/A for foliar and soil treatment; 0.8 to 1.5 oz/50,000 ft^3 for greenhouse; 0.006 to 0.11 lb/gal for bark; 0.023 to 3% sprays, dips, and dusts for indoor and animal treatment; ≤0.01 lb/1000 ft^2 for animal premises; and ≤4 lb/1000 ft^2 (14.64% solutions) for wood and wooden structures. Lindane may be formulated with captan, methoxychlor, sulfur, maneb, zineb, carbaryl, terrachlor, orthodichlorobenzene, kerosene, heavy aromatic naphtha, toxaphene, DDVP, malathion, pine oil, piperonyl butoxide, pyrethrins, naled, dicofol, tetrachlorophenols, methylated napthalenes, dinocap, benzyl benzoate, rotenone, diazinon, basic copper sulfate, and mancozeb. Single active ingredient formulations consist of 0.75 and 1% D, 6-75% WP, 1-75% WP/D, 0.27-11.2% Impr, 0.35-1.75 lb/gal and 0.45-40% EC, 1.65 lb/gal and 20% SC/L, 2.67 and 4 lb/gal and 0.09725% RTU-L, 0.75 and 3% PrL, and 1-40% FlC. Lindane is generally surface applied using ground equipment but may be incorporated. Applicators must be certified or under the direct supervision of applicators certified to apply lindane products registered for the following uses: commercial ornamentals, pecans, livestock, forestry, Christmas trees, structural treatments, dog shampoos, and dog dusts.

CASE GS -- LINDANE STUDY 1 PM --

CHEM 009001 Lindane

BRANCH EAB DISC --

FORMULATION 00 - ACTIVE INGREDIENT

FICHE/MASTER ID No MRID CONTENT CAT 01

Mirfakhrae, K.D. 1986. The hydrolysis of lindane at pH levels of 5, 7, and 9. Report No. 86/BHL/405/AG. Unpublished study prepared and submitted by Rhone-Poulenc, Inc., Monmouth Junction, NJ. Acc. No. 263945.

SUBST. CLASS = S.

DIRECT RVW TIME = 8 (MH) START-DATE END DATE

REVIEWED BY: J. Harlin
TITLE: Staff Scientist
ORG: Dynamac Corp., Rockville, MD
TEL: 468-2500

APPPOVED BY: P. Mastradone
TITLE: Chemist
ORG: EAB/HED/OPP
TEL: 557-9734

SIGNATURE: Paul J Mastradone DATE: 7/8/87

CONCLUSIONS:

Degradation - Hydrolysis

1. This study is scientifically valid.

2. Ring-labeled [^{14}C]lindane (radiochemical purity >98%), at ~1.03 ppm, degraded with a half-life of >30 days in 0.05 and 0.10 M buffer solutions (pH 5, 7, and 9) maintained at 25 ± 1°C in the dark. The registrant-calculated half-lives were 115.5, 281.7, and 35.4 days for the 0.10 M pH 5, 7, and 9 solutions, respectively, and 173.3, 309.4, and 36.3 days for the 0.05 M solutions. At pH 9, the major degradates were pentachlorocyclohexene, 1,2,4-trichlorobenzene, and 1,2,3-trichlorobenzene.

3. This study is acceptable and fulfills EPA Data Requirements for Registering Pesticides by providing information on the hydrolysis of lindane in pH 5, 7, and 9 aqueous buffered solutions.

MATERIALS AND METHODS:

Ring-labeled [^{14}C]lindane (radiochemical purity >98%, specific activity

25.26 mCi/mmol, Pathfinder Laboratories) was added at ~1.03 ppm to filter-sterilized (0.45 µm) buffer solutions having ionic strengths of 0.05 M and 0.10 M and adjusted to pH 5 (potassium dihydrogen phosphate and disodium hydrogen phosphate), pH 7 (potassium hydrogen phosphate and sodium hydroxide), and pH 9 (sodium borate and hydrochloric acid). The solutions were incubated in the dark at 25 ± 1°C. Aliquots of each solution were removed for analysis at 0, 3, 7, 14, and 30 days posttreatment. The pH of the solutions was measured at each sampling interval.

Aliquots of each sample were analyzed for total radioactivity by LSC. The samples were extracted twice with hexane, then twice with ethyl acetate. Aliquots of the hexane and ethyl acetate extracts and the extracted solutions were analyzed by LSC. The hexane and ethyl acetate extracts were concentrated and applied to silica gel TLC plates. Half of the TLC plates were developed in acetone:hexane (15:85, v:v); the second half were developed in acetone:chloroform (15:85, v:v). Reference standards were cochromatographed with the extracts. Radioactive areas were located using autoradiography, scraped from the TLC plates, and quantified by LSC. The hexane extracts from the pH 9 test solution were also analyzed by GC/MS.

REPORTED RESULTS:

[^{14}C]Lindane degraded with a half-life of >30 days in 0.05 and 0.10 M buffer solutions at pH 5, 7, and 9 (Tables 1 and 2). The registrant-calculated half-lives were 115.5, 281.7, and 35.4 days for the 0.10 M pH 5, 7, and 9 solutions, respectively, and 173.3, 309.4, and 36.3 days for the 0.05 M solutions. The major degradates at pH 9 were pentachlorocyclohexene, identified by GC and TLC, and 1,2,4-trichlorobenzene and 1,2,3-trichlorobenzene, identified by GC/MS. The trichlorobenzenes, combined, accounted for ~4% of the radioactivity in the pH 9 solution after 30 days of incubation.

DISCUSSION:

1. Based on data from the GC analysis, 92% of the applied radioactivity remained in the pH 9 solution after 30 days of incubation; 61% (56% of the applied) of the radioactivity in solution was lindane. However, based on data from the TLC analysis, lindane was the only [^{14}C]-compound in solution. The discrepancy may be due to volatilization from the TLC plates.

2. Quantitative data were not provided for the degradates.

3. Recovery values for radioactivity applied to the TLC plates were not reported.

4. Recovery values from fortified samples and detection limits were not reported.

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Table 1. Distribution of radioactivity (% of the applied) in 0.05 ' buffer solutions at pH 5, 7, and 9 that were treated with [^{14}C]lindane (radiochemical purity >98%) at ~1.03 ppm and incubated in the dark at 25 ± 1°C.

Sampling interval (days)	GC Analysis		TLC Analysis		
	Total residues	Lindane	Low R_f	Lindane	High R_f
		pH 5			
0	100	104.1	--	--	--
3	93	92.9	0.60	99.4	ND[a]
7	89	72.0	0.25	98.5	1.22
14	90	91.3	0.50	98.7	0.80
30	93	95.2	0.60	98.7	0.70
		pH 7			
0	100	102.8	--	--	--
3	89	90.8	0.30	99.7	ND
7	94	89.1	0.31	98.3	1.42
14	93	95.1	0.50	99.0	0.20
30	96	95.4	0.40	98.3	1.40
		pH 9			
0	100	97.9	--	--	--
3	90	94.1	0.60	99.0	0.50
7	91	68.6	0.45	94.2	5.40
14	92	74.6	0.70	97.0	3.00
30	85	57.0	0.90	96.0	3.10

[a] Not detected; the detection limit was not reported.

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Table 2. Distribution of radioactivity (% of the applied) in 0.10 M buffer solutions at pH 5, 7, and 9 that were treated with [^{14}C]lindane (radiochemical purity >98%) at ~1.03 ppm and incubated in the dark at 25 ± 1°C.

Sampling interval (days)	GC Analysis		TLC Analysis		
	Total residues	Lindane	Low Rf	Lindane	High Rf
		pH 5			
0	100	108.7	--	--	--
3	88	94.3	0.45	99.5	ND[a]
7	90	76.2	0.35	98.9	0.98
14	89	87.5	0.40	99.0	0.50
30	90	87.6	0.50	98.7	0.70
		pH 7			
0	100	101.2	--	--	--
3	86	95.3	0.30	99.7	ND
7	93	72.5	0.40	98.8	1.12
14	94	109.6	0.60	100.0	0.70
30	90	94.8	0.40	98.7	0.80
		pH 9			
0	100	104.5	--	--	--
3	88	87.5	3.80	91.3	4.80
7	96	69.2	--	--	--
14	85	70.7	0.80	86.6	12.60
30	92	56.3	1.20	92.9	5.90

[a] Not detected; the detection limit was not reported.

CASE GS -- LINDANE STUDY 2 PM --

CHEM 009001 Lindane

BRANCH EAB DISC --

FORMULATION 00 - ACTIVE INGREDIENT

FICHE/MASTER ID No MRID 00164547 CONTENT CAT 01

Norris, F.A. and K.D. Mirfakhrae. 1986. Lindane-^{14}C-photodegradation in aqueous solution by natural sunlight. Report No. 86/BHL/AG. Unpublished study submitted by Rhone-Poulenc, Inc., Monmouth Junction, NJ. Acc. No. 265726.

SUBST. CLASS = S.

DIRECT RVW TIME = 5 (MH) START-DATE END DATE

REVIEWED BY: J. Harlin
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TITLE: Chemist
ORG: EAB/HED/OPP
TEL: 557-9734

SIGNATURE: Paul J Mastradone DATE: 7/8/87

CONCLUSIONS:

Degradation - Photodegradation in Water

1. This study is scientifically valid.

2. Ring-labeled [^{14}C]lindane (radiochemical purity 97.8%), at 0.642 ppm, was stable in deionized water during 28 days of irradiation with natural sunlight, with parent lindane comprising 96.9% of the applied at day 28 posttreatment. At 28 days posttreatment, 92.8% of the applied [^{14}C]-lindane in the dark control remained undegraded.

3. The study does not fulfill EPA Data Requirements for Registering Pesticides and will be considered as supplemental because the test solutions were not buffered and incubation temperatures were not reported.

MATERIALS AND METHODS:

Ring-labeled [^{14}C]lindane (radiochemical purity 97.8%, specific activity 3.55 mCi/mmol, Pathfinder Laboratories) dissolved in deionized water at 0.642 ppm was irradiated outdoors in a Pyrex vessel with natural sunlight

for 28 days during August and September, 1986, at Monmouth Junction, NJ (Table 1). A similar solution was maintained in a sealed amber bottle at 25°C to serve as a dark control. The irradiated solution and dark control were sampled at 0, 7, 14, 21, and 28 days posttreatment.

Samples were extracted twice with ethyl acetate, and total radioactivity in the extract was quantified using LSC. An aliquot of each extract was analyzed for [^{14}C]lindane using GC with electron capture detection. Also, an aliquot of each extract was analyzed for [^{14}C]lindane and its degradates using TLC on silica gel plates developed in either acetone:hexane (10:90) or acetone:chloroform (10:90). Plates were developed to a distance of 15 cm and radioactive areas were visualized using autoradiography and identified by comparison to standards. Individual bands were scraped from the plate and radioactivity was quantified using LSC.

REPORTED RESULTS:

Ring-labeled [^{14}C]lindane was stable during 28 days of irradiation with natural sunlight (Table 2). At day 28 posttreatment, parent lindane comprised 96.9% of the applied radioactivity in the irradiated solution. In the dark control at day 28 posttreatment, parent lindane comprised 92.8% of the applied radioactivity.

DISCUSSION:

1. The test solutions were not buffered.

2. Incubation temperatures were not reported, with the exception of September 10, 1986 (temperatures ranged from 18-29°C).

3. Volatile compounds were trapped; however, since lindane did not degrade, the traps were not analyzed.

Table 1. Average natural sunlight intensities for Monmouth Junction, NJ.[a]

Date (1986)		Average daily intensity ($\mu E/m^2 \cdot s$)[b]	Total daily solar irradiation (E/m^2)
August	15	436-1251	34.5
	16	--	35.0
	17	--	35.0
	18	--	30.0
	19	405-1081	26.5
	20	520-1326	29.8
	21	--	12.0
	22	800-1287	38.1
	23	600-1441	35.6
	24	871-1429	41.6
	25	442-1418	34.7
	26	773-1227	33.0
	27	--	12.0
	28	--	12.0
	29	762-1477	38.4
	30	841-1586	44.3
	31	822-1552	42.5
September	1	623-1256	37.1
	2	--	12.0
	3	262-1051	22.2
	4	133-623	12.8
	5	325-816	20.4
	6	583-1443	35.6
	7	312-916	25.4
	8	639-1286	36.5
	9	669-1478	39.5
	10	688-1216	33.2
	11	330-1313	31.9

[a] Latitude 40°25'N, longitude 74°30'E.

[b] Sunlight intensity recorded between 7 am and 5 pm.

Table 2. [^{14}C]Lindane (% of the applied) in aqueous solutions treated with [^{14}C]lindane (radiochemical purity 97.8%) at 0.642 ppm and irradiated with natural sunlight.[a]

Sampling interval (days)	Irradiated	Dark control
0	100.0	100.0
7	93.0	--
14	93.3	92.1
21	90.0	95.0
28	96.9	92.8

a GC data.

CASE GS -- LINDANE STUDY 3 PM --

CHEM 009001 Lindane

BRANCH EAB DISC --

FORMULATION 00 - ACTIVE INGREDIENT

FICHE/MASTER ID No MRID 00164 545 CONTENT CAT 01
Norris, F.A. 1986a. Lindane-^{14}C-photodegradation in aqueous solution by natural sunlight using acetone as a photosensitizer. Report No. 86/BHL/596/AG. Unpublished study prepared and submitted by Rhone-Poulenc, Inc., Monmouth Junction, NJ. Acc. No. 265724.

SUBST. CLASS = S.

DIRECT RVW TIME = 3 (MH) START-DATE END DATE

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APPROVED BY: P. Mastradone
TITLE: Chemist
ORG: EAB/HED/OPP
TEL: 557-9734

SIGNATURE: Paul J Mastradone DATE: 7/8/87

CONCLUSIONS:

Degradation - Photodegradation in Water

1. This study is scientifically valid.

2. Ring-labeled [^{14}C]lindane (radiochemical purity 97.8%), at 1.282 ppm, was stable in an aqueous 2% acetone solution during 14 days of irradiation with natural sunlight, with parent lindane comprising 97.7% of the applied at day 14.

3. This study does not fulfill EPA Data Requirements for Registering Pesticides and will be considered as supplemental because the study was only conducted for 14 days, the test solutions were not buffered, and incubation temperatures were not reported.

MATERIALS AND METHODS:

Ring-labeled [^{14}C]lindane (radiochemical purity 97.8%, specific activity 3.55 mCi/mmol, Pathfinder Laboratories) dissolved in an aqueous 2% acetone solution at 1.282 ppm was irradiated outdoors in a Pyrex vessel

with natural sunlight for 28 days during August and September, 1986, at Monmouth Junction, NJ (Table 1). A similar solution was maintained in a sealed amber bottle in the dark at 25°C to serve as the dark control. The irradiated solution and dark control were sampled at 0, 7, 14, 21, and 28 days posttreatment.

Samples were extracted twice with ethyl acetate, and total radioactivity in the extract was quantified using LSC. An aliquot of each extract was analyzed for [^{14}C]lindane using GC with electron capture detection. Also, an aliquot of each extract was analyzed for [^{14}C]lindane and its degradates using TLC on silica gel plates developed in either acetone:hexane (10:90) or acetone:chloroform (10:90). Plates were developed to a distance of 15 cm and radioactive areas were visualized using autoradiography and identified by comparison to standards. Individual bands were scraped from the plate and radioactivity was quantified using LSC.

The study was repeated, but terminated after 14 days.

REPORTED RESULTS:

[^{14}C]Lindane did not degrade during 14 days of irradiation (Table 2). No data were provided for the dark control.

DISCUSSION:

1. In the 28-day study, data were too variable to assess the decline of lindane in aqueous 2% acetone solutions. Total radioactivity prior to extraction declined from 100 to 92.4% of the applied during 28 days of irradiation; however, extractable radioactivity ranged from 96.5 to 122.6% and lindane ranged from 83.1 to 124.2% with no discernible pattern (Table 2). The concentration of lindane did not reflect the concentration of extractable residues in most cases.

2. The test solutions were not buffered.

3. Incubation temperatures were not reported, with the exception of September 10, 1986 (temperatures ranged from 18-26°C).

4. No data were provided for the dark control.

5. Volatile compounds were trapped; however, since lindane did not degrade, the traps were not analyzed.

Table 1. Average natural sunlight intensities for Monmouth Junction, NJ.[a]

Date (1986)		Average daily intensity ($\mu E/m^2 \cdot s$)[b]	Total daily solar irradiation (E/m^2)
August	27	--	12.0
	28	--	12.0
	29	762-1477	38.4
	30	841-1586	44.3
	31	822-1552	42.5
September	1	623-1256	37.1
	2	--	12.0
	3	262-1051	22.2
	4	133-623	12.8
	5	325-816	20.4
	6	583-1443	35.6
	7	312-916	25.4
	8	639-1286	36.5
	9	669-1478	39.5
	10	773-1216	33.2
	11	330-1313	31.9
	12	307-884	22.9
	13	--	39.5
	14	--	28.9
	15	270-1241	29.4
	16	779-1463	39.6
	17	678-1421	38.3
	18	384-1042	27.0
	19	--	~29
	20	--	~29
	21	--	~29
	22	--	~29
	23	--	~29
	24	--	~13
	25	--	~13
	26	--	~31
	27	--	~12
	28	--	~12
	29	--	~31
	30	--	~29

[a] Latitude 40°25'N, longitude 74°30'E.

[b] Sunlight intensity recorded between 7 am and 5 pm.

Table 2. Distribution of radioactivity (% of the applied) in aqueous 2% acetone solutions of [^{14}C]lindane (radiochemical purity 97.8%) at 1.282 ppm irradiated with natural sunlight.

Sampling interval (days)	Total [^{14}C]residues[a]	Extractable	
		Total	Lindane
	Experiment 1		
0	100.0	122.6	124.2
7	97.8	99.2	83.1
14	96.5	101.0	96.8
21	96.9	102.6	84.3
28	92.4	96.5	109.3
	Experiment 2		
0	100.0	102.7	100.0
7	97.1	104.7	104.1
14	98.8	97.5	97.7

[a] By LSC prior to extraction.

CASE GS -- LINDANE STUDY 4 PP --

CHEM 009001 Lindane

BRANCH EAB DISC --

FORMULATION 00 - ACTIVE INGREDIENT

FICHE/MASTER ID No MRID CONTENT CAT 01

Jordan, E.G. and F.A. Norris. 1986. Lindane-^{14}C-photodegradation on soil by natural sunlight. Pesticide Assessment Guideline 161-3. Report No. 86/RHL/605/AG. Unpublished study prepared and submitted by Rhone-Poulenc, Inc., Monmouth Junction, NJ. Acc. No. 265725.

SUBST. CLASS = S.

DIRECT RVW TIME = 10 (MH) START-DATE END DATE

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CONCLUSIONS:

Degradation - Photodegradation on Soil

This study is scientifically invalid and unacceptable because the material balance was incomplete (>40% of the applied radioactivity was not accounted for after 21 days of irradiation). In addition, this study would not fulfill EPA Data Requirements for Registering Pesticides because volatilization was neither measured nor controlled.

MATERIALS AND METHODS:

A slurry of air-dried, sieved (250 µm) sandy loam soil (70% sand, 15% silt, 15% clay, 2.8% organic matter, pH 6.4, CEC 10 meq/100 g) and water was spread on four glass plates (20 x 20 cm) and air-dried. Each plate was divided into 16 squares; soil on three of the plates was treated with [^{14}C]lindane (uniformly labeled, radiochemical purity 96.73%, specific activity 1.93 mCi/mmol, Pathfinder Laboratories) at 445.7 µg/square (~0.99 lb ai/A). Two of the treated plates were irradiated with natural sunlight (intensity 200-5000 µw/cm^2; Table 1) by setting the plates outdoors for 8 hours per day for 28 days (samples were kept

indoors during bad weather; the study was conducted over a period of 35 days, but the days the plates remained indoors were not counted). A third treated plate and an untreated control plate were incubated in darkness in the laboratory at room temperature. Treated and control samples (2 squares/plate) were analyzed after 0, 1, 3, 7, 14, 21, and 28 days or irradiation.

A portion of the soil sampled from each plate was analyzed for total radioactivity by LSC following combustion. Additional soil samples were extracted three times with toluene:methanol:acetone (1:1:1, v:v:v). Samples were filtered after each extraction. An aliquot of each extract was analyzed by LSC. Extracts containing significant amounts of radioactivity were analyzed for lindane by GC with electron capture detection. The extracted soil samples were analyzed for unextractable radioactivity by LSC following combustion.

REPORTED RESULTS:

[^{14}C]Lindane degraded with a half-life of 21-28 days on sandy loam soil irradiated with natural sunlight (Table 2). Lindane declined from 97 to 44% of the applied in irradiated (28 days) samples during 35 days of incubation, and was the only extractable [^{14}C]compound in the soil. In the dark control sample, lindane comprised 81% of the applied after 28 days (calculated half-life 58.4 days) and was the only extractable [^{14}C]-compound in the soil.

DISCUSSION:

1. The material balance was incomplete; >40% of the applied radioactivity was not accounted for by the termination of the study. The registrant suggested that the loss of material was due to volatilization of either lindane or its degradates.

2. Irradiated samples were reportedly incubated for 35 days, but in reality appeared to be irradiated for 28 days because samples were kept indoors during bad weather.

3. Recovery values from fortified samples and detection limits were not reported.

Table 1. Average natural sunlight intensities for Monmouth Junction, NJ.[a]

Date (1986)		Average daily intensity ($\mu E/m^2 \cdot s$)[b]	Total daily solar irradiation (E/m^2)
August	15	436-1251	34.5
	19	405-1081	26.5
	20	520-1326	29.8
	22	800-1287	38.1
	23	600-1441	35.6
	24	871-1429	41.6
	25	442-1418	34.7
	26	773-1227	33.0
	27	--	12.0
	28	--	12.0
	29	762-1477	38.4
	30	841-1586	44.3
	31	822-1552	42.5
September	1	623-1256	37.1
	2	--	12.0
	3	202-1051	22.2
	4	133-623	12.8
	5	325-816	20.4
	6	583-1443	35.6
	7	312-916	25.4
	8	639-1286	36.5
	9	669-1478	39.5
	10	688-1216	33.2
	11	330-1313	31.9
	12	307-884	22.9
	13	--	39.5
	14	--	28.9
	15	270-1241	29.4
	16	779-1463	39.6
	17	678-1421	38.3
	18	384-1042	27.0

[a] Latitude 40°25'N, longitude 74°30'E.

[b] Sunlight intensity recorded between 7 am and 5 pm.

Table 2. Distribution of radioactivity (% of the applied) in sandy loam soil treated with [^{14}C]lindane at 445.7 µg/sample (~0.99 lb ai/A) and irradiated with natural sunlight for 28 days.

Sampling interval (days)	Extractable		Unextractable	Total [^{14}C]a
	Lindane	Total		
		Irradiated		
0	96.9	96.2	0.14	102.2
1	85.2	87.0	1.54	97.2
3	78.6	79.3	1.45	93.3
7	71.1	74.8	2.30	83.1
14	58.0	55.9	3.42	69.7
21	50.7	51.5	4.09	58.9
28	44.2	44.1	5.72	55.9
		Dark control		
0	94.2	93.4	0.19	102.6
1	91.1	89.6	0.12	96.7
3	88.0	89.3	0.20	99.3
7	79.7	80.5	0.22	94.5
14	76.5	72.4	0.76	82.3
21	73.7	77.2	0.77	80.9
28	81.0	73.9	1.08	72.1

a By LSC following combustion of unextracted soil.

CASE GS — LINDANE STUDY 5 PM —

CHEM 009001 Lindane

BRANCH EAB DISC —

FORMULATION 12 - EMULSIFIABLE CONCENTRATE (EC)

FICHE/MASTER ID No MRID CONTENT CAT 01
Norris, F. 1986b. The volatilization of lindane from soil. Prepared by Agrisearch Incorporated, Frederick, MD, and submitted by Rhone-Poulenc, Inc., Monmouth Junction, NJ. Acc. No. 265721.

SUBST. CLASS = S.

DIRECT RVW TIME = 12 (MH) START-DATE END DATE

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CONCLUSIONS:

Mobility - Laboratory Volatility

1. This study is scientifically valid.

2. Lindane (20% EC), at 1.21 g/g, volatilized at 1.19×10^{-3} g/cm^2/hour from sandy loam soil under conditions of 100% humidity, 25 ± 1°C, and an air-flow rate of 0.432 m^3/day. The concentration of lindane in air was 11.9 g/m^3/day. Lindane did not volatilize when the humidity was 0%.

3. This study does not fulfill EPA Data Requirements for Registering Pesticides and will be considered as supplemental because the vapor pressure at 25°C was not reported, the water solubility of lindane was not reported, the soil adsorption coefficient (K_d) was not reported for the test soil.

MATERIALS AND METHODS:

Sterile sandy loam soil (63.2% sand, 20% silt, 16.8% clay, organic matter 1.9%, pH 7.5, CEC 6.1 meq/100 g) moistened to either 15.8 or 100% of field capacity (for the 0 and 100% humidity tests) were treated with

lindane (20% EC, Prentiss) at 1.21 ppm. The treated soils were mixed for one hour and then transferred to airless-wave cylindrical funnels. Nitrogen was flushed through the funnels for 8 days at either 0% or 100% humidity at a flow rate of 300 mL/minute. The studies were conducted within an incubator which kept the humidity constant and the temperature at 25 ± 1°C. After passing over the treated soil, the nitrogen flowed through two polyurethane foam plugs (preextracted with dichloromethanol [DCM] and air-dried prior to use) which were changed daily except after day 6, when the plugs were left on for 2 days until day 8. On days 1 and 3 the N_2 flow was interrupted overnight due to tube separation.

The polyurethane plugs were extracted with hexane; a subsample of the extracts were analyzed for lindane using GC with electron capture detection. Soil samples were extracted on the eighth day with hexane: ethyl acetate (80:20, v:v) using a soil:solvent ratio of 1:10 (w:v). The extract was centrifuged to remove soil particles and diluted in hexane prior to GC analysis. The sensitivity of the GC equipment was 0.02 ng. Recovery efficiencies from four soil samples fortified with 0.3 ppm lindane were 104.7-109.7%. Recovery efficiencies from two polyurethane foam plugs fortified with 8.67 µg lindane were 91.2-103.3%.

REPORTED RESULTS:

Lindane volatilized into nitrogen containing 100% relative humidity at 1.19×10^{-5} µg/ cm^2/hour from sandy loam soil; the concentration of lindane in air was 11.9 µg/m^3/day (Table 1). Lindane volatilization was not detected (<0.05% of the applied) when nitrogen at 0% humidity was used.

DISCUSSION:

1. The soil was not sampled immediately after treatment to confirm the application rate; however, the high recovery of the theoretical dosage by day 8 indicates that the material balance was complete and that most of the lindane remained in the soil.

2. Vapor pressure at 25°C was not reported.

3. Water solubility was not reported.

4. The soil adsorption coefficient (K_d) of lindane was not reported for the test soil.

5. It was not indicated if the soil application rate approximated the rate of field usage.

Table 1. Lindane in the primary polyurethane plugs and from sandy loam soil that was treated with lindane (20% EC) at 1.21 ppm and flushed with nitrogen at 100% humidity for 8 days.[a]

Sampling interval (days)		Lindane (µg)	Lindane (% of applied)
Plugs	1	2.24	0.9
	2	5.07	2.1
	3	5.27	2.2
	4	5.46	2.3
	5	5.60	2.3
	6	5.26	2.2
	8	8.84	3.7
Soil	8	50.25	83.1
Total		--	98.8

[a] The secondary or "breakthrough" plugs contained <0.1 µg lindane, or <0.05% of the total applied dose.

EXECUTIVE SUMMARY

With the exception of the hydrolysis (Mirfakhrae, 1986) included in this submission the data summarized here are scientifically valid data that have been reviewed in this report. With the exception of the hydrolysis (Mirfakhrae, 1986), these data do not fulfill data requirements and must be considered as supplemental.

Ring-labeled [^{14}C]lindane (radiochemical purity >98%), at 1.03 ppm, degraded with a half-life of >30 days in 0.05 and 0.10 M buffer solutions (pH 5, 7, and 9) maintained at 25 1°C in the dark. The registrant-calculated half-lives were 115.5, 281.7, and 35.4 days for the 0.10 M pH 5, 7, and 9 solutions, respectively, and 173.3, 309.4, and 36.3 days for the 0.05 M solutions. At pH 9, the major degradates were pentachlorocyclohexene, 1,2,4-trichlorobenzene, and 1,2,3-trichlorobenzene.

Ring-labeled [^{14}C]lindane (radiochemical purity 97.8%), at 0.642 ppm, was stable in deionized water during 28 days of irradiation with natural sunlight, with parent lindane comprising 96.9% of the applied at day 28 posttreatment. At 28 days posttreatment, 92.8% of the applied [^{14}C]lindane in the dark control remained undegraded.

Ring-labeled [^{14}C]lindane (radiochemical purity 97.8%), at 1.282 ppm, was stable in an aqueous 2% acetone solution during 14 days of irradiation with natural sunlight, with parent lindane comprising 97.7% of the applied at day 14.

Lindane (20% EC), at 1.21 g/g, volatilized at 1.19×10^{-3} g/cm^2/hour from sandy loam soil under conditions of 100% humidity, 25 1°C, and an air-flow rate of 0.432 m^3/day. The concentration of lindane in air was 11.9 g/m^3/day. Lindane did not volatilize when the humidity was 0%.

RECOMMENDATIONS

Available data are insufficient to fully assess the environmental fate of lindane. The submission of data relevant to registration requirements (Subdivision N) for terrestrial food crop, terrestrial nonfood, greenhouse food crop, greenhouse nonfood, domestic outdoor, and indoor sites is summarized below:

Hydrolysis studies: One study (Mirfakhrae, 1986, Acc. No. 263945) was reviewed for this addendum. This study fulfills data requirements by providing information on the hydrolysis of lindane in pH 5, 7, and 9 aqueous buffered solutions.

Photodegradation studies in water: Two studies were reviewed for this addendum. One study (Norris and Mirfakhrae, 1986, Acc. No. 265726) is scientifically valid but does not fulfill data requirements because the test solutions were not buffered and incubation temperatures were not reported. The second study (Norris, 1986a, Acc. No. 265724) is scientifically valid but does not fulfill data requirements because the study was only conducted for 14 days, the test solutions were not buffered, and incubation temperatures were not reported. All data are required.

Photodegradation studies on soil: One study (Jordan and Norris, 1986, Acc. No. 265725) was reviewed for this addendum. This study is scientifically invalid and unacceptable because the material balance was incomplete (>40% of the applied radioactivity was not accounted for after 21 days or irradiation). In addition, this study would not fulfill data requirements because volatilization was neither measured nor controlled. All data are required.

Photodegradation studies in air: No data were reviewed for this addendum, Data are reserved pending the receipt and evaluation of data on photodegradation in water, photodegradation in air, and aerobic soil metabolism studies.

Aerobic soil metabolism studies: No data were reviewed for this addendum, but all data are required.

Anaerobic soil metabolism studies: No data were reviewed for this addendum, but all data are required.

Anaerobic aquatic metabolism studies: No data were reviewed for this addendum. No data are required because there are no registered aquatic uses.

Aerobic aquatic metabolism studies: No data were reviewed for this addendum. No data are required because ther are no registered aquatic uses.

Leaching and adsorption/desorption studies: No data were reviewed for this addendum, but all data are required.

Laboratory volatility studies: One study (Norris, 1986b, Acc. No. 265721) was reviewed for this addendum and is scientifically valid. This study does not fulfill data requirements because the vapor pressure at 25°C was not reported, the water solubility of lindane was not reported, and the soil adsorption coefficient (K_d) was not reported for the test soil.

Field volatility studies: No data were reviewed for this addendum. Data requirements are reserved pending reciept and results of an acceptable laboratory volatilitry study

Terrestrial field dissipation studies: No data were reviewed for this addendum, but all data are required.

Aquatic field dissipation studies: No data were reviewed for this addendum; however, no data are required because lindane has no registered aquatic or aquatic impact uses.

Forestry dissipation studies: No data were reviewed for this addendum, but all data are required.

Dissipation studies for combination products and tank mix uses: No data were reviewed for this addendum; however, no data are required because data requirements for combination products and tank mix uses are currently not being imposed.

Long-term field dissipation studies: No data were reviewed for this addendum; however, the data requirement is deferred pending the receipt of acceptable field dissipation data.

Photodegradation studies on soil: One study (Jordan and Norris, 1986, Acc. No. 265725) was reviewed for this addendum. This study is scientifically invalid and unacceptable because the material balance was incomplete (>40% of the applied radioactivity was not accounted for after 21 days or irradiation). In addition, this study would not fulfill data requirements because volatilization was neither measured nor controlled. All data are required.

Photodegradation studies in air: No data were reviewed for this addendum, Data are reserved pending the receipt and evaluation of data on photodegradation in water, photodegradation in air, and aerobic soil metabolism studies.

Aerobic soil metabolism studies: No data were reviewed for this addendum, but all data are required.

Anaerobic soil metabolism studies: No data were reviewed for this addendum, but all data are required.

Anaerobic aquatic metabolism studies: No data were reviewed for this addendum. No data are required because there are no registered aquatic uses.

Aerobic aquatic metabolism studies: No data were reviewed for this addendum. No data are required because ther are no registered aquatic uses.

Leaching and adsorption/desorption studies: No data were reviewed for this addendum, but all data are required.

Laboratory volatility studies: One study (Norris, 1986b, Acc. No. 265721) was reviewed for this addendum and is scientifically valid. This study does not fulfill data requirements because the vapor pressure at 25°C was not reported, the water solubility of lindane was not reported, and the soil adsorption coefficient (K_d) was not reported for the test soil.

Field volatility studies: No data were reviewed for this addendum. Data requirements are reserved pending reciept and results of an acceptable laboratory volatilitry study

Terrestrial field dissipation studies: No data were reviewed for this addendum, but all data are required.

Aquatic field dissipation studies: No data were reviewed for this addendum; however, no data are required because lindane has no registered aquatic or aquatic impact uses.

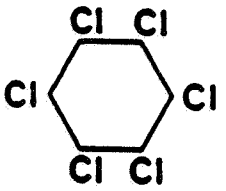
Forestry dissipation studies: No data were reviewed for this addendum, but all data are required.

Dissipation studies for combination products and tank mix uses: No data were reviewed for this addendum; however, no data are required because data requirements for combination products and tank mix uses are currently not being imposed.

Long-term field dissipation studies: No data were reviewed for this addendum; however, the data requirement is deferred pending the receipt of acceptable field dissipation data.

APPENDIX

STRUCTURE OF LINDANE



Gamma isomer of 1,2,3,4,5,6-hexachlorocyclohexane