6-19-87

DYNAMAC
CORPORATION

BIFENTHRIN

FINAL REPORT

Task 1: Review and Evaluation of Individual Studies

Task 2: Environmental Fate Assessment

Contract No. 68-02-4250

JUNE 19, 1987

Submitted to:
Environmental Protection Agency
Arlington, VA 22202

Submitted by:
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INTRODUCTION

Bifenthrin is an insecticide/acaracide registered for use on greenhouse grown ornamentals, trees, and shrubs. EUP's have been issued for peaches, pears, pecans, walnuts, strawberries, orchard crops, and corn. Single application rates range from 0.04 to 0.2 lb ai/A. Bifenthrin is not formulated with any other pesticide. Single active ingredient formulations consist of 10% WP and 2 lb/gal EC.

The registrant is seeking registration of Capture 2 EC for use on cotton, and Brigade 10 WP for use on peaches, pears, pecans, strawberries, and walnuts. The registrant is also seeking registration of Talstar 10 WP for field ornamentals.

BIFENTHRIN

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CASE GS -- BIFENTHRIN STUDY 1 PM --

CHEM 128825 Bifenthrin

BRANCH EAB DISC --

FORMULATION 00 - ACTIVE INGREDIENT

FICHE/MASTER ID No MRID CONTENT CAT 01

Wu, J. 1985a. Photodegradation of FMC 54800 in aqueous solution. Unpublished study prepared and submitted by FMC Corporation, Princeton, NJ. Acc. No. 264642. Reference 3.

SUBST. CLASS = S.

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

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CONCLUSIONS:

Degradation - Photodegradation in Water

1. This study is scientifically sound and provides supplemental information towards the registration of bifenthrin.

2. Phenyl- and cyclopropyl-labeled [^{14}C]bifenthrin (purities >96.6%), at 1 ppm, degraded with a half-life of >30 days (calculated 300 and 209 days, respectively) in a sterile 30% acetonitrile:water solution irradiated outdoors with natural sunlight at 25°C. Degradates (total <10% of the applied) included 2-methyl-3-phenylbenzoic acid (BP acid); 2-methyl-3-phenylbenzyl alcohol (BP alcohol); 2-methyl-3-phenylbenzaldehyde (BP aldehyde); 3-(4'-hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate (4'-OH-bifenthrin); and cis,trans-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid (TFP acid).

3. This study does not fulfill EPA Data Requirements for Registering Pesticides because the test solution was not buffered, the cosolvent was 30% by volume, and the temperature of the solutions ranged from 14 to 30°C.

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MATERIALS AND METHODS:

Phenyl- or cyclopropyl-labeled [^{14}C]bifenthrin (purities > 96.6%; specific activities 33.52 and 11.27 μCi/mmol, respectively; Pathfinder Laboratories and New England Nuclear) was dissolved in acetonitrile and added at 1 ppm to sterile distilled water. The acetonitrile concentration was 30% by volume. The treated solutions were transferred to 10-mL sterilized borosilicate glass ampules, which were then sealed and placed into a flat glass tray in a waterbath maintained at 14-30°C. The solutions were irradiated outdoors in Princeton, New Jersey, on August 27 to October 10, 1985. For the dark controls, additional samples were protected from the sunlight (method unspecified) and incubated outdoors adjacent to the irradiated samples. Sunlight intensities during this period are reported in Table 1. Samples were taken at various intervals up to 30 days posttreatment.

Additional aliquots of the same solution were irradiated continuously with a 275-watt GE sunlamp (~1500 μW/cm^2; additional information illegible) for 14 days, and aliquots sensitized with 2% acetone were irradiated continuously with a 275-watt GE sunlamp for 8 hours. Dark controls were incubated under similar conditions. Samples were taken at various intervals up to 14 days posttreatment from both irradiated samples and dark controls.

An aliquot of each sample was analyzed for total radioactivity by LSC. Additional aliquots were analyzed with reference standards using HPLC.

REPORTED RESULTS:

Phenyl- and cyclopropyl-labeled [^{14}C]bifenthrin degraded with a half-life of >30 days in solutions irradiated with natural sunlight; > 91.6% of the recovered radioactivity was undegraded bifenthrin at 30 days posttreatment (Tables 2 and 3). The calculated half-lives were 300.5 and 209 days, respectively. In the dark controls, > 93.4% of the recovered radioactivity remained undegraded bifenthrin at 30 days posttreatment.

In nonsensitized artifical light-irradiated solutions, 51.7% of the recovered radioactivity was bifenthrin at 14 days posttreatment (Table 3). In the dark control, bifenthrin comprised 99.3% of the recovered at 14 days posttreament. The major degradate was TFP acid which comprised 38.4% of the recovered radioactivity at 14 days posttreatment. One minor degradate, 4'-OH bifenthrin, was identified.

In sensitized artificial light-irradiated solutions, bifenthrin degraded with a half-life >8 hours. At 8 hours posttreatment, 89.2 and 95.5% of the recovered radioactivity was bifenthrin in solutions treated with phenyl- or cyclopropyl-labeled [^{14}C]bifenthrin. Minor degradates were BP acid, BP alcohol, BP aldehyde, 4'-OH bifenthrin, and TFP acid. In the dark controls, > 94.6% of the recovered was bifenthrin at 8 hours posttreatment.

DISCUSSION:

1. The test solution was not buffered, and the pH was not reported.

2. The cosolvent, acetonitrile, was 30% by volume in the solutions.

3. Although the registrant stated the outdoor waterbath was maintained at 25°C, raw data indicated that the waterbath temperature ranged from 14 to 30°C.

4. Although the spectral energy distribution of the artifical light source was provided and was compared to sunlight, the information could not be reviewed because it was illegible.

5. A more appropriate light intensity indicator, e.g., lumens, should be used to designate relative intensities. BTU's ft^2 was used in the study.

6. The data indicate that bifenthrin is stable to photolysis, however, the preliminary nature (unacceptable for registration) of the information does not permit definite conclusions regarding photolysis in water.

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Table 1. Total daily solar radiation (BTU/ft^2) received in Princeton, NJ, from August 27 to October 10, 1985.

Date		Total solar irradiation
August	27	1475
	28	1713
	29	1443
	30	1322
	31	375
September	1	1280
	2	1293
	3	1420
	4	1553
	5	1613
	6	1522
	7	233
	8	991
	9	1093
	10	992
	11	1527
	12	1691
	13	1434
	14	1719
	15	1725
	16	1640
	17	1543
	18	1363
	19	1354
	20	1411
	21	1166
	22	937
	23	345
	24	744
	25	1561
	26	408
	27	373
	28	1526
	29	1450
	30	1288
October	1	1289
	2	477
	3	148
	4	285
	5	767
	6	1067
	7	1343
	8	1331
	9	1162
	10	1009

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Table 2. Distribution of radioactivity (% of the recovered) in 30% acetonitrile:water solutions treated with phenyl-labeled [^{14}C]bifenthrin (purity 97.6%) at 1 ppm and irradiated with sunlight.

Sampling interval (days)	Bifenthrin	BP acid[a]	BP alcohol[b]	BP aldehyde[c]	4'-OH bifenthrin[d]	Polar compounds	Unknowns	Total radioactivity (% of applied)
				Irradiated				
0	98.7	0.3	ND[e]	0.1	0.1	0.3	0.6	98.7
3	93.9	0.2	ND	0.1	ND	0.6	5.2	95.0
7	98.7	0.2	0.2	ND	ND	0.5	0.6	91.8
14	94.0	ND	ND	0.2	ND	0.2	5.6	91.0
21	94.2	ND	ND	ND	ND	1.0	4.8	96.2
30	92.7	ND	0.2	ND	0.2	0.5	6.4	94.7
				Dark control				
30	96.6	ND	ND	ND	ND	1.4	2.0	92.5

a 2-Methyl-3-phenylbenzoic acid.

b 2-Methyl-3-phenylbenzyl alcohol.

c 2-Methyl-3-phenylbenzaldehyde.

d 3-(4'-Hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate.

e Not detected; the detection limit was not reported.

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Table 3. Distribution of radioactivity (% of the recovered) in 30% acetonitrile:water solutions treated with cyclopropyl-labeled [^{14}C]bifenthrin (purity 96.6%) at 1 ppm and irradiated with sunlight.

Sampling interval (days)	Bifenthrin	TFP acid[a]	4'-OH bifenthrin[b]	Polar compounds	Unknowns	Total radioactivity (% of applied)
			Irradiated			
0	97.4	1.9	ND[c]	0.2	0.6	99.9
3	96.4	1.8	ND	0.5	1.3	115.7
7	97.2	0.6	ND	2.0	0.4	108.1
14	95.2	1.1	0.2	2.2	1.5	113.7
21	90.2	1.4	ND	ND	8.4	112.5
30	91.6	1.7	ND	ND	6.8	109.9
			Dark control			
30	93.4	0.7	ND	ND	6.0	105.9

a cis,trans-4-(2-Chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid.

b 3-(4'-Hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate.

c Not detected; the detection limit was not reported.

CASE GS -- BIFENTHRIN STUDY 2 PM --

CHEM 128825 Bifenthrin

BRANCH EAB DISC --

FORMULATION 00 - ACTIVE INGREDIENT

FICHE/MASTER ID No MRID CONTENT CAT 01

Wu, J. 1985b. Photodegradation of FMC 54800 in/on soil. Prepared and submitted by FMC Corporation, Princeton, NJ. Acc. No. 264642. Reference 9.

SUBST. CLASS = S.

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

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SIGNATURE: J. Jordan DATE: 7/10/87

CONCLUSIONS:

Degradation - Photodegradation on Soil

1. This study is acceptable.

2. Phenyl- and cyclopropyl-labeled [^{14}C]bifenthrin (purities >96.6%), at 0.1 lb ai/A, degraded with a half-life of >30 days in sunlight-irradiated silt loam soil. Bifenthrin comprised >78.6% of the recovered in irradiated soil and ~97% of the recovered in the dark control at 30 days posttreatment. Minor degradates included 2-methyl-3-phenylbenzyl alcohol (BP alcohol); 2-methyl-3-phenylbenzoic acid (BP acid); 2-methyl-3-phenylbenzaldehyde (BP aldehyde); 3-(4'-hydroxyphenyl)-2-methyl benzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate (4'-OH bifenthrin); and cis,trans-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid (TFP acid).

3. This study fulfills EPA Data Requirements for Registering Pesticides by providing information on the photodegradation of phenyl- and cyclopropyl-labeled [^{14}C]bifenthrin on soil.

MATERIALS AND METHODS:

A soil:water slurry containing sieved Dunkirk silt loam soil (24.8% sand, 60% silt, 15.2% clay, 2.1% organic matter, pH 4.8, CEC 10.9 meq/100 g) was spread over glass petri plates and allowed to dry to a thickness of 0.5 mm. Either phenyl- or cyclopropyl-labeled [^{14}C]bifenthrin (purities 96.6%; specific activities 33.52 and 11.27 mCi/mmol, respectively; Pathfinder Laboratories and New England Nuclear) in methylene chloride was applied to the plates at 0.1 lb ai/A. The solvent was allowed to evaporate, and the soil plates were covered with Pyrex glass tops and sealed with plastic tape. Half of the plates were wrapped in aluminum foil and served as dark controls. All plates were then placed outdoors in a water-cooled stainless steel soil chamber from mid-July to mid-August, 1985. The natural sunlight intensities are reported in Table 1. The chamber was also covered with a Pyrex glass top, and the soil chamber was immersed into a cold water styrofoam chest. The temperature in the photolysis chamber ranged from 18 to 33°C. Samples were removed after 0, 3, 7, 14, 21, and 30 days.

Soil from each plate was analyzed for total radioactivity by LSC following combustion. Additional soil was extracted with acetonitrile by blending for 5 minutes; the resulting extracts were filtered, concentrated, and analyzed by HPLC. The extracted soils were air-dried and subsamples were analyzed for total radioactivity using LSC following combustion. If the remaining radioactivity was >5% of the applied, the extracted soils were Soxhlet-extracted with acetone. The acetone extract was filtered, concentrated, and analyzed using HPLC. The extracted soils were air-dried and analyzed for remaining radioactivity by LSC following combustion. Again, if the remaining radioactivity was >5% of the applied, the extracted soil samples were refluxed in hydrochloric acid, the acidic solution was separated from solids by filtration, and the [^{14}C]residues in the soil and solution were analyzed by LSC.

REPORTED RESULTS:

Phenyl- and cyclopropyl-labeled [^{14}C]bifenthrin degraded with a half-life of >30 days in irradiated and nonirradiated silt loam soil (Tables 2 and 3). Bifenthrin comprised 78.6% of the recovered in irradiated soil and 97% of the recovered in nonirradiated soil at 30 days posttreatment. Minor degradates included 2-methyl-3-phenylbenzyl alcohol (BP alcohol); 2-methyl-3-phenylbenzoic acid (BP acid); 2-methyl-3-phenylbenzaldehyde (BP aldehyde); 3-(4'-hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate (4'-OH bifenthrin); and cis,trans-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid (TFP acid).

DISCUSSION:

This study fulfills EPA Data Requirements for Registering Pesticides by providing information on the photodegradation of phenyl- and cyclopropyl-labeled [^{14}C]bifenthrin on soil. Data indicate that biphenthrin on soil is stable to photolysis and is not a major degradation pathway.

Table 1. Daily solar radiation (BTU/ft^2) in Princeton, NJ, from July 18 to August 18, 1985.[a]

Date		Total solar irradiation (BTU/ft^2)
July	18	2165
	19	2044
	20	1609
	21	1899
	22	1892
	23	2315
	24	2315
	25	1621
	26	838
	27	2075
	28	2038
	29	1322
	30	1527
	31	915
August	1	1798
	2	538
	3	454
	4	1699
	5	1713
	6	1949
	7	1411
	8	1288
	9	1732
	10	1578
	11	1333
	12	2129
	13	1801
	14	1569
	15	1792
	16	1289
	17	1658
	18	372

[a] The phenyl-labeled [^{14}C]bifenthrin study was conducted from July 18 to August 17, 1985. The cyclopropyl-labeled [^{14}C]bifenthrin study was conducted from July 19 to August 18, 1985.

Table 2. Distribution of radioactivity (% of the recovered) in silt loam soil treated with phenyl-labeled [^{14}C]bifenthrin at 0.1 lb ai/A and irradiated with sunlight.

Sampling interval (days)	Bifenthrin	BP acid[b]	BP alcohol[c]	BP aldehyde[d]	4'-OH bifenthrin[e]	Polar compounds	Unknowns	Unextractable	Total [^{14}C] (% of applied)
					Irradiated				
0	98.4	ND[a]	0.2	ND	ND	ND	0.8	0.6	100.0
3	92.8	0.7	0.5	0.4	0.2	1.2	2.1	2.2	106.9
7	85.4	1.0	0.6	0.9	0.3	1.8	7.9	2.4	105.3
14	81.5	1.4	1.0	0.9	0.6	2.7	9.0	2.8	105.5
21	80.1	1.3	1.4	1.2	0.4	3.5	8.7	3.2	100.5
30	78.6	1.4	1.6	1.3	0.5	3.6	8.8	4.4	100.5
					Dark control				
14	97.4	ND	ND	ND	ND	0.1	0.8	1.5	113.1
30	96.9	ND	ND	ND	ND	0.1	1.2	1.8	101.8

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

[b] 2-Methyl-3-phenylbenzoic acid.

[c] 2-Methyl-3-phenylbenzyl alcohol.

[d] 2-Methyl-3-phenylbenzaldehyde.

[e] 3-(4'-Hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate.

Table 3. Distribution of radioactivity (% of the recovered) in silt loam soil treated with cyclopropyl-labeled [^{14}C]bifenthrin at 0.1 lb ai/A and irradiated with sunlight.

Sampling interval (days)	Bifenthrin	TFP acid[b]	4'-OH bifenthrin[c]	Polar compounds	Unknowns	Unextractable	Total [^{14}C] (% of applied)
				Irradiated			
0	96.6	0.6	ND[a]	ND	2.2	0.7	100.6
3	94.1	1.7	ND	1.6	0.8	2.0	99.1
7	92.4	2.4	ND	2.0	0.6	2.9	100.6
14	88.1	3.0	0.5	3.3	2.7	2.4	94.1
21	88.5	3.1	0.4	2.4	3.9	2.0	97.7
30	82.7	3.8	0.3	3.6	5.8	3.8	94.0
				Dark control			
14	96.6	0.4	ND	0.4	1.4	1.3	102.6
30	97.1	0.4	ND	ND	1.2	1.4	96.2

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

[b] cis,trans-4-(2-Chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid.

[c] 3-(4'-Hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate.

CASE GS -- BIFENTHRIN STUDY 3 PM --

CHEM 128825 Bifenthrin

BRANCH EAB DISC --

FORMULATION 00 - ACTIVE INGREDIENT

FICHE/MASTER ID No MRID CONTENT CAT 01

Reynolds, J.L. 1986. Metabolism of acid (cyclopropyl ring)-^{14}C and alcohol (phenyl ring)-^{14}C FMC 54800 in soil under anaerobic conditions. Project No. G182. Submitted by FMC Corporation. Acc. No. 264642. Reference 11.

SUBST. CLASS = S.

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

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SIGNATURE: J. Jordan DATE: 8/5/87

CONCLUSIONS:

Metabolism - Anaerobic Soil

1. This study is scientifically sound and satisfies the data requirement for registration of bifenthrin.

2. Cyclopropyl- and phenyl-labeled [^{14}C]bifenthrin (radiochemical purities >99.4%), at 3.01 and 2.42 ppm, respectively, degraded with a half-life >61 days in sandy loam soil incubated under anaerobic conditions in the dark at 25 3°C. After 61 days of anaerobic incubation, 75-79% of the recovered was bifenthrin. The degradates 4'-OH bifenthrin [3-(4'-hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate], TFP acid [cis,trans-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid], BP acid [2-methyl-3-phenylbenzoic acid], BP alcohol [2-methyl-3-phenylbenzyl alcohol], and BP aldehyde [2-methyl-3-phenylbenzaldehyde] were <6.3% of the recovered. Volatile compounds totaled 2.0 and 8.1% for soils treated with cyclopropyl- and phenyl-labeled [^{14}C]bifenthrin, respectively, after 61 days of anaerobic incubation. The material balance was 93.0-101.3% of the applied.

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3. This study fulfills EPA Data Requirements for Registering Pesticides.

MATERIALS AND METHODS:

Samples (50-g) of sieved (2-mm) Cosad sandy loam soil (54.4% sand, 35.2% silt, 10.4% clay, 3.0% organic matter, pH 7.0, CEC 16.1) were treated with either cyclopropyl-labeled [^{14}C]bifenthrin (radiochemical purity 99.7%, specific activity 11.93 mCi/mmol, New England Nuclear) at 3.01 ppm or phenyl-labeled [^{14}C]bifenthrin (radiochemical purity 99.4%, specific activity 33.53 mCi/mmol, Pathfinder Laboratories) at 2.42 ppm. The soil moisture was adjusted to 75% of field capacity. The treated soil samples were incubated at 25 3°C in the dark in biometer flasks with sidearms containing a potassium hydroxide solution to trap volatiles. After 29 days of incubation, alfalfa (0.5 g) was added to each soil sample and the soils were flooded with distilled water. Soil and water were sampled immediately before establishing anaerobic conditions (29 days posttreatment)and at 31 and 61 days after anaerobic conditions were established (60 and 90 days posttreatment). Potassium hydroxide trapping solutions were sampled weekly.

Soil samples were extracted with acetonitrile:water (7:3) using a Waring blender, then filtered under a vacuum (Figure 1). The acetonitrile:water filtrate was mixed with water and partitioned with methylene chloride, removing the acetonitrile:methylene chloride phase. The soil samples were further Soxlet-extracted with acetone for 24 hours. The acetonitrile:methylene chloride and acetone extracts, and the extracted aqueous phases were analyzed for total radioactivity by LSC. The acetonitrile: methylene chloride and acetone extracts were concentrated, and then analyzed by one-dimensional TLC with nonradiolabeled standards on silica gel plates developed with hexane:toluene:ether:acetic acid (11.5:8.5:2.0: 0.3). Radioactive compounds were located by autoradiography, identified by comparison to standards, and quantified by LSC. The acetonitrile: methylene chloride extracts were also analyzed by HPLC. Extracted soils were analyzed for total radioactivity by LSC following combustion.

Water samples were extracted with methylene chloride. The methylene chloride extracts and extracted aqueous phases were analyzed by LSC, and the methylene chloride extracts were analyzed by TLC as described above.

Postassium hydroxide trapping solutions were adjusted to pH 7 with 1 N hydrochloric acid and mixed with saturated barium hydroxide. The solutions were refrigerated for two hours and centrifuged. The [^{14}C]barium carbonate precipitate was mixed with water and analyzed by LSC.

REPORTED RESULTS:

[^{14}C]Bifenthrin degraded with a half-life of >61 days; 75-79% of the recovered at 61 days was undegraded bifenthrin (Table 1). 4'-OH Bifenthrin [3-(4'-hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate], TFP acid [cis,trans-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3dimethylcylopro panecarboxylic acid], BP acid [2-methyl-3-phenylbenzoic acid], BP alcohol [2-methyl-3phenylbenzyl alcohol], and BP aldehyde [2-methyl-3-phenyl-

benzaldehyde] were 6.3% of the recovered. Volatile compounds totaled 2.0 and 8.1% for soils treated with cyclopropyl- and phenyl-labeled [^{14}C]-bifenthrin, respectively, after 61 days of anaerobic incubation.

The material balance was 93.0-101.3% of the applied.

DISCUSSION:

1. All degradates comprising 0.01 ppm (0.33 and 0.41% for cyclopropyl-labeled and phenyl-labeled residues, respectively) were not characterized. Unknowns were 0.3-1.2% of the recovered, and uncharacterized residues in the aqueous fractions were 0.7-5.6% (Table 1).

2. The data indicate that anaerobic degradation of bifenthrin is very slow

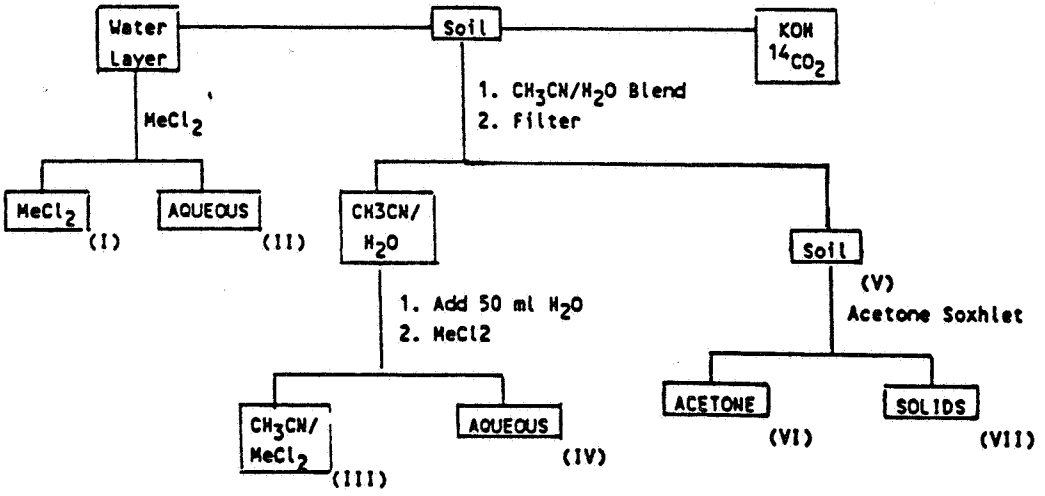
Water Layer
Soil
KOH
$^{14}CO_2$
$MeCl_2$
1. CH_3CN/H_2O Blend
2. Filter
$MeCl_2$
(I)
AQUEOUS
(II)
CH3CN/ H_2O
Soil
(V)
Acetone Soxhlet
1. Add 50 ml H_2O
2. MeCl2
$CH_3CN/MeCl_2$
(III)
AQUEOUS
(IV)
ACETONE
(VI)
SOLIDS
(VII)

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Table 1. Distribution of radioactivity (% of the recovered) in sandy loam soil treated with cyclopropyl- and phenyl-labeled [^{14}C]bifenthrin at 3.01 and 2.42 ppm, respectively. The soils were incubated aerobically for 29 days at 25 ± 3°C and then flooded with water and incubated anaerobically for 61 days.

Compound	Sampling interval (days)		
	0[a]	31	61
Cyclopropyl-labeled			
Bifenthrin	97.4	82.6	79.2
4'-OH Bifenthrin[b]	ND[c]	4.5	4.5
TFP Acid[d]	ND	2.8	6.3
Unknowns	0.4	0.3	0.9
Aqueous fractions	ND	5.6	3.3
Cumulative volatiles	--	1.4	2.0
Unextractable	2.2	2.8	3.8
Phenyl-labeled			
Bifenthrin	96.9	79.6	75.3
4'-OH Bifenthrin[b]	ND	4.9	4.2
BP Acid[e]	ND	0.5	0.3
BP Alcohol[f]	ND	0.5	0.7
BP Aldehyde[g]	ND	0.1	0.3
Unknowns	0.3	0.7	1.2
Aqueous fractions	0.9	0.7	0.8
Cumulative volatiles	--	5.4	8.1
Unextractable	1.9	7.6	9.1

a Day 0 of anaerobic conditions is equivalent to day 29 of aerobic conditions.

b 3-(4'-Hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate.

c Not detected; the detection limit was not reported.

d cis,trans-4-(2-Chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid.

e 2-Methyl-3-phenylbenzoic acid.

f 2-Methyl-3-phenylbenzyl alcohol.

g 2-Methyl-3-phenylbenzaldehyde.

CASE GS -- BIFENTHRIN STUDY 4 PM --

CHEM 128825 Bifenthrin

BRANCH EAB DISC --

FORMULATION 12 - EMULSIFIABLE CONCENTRATE (EC)

FICHE/MASTER ID No MRID CONTENT CAT 01

Ferraro, C.F. and W.J. Zuccarello. 1986. FMC 54800. Laboratory volatility study: the volatility of active ingredient in Capture 2.0 EC insecticide/miticide from soil under varying conditions of temperature, soil moisture and air flow rate. Prepared and submitted by FMC Corporation, Princeton, NJ. Acc. No. 264642. Reference 16.

SUBST. CLASS = S.

DIRECT RVW TIME = 6 (MH) START-DATE END DATE

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CONCLUSIONS:

Mobility - Laboratory Volatility

This study is unacceptable because the concentration of bifenthrin residues in the soils was not measured to confirm the application rate and complete the material balance. In addition, this study would not fulfill EPA Data Requirements for Registering Pesticides because the vapor pressure and solubility of bifenthrin were not reported, and the relative humidity in the volatilization flasks was not reported.

MATERIALS AND METHODS:

Princeton greenhouse loam soil (42% sand, 37% silt, 21% clay, 1.9% organic matter, pH 5.8, CEC 5.7 meq/100 g) that had been moistened to 75% of the soil moisture capacity and placed in a glass pyrex dish (surface area 580.6 cm^2) was treated at 0.1 lb ai/A with phenyl-labeled [^{14}C]bifenthrin (purity 99%, specific activity and source unspecified) formulated with unlabeled bifenthrin (Capture, 2 lb/gal EC, FMC Corporation). The glass dish was placed in a bell jar through which humidified air flowed at

either 5.7, 11.3, or 16.7 L/minute (Figure 1); temperatures were maintained at either 25 or 40°C. In addition, soils at 0 and 25% of its moisture holding capacity were tested under an air flow of 11.3 L/minute at 25°C. In all studies, volatiles collected in polyurethane foam plugs were sampled after 18 and 39 hours of incubation.

The polyurethane plugs were extracted with methanol and the extract was analyzed for total radioactivity by LSC. Trapping efficiency was reported to be 132%.

REPORTED RESULTS:

Increasing soil moisture, air flow rate, or temperature increased the rate of volatilization of bifenthrin (Tables 1 and 2). In general, volatility was extremely low, ranging from a minimum of 7.94×10^{-5} g/cm^2/hour during the 0- to 18-hour intervals (from soil moistened to 75% of soil moisture capacity and maintained at 25°C with an air flow of 5.7 L/minute) to a maximum 63.4×10^{-5} g/cm^2/hour (from soil during the 0- to 18-hour interval moistened to 75% and maintained at 40°C with an air flow of 16.7 L/minute).

DISCUSSION:

1. The material balance was incomplete. Soils were not measured for bifenthrin residues at any point during the study.

2. The vapor pressure and water solubility of bifenthrin were not reported.

3. The relative humidity in the volatilization flasks was not reported.

4. The soil adsorption coefficient (K_d) of bifenthrin was not reported for the loam soil.

5. This study will be accepted if the deficiencies are corrected.

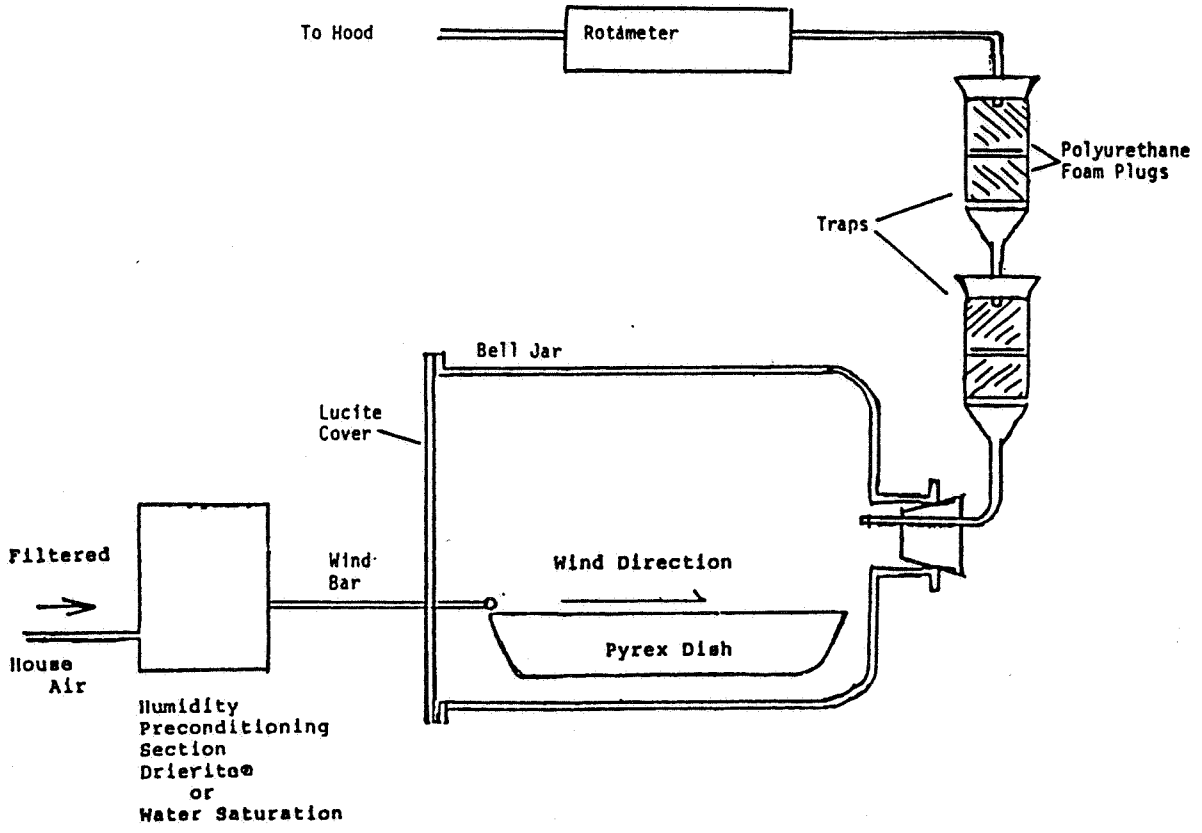

Figure 1. Schematic of volatility chamber.

Table 1. Effect of air flow and temperature on the volatility (x 10^5 µg per cm^2 per hour) and air concentration (µg/m^3) of bifenthrin from loam soil at 75% soil moisture capacity treated with phenyl-labeled [^{14}C]bifenthrin (formulated with Capture 2 lb/gal EC) at 0.1 lb ai/gallon.

Air flow (L/minute)	5.7		11.3		16.7	
	Sampling interval (hours)					
	18	39	18	39	18	39
			25° C			
Volatility	7.940	8.010	17.590	15.400	21.440	19.040
Air concentration	0.135	0.136	0.151	0.132	0.124	0.110
			40° C			
Volatility	25.500	21.420	46.380	38.350	63.400	50.890
Air concentration	0.433	0.363	0.397	0.329	0.367	0.295

Table 2. Effect of soil moisture on the volatility (x 10^5 µg per cm^2 per hour) and air concentration (µg/m^3) of bifenthrin from loam soil treated with phenyl-labeled [^{14}C]bifenthrin (formulated with Capture 2 lb/gal EC) at 0.1 lb ai/gallon. The incubation temperature was 25°C, and the air flow rate was 11.3 L/minute.

	Sampling interval (hours)	
	0-18	18-39
	0% Soil moisture capacity	
Volatility	11.63	10.66
Air concentration	0.100	0.091
	25% Soil moisture capacity	
Volatility	13.09	12.11
Air concentration	0.112	0.104
	75% Soil moisture capacity	
Volatility	13.65	12.84
Air concentration	0.117	0.110

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CASE GS -- BIFENTHRIN STUDY 5 PM --

CHEM 128825 Bifenthrin

BRANCH EAB DISC --

FORMULATION 12 - EMULSIFIABLE CONCENTRATE (EC)

FICHE/MASTER ID No MRID CONTENT CAT 01

Stearns, J.W. 1984. Dissipation of residues of FMC 54800 in soils treated with Capture 2.0 EC. Study Number S 182-84-16. Prepared and submitted by FMC Corporation, Princeton, NJ. Acc. No. 264642. Reference 17.

SUBST. CLASS = S.

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

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CONCLUSIONS:

Field Dissipation - Terrestrial

1. This study is scientifically sound and provides supplemental information towards the registration of bifenthrin.

2. Bifenthrin (2 lb/gallon EC), at 2 lb ai/A, degraded with half-lives of 14-30 days in the 0- to 6-inch depth of loamy sand soil in Tifton, Georgia; 90-180 days in loam soil in Marion, Arkansas; 30-90 days in loam soil in Champaign, Illinois; and <7 days in loam soil in Fresno, California. At 360 days posttreatment, bifenthrin was 0.05-0.13 ppm at the four sites. In the 6- to 12-inch depth, bifenthrin was <0.08 ppm in the Georgia site, <0.21 ppm in the California and Illinois sites, and <0.45 ppm in the Arkansas site at all sampling intervals.

3. This study does not fulfill EPA Data Requirements for Registering Pesticides because the formation and decline of degradates were not addressed, the soil was not sampled deep enough to define the leaching potential of bifenthrin, field test data were incomplete, and storage stability data were not reported.

MATERIALS AND METHODS:

A single broadcast application of bifenthrin (Capture 2 lb/gal EC, FMC Corporation) at 2 lb ai/A was made to unvegetated plots (size unspecified) at four locations: Tifton, Georgia, on May 13, 1983; Marion, Arkansas, on July 12, 1984; Fresno, California, on May 31, 1983; and Champaign, Illinois, on June 23, 1983 (soil characteristics are presented in Table 1). Soil samples (0- to 6-inch and 6- to 12-inch depths) were taken at intervals up to 360 days posttreatment. The samples were air-dried, thoroughly mixed, and stored for an unspecified length of time at -18°C prior to analysis. Storage stability data were not provided.

Subsamples of soil were blended with acetone and filtered. The extracts were shaken with hexane, "salt", and deionized water, and allowed to separate into aqueous and organic fractions. The aqueous fraction was reextracted with hexane, and the combined hexane fractions were dried with anhydrous sodium sulfate, concentrated, and cleaned up on a Florisil column which was eluted with hexane:methyl t-butyl ether (9:1, v:v). The residues were concentrated and then analyzed by GC with ^{63}Ni electron capture detection. The estimated detection limit for this method was 0.01 ppm. Recovery efficiencies for 16 samples fortified with 0.05 to 2.00 ppm bifenthrin were 60-106%.

REPORTED RESULTS:

Meteorological data for the test sites are presented in Table 2.

Bifenthrin degraded with half-lives ranging from <7 days to 180 days in the 0- to 6-inch depth of soil from Georgia, Arizona, California, and Illinois (Table 3). At 360 days posttreatment, bifenthrin was 0.05-0.13 ppm at the four sites. In the 6- to 12-inch depth, bifenthrin ranged from <0.01 ppm (detection limit) to 0.45 ppm.

Residues in all control samples were <0.01 ppm (detection limit) with the exception of two California samples, one from the 0- to 6-inch depth which contained 0.10 ppm at 183 days posttreatment, and one from the 6- to 12-inch depth which contained 0.01 ppm at 0 days posttreatment.

DISCUSSION:

1. The formation and decline of degradates were not addressed.

2. The soil was not sampled deep enough to define the extent of leaching.

3. Field test data, including depth to the water table, test plot dimensions, grade, and soil temperatures, were incomplete.

4. Storage stability data were not provided. Furthermore, the storage intervals were not reported.

5. The test soil from Arkansas was identified as a silt loam but was actually a loam according to the USDA Soil Textural Classification System, and is referred to as such in this report.

6. Soils were not sampled prior to treatment.

Table 1. Soil characteristics.

Location	Soil type	Sand	Silt	Clay	Organic matter	pH	CEC (meq/100 g)
		%					
Georgia	Loamy sand	81.2	8.4	10.4	1.1	4.5	7.2
Arkansas	Loam	30.9	46.7	22.4	0.9	6.4	6.6
California	Loam	50.4	33.4	16.2	3.9	6.1	16.4
Illinois	Loam	29.0	47.0	24.0	2.2	6.3	18.6

Table 2. Meteorological data for the test sites.

Month	Georgia		Arkansas		California		Illinois	
	Cumulative rainfall (inches)	Average temperature (°F)	Cumulative rainfall (inches)	Average temperature (°F)	Cumulative rainfall (inches)	Average temperature (°F)	Cumulative rainfall (inches)	Average temperature (°F)
May, 1983	1.09	72	--	67	--	70	--	58
June	5.20	77	--	77	0.01	76	9.15	73
July	6.67	82	1.48	83	0.01	79	10.55	79
August	12.24	82	2.14	84	0.10	82	15.18	78
September	17.32	74	2.42	73	1.13	79	16.01	68
October	18.53	68	6.40	64	1.22	68	23.25	56
November	19.44	57	12.34	51	3.73	55	28.06	44
December	25.74	48	20.12	32	5.48	51	53.05	16
January, 1984	32.77	46	21.90	34	5.63	48	59.57	21
February	36.77	53	25.51	47	6.68	51	74.04	36
March	44.73	57	31.70	50	6.87	58	87.29	32
April	52.58	65	37.21	60	7.12	61	91.97	50
May	57.41	73	45.69	68	7.14	75	97.62	59
June	--	--	48.38	80	--	--	98.84	76
July, 1984	--	--	49.52	79	--	--	102.59	73

Table 3. Bifenthrin (ppm) in loamy sand soil (Georgia) and loam soils (Arkansas, California, Illinois) treated with bifenthrin (Capture 2 lb/gal EC) at 2 lb ai/A.

Approximate treatment-to-sampling interval (days)	Sampling depth (inches)							
	Georgia		Arkansas		California		Illinois	
	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12
0	1.45	ND[a]	1.30	0.45	0.79	0.21	0.58	0.14
7	0.82	0.08	1.40	0.01	0.35	0.18	1.75	0.02
14	0.85	0.08	1.64	0.16	0.37	0.07	1.66	0.11
30	0.39	0.06	0.78	0.06	0.14	0.06	1.62	0.16
90	0.34	0.03	1.12	ND	0.08	0.04	0.28	0.02
180	0.44	ND	0.44	ND	0.38	0.05	0.23	0.02
270	0.23	ND	--	--	0.17	0.15	0.42	0.01
360	0.09	ND	0.05	ND	0.07	0.06	0.13	ND

[a] Not detected; the detection limit was 0.01 ppm.

CASE GS -- BIFENTHRIN STUDY 6 PM --

CHEM 128825 Bifenthrin

BRANCH EAB DISC --

FORMULATION 06 - WETTABLE POWDER (WP)

FICHE/MASTER ID No MRID CONTENT CAT 01

Pejovich, R.J. 1985. Determination of residues of bifenthrin in soils treated with Brigade 10 WP. Study Number 182E41E02. Prepared and submitted by FMC Corporation, Princeton, NJ. Acc. No. 264642. Reference 18.

SUBST. CLASS = S.

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

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CONCLUSIONS:

Field Dissipation - Terrestrial

1. This study is scientifically sound and provides supplemental information towards the registration of bifenthrin.

2. Bifenthrin (10% WP), at 2 lb ai/A, degraded with half-lives of 14-30 days in Champaign, Illinois, and 31-179 days in and Marion, Arkansas, in the 0- to 6-inch depths of loam soils. At 360 days posttreatment, bifenthrin was 0.06 ppm in the Illinois soil and 0.13 ppm in the Arkansas soil. The degradate 3-(4'-hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate (4'-OH bifenthrin) was <0.01 ppm in all samples. In the 6- to 12-inch soil depth, bifenthrin was <0.13 ppm at all sampling intervals.

3. This study does not fulfill EPA Requirements for Registering Pesticides because the soil was not sampled deep enough to define the leaching potential of bifenthrin, field test data were incomplete, and storage stability data were not reported.

MATERIALS AND METHODS:

A single application of bifenthrin (Brigade, 10% WP, FMC Corporation) at 2 lb ai/A was made to unvegetated plots (size unspecified) of loam soil (30% sand, 46.7% silt, 22.4% clay, 0.9% organic matter, pH 6.4, CEC 6.6 meq/100 g) in Marion, Arkansas, on July 13, 1984, and loam soil (28.8% sand, 46.8% silt, 22.4% clay, 2.2% organic matter, pH 6.3, CEC 6.6 meq/100 g) in Champaign, Illinois, on June 12, 1984. Soil samples (0- to 6-inch and 6- to 12-inch depths) were taken at intervals up to ~60 days posttreatment. Soil samples were air-dried, thoroughly mixed, and stored at -18°C for an unspecified length of time prior to analysis. No storage stability data were provided.

Subsamples of soil were blended with acetone:deionized water (4:1, v:v), and filtered. The extracts were concentrated to eliminate the acetone; shaken with ethyl acetate, deionized water, and sodium chloride; and allowed to separate into the aqueous and organic fractions. The aqueous fraction was extracted two more times with ethyl acetate, and the combined organic fractions were filtered through sodium sulfate, concentrated, and treated with toluene. The resulting extract was cleaned up on a Florisil chromatographic column which was eluted with hexane:methyl t-butyl ether (85:15, v:v). The residues were concentrated and analyzed using GC with ^{63}Ni electron capture detection. The detection limit was 0.01 ppm for bifenthrin and for the degradate 4'-OH bifenthrin. Recovery efficiencies were 86-111% for ten samples fortified with 0.05-2.00 ppm of bifenthrin, and 68-92% for ten samples fortified with 0.05 ppm of 4'-OH bifenthrin.

REPORTED RESULTS:

Meteorological data for the test sites are presented in Table 1.

Bifenthrin degraded with half-lives of 14-30 days and 31-179 days in the 0- to 6-inch depth of the Illinois and Arizona loam soils, respectively (Table 2). At 360 days posttreatment, bifenthrin was 0.6 ppm in the Illinois soil and 0.13 ppm in the Arkansas soil. The degradate 4'-OH bifenthrin was detected in only one sample, at 0.01 ppm, in the 0- to 6-inch layer of the Arkansas test plot 180 days posttreatment. Bifenthrin and 4'-OH bifenthrin were <0.01 (detection limit) in all control samples.

DISCUSSION:

1. The soil was not sampled deep enough to define the extent of leaching.

2. Field test data, including plot size, depth to the water table, grade, and soil temperature, were not reported.

3. Storage stability data were not provided. Furthermore, the length of time the samples were stored at -18°C was not reported.

4. The test soils were identified as silt loam but were actually loam soils according to the USDA Soil Textural Classification System, and are referred to as such in this report.

5. The soils were not sampled prior to treatment.

Table 1. Meteorological data for the two test sites.

Month	Illinois		Arkansas	
	Cumulative rainfall (inches)	Average temperature (°F)	Cumulative rainfall (inches)	Average temperature (°F)
June, 1984	1.22	76	--	--
July	4.97	73	3.83	79
August	6.15	75	6.38	77
September	8.91	65	9.61	69
October	11.19	59	17.97	66
November	14.83	40	25.97	48
December, 1984	18.73	36	30.41	50
January, 1985	19.4	19	32.96	30
February	23.92	25	36.19	37
March	28.94	44	39.07	55
April	31.34	57	45.67	64
May	34.62	67	49.17	72
June	38.72	71	52.94	79
July, 1985	--	--	55.46	82

Table 2. Bifenthrin (ppm) in loam soils treated with a single broadcast application of bifenthrin (Brigade, 10% WP) at 2 lb ai/A.

Treatment-to-sampling interval (days)	Sampling depth (inches)			
	Illinois		Arkansas	
	0-6	6-12	0-6	6-12
0	0.65	--	0.92	--
7	0.66	0.13	0.85	0.06
14	0.44	0.05	1.06	0.02
30	0.28	0.04	--	--
31	--	--	0.50	0.02
90	0.28	ND[a]	--	--
179	--	--	0.25	ND
183	0.18	0.02	--	--
270	--	--	0.16	ND
325	0.11	0.02	--	--
360	0.06	ND	0.13	ND

[a] Not detected; the detection limit was 0.01 ppm.

CASE GS -- BIFENTHRIN STUDY 7 PM --

CHEM 128825 Bifenthrin

BRANCH EAB DISC --

FORMULATION 00 - ANALYTICAL GRADE

FICHE/MASTER ID No MRID CONTENT CAT 01

Bixler, T.A. 1986. FMC 54800 Confined rotational crop study. Study No. 182E51E01. Prepared and submitted by FMC Corporation, Princeton, NJ. Acc. No. 264642. Reference 19.

SUBST. CLASS = S.

DIRECT RVW TIME = 32 (MH) START-DATE END DATE

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CONCLUSIONS:

Confined Accumulation - Rotational Crops

1. This study is scientifically sound and provides supplemental information towards the registration of bifenthrin.

2. [^{14}C]Bifenthrin residues accumulated in wheat (immature whole plants; mature grain and straw), sugar beets (immature whole plants; mature foliage and roots) and lettuce (immature and mature whole plants) planted up to 120 days following a single application of phenyl ring-labeled (alcohol) or cyclopropyl ring-labeled (acid) [^{14}C]bifenthrin (radiochemical purities > 97.3) at 0.5 lb ai/A to a loamy sand soil. [^{14}C]Residues in the crops ranged from 0.009 to 0.247 ppm for the 30-day treatment-to-planting interval, 0.007 to 0.247 ppm for the 60-day interval, and 0.004 to 0.312 ppm for the 120-day interval. Residues in control samples were <0.003 (detection limit) to 0.034 ppm. Extractable radioactivity from wheat straw from the 30, 60, and 120 day treatment-to-planting intervals comprised 22-28%, 27-28%, and 18-51% of the recovered radioactivity, respectively. In the wheat straw, unextractable residues comprised > 49% of the radioactivity. Extractable [^{14}C]residues included bifenthrin; 2-methyl-3-phenylbenzoic acid (BP acid); 2-methyl-3-phenylbenzyl alcohol (BP alcohol); 2-methyl-3-phenylbenzaldehyde (BP aldehyde); 3-(4'-hydroxy-

phenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate (4'-OH bifenthrin); and cis,trans-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid (TFP acid), which collectively comprised ≤13% of the radioactivity in wheat straw. [^{14}C]Residues in the top 3 inches of soil were 1.17 ppm-2.48 ppm immediately following treatment, 0.34-1.08 ppm at 30 days posttreatment, 1.20-1.43 ppm at 60 days posttreatment, and 0.43-0.72 ppm at 120 days posttreatment. The majority of the extractable [^{14}C]residues in the soil was bifenthrin.

3. This study does not fulfill EPA Data Requirements for Registering Pesticides because [^{14}C]residues in lettuce, sugarbeet, and wheat (grain) were not characterized.

MATERIALS AND METHODS:

Phenyl ring-labeled [^{14}C]bifenthrin (alcohol; radiochemical purity >97.3%, specific activity 33.52 mCi/mmol, Pathfinder Laboratories) and cyclopropyl ring-labeled [^{14}C]bifenthrin (acid; radiochemical purity 98%, specific activity 11.93 mCi/mmol New England Nuclear) were pipetted onto the surface of sandy loam soil (69% sand, 28.5% silt, 2.5% clay, 3.1% organic matter, pH 6.8, CEC 1.12 meq/100 g) contained within Nalgene tanks (1.5 x 1 x 1.5 ft) at 0.5 lb ai/A. The tanks were kept in a greenhouse for the duration of the study. The soils were hand-tilled to a depth of 3 inches immediately following treatment and just prior to the sowing of lettuce, sugarbeet and wheat seeds at ~30, 60, and 120 days posttreatment (one container each for lettuce and sugarbeets, and two containers each for wheat per planting interval per radiolabeled compound). Control plants were grown in 8-inch diameter pots under the same planting regime. Crops (both treated and control) were sampled prior to and at maturity. Mature sugarbeets were separated into roots and foliage, and excess soil was washed from the roots. Mature wheat was separated into grain and straw. The wheat grain was ground in a mill prior to analysis. All other crop samples, whether immature or mature, were frozen in liquid nitrogen and then ground prior to analysis. Samples (3-inch cores, 0- to 3- and 3- to 5-inch depths) of treated and control soils were collected immediately following treatment, at each planting interval, and at the final harvest of each crop.

Soil samples were analyzed for total radioactivity by LSC following combustion. Portions of each soil sample were blended with acetonitrile:-water (7:3, v:v) and filtered. Acetonitrile was removed from the extracts, and the extracts were treated with sodium chloride, partitioned into ethyl acetate, and dried over anhydrous sodium sulfate. The resulting extract was analyzed by TLC on silica gel plates developed in hexane: ether:toluene:acetic acid (11.5:2:8.5:03) and cochromatographed with unlabeled bifenthrin; 2-methyl-3-phenylbenzyl alcohol (BP alcohol); 2-methyl-3-phenylbenzoic acid (BP acid); cis,trans-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid (TFP acid); 3-(4'-hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate (4'-OH bifenthrin); and 2-methyl-3-phenylbenzaldehyde (BP aldehyde). Radioactive compounds were located by autoradiography, identified by comparison to standards, and quantified by LSC.

Plant samples were analyzed for total radioactivity by LSC following combustion. Subsamples of wheat straw were hydrated with water and acetone for eight hours, blended, and filtered twice with additional acetone. Acetone in the extract was evaporated in vacuo, and the extracts were treated with sodium chloride and extracted twice each with methylene chloride followed by ethyl acetate. The organic fractions were combined, concentrated, and analyzed for [^{14}C]residues by HPLC. The aqueous fraction was brought to volume with distilled water, treated with concentrated HCl to form a 0.25 N HCl solution, combined with the extracted wheat straw solids, and refluxed for one hour. The resulting extract was partitioned into ethyl acetate; the organic and aqueous fractions along with the extracted solids were analyzed for total radioactivity by LSC. The limit of detection for both the acid- and alcohol-labeled [^{14}C]bifenthrin residues was 0.003 ppm. Extraction efficiencies (total [^{14}C]residues) for the analytical method used for wheat straw ranged from 84.4 to 100.2% and 88.4 to 94.9% in the alcohol-labeled and acid-labeled samples, respectively.

REPORTED RESULTS:

Total radioactivity in lettuce (whole plants) sugar beets (whole plants, mature foliage and mature roots), and wheat (whole immature plants and mature grain) planted ~30, 60, and 120 days posttreatment ranged from 0.004 ppm to 0.065 ppm for phenyl ring-labeled (alcohol) [^{14}C]bifenthrin (Tables 1-3), and from 0.008 to 0.058 ppm for cyclopropyl ring-labeled (acid) [^{14}C]bifenthrin (Tables 4-6). Total radioactivity in wheat straw from all planting intervals ranged from 0.094 ppm to 0.193 in plants grown in soil treated with alcohol-labeled bifenthrin, and 0.247 ppm to 0.312 ppm from plants grown in soil treated with acid-labeled bifenthrin (Tables 3 and 6). Total radioactivity in control lettuce (whole plants) and sugar beets (immature whole plants, and mature tops and roots) ranged from <0.003 (detection limit) to 0.009 ppm, while total radioactivity in wheat ranged from <0.003 (detection limit) to 0.015 ppm in whole immature plants, 0.006 to 0.022 ppm in grain, and 0.009 to 0.034 ppm in straw.

Extraction of alcohol-labeled wheat straw yielded residues of bifenthrin, 4'-OH bifenthrin, BP acid, and BP alcohol, which collectively comprised <13% of the total recovered radioactivity. Up to 48% of the recovered was unextractable and >40% of the recovered was unidentified (Table 3). Extraction of acid-labeled wheat straw yielded residues of bifenthrin, 4'-OH bifenthrin, and TFP acid, which collectively comprised <15% of the recovered [^{14}C]activity; up to 20% of the recovered was unextractable and up to 65% of the recovered was unidentified (Table 6).

Most of the [^{14}C]residues remained in the top three inches of the soil throughout the study. The average 0-day posttreatment concentrations of bifenthrin the soils were 1.17 (acid-label) and 2.48 ppm (alcohol-label). [^{14}C]Residues in the alcohol-labeled soils at 30, 60 and 120 days posttreatment were 0.34, 1.20 and 0.43 ppm (Tables 1-3), respectively, and [^{14}C]residues in the acid-labeled soils over the same intervals were 1.08, 1.43 and 0.72 ppm, respectively (Tables 4-6). The majority of the extracted [^{14}C]residues was bifenthrin (Tables 1-6).

DISCUSSION:

1. Residues in lettuce, sugar beets (roots and foliage), and wheat (grain) not characterized.

2. Values for the control soil were not reported.

3. The maximum single rate of application is 0.2 lb ai/A; however, the label states that up to a total of 1 lb ai/year may be applied. Only 0.5 lb/A ai was applied in the study.

4. Soil residue levels suggest that >0.5 lb/A ai was applied.

5. Recovery efficiencies from fortified soil and plant samples were not reported.

6. The study was not continued for 365 days, and residues were present at the 120 interval.

Table 1. [^{14}C]Residues in lettuce and soil from pots of sandy loam soil treated with phenyl-labeled [^{14}C]bifenthrin (radiochemical purity 97.3%) at 0.5 lb ai/A.

Treatment-to-planting interval (days)	Sample	Sampling interval	Total (ppm)	Organic fraction					Aqueous fraction	Unextractable
				Bifenthrin	4'-OH Bifenthrin[a]	BP acid[b]	BP alcohol[c]	Unidentified[d]		
				% of the recovered						
--	Soil 0-3 inches	Treatment	2.48	95.3	--	--	--	1.8	0.1	2.8
30	Soil 0-3 inches	Planting	0.34	80.4	2.2	2.0	0.4	3.2	0.8	10.9
		Harvest	1.33	77.8	6.9	0.9	0.6	4.0	0.4	9.4
	3-15 inches	Harvest	0.07	--	--	--	--	--	--	--
	Lettuce (whole)	Immature	0.016	--	--	--	--	--	--	--
		Mature	0.120	--	--	--	--	--	--	--
66	Soil 0-3 inches	Planting	1.20	77.7	3.9	0.9	0.4	4.9	0.8	11.4
		Harvest	0.59	76.5	5.0	0.4	0.7	4.6	0.3	12.5
	3-15 inches	Harvest	0.08	--	--	--	--	--	--	--
	Lettuce (whole)	Immature	0.027	--	--	--	--	--	--	--
		Mature	0.021	--	--	--	--	--	--	--
120	Soil 0-3 inches	Planting	0.430	46.9	9.4	6.8	1.2	7.0	1.1	27.6
		Harvest	0.430	28.1	10.9	1.6	1.4	8.4	1.3	48.3
	3-15 inches	Harvest	0.050	--	--	--	--	--	--	--
	Lettuce (whole)	Immature	0.026	--	--	--	--	--	--	--
		Immature	0.010	--	--	--	--	--	--	--
		Mature	0.014	--	--	--	--	--	--	--

[a] 3-(4'-Hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate; 4'-OH bifenthrin.

[b] 2-Methyl-3-phenylbenzoic acid; BP acid.

[c] 2-Methyl-3-phenylbenzyl alcohol; BP alcohol.

[d] Six products were isolated but not identified; each comprised <2% of the total [^{14}C]residues.

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Table 2. [^{14}C]Residues in sugar beets and soil from pots of sandy loam soil treated with phenyl-labeled [^{14}C]bifenthrin (radiochemical purity >97.3%) at 0.5 lb ai/A.

Treatment-to-planting interval (days)	Sample	Sampling interval	Total (ppm)	Organic fraction					Aqueous fraction	Unextractable
				Bifenthrin	4'-OH Bifenthrin[a]	BP acid[b]	BP alcohol[c]	Unidentified[d]		
				% of the recovered						
--	Soil 0-3 inches	Treatment	2.48	95.3	--	--	--	1.8	0.1	2.1
30	Soil 0-3 inches	Planting	0.34	80.4	2.2	2.0	0.4	3.2	0.8	10.9
		Harvest	0.53	40.4	5.4	0.3	0.6	7.2	0.1	45.3
	3-15 inches	Harvest	0.07	--	--	--	--	--	--	--
	Sugar beet	Immature	0.036	--	--	--	--	--	--	--
		Immature	0.031	--	--	--	--	--	--	--
		Tops	0.009	--	--	--	--	--	--	--
		Roots	0.009	--	--	--	--	--	--	--
66	Soil 0-3 inches	Planting	1.20	77.7	3.9	0.9	0.4	4.9	0.8	10.9
		Harvest	0.36	36.9	4.7	0.6	0.7	6.7	1.8	48.7
		Harvest	0.03	--	--	--	--	--	--	--
	Sugar beet	Immature	0.065	--	--	--	--	--	--	--
		Immature	0.021	--	--	--	--	--	--	--
		Tops	0.007	--	--	--	--	--	--	--
		Roots	0.008	--	--	--	--	--	--	--
120	Soil 0-3 inches	Planting	0.43	46.9	9.4	6.8	1.2	7.0	1.1	27.6
		Harvest	1.18	30.9	3.6	1.1	0.6	6.7	1.7	55.4
	3-15 inches	Harvest	0.10	--	--	--	--	--	--	--
	Sugar beet	Immature	0.049	--	--	--	--	--	--	--
		Immature	0.021	--	--	--	--	--	--	--
		Tops	0.004	--	--	--	--	--	--	--
		Roots	0.005	--	--	--	--	--	--	--

[a] 3-(4'-Hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate; 4'-OH bifenthrin.

[b] 2-Methyl-3-phenylbenzoic acid; BP acid.

[c] 2-Methyl-3-phenylbenzyl alcohol; BP alcohol.

[d] Six products were isolated but not identified; each comprised <2% of the total [^{14}C]residues.

Table 3. [^{14}C]Residues in wheat and soil from pots of sandy loam soil treated with phenyl-labeled [^{14}C]bifenthrin (radiochemical purity >97.3%) at 0.5 lb ai/A.

Treatment-to-planting interval (days)	Sample	Sampling interval	Total (ppm)	Organic fractions						Aqueous fraction	Unextractable
				Bifenthrin	4'-OH Bifenthrin[a]	BP acid[b]	BP alcohol[c]	BP aldehyde[d]	Unidentified[e]		
				% of the recovered							
--	Soil 0-3 inches	Treatment	2.480	95.3	--	--	--	--	1.8	0.1	2.8
30	Soil 0-3 inches	Planting	0.340	80.4	2.2	2.0	0.4	--	3.2	0.8	10.9
		Harvest	0.280	38.1	3.4	0.9	0.9	--	12.5	5.5	38.7
	3-15 inches	Harvest	0.080	--	--	--	--	--	--	--	--
	Wheat	Immature	0.012	--	--	--	--	--	--	--	--
		Immature	0.014	--	--	--	--	--	--	--	--
		Grain	0.016	--	--	--	--	--	--	--	--
		Straw	0.094	7.5	1.3	1.5	1.2	0.6	36.1	12.2	39.7
66	Soil 0-3 inches	Planting	1.200	77.7	3.9	0.9	0.4	--	4.9	0.8	11.4
		Harvest	0.780	48.7	5.8	0.6	0.9	--	6.7	1.0	36.3
	3-15 inches	Harvest	0.070	--	--	--	--	--	--	--	--
	Wheat	Immature	0.019	--	--	--	--	--	--	--	--
		Immature	0.021	--	--	--	--	--	--	--	--
		Grain	0.025	--	--	--	--	--	--	--	--
		Straw	0.160	10.7	2.9	1.6	1.3	0.8	22.6	13.5	46.5
137	Soil 0-3 inches	Planting	0.430	46.9	9.4	6.8	1.2	--	7.0	1.1	27.6
		Harvest	0.600	32.9	5.6	1.5	0.9	--	8.1	0.9	50.1
	3-15 inches	Harvest	0.040	--	--	--	--	--	--	--	--
	Wheat	Immature	--	--	--	--	--	--	--	--	--
		Immature	0.021	--	--	--	--	--	--	--	--
		Grain	0.032	--	--	--	--	--	--	--	--
		Straw	0.193	5.3	1.2	2.2	0.8	0.3	27.2	15.3	47.7

[a] 3-(4'-Hydroxyphenyl)-2-methylbenzyl (+)cis-3-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate; 4'-OH bifenthrin.

[b] 2-Methyl-3-phenyl benzoic acid; BP acid.

[c] 2-Methyl-3-phenylbenzyl alcohol; BP alcohol.

[d] 2-Methyl-3-phenylbenzaldehyde; BP aldehyde.

[e] Includes unidentified from both the acetone and ethyl acetate (straw only) fractions.

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Table 4. [^{14}C]Residues in lettuce and soil from pots of sandy loam soil treated with cyclopropyl-labeled [^{14}C]bifenthrin (radiochemical purity 98%) at 0.5 lb ai/A.

Treatment-to-planting interval (days)	Sample	Sampling interval	Total (ppm)	Organic fraction				Aqueous fraction	Unextractable
				Bifenthrin	4'-OH Bifenthrin[a]	TFP acid[b]	Unidentified[c]		
				% of the recovered					
--	Soil 0-3 inches	Treatment	1.17	96.4	ND	ND	2.5	0.3	0.8
30	Soil 0-3 inches	Planting	1.08	85.0	2.3	1.4	5.8	0.2	5.3
		Harvest	0.90	67.8	7.8	2.2	8.3	2.4	11.5
	3-15 inches	Harvest	0.08	--	--	--	--	--	--
	Lettuce (whole)	Immature	0.019	--	--	--	--	--	--
		Mature	0.014	--	--	--	--	--	--
66	Soil 0-3 inches	Planting	1.43	80.3	4.1	0.9	6.9	0.3	7.5
		Harvest	0.69	41.6	14.1	9.8	9.6	1.9	23.0
	3-15 inches	Harvest	0.25	--	--	--	--	--	--
	Lettuce (whole)	Immature	1.43	--	--	--	--	--	--
		Immature	0.69	--	--	--	--	--	--
		Mature	0.25	--	--	--	--	--	--
120	Soil 0-3 inches	Planting	0.021	55.5	5.8	5.2	11.7	1.1	20.7
		Harvest	0.026	35.7	8.9	9.0	15.7	5.0	25.7
	3-15 inches	Harvest	0.029	--	--	--	--	--	--
	Lettuce (whole)	Immature	0.019	--	--	--	--	--	--
		Immature	0.009	--	--	--	--	--	--
		Mature	0.017	--	--	--	--	--	--

[a] 3-(4'-Hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate; 4'-OH bifenthrin.

[b] cis,trans-4-(2-Chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid; TFP acid.

[c] Eight products were isolated but not identified; each comprised <2% of the total [^{14}C]residue.

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Table 5. [^{14}C]Residues in sugar beets and soil from pots of sandy loam soil treated with cyclopropyl-labeled [^{14}C]bifenthrin (radiochemical purity 98%) at 0.5 lb ai/A.

Treatment-to-planting interval (days)	Sample	Sampling interval	Total (ppm)	Organic fraction				Aqueous fraction	Unextractable
				Bifenthrin	4'-OH Bifenthrin[a]	TFP acid[b]	Unidentified[c]		
				% of the recovered					
--	Soil 0-3 inches	Treatment	1.17	96.4	ND	ND	2.5	0.3	0.8
30	Soil 0-3 inches	Planting	1.08	85.0	2.3	1.4	5.8	0.2	5.3
		Harvest	0.81	59.3	5.0	0.8	5.9	5.1	23.9
	3-15 inches	Harvest	0.08	--	--	--	--	--	--
	Sugar beet	Immature	0.024	--	--	--	--	--	7.5
		Immature	0.023	--	--	--	--	--	--
		Tops	0.031	--	--	--	--	--	39.7
		Roots	0.021	--	--	--	--	--	--
66	Soil 0-3 inches	Planting	1.43	80.3	4.1	0.9	6.9	0.3	--
		Harvest	0.77	37.2	5.7	2.3	9.4	5.7	--
		Harvest	0.05	--	--	--	--	--	--
	Sugar beet	Immature	0.058	--	--	--	--	--	--
		Immature	0.035	--	--	--	--	--	--
		Tops	0.023	--	--	--	--	--	--
		Roots	0.019	--	--	--	--	--	
120	Soil 0-3 inches	Planting	0.72	55.5	5.8	5.2	11.7	1.1	20.7
		Harvest	0.52	19.5	4.6	1.6	13.2	3.8	57.3
	3-15 inches	Harvest	0.15	--	--	--	--	--	--
	Sugar beet	Immature	0.052	--	--	--	--	--	-
		Immature	0.027	--	--	--	--	--	--
		Tops	0.017	--	--	--	--	--	--
		Roots	0.008	--	--	--	--	--	--

[a] 3-(4'-Hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate; 4'-OH bifenthrin.

[b] cis,trans-4-(2-Chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid; TFP acid.

[c] Eight products were isolated but not identified; each comprised <2% of the total [^{14}C]residue.

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Table 6. [^{14}C]Residues in wheat and soil from pots of sandy loam soil treated with cyclopropyl-labeled [^{14}C]bifenthrin (radiochemical purity 98%) at 0.5 lb ai/A.

Treatment-to-planting interval (days)	Sample	Sampling interval	Total (ppm)	Organic fractions					Unextractable
				Bifenthrin	4'-OH Bifenthrin[a]	TFP acid[b]	Unidentified[c]	Aqueous fraction	
				% of the recovered					
--	Soil 0-3 inches	Treatment	1.17	96.4	ND	ND	2.5	0.3	0.8
30	Soil 0-3 inches	Planting	1.08	85.0	2.3	1.4	5.8	0.2	5.3
		Harvest	0.42	26.7	9.1	3.1	10.4	2.6	48.1
	3-15 inches	Harvest	0.11	--	--	--	--	--	--
	Wheat	Immature	0.032	--	--	--	--	--	--
		Immature	0.033	--	--	--	--	--	--
		Grain	0.035	--	--	--	--	--	--
		Straw	0.247	2.9	0.5	4.6	63.1	8.5	20.5
66	Soil 0-3 inches	Planting	1.43	80.3	4.1	0.9	6.9	0.3	7.5
		Harvest	0.51	40.8	11.6	1.5	11.1	2.8	32.2
	3-15 inches	Harvest	0.08	--	--	--	--	--	--
	Wheat	Immature	0.032	--	--	--	--	--	--
		Immature	0.020	--	--	--	--	--	--
		Grain	0.042	--	--	--	--	--	--
		Straw	0.247	7.0	1.4	6.7	56.4	10.3	18.1
137	Soil 0-3 inches	Planting	0.72	55.5	5.8	5.2	11.7	1.1	20.7
		Harvest	0.42	67.5	2.2	1.2	9.4	0.4	19.3
	3-15 inches	Harvest	0.06	--	--	--	--	--	--
	Wheat	Immature	0.039	--	--	--	--	--	--
		Immature	0.053	--	--	--	--	--	--
		Grain	0.049	--	--	--	--	--	--
		Straw	0.312	7.4	1.4	2.9	63.8	9.3	15.3

[a] 3-(4'-Hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate; 4'-OH bifenthrin.

[b] cis,trans-4-(2-Chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid; TFP acid.

[c] Includes unidentified from both the acetone and ethyl acetate (straw only) fractions.

CASE GS -- BIFENTHRIN STUDY 8 PM --

CHEM 128825 Bifenthrin

BRANCH EAB DISC --

FORMULATION 00 - ACTIVE INGREDIENT

FICHE/MASTER ID No MRID CONTENT CAT 01

Suprenant, D.C. 1986. Accumulation and elimination of ^{14}C-residues by bluegill sunfish (Lepomis macrochirus) exposed to ^{14}C-FMC 54800; and, Tullman, R.H. 1986. Analysis of ^{14}C-FMC 54800 residues in bluegill sunfish and water. Prepared and submitted by the FMC Corporation, Princeton, NJ. Acc. No. 264642. References 20 and 21.

SUBST. CLASS = S.

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

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CONCLUSIONS:

Laboratory Accumulation - Fish

1. This study is scientifically sound and provides supplemental information towards the registration of bifenthrin.

2. Total [^{14}C]bifenthrin residues accumulated in bluegill sunfish with bioconcentration factors of 614-2110x in edible tissues, 1170-8720x in nonedible tissues, and 833-6090x in whole fish after 42 days of exposure to phenyl ring-labeled [^{14}C]bifenthrin (radiochemical purity >96%) at 0.0006-0.001 ppb. After 52 and 63 days of exposure to ≤0.019 ppb of [^{14}C]bifenthrin, parent bifenthrin comprised >66% of the total radioactivity in the tissues. The degradate 3-(4'-hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylate (4'-OH bifenthrin) was identified in both the edible and nonedible tissues (<4% of the recovered radioactivity), and 2-methyl-3-phenylbenzyl alcohol (BP alcohol) was identified in the inedible tissues (<1% of the recovered radioactivity). Residues accumulated by day 42 depurated slowly, with total [^{14}C]residues remaining at 0.81 ppb in

edible tissues, 3.52 ppb in nonedible tissues, and 2.92 ppb in whole fish after 42 days of depuration.

3. This study does not fulfill EPA Data Requirements for Registering Pesticides because the fish were exposed to a mixture of [^{14}C]bifenthrin residues instead of parent [^{14}C]bifenthrin.

MATERIALS AND METHODS:

Bluegill sunfish (Lepomis macrochirus; average length and weight of 57 mm and 2.9 g, respectively) were held in culture tanks for at least two weeks prior to study initiation. Three flow-through aquatic exposure systems were prepared using 100-L aquaria filled with 75-L well water (pH 7.1-7.5, dissolved oxygen at 90-98% of saturation, alkalinity 20-30 mg/L $CaCO_3$, hardness 27-29 mg/L $CaCO_3$, specific conductance 80-90 µmhos/cm, temperature 16-17°C) at a rate of 3.8 turnovers/day.

Two aquaria were continuously treated with phenyl ring-labeled [^{14}C]bifenthrin (radiochemical purity >96%, specific activity 33.52 mCi/mmol, FMC Corporation) in dimethyl formamide at a nominal rate of 0.0026 ppb for 42 days following study initiation. The third aquarium served as an untreated control. Bluegill sunfish (110) were placed in each aquarium. All fish were fed dry pelleted food at 1.5% of the mean body weight. Fecal matter was siphoned from the aquarium as needed. Water samples and fish (5) were taken from one treated aquarium and the control aquarium at intervals up to 42 days posttreatment.

Following 42 days of exposure, the fish remaining in the treated tank that had been continuously sampled were transferred to a similar tank containing untreated water for a 42-day depuration period. Fish and water were sampled on days 0, 3, 7, 14, 21, 28, 35, and 42 from this tank. [^{14}C]Bifenthrin concentrations in the second treated tank were increased to 10x and 30x the original concentration on days 42 and 52, respectively; fish were sampled for residue characterization on days 52 and 63 from this tank.

Total [^{14}C]activity in water was analyzed by LSC. Pooled samples of water (from exposure days 0, 14, and 42) were concentrated, redissolved in cyclohexane:methylene chloride (85:15), applied to a gel permeation chromotography column eluted with the same solvent, concentrated, and analyzed for degradates by HPLC.

Edible tissues, nonedible tissues and whole fish (2-3 fish/interval) from each sampling interval were homogenized with dry ice and analyzed for total radioactivity using LSC following combustion. Edible (fillet) and nonedible (viscera) tissues from exposure days 52 and 63 were analyzed for total [^{14}C]activity in the same manner. Portions of these tissues were extracted with acetone. The filtered solids were extracted twice with acetone:hexane (50:50) and the resulting extract was combined with the original acetone extract, condensed, redissolved in hexane, and partitioned four to five times into acetonitrile. The acetonitrile fraction, was cleaned up on a gel permeation column eluted with cyclohexane: methylene chloride (85:15), and the eluate was concentrated and analyzed for degradates using HPLC. Occasionally, a solid precipitate would form

upon condensing; this precipitate was removed by centrifugation, rinsed repeatedly with solvent, combined with the supernatant, and analyzed by HPLC. All extracts were cochromatographed with unlabeled bifenthrin, 2-methyl-3-phenylbenzyl alcohol, 2-methyl-3-phenylbenzoic acid, 2-methyl-3-phenylbenzaldehyde, and 3-(4'-hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-tri-fluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylate.

REPORTED RESULTS:

Total [^{14}C]residues in the treated water ranged from 0.0006 to 0.0014 ppb during the 42-day exposure study and from 0.0009 to 0.019 ppb during the 63-day exposure study; 56% of the [^{14}C]residues were parent [^{14}C]bifenthrin, and 26% of the [^{14}C]activity was unidentified (Tables 1 and 2). Maximum accumulation of [^{14}C]residues during the 42 day exposure study occurred by day 42, with bioconcentration factors of 2110x (1.9 ppb) for edible tissues, 8720x (7.85 ppb) for nonedible tissues and 6090x (5.48 ppb) for whole fish (Table 1). Analysis of the 52-day and 63-day edible and nonedible tissue samples indicated >66% of the total radioactivity was parent bifenthrin and 10-27% of the residues were unidentified or unextractable (Table 2). BP alcohol and 4'-OH bifenthrin collectively comprised <7% of the total [^{14}C]activity (Table 2). After 42 days of depuration, [^{14}C]residues were 0.81 ppb in edible tissue, 3.52 ppb in nonedible tissue, and 2.92 ppb in whole fish (Table 1). No mortality of fish occurred in either treated aquaria.

DISCUSSION:

1. Fish accumulation studies must use the parent material, and the system must maintain a constant concentration throughout the test.

2. The fish were exposed to a mixture of [^{14}C]bifenthrin residues instead of parent [^{14}C]bifenthrin. HPLC analysis of treated water (0, 14, and 42 day pooled samples) determined the concentration of parent bifenthrin to be <60% of the total [^{14}C]activity.

3. It was not specified if the concentration of the test substance in water was 1/10 of the 96-hour LC_{50} for bluegill sunfish.

4. Results from analysis of the untreated water and fish were not provided.

Table 1. Total [^{14}C]residues in (ppb) water and tissues of bluegill sunfish treated with phenyl ring-labeled [^{14}C]bifenthrin (radiochemical purity >96%) during a 42-day exposure and 42-day depuration period.[a]

Sampling interval (days)	Water (ppb)	Edible		Non edible		Whole fish	
		ppb	BCF	ppb	BCF	ppb	BCF
			Exposure				
0	0.0006	ND	--	ND	--	ND	--
3	0.0006	ND	--	0.70	1170	0.50	833
7	0.0008	0.43	614	2.18	3110	1.00	1430
14	0.0008	1.01	1440	3.83	5470	2.88	4110
21	0.0014	1.56	1950	5.25	6560	4.17	5210
28	0.0012	1.47	1630	5.74	6380	3.62	4020
35	0.0011	1.93	2140	7.73	8590	3.88	4310
42	0.0008	1.90	2110	7.85	8720	5.48	6090
			Depuration				
0	--	1.90	--	7.85	--	5.48	--
1	ND	1.70	--	7.64	--	ND	--
3	ND	1.53	--	7.32	--	ND	--
7	ND	1.69	--	6.82	--	3.28	--
10	ND	1.62	--	5.88	--	4.34	--
14	ND	1.03	--	6.30	--	3.64	--
21	ND	0.86	--	4.60	--	3.08	--
28	ND	1.14	--	5.01	--	3.18	--
35	ND	0.87	--	4.30	--	2.96	--
42	ND	0.81	--	3.52	--	2.92	--

[a] Data are averages of two samples for whole fish and three samples of edible fish.

[b] ND = not detected (detection limits: edible = >0.052 to <0.25 ppb; non-edible = >0.042 to <0.17 ppb whole body = >0.060 to <0.49 ppb.

[c] Daily bioconcentration factor (BCF) calculated by dividing the concentration of [^{14}C]residues measured in the tissue, by the mean measured water concentration. The mean measured water concentration was calculated using all mean measured water concentrations prior to and including the respective test day.

Table 2. Distribution of radioactivity (% of recovered) in water and tissues of bluegill sunfish exposed to phenyl ring-labeled [^{14}C]bifenthrin (radiochemical purity >96%) at 0.0009-0.019 ppb.

Sampling interval (days)	Total (ppb)	Bifenthrin	Degradates			Unextractable
			4'-OH Bifenthrin[a]	BP alcohol[b]	Unknowns	
		%				
Edible tissue (fillet)						
52	5.88	86.0	2.8	ND[d]	4.7	6.5
63	15.23	70.2	3.6	ND	4.8	21.4
Inedible tissue (viscera)						
52	27.09	69.7	2.9	ND	4.0	23.4
63	63.74	66.8	3.2	0.5	6.3	23.2
Water						
0, 14, 42 (Pooled)	NR[c]	56	ND	ND	26	--

[a] 3-(4'-Hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylate.

[b] 2-methyl-3-phenylbenzyl alcohol.

[c] Not reported, the average was ~0.0009 ppb.

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

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EXECUTIVE SUMMARY

The following findings are derived from those reviewed studies which have met the requirements of 40 CFR Part 158.130 and the guidance of Subdivision N and were also deemed acceptable.

Phenyl- and cyclopropyl-labeled [^{14}C]bifenthrin (purities >96.6%), at 0.1 lb ai/A, degraded with a half-life of >30 days in sunlight-irradiated silt loam soil. Bifenthrin comprised >78.6% of the recovered in irradiated soil and ~97% of the recovered in the dark control at 30 days posttreatment. Minor degradates included 2-methyl-3-phenylbenzyl alcohol (BP alcohol); 2-methyl-3-phenylbenzoic acid (BP acid); 2-methyl-3-phenylbenzaldehyde (BP aldehyde); 3-(4'-hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate (4'-OH bifenthrin); and cis,trans-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid (TFP acid)

Cyclopropyl- and phenyl-labeled [^{14}C]bifenthrin (radiochemical purities >99.4%), at 3.01 and 2.42 ppm, respectively, degraded with a half-life >61 days in sandy loam soil incubated under anaerobic conditions in the dark at 25 3°C. After 61 days of anaerobic incubation, 75-79% of the recovered was bifenthrin. The degradates 4'-OH bifenthrin [3-(4'-hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate], TFP acid [cis,trans-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid], BP acid [2-methyl-3-phenylbenzoic acid], BP alcohol [2-methyl-3-phenylbenzyl alcohol], and BP aldehyde [2-methyl-3-phenylbenzaldehyde] were 6.3% of the recovered. Volatile compounds totaled 2.0 and 8.1% for soils treated with cyclopropyl- and phenyl-labeled [^{14}C]bifenthrin, respectively, after 61 days of anaerobic incubation. The material balance was 93.0-101.3% of the applied.

The following findings are derived from those reviewed studies which have not met the requirements of 40 CFR 158.130 and/or the guidance of Subdivision N, but have been deemed good studies following generally sound scientific practice. They thereby provide supplemental information on the fate of bifenthrin.

Phenyl- and cyclopropyl-labeled [^{14}C]bifenthrin (purities >96.6%), at 1 ppm, degraded with a half-life of >30 days (calculated 300 and 209 days, respectively) in a sterile 30% acetonitrile:water solution irradiated outdoors with natural sunlight at 25°C. Degradates (total <10% of the applied) included 2-methyl-3-phenylbenzoic acid (BP acid); 2-methyl-3-phenylbenzyl alcohol (BP alcohol); 2-methyl-3-phenylbenzaldehyde (BP aldehyde); 3-(4'-hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate (4'-OH-bifenthrin); and cis,trans-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid (TFP acid).

Bifenthrin (2 lb/gallon EC), at 2 lb ai/A, degraded with half-lives of 14-30 days in the 0- to 6-inch depth of loamy sand soil in Tifton, loam soil in Champaign, Illinois; and <7 days in loam soil in Fresno, California. At 360 days posttreatment, bifenthrin was 0.05-0.13 ppm at the four sites. In the 6- to 12-inch depth, bifenthrin was <0.08 ppm in the Georgia site, <0.21 ppm in the California and Illinois sites, and <0.45 ppm in the Arkansas site at all sampling intervals.

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Bifenthrin (10% WP), at 2 lb ai/A, degraded with half-lives of 14-30 days in Champaign, Illinois, and 31-179 days in Marion, Arkansas, in the 0- to 6-inch depth of loam soils at 360 days posttreatment, bifenthrin was 0.06 ppm in the Illinois soil and 0.13 ppm in the Arkansas soil. The degradate 3-(4'-hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate (4'-OH bifenthrin) was 0.01 ppm in all samples. In the 6- to 12-inch soil depth, bifenthrin was <0.13 ppm at all sampling intervals.

[^{14}C]Bifenthrin residues accumulated in wheat (immature whole plants; mature grain and straw), sugar beets (immature whole plants; mature foliage and roots) and lettuce (immature and mature whole plants) planted up to 120 days following a single application of phenyl ring-labeled (alcohol) or cyclopropyl ring-labeled (acid) [^{14}C]bifenthrin (radiochemical purities 97.3) at 0.5 lb ai/A to a loamy sand soil. [^{14}C]Residues in the crops ranged from 0.009 to 0.247 ppm for the 30-day treatment-to-planting interval, 0.007 to 0.247 ppm for the 60-day interval, and 0.004 to 0.312 ppm for the 120-day interval. Residues in control samples were <0.003 (detection limit) to 0.034 ppm. Extractable radioactivity from wheat straw from the 30, 60, and 120 day treatment-to-planting intervals comprised 22-28%, 27-28%, and 18-51% of the recovered radioactivity, respectively. In the wheat straw, unextractable residues comprised >49% of the radioactivity. Extractable [^{14}C]residues included bifenthrin; 2-methyl-3-phenylbenzoic acid (BP acid); 2-methyl-3-phenylbenzyl alcohol (BP alcohol); 2-methyl-3-phenylbenzaldehyde (BP aldehyde); 3-(4'-hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate (4'-OH bifenthrin); and cis,trans-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylic acid (TFP acid), which collectively comprised 13% of the radioactivity in wheat straw. [^{14}C]Residues in the top 3 inches of soil were 1.17 ppm-2.48 ppm immediately following treatment, 0.34-1.08 ppm at 30 days posttreatment, 1.20-1.43 ppm at 60 days posttreatment, and 0.43-0.72 ppm at 120 days posttreatment. The majority of the extractable [^{14}C]residues in the soil was bifenthrin.

Total [^{14}C]bifenthrin residues accumulated in bluegill sunfish with nonedible tissues, and 833-6090x in whole fish after 42 days of exposure to phenyl ring-labeled [^{14}C]bifenthrin (radiochemical purity >96%) at 0.0006-0.001 ppb. After 52 and 63 days of exposure to 0.019 ppb of [^{14}C]bifenthrin, parent bifenthrin comprised >66% of the total radioactivity in the tissues. The degradate 3-(4'-hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylate (4'-OH bifenthrin) was identified in both the edible and nonedible tissues (<4% of the recovered radioactivity), and 2-methyl-3-phenylbenzyl alcohol (BP alcohol) was identified in the nonedible tissues (<1% of the recovered radioactivity). Residues accumulated by day 42 depurated slowly, with total [^{14}C]residues remaining at 0.81 ppb in bioconcentration factors of 614-2110x in edible tissues, 1170-8720x in edible tissues, 3.52 ppb in nonedible tissues, and 2.92 ppb in whole fish after 42 days of depuration.

RECOMMENDATIONS:

Available data are insufficient to fully assess the environmental fate of bifenthrin. The submission of data relevant to registration requirements for terrestrial food crops, terrestrial nonfood, and greenhouse nonfood use sites are summarized below.

Data Requirements Satisfied

Hydrolysis: No data were reviewed for this addendum; however, based on data previously submitted, no additional data are required.

Photolysis on Soil: One study (WU, 1985 b, Acc. no. 26464n,mRef. # 3) was reviewed for this addendum, and is scientifically sound. This study satisfies data requirements by providing information on the photodegradation of phenyl and cyclopropyl-labeled [^{14}C] bifenthrin on soil.

Anaerobic Soil Metabolism: One study (Reynolds, 1986, Acc. no. 264642, Ref. # 11) was reviewed for this addendum and it meets data requirements.

Leaching Adsorption/Desorption: No data were reviewed for this addendum; however, based on data previously submitted, no additional data are required.

Data Required (Gaps) for Proposed Uses

Photodegradation in Water: One study (Wu, 1985a, Acc. no. 264642, Ref. # 2) was reviewed for this addendum, and is scientifically sound. This study does not satisfy data requirements because the test solution was not buffered, the cosolvent was 30% by volume, and the temperatures of solutions ranged from 14 to 30°C.

Aerobic Soil Metabolism: No data were reviewed for this addendum, but the data are required.

Laboratory Volatility: One study,(Ferraro et al., 1886, Acc. no. 264642, Re. # 16) was reviewed for this addendum. This study is unacceptable because the concentration of bifenthrin reidues in the soi8ls was not measured to confirm the application rate and complete the material balance. In addition,this study would not satisfy data requirements, because the vapor pressure, solubility,and relative humidity of bifenthrin in volatilization flasks were not reported.

Terrestrial Field Dissipation: Two studies were reviewed. The first study (Stearns, 1984, Acc. no. 264642, Ref. # 17) is scientifically sound but does not satisfy dat a requirements because the formatioin and decline of degradates was not addressed, the soil was not sampled deeply enough to define the leaching potential, field test data were incomplete, and storage stability was not reported. The second study (P ejovich, 1985 , Acc. no. 264642 Ref. # 18) is scientifically sound but does not satisfy data requirements because the soil was not sampled deeply enough to define the leaching potential, field test data were incomplete, and storage stability data were not reported.

Confined Rotation Crop: One study (Ferraro et al., is scientifically sound,but does not satisfy the data requirement because [^{14}C] residues in lettuce, sugarbeets, and wheat (grain) were not characterized.

Accumulation in Fish: One study (Suprenant, 1986 Acc. no. 264642 Ref.# 20, 21) was reviewed and is scientifically sound. This study does not satisfy data requirements, because the fish were not exposed to a constant concentration of the parent compound. Only about 60% of the test material was parent.

Data Deferred/Conditional for the Proposed Uses

Photodegradation in Air: No data were reviewed for this addendum. The data requirement is deferred pending assessment of inhalation toxicity by Toxicology Branch.

Field Volaility: No studies were reviewed for this addendum; the data requirement is deferred pending results of the laboratory study.

Long-term Field Dissipation: No data were reviewed for this addendum; however, the data requirement is deferred pending receipt of acceptable aerobic soil metabolism and and field dissipation data.

Rotation Crop Field Accumulation: No data were reviewed for this addendum. The data requirement is deferred pending receipt of acceptable confined rotation crop data.

Aquatic Non-target Field Accumulation: No data were reviewed for this addendum. The data requirement is deferred pending receipt of acceptable laboratory study accumulation in fish.

Data Not Required for the Proposed Uses

Anaerobic Aquatic Metabolism: Data were not reviewed for this addendum, but no data are required, because there is no aquatic use, at present.

Aerobic Aquatic Metabolism: Data were not reviewed for this addendum, but no data are required, because there is no aquatic use, at present.

Aquatic Field Dissipation: Data were not reviewed for this addendum, but data are not required, because there is no aquatic, at present.

Forestry Dissipation: Data were not reviewed for this addendum, but data are not required, because there is no forest use, at present.

Combination and Tank Mixes: Data were not reviewed for this addendum, but no data are required, because requirements for tank-mixes are currently not being imposed.

Irrigated Crops Accumulation: Data were not reviewed for this addendum, but no data are required, because it is unlikely that irrigation water from crops treated with bifenthrin will be used to irrigate secondary crops.

Re-entry Studies: No data were reviewed for this addendum, but no data are required for present use patterns.

REFERENCES

Bixler, T.A. 1986. FMC 54800. Confined rotational crop study. Study No. 182E51E01. Prepared and submitted by FMC Corporation, Princeton, NJ. Acc. No. 264642. Reference 19.

Ferraro, C.F. and W.J. Zuccarello. 1986. FMC 54800. Laboratory volatility study: the volatility of active ingredient in Capture 2.0 EC insecticide/ miticide from soil under varying conditions of temperature, soil moisture and air flow rate. Prepared and submitted by FMC Corporation, Princeton, NJ. Acc. No. 264642. Reference 16.

Pejovich, R.J. 1985. Determination of residues of bifenthrin in soils treated with Brigade 10 WP. Study Number 182E41E02. Prepared and submitted by FMC Corporation, Princeton, NJ. Acc. No. 264642. Reference 18.

Reynolds, J.L. 1986. Metabolism of acid (cyclopropyl ring)-^{14}C and alcohol (phenyl ring)-^{14}C FMC 54800 in soil under anaerobic conditions. Project No. G182. Submitted by FMC Corporation. Acc. No. 264642. Reference 11.

Stearns, J.W. 1984. Dissipation of residues of FMC 54800 in soils treated with Capture 2.0 EC. Study Number S 182-84-16. Prepared and submitted by FMC Corporation, Princeton, NJ. Acc. No. 264642. Reference 17.

Suprenant, D.C. 1986. Accumulation and elimination of ^{14}C-residues by bluegill sunfish (Lepomis macrochirus) exposed to ^{14}C-FMC 54800. Prepared and submitted by the FMC Corporation, Princeton, NJ. Acc. No. 264642. Reference 20.

Tullman, R.H. 1986. Analysis of ^{14}C-FMC 54800 residues in bluegill sunfish and water. Prepared and submitted by the FMC Corp., Princeton, N.J. ACC. No. 264642. Ref. 21.

Wu, J. 1985a. Photodegradation of FMC 54800 in aqueous solution. Unpublished study prepared and submitted by FMC Corporation, Princeton, NJ. Acc. No. 264642. Reference 2.

Wu, J. 1985b. Photodegradation of FMC 54800 in/on soil. Prepared and submitted by FMC Corporation, Princeton, NJ. Acc. No. 264642. Reference 3.

The following study was not reviewed because the hydrolysis data requirement has been satisfied:

Takahashi, N., N. Mikami, T. Matsuda, and J. Miyamoto. 1985. Hydrolysis of the pyrethroid insecticide cypermethrin in aqueous media. J. Pest. Sci. 10: 643.

The following study was not reviewed because the mobility data requirement has been satisfied:

Kinne, L.P. 1984. Mobility of FMC 54800 aged soil residues. FMC Report No. P-1029. Unpublished report prepared by FMC Corporation.

The following study was not reviewed because it was incomplete (the 180-day sampling interval only):

Reynolds, J.L. 1986. Characterization of metabolites and bound residues obtained from soil treated with acid (cyclopropyl ring)-^{14}C FMC 54800. FMC Report No. P-1339. Unpublished report prepared by FMC Corporation.

The following study was not reviewed because it contains product chemistry data only:

Hu, H.C. 1983. Technical Report: Vapor pressure of FMC 54800. FMC Report No. CGP-83-1. Unpublished report prepared by FMC Corporation.

The following studies were cited by the registrant in the Table of Contents but were not included in the document:

Bixler, T.A. 1984. Fate of alcohol(phenyl)-^{14}C FMC 54800 in soil after 120 days. FMC Report No. P-0800. Unpublished report prepared by FMC Corporation. Originially submitted to EPA on August 15, 1984, in support of Registration Application No. 279-NLA for FMC 54800 use on greenhouse ornamentals, trees, and shrubs. EPA Accession No. 254401.

Bixler, T.A. 1983. FMC 54800 Aerobic soil degradation. FMC Report No. P-0712. Unpublished report prepared by FMC Corporation. Originally submitted to EPA on November 3, 1983, in support of the Experimental Use Permit No. 279-EUP-101 for FMC 54800 insecticide. EPA Accession No. 251728.

Froelih, L.W. 1984. Soil adsorption/desorption characteristics of FMC 54800. FMC Report No. P-0797. Unpublished report prepared by FMC Corporation. Originally submitted to EPA on August 15, 1984, in support on Registration Application No. 279-NLA for FMC 54800 use on greenhouse ornamentals, trees, and shrubs. EPA Accession No. 254401.

Herbst. R.M. 1984. Hydrolysis of FMC 54800. FMC Report No. P-0701. Unpublished report prepared by FMC Corporation. Originally submitted to EPA on November 3, 1983, in support of the Experimental Use Permit No. 279-EUP 101 for FMC 54800 insecticide. EPA Accession No. 251728.

Kinne, L.P. 1983. Soil mobility of FMC 54800. FMC Report No. P-0721. Unpublished report prepared by FMC Corporation. Originally submitted to EPA on November 3, 1983, in support of the Experimental Use Permit No. 279-EUP-101 for FMC 54800 insecticide. EPA Accession No. 251728.

Reynolds, J.L. 1984. Aerobic soil metabolism of FMC 54800 degradation during the first 21 days following treatment. FMC Report No.P-1009. Unpublished

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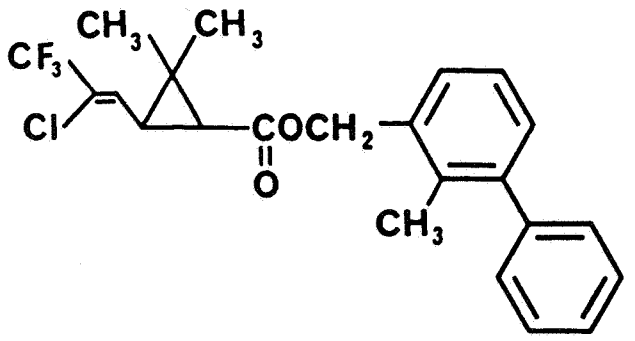
report prepared by FMC Corporation. Originally submitted to EPA on December 20, 1984, in support of EUP/Temporary Tolerance Petition No. 5G3201 for FMC 54800 use on cotton. EPA Accession No. 073174.

Reynolds, J.L. 1984. Aerobic soil metabolism of FMC 54800 -- Fate of acid-(cyclopropyl ring)-^{14}C FMC 54800 and metabolite characterization. FMC Report No. P-0872. Unpublished report prepared by FMC Corporation. Originally submitted to EPA on August 15, 1984, in support of Registration Application No. 279-NLA for FMC 54800 use on greenhouse ornamentals, trees, and shrubs. EPA Accession No. 254401.

Reynolds, J.L. 1986. Characterization of metabolites and bound residues obtained from soil treated with alcohol(phenyl ring)-^{14}C FMC 54800. FMC Report No. P-1343. Unpublished report prepared by FMC Corporation.

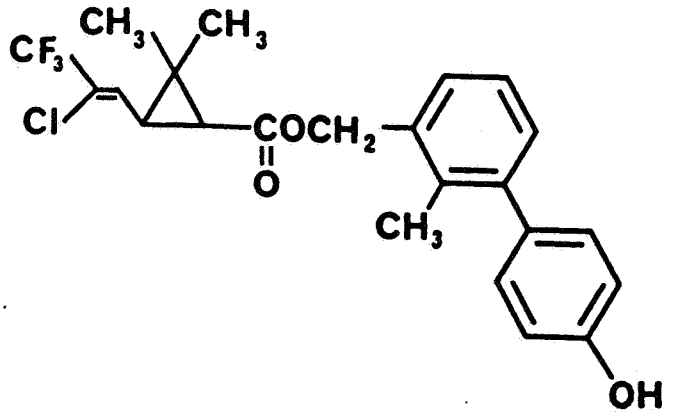
APPENDIX

BIFENTHRIN AND ITS DEGRADATES



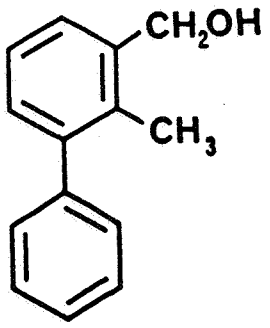
(2-Methyl-1,1'-biphenyl-3-yl)methyl trans-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate

(Bifenthrin)



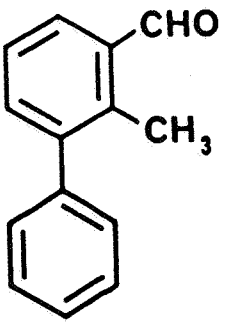
3-(4'-Hydroxyphenyl)-2-methylbenzyl (+)cis-4-(2-chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethylcyclopropanecarboxylate

(4'-OH Bifenthrin)



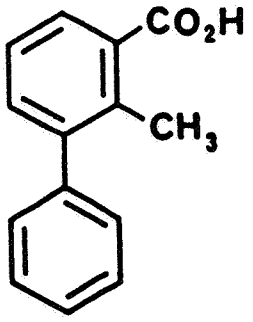
2-Methyl-3-phenylbenzyl alcohol

(BP Alcohol)



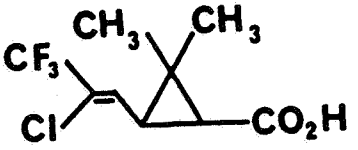
2-Methyl-3-phenylbenzaldehyde

(BP Aldehyde)



2-Methyl-3-phenylbenzoic acid

(BP Acid)



cis,trans-4-(2-Chloro-3,3,3-trifluoro-1-propenyl)-3,3-dimethycyclopropane-carboxylic acid

(TFP Acid)