Data Evaluation Report on the aerobic biotransformation of BAS 510 F in soil

PMRA Submission Number {......} EPA MRID Number 45643802

Data Requirement: PMRA Data Code:
EPA DP Barcode: D283819
OECD Data Point:
EPA Guideline: 162-1

Test material:
Common name: BAS 510 F
Chemical name
IUPAC: 2-Chloro-*N*-(4-chlorobiphenyl-2-yl)-nicotinamide.
CAS name: 2-Chloro-*N*-(4-chloro[1,1-biphenyl]-2-yl)-3-pyridinecarboxamide.
CAS No: 188425-85-6.
Synonyms: 2-Chloro-*N*-(4'-chlorobiphenyl-2-yl)-nicotinamide.
Nicobifen.
~~BAS 516 02 F.~~
SMILES string:

Primary Reviewer: Dana Worcester M.S.
Dynamac Corporation
Signature: Dana Worcester
Date: 7/11/02

QC Reviewer: Kathleen Ferguson Ph.D.
Dynamac Corporation
Signature: Kathleen Ferguson
Date: 7/11/02

Secondary Reviewer: Cheryl A. Sutton Ph.D.
EPA
Signature: Cheryl Sutton
Date: 4/02

Company Code: [for PMRA]
Active Code: [for PMRA]
Use Site Category: [for PMRA]
EPA PC Code: 128008

CITATION: Paulick, R.C. 2002. Aerobic soil metabolism of ^{14}C-BAS 510 F. Unpublished study performed by BASF Corporation, BASF Agro Research, Research Triangle Park, NC and AgVise Laboratories, Northwood, ND. Submitted by BASF Corporation, Research Triangle Park, NC. Laboratory Project Identification: BASF Protocol No. 64052; BASF Registration Document No. 2002/5002772. Study initiated July 11, 2000, and completed March 27, 2001 (p. 11).

EXECUTIVE SUMMARY:

The biotransformation of radiolabeled [pyridine-3-^{14}C]2-chloro-*N*-(4-chlorobiphenyl-2-yl)-nicotinamide (BAS 510 F) was studied in a California clay loam soil (pH 7.8, organic matter 4.6%), an Idaho clay loam soil (pH 6.8, organic matter 3.4%), an Illinois silt loam soil (pH 6.5, organic matter 2.3%), and a North Dakota loam (pH 7.7, organic matter 3.6%) for 127 days under aerobic conditions in darkness at 27°C with a soil moisture content of 75% of field capacity at 1/3 bar. [^{14}C]BAS 510 F was applied at a nominal rate of 0.825 mg a.i./kg, (reported to be equivalent to 0.937 kg a.i./ha for all soil types). The experiment was conducted in accordance with USEPA Subdivision N Guideline §162-1 and PMRA Guideline T-1-255, DACO 8.2.3.4.2. and in compliance with the 40 CFR Part 160 GLP standards. The test system consisted dishes of treated soil that were contained in glass metabolism towers (not described); at each sampling interval, the air in the towers was evacuated through a 1 N NaOH trapping solution. Duplicate samples of each soil were collected after 0, 7, 14, 29, 63, 91, 127, 179/181, 273, and 371 days of incubation. Single samples were analyzed at all intervals except 0, 29, 127, and 371 days. The soil samples were sequentially extracted 2 to 3 times with methanol and 1 to 3 times with methanol and water (1:1, v:v). Additional portions of the 127 through 371 day soils were further extracted twice by shaking with 0.5N sodium hydroxide. The alkaline extracts were acidified, and the resulting precipitate was removed by centrifugation. Extracts and extracted soil were analyzed for total radioactivity using LSC. [^{14}C]BAS 510 F and its transformation products were separated by HPLC and identified by comparison to reference standards. Identifications were confirmed using LC/MS/MS.

Overall recoveries of radiolabeled material averaged 97.11 ± 5.04% of the applied in the four soils during 371 days of incubation. There was a gradual decline in the California clay loam soil with the recovery decreasing from 100.2% at day 0 to 79.4% at 371 days posttreatment; there was no pattern of decline in the other three soils. The half-lives of [^{14}C]BAS 510 F were estimated to be 182 days in the California clay loam soil, 289 days North Dakota loam soil, 408 days in the Illinois silt loam soil, and 578 days in the Idaho clay loam soil. The rate of degradation appeared to be unrelated to microbial biomass, clay content, organic matter content, CEC, or pH. Volatilized $^{14}CO_2$ and M510F49 [2-hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide; BAS Number 391572] were the only major transformation products; one minor transformation product was 2-chloronicotinic acid (BAS Number 107371).

In the California clay loam soil, mean [^{14}C]BAS 510 F decreased from 96.6 ± 0.9% of the applied radioactivity at day 0 to 33.1 ± 3.1% at 371 days; the half-life was estimated to be 182 days (r^2 = 0.9363). 2-hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide (BAS No. 391572) was a maximum 1.5% of the applied at 7 days posttreatment. Extractable [^{14}C]residues decreased from 98.0 ± 0.9% of the applied at day 0 to 34.5 ± 3.5% at 371 days, and nonextractable [^{14}C] residues increased from 2.2 ± 0.1% to 36.6 ± 1.8%. Volatile [^{14}C]residues (most likely CO_2) totaled 8.3 ± 1.1% of the applied at 371 days posttreatment.

In the Idaho clay loam soil, mean [^{14}C]BAS 510 F decreased from 97.1 ± 0.3% of applied radioactivity at day 0 to 58.7 ± 0.1% at 371 days; the half-life was estimated to be 578 days (r^2 =

0.9292). 2-hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide and 2-chloronicotinic acid, were a maximum 5.4 ± 1.3% and 0.8% of the applied at 371 and 14 days posttreatment, respectively. Extractable [^{14}C]residues decreased from 98.7 ± 0.4% at day 0 to 64.3 ± 1.1% at 371 days, and nonextractable [^{14}C]residues increased from 1.3 ± 0.0% to 23.8 ± 0.5%. Volatile [^{14}C]residues (most likely CO_2) totaled 2.6 ± 0.2% of the applied at 371 days posttreatment.

In the Illinois silt loam soil, mean [^{14}C]BAS 510 F decreased from 93.8 ± 3.3% of the applied radioactivity at day 0 to 47.6 ± 4.3% at 371 days; the half-life was estimated to be 408 days (r^2 = 0.9229). The major transformation product 2-hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide, was a maximum 14.4 ± 1.9% of the applied at 371 days posttreatment. The minor transformation product 2-chloronicotinic acid was a maximum of 1.4 ± 0.2% 29 and 127 days. Extractable [^{14}C]residues decreased from 95.4 ± 3.1% at day 0 to 62.2 ± 6.3% at 371 days, and nonextractable [^{14}C]residues increased from 1.6 ± 0.8% to 25.7 ± 1.7%. Volatile [^{14}C]residues (most likely CO_2) totaled 2.2 ± 0.4% of the applied at 371 days posttreatment.

In the North Dakota loam soil, mean [^{14}C]BAS 510 F decreased from 97.2 ± 1.0% of the applied at day 0 to 44.8 ± 3.4% at 371 days; the half-life was estimated to be 289 days (r^2 = 0.7721). 2-hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide and 2-chloronicotinic acid, were a maximum 1.8 ± 0.1% and 4.3% of the applied at 0 and 273 days posttreatment, respectively. Extractable [^{14}C] residues decreased from 99.0 ± 1.1% at day 0 to 49.5 ± 3.0% at 371 days, and nonextractable [^{14}C]residues increased from 2.1 ± 0.3% to 44.8 ± 0.2%. Volatile [^{14}C]residues (most likely CO_2) totaled 2.8 ± 0.1% of the applied at 371 days posttreatment.

A biotransformation pathway was not proposed by the registrant. In MRID 45405208, it was proposed that BAS 510 F degrades to 2-hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide and 2-chloronicotinic acid. The parent and these transformation products are degraded to CO_2 and are converted to soil bound residues.

Results Synopsis:

Soil type: California clay loam
Half-life/DT_{50}: *ca.* 182 days
Major transformation products: None.
Minor transformation products:
  2-Hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide.
  CO_2.

Soil type: Idaho clay loam
Half-life/DT_{50}: *ca.* 578 days
Major transformation products: None.
Minor transformation products:
  2-Hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide.
  2-Chloronicotinic acid.
  CO_2.

Soil type: Illinois silt loam
Half-life/DT_{50}: *ca.* 408 days
Major transformation products: 2-Hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide.
Minor transformation products:
  2-Chloronicotinic acid.
  CO_2.

Soil type: North Dakota loam
Half-life/DT_{50}: *ca.* 289 days
Major transformation products: None.
Minor transformation products:
  2-Hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide.
  2-Chloronicotinic acid.
  CO_2.

Study Acceptability: This study is classified as acceptable. It is noted, however, that replicate data were not obtained for all sampling intervals, as is necessary for a quantitative determination of data variability.

I. MATERIALS AND METHODS

GUIDELINE FOLLOWED: This study was conducted in accordance with the USEPA Subdivision N Guideline §162-1 and PMRA Guideline T-1-255, DACO 8.2.3.4.2 (p. 12). A significant deviation from USEPA Subdivision N Guideline §162-1 was:

> The data from the interim report and final report for identical sampling points differed. No explanation was provided by the study author.

COMPLIANCE: This study was conducted in compliance with USEPA GLP Standards (40 CFR Part 160, 1989; p. 3). Signed and dated Data Confidentiality, GLP, Quality Assurance and certification of authenticity statements were provided (pp. 2-5).

A. MATERIALS:

1. Test Material [Pyridine-3-^{14}C]-labeled BAS 510 F.

Chemical Structure:

Description: Solid (p. 14).

Purity:

Radiochemical purity: >99% (p. 12)
Analytical purity: >97%
Batch No. 640-2037
Specific activity: 310,000 dpm/μg
Location of the radiolabel: Carbon 3 of pyridine ring.

Storage conditions of test chemicals: Storage conditions were not reported.

Table 1. Physico-chemical properties of BAS 510 F.

Parameter	**Values**	**Comments**
Molecular weight	343.2 g/mol	
Water solubility	4.64 mg/L at 20°C	
Vapor pressure/volatility	Not reported.	
UV absorption	Not reported.	
pK_a	Not reported.	
K_{ow}/log K_{ow}	Not reported.	
Stability at room temperature	Not reported.	

Data obtained from p. 12, Table 1, p. 22 of the study report.

2. Soil Characteristics

Table 2: Description of soil collection and storage.

Description	**California**	**Idaho**	**Illinois**	**North Dakota**
Geographic location	Santa Maria, California	Payette, Idaho	Carlyle, Illinois	Gardner, North Dakota
Collection Date	Not reported. Soils received at the lab between May 11, 2000 and June 29, 2000.			
Pesticide use history at the collection site	Not reported.			
Collection procedures	Not reported.			
Sampling depth (cm)	0-6 inches.			
Storage conditions	Upon receipt, soil samples were refrigerated until use.			
Storage length	Not reported.			
Soil preparation	Allowed to dry slightly if necessary, then 2-mm sieved			

Data obtained from p. 13 and Appendix 1, pp. 56-67 of the study report.

Table 3: Properties of the soils.

Property	**California**	**Idaho**	**Illinois**	**North Dakota**
Soil texture	Clay loam	Clay loam	Silt loam	Loam
% sand	44	32	28	46
% silt	28	38	54	34
% clay	28	30	18	20
pH (saturated paste)	7.8	6.8	6.5	7.7
Organic carbon (%)	Not reported.			
Organic matter (%)	4.6	3.4	2.3	3.6
CEC (meq/100 g)	23.1	22.0	12.9	22.7
Moisture at 1/3 atm (%)	24.1	35.7	30.2	26.1
Bulk density (g/cm^3)	Not reported.			
Soil Taxonomic classification	Sorrento, fine-loamy, mixed, superactive, thermic Calcic Haploxerolls	Hall, fine-silty, mixed, mesic, Pachic Argiustolls	Cisne, fine, montmorillinitic, mesic Mollic Albaqualfs	Beardon, fine-silty, frigid Aeric Calciaquolls
Soil Mapping Unit (for EPA)	Not reported.			

Data obtained from Table 2, p. 23 of the study report.

B. EXPERIMENTAL CONDITIONS:

1. Preliminary experiments: Preliminary experiments were not conducted.

2. Experimental conditions:

Table 4: Experimental design.

Parameter	**California**	**Idaho**	**Illinois**	**North Dakota**
Duration of the test	371 days			
Soil condition (air dried/fresh)	Bulk soils were moistened to 75% of 1/3 bar and allowed to equilibrate in the refrigerator for at least 3 days.			
Soil (g/replicate)	40 g dry wt			
Application rate (measured	0.88 mg/kg; 0.99 kg/ha		0.95 mg/kg; 1.07 kg/ha	
Control conditions, if used	No controls were used.			

Parameter		**California**	**Idaho**	**Illinois**	**North Dakota**
No. of Replication	Controls, if used	None			
	Treatments	Duplicate samples were collected at each sampling interval. Only one of the two samples was analyzed at most intervals; the second sample was stored frozen. Both samples collected on days 0, 29, 127, and 371 were analyzed.			
Test apparatus (Type/material/volume)		Soil samples (40 g) were weighed into glass test dishes (not described) and treated with ^{14}C-BAS 510 F. The dishes were then placed into glass metabolism towers and incubated in darkness.			
Details of traps for CO_2 and organic volatile, if any		At each sampling interval, the air in the tower was evacuated through a pair of tubes containing 1N NaOH (volume not reported). Air was drawn through system for at least 60 minutes. No other description of the volatile trapping system was provided.			
If no traps were used, is the system closed/open		Volatile traps were used.			
Co-solvent	Identity	Acetonitrile			
	Final concentration	Approximately 0.4%			
Test material application	Volume of test solution used/treatment	170 µL of 0.20 µg a.i./µL test solution per 40 g soil		180 µL of 0.20 µg a.i./µL test solution per 40 g soil	
	Application method	Not reported.			
	Is the co-solvent evaporated?	No.			
Microbial biomass of the soil (Initial)		218.9 µg/g	301.5 µg/g	24.3 µg/g	80.1 µg/g
CFU per g dry soil	Actinomycetes	6.04 x 10^{5}	4.57 x 10^{5}	4.95 x 10^{5}	1.62 x 10^{5}
	Fungi	3.07 x 10^{3}	1.38 x 10^{4}	3.47 x 10^{4}	1.69 x 10^{4}
	Bacteria	2.69 x 10^{6}	9.91 x 10^{5}	2.86 x 10^{6}	4.55 x 10^{6}
Microbial biomass/microbial population of treated soil, if provided		Not reported.			

Parameter		**California**	**Idaho**	**Illinois**	**North Dakota**
Any indication of the test material adsorbing to the walls of the test apparatus?		Not determined.			
Experimental conditions	Temperature (°C)	27 °C			
	Moisture content Moisture maintenance method:	75% of 1/3 bar Soil moisture maintenance methods were not reported.			
	Continuous darkness (Yes/No):	Yes			
Other details, if any		None			

Data obtained from pp. 13-18, Table 2, p. 23, and Table 5, p. 26 of the study report.

3. Aerobic conditions: Samples were incubated in glass metabolism towers at 27°C in the dark (pp. 15 and 18). Aerobic conditions were maintained throughout the study by flushing the metabolism towers at each sampling period. No determinations were made, such as redox potentials, to verify that aerobic conditions were maintained

4. Supplementary experiments: No supplemental experiments were conducted.

5. Sampling:

Table 5: Sampling details.

Parameters	Details
Sampling intervals	0, 7, 14, 29, 63, 91, 127, 179/181, 273, and 371 days
Sampling method for soil samples	Two dishes of each soil were collected at each sampling interval. At most intervals, one sample was analyzed and the other sample frozen.
Method of collection of CO_2 and volatile organic compounds	Gases were evacuated from each tower at each sampling interval.
Sampling intervals/times for:	
Sterility check, if sterile controls are used:	Sterile controls were not used.
Moisture content:	Not reported.
Redox potential/other:	Not reported.
Sample storage before analysis	Not reported. Primary analysis was conducted within 30 days of sampling.
Other observations, if any	None

Data obtained from pp. 14-15 and Table 4, p. 25 of the study report.

C. ANALYTICAL METHODS:

Extraction/clean up/concentration methods: Soil samples were extracted sequentially 2-3 times with 100 mL of methanol and 1-3 times with 100 mL of methanol:water (1:1, v:v) by mechanical shaking (300 strokes/minute) for 45 minutes per extraction; the number of extractions increased with the duration of the study (p. 17). Following each extraction, the mixtures were separated by centrifugation. Portions of each extract were analyzed using LSC. The extracts were combined and evaporated to dryness, and the residues were dissolved in methanol:water (1:2, v:v) for HPLC analysis (p. 20).

Nonextractable residue determination: Portions of the extracted soils were analyzed for total radioactivity using LSC following combustion (p. 17). Additional portions of the 127 through 371 day extracted soils were further extracted twice by shaking (300 strokes/minute) for ≥14 hours and 45 minutes with 0.5N sodium hydroxide. Aliquots of the extracts were analyzed for total radioactivity by LSC. The alkaline extracts were acidified, and the resulting precipitate was removed by centrifugation. The supernatant (fulvic acid) was analyzed by LSC; the precipitate (humic acid) was redissolved in 1N sodium hydroxide and analyzed using LSC. [^{14}C]Residues remaining in the extracted soil (humin) were quantified by LSC following combustion. The fulvic acid fraction was extracted three times with ethyl acetate (100 mL), and each fraction was analyzed using LSC and HPLC.

Volatile residue determination: Aliquots of each trapping solution were analyzed for total radioactivity by LSC (p. 17).

Total ^{14}C measurement: Total ^{14}C residues were determined by summing the concentration of residues measured in the soil extracts, extracted soil, and volatile trapping solutions.

Derivatization method, if used: A derivation method was not employed.

Identification and quantification of parent compound: Extracts from days 0-91 were analyzed by HPLC under the following conditions: YMC-Pack ODS-AQ 120 A column (dimensions and particle size not specified); gradient mobile phase combined A) 0.1% formic acid in water and B) 0.1% formic acid in acetonitrile [% A:B at 0 min. 95:5 (v:v), 5 min 95:5, 15 min 45:55, 25 min 35:65, 31 min 5:95, 36 min. 5:95, 40 min 95:5]; flow rate of 1 mL/minute; UV (254 nm) and IN/US radioactivity detection (p. 15). BAS 510 F was identified by comparison to a reference standard.

Extracts from days 127-371 were analyzed by HPLC under the following conditions: Phenomenex Synergi Hydro-RP 80 A column (dimensions and particle size not specified); gradient mobile phase combined A) 0.1% formic acid in water and B) 0.1% formic acid in acetonitrile [% A:B at 0 min. 95:5 (v:v), 5 min 95:5, 7 min 45:55, 27 min 43:57, 31 min 5:95, 36 5:95, 40 min 95:5]; flow rate of 1 mL/minute; UV (254 nm) and IN/US radioactivity detection (pp. 15-16). BAS 510 F was identified by comparison to a reference standard.

Identifications were confirmed using LC/MS/MS operated in positive ion mode with an Atmospheric Chemical Ionization source and a MetaChem Inertsil ODS3 column (2.1 x 100 mm; 5 µ particle size, gradient mobile phase combining 4 mM ammounium formate:0.1% formic acid in water and (B) 4mM ammounium formate:0.1% formic acid in methylene chloride [percent B at 0-0.1 min. 20%, to 90% at 0.6 min., hold at 90% until 3 min., 3.1-4.0 min. 20%], injection volume 20 µL, flow rate 400 µL/minute (p. 16).

Identification and quantification of transformation products: Transformation products were separated and quantified as described for the parent. Identification was attempted by comparison to reference standards of 2-(4-chlorophenyl)aniline (BAS No. 363487), 2-hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide (M510F49; BAS No. 391572), and 2-chloronicotinic acid (BAS No. 107371) (Table 1, p. 22).

Detection limits (LOD, LOQ) for the parent compound: Limits of detection for LSC were 60 dpm or 0.007% of the applied radioactivity. The limit of detection for the HPLC on-screen quantification was influenced by the dpm injected and the percent applied radioactivity contained in the fraction. The limit of detection was 0.5-1.0% of the applied radioactivity (p. 17).

Detection limits (LOD, LOQ) for the transformation products: Limits of detection were the same as those described for the parent.

II. RESULTS AND DISCUSSION:

A. TEST CONDITIONS: It was reported that aerobicity, moisture, temperature and other environmental conditions were maintained throughout the study. No supporting records were provided.

B. MATERIAL BALANCE: Overall recoveries of radiolabeled material averaged 97.11 ± 5.0% of applied in the four soils during 371 days of incubation (Tables 7-10, pp. 28-31). The material balance declined in the California clay loam from 100.2% of the applied at day 0 to 79.4% at 371 days posttreatment; there was no pattern of decline in the other three soils. In the California clay loam, total recoveries ranged from 77.4 to 100.7% of the applied. In the Idaho clay loam, total recoveries ranged from 89.7 to 100.5% of applied. In the Illinois silt loam, total recoveries ranged from 84.2 to 102.9% of the applied. In the North Dakota loam, total recoveries ranged from 94.9 to 104.9% of the applied.

Table 6: Biotransformation of [^{14}C]BAS 510 F, expressed as percentage of applied radioactivity (mean ± s.d when n = 2), in **California clay loam** under aerobic conditions.*

Compound	**Sampling times (days after treatment)**									
	0	7	14	29	63	91	127	179	273	371
BAS 510 F	96.6 ± 0.9	85.1	77.7	73.8 ± 0.8	65.5	59.7	54.6 ± 0.5	46.3	41.7	33.1 ± 3.1
M510F49	1.4 ± 0.0	1.4	0.9	1.0 ± 0.1	1.4	1.0	0.6 ± 0.1	0.5	0.7	0.6 ± 0.4
Total extractable residues	98.0 ± 0.9	86.6	78.6	74.8 ± 0.8	66.9	60.7	56.2 ± 0.4	48.2	42.4	34.5 ± 3.5
Total volatiles[1]	---	0.0	0.2	0.2 ± 0.0	1.1	1.7	2.2 ± 0.2	4.3	5.8	8.3 ± 1.1
Nonextractable residues	2.2 ± 0.1	12.5	17.1	22.7 ± 0.8	29.9	34.0	35.6 ± 0.5	39.2	42.0	36.6 ± 1.8
Total % recovery	100.2 ± 0.8	99.1	95.9	97.6 ± 1.6	97.9	96.4	94.0 ± 0.6	91.7	90.2	79.4 ± 2.8

Data obtained from Table 7, p. 28, and Table 12, p. 33, Appendix 3, Table A3-13, p. 89 of the study report. Standard deviations were calculated by reviewer.

* At most sampling intervals, only a single sample was analyzed. At 0, 29, 127, and 371 days, duplicate samples were analyzed.

1 The study author refers to this as CO_2 in the text. In other aerobic soil metabolism studies using BAS 510 F, CO_2 is the only volatile degradate.

Table 7: Biotransformation of [^{14}C]BAS 510 F, expressed as percentage of applied radioactivity (mean ± s.d when n=2), in **Idaho clay loam** under aerobic conditions.*

Compound	**Sampling times (days after treatment)**									
	0	7	14	29	63	91	127	179	273	371
BAS 510 F	97.1 ± 0.3	91.2	88.3	86.1 ± 1.0	80.0	78.7	76.6 ± 1.2	66.3	67.9	58.7 ± 0.1
M510F49	1.6 ± 0.1	1.3	1.5	1.4 ± 0.0	1.8	2.6	2.8 ± 0.3	3.3	3.5	5.4 ± 1.3
CNA			0.8							
Total extractable residues	98.7 ± 0.4	92.5	90.6	87.5 ± 1.0	81.8	81.3	79.6 ± 1.4	69.8	71.4	64.3 ± 1.1
Total volatile organics[1]	---	0.3	0.7	0.8 ± 0.4	1.4	1.5	1.8 ± 0.1	2.0	2.2	2.6 ± 0.2
Nonextractable residues	1.3 ± 0.0	6.7	8.0	10.6 ± 0.2	14.4	17.7	17.5 ± 0.3	20.5	22.2	23.8 ± 0.5
Total % recovery	100.0 ± 0.4	99.5	99.3	99.0 ± 0.4	97.6	100.5	98.8 ± 1.6	92.3	95.8	90.7 ± 1.4

Data obtained from Table 8, p. 29, and Table 12, p. 33, Appendix 3, Table A3-13, p. 89 of the study report. Standard deviations were calculated by reviewer.

* At most sampling intervals, only a single sample was analyzed; only mean data was provided for duplicate sample analysis. At 0, 29, 127, and 371 days, duplicate samples were analyzed.

1 The study author refers to this as CO_2 in the text. In other aerobic soil metabolism studies using BAS 510 F, CO_2 is the only volatile degradate.

Table 8: Biotransformation of [^{14}C]BAS 510 F, expressed as percentage of applied radioactivity (mean ± s.d. when n = 2), in **Illinois silt loam** under aerobic conditions.*

Compound	**Sampling times (days after treatment)**									
	0	7	14	29	63	91	127	181	273	371
BAS 510 F	93.8 ± 3.3	90.5	90.1	85.6 ± 0.1	74.8	71.4	66.8 ± 0.1	57.8	61.1	47.6 ± 4.3
M510F49	1.6 ± 0.2	1.6	1.6	2.8 ± 0.0	5.7	8.4	9.0 ± 0.6	9.0	12.6	14.4 ± 1.9
CNA	0.0 ± 0.0	0.0	0.8	1.4 ± 0.1	0.6	0.9	1.4 ± 0.2	1.2	0.0	0.0 ± 0.0
Total extractable residues	95.4 ± 3.1	92.4	92.5	89.8 ± 0.1	81.2	80.6	77.8 ± 0.4	69.0	73.7	62.2 ± 6.3
Total volatile organics[1]	---	0.4	0.5	0.5 ± 0.1	0.7	0.8	0.8 ± 0.1	1.2	1.7	2.2 ± 0.4
Nonextractable residues	1.6 ± 0.8	6.5	8.2	12.2 ± 0.6	13.6	18.9	21.7 ± 1.1	23.4	24.4	25.7 ± 1.7
Total % recovery	97.0 ± 3.9	99.3	101.2	102.4 ± 0.6	95.5	100.3	100.2 ± 0.5	93.6	99.8	90.2 ± 8.4

Data obtained from Table 9, p. 30, and Table 12, p. 33 Appendix 3, Table A3-13A, p. 90 of the study report. Standard deviations were calculated by reviewer.

* At most sampling intervals, only a single sample was analyzed; only mean data was provided for duplicate sample analysis. At 0, 29, 127, and 371 days, duplicate samples were analyzed.

[1] The study author refers to this as CO_2 in the text. In other aerobic soil metabolism studies using BAS 510 F, CO_2 is the only volatile degradate.

Table 9: Biotransformation of [^{14}C]BAS 510 F, expressed as percentage of applied radioactivity (mean ± s.d when n=2), in **North Dakota loam** under aerobic conditions.*

Compound	**Sampling times (days after treatment)**									
	0	7	14	29	63	91	127	181	273	371
BAS 510 F	97.2 ± 1.0	77.0	73.0	70.7 ± 2.4	64.0	59.1	53.2 ± 0.1	51.3	47.9	44.8 ± 3.4
M510F49	1.8 ± 0.1	1.4	1.1	1.2 ± 0.0	1.1	1.1	0.8 ± 0.1	0.5	0.7	1.4 ± 0.1
CNA	0.0 ± 0.0	1.0	0.0	0.4 ± 0.6	0.5	0.9	2.2 ± 6	3.2	4.3	3.1 ± 0.4
Total extractable residues	99.0 ± 1.1	79.4	74.1	72.3 ± 3.0	65.8	61.1	57.0 ± 0.1	55.7	52.9	49.5 ± 3.0
Total volatile organics[1]	---	0.1	0.5	0.6 ± 0.2	1.0	1.1	1.2 ± 0.1	1.7	2.2	2.8 ± 0.1
Nonextractable residues	2.1 ± 0.3	22.8	24.4	28.2 ± 2.6	32.8	35.8	40.4 ± 1.5	40.9	44.9	44.8 ± 0.2
Total % recovery	101.1 ± 0.8	102.3	99.0	101.1 ± 5.4	99.6	98.0	98.6 ± 1.4	98.3	100.0	97.1 ± 3.1

Data obtained from Table 10, p. 31, and Table 12, p. 33 Table A3-13A, p. 90 of the study report. Standard deviations were calculated by reviewer.

* At most sampling intervals, only a single sample was analyzed; only mean data was provided for duplicate sample analysis. At 0, 29, 127, and 371 days, duplicate samples were analyzed.

[1] The study author refers to this as CO_2 in the text. In other aerobic soil metabolism studies using BAS 510 F, CO_2 is the only volatile degradate.

C. TRANSFORMATION OF PARENT COMPOUND: BAS 510 F degraded most quickly in the California clay loam with BAS 510 F comprising 33.1% of the applied (nominal application) at 371 days posttreatment (final sampling interval; Table 12, p. 33). Degradation proceeded more slowly in the Illinois silt loam and North Dakota loam soils, (44.8-47.6% at 371 days) and most slowly in the Idaho clay loam soil (58.7% at 371 days). The rate of degradation appeared to be unrelated to microbial biomass, clay content, organic matter content, CEC, or pH.

In the California clay loam soil, [^{14}C]BAS 510 F decreased from 96.6% of applied radioactivity (nominal application) at day 0 to 65.5% at 63 days to 54.6% at 127 days, and to 33.1% at 371 days (Table 12, p. 33). In the Idaho clay loam soil, [^{14}C]BAS 510 F decreased from 97.1% at day 0 to 80.0% at 63 days to 66.3% at 179 days and to 58.7% at 371 days. In the Illinois silt loam soil, [^{14}C]BAS 510 F decreased from 93.8% at day 0, to 74.8% at 63 days, to 66.8% at 127 days and to 47.6% at 371 days. In the North Dakota loam soil, [^{14}C]BAS 510 F decreased from 97.2% at day 0 to 64.0% at 63 days to 53.2% at 127 days and to 44.8% at 371 days.

HALF-LIFE: The half-life for BAS 510 F was determined by the reviewer using linear regression analysis based on first-order kinetics as calculated by Excel 2000.

Table 10: Half-life values of BAS 510 F in aerobic soil.

	First order Linear		
Soil type	**Half-life (days)**	**Regression equation**	**r^2**
California clay loam	182	y = -0.0038x + 4.47	0.9363
Idaho clay loam	578	y = -0.0012x + 4.5066	0.9292
Illinois silt loam	408	y = -0.0017x + 4.4855	0.9229
North Dakota loam	289	y = -0.0024x + 4.3828	0.7721

[1] Half-lives calculated using data obtained from data obtained from Appendix 3, Tables A3-13 and A3-13A, pp. 89-90.

TRANSFORMATION PRODUCTS: Two transformation products, 2-hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide (M510F49) and 2-chloronicotinic acid, were identified by the study author.

The concentration of 2-hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide (M510F49) ranged from 0.6 to 1.5% of the applied in the California clay loam soil, from 1.3 to 5.4% in the Idaho clay loam soil, and from 0.5 to 1.8% in the North Dakota loam soil (Table 12, p. 33). In the Illinois silt loam soil, 2-hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide (M510F49) was a maximum of 14.5% of the applied at 371 days posttreatment.

The transformation product 2-chloronicotinic acid was not detected in the California clay loam soil; the concentration was 0.8% of the applied at day 14 in the Idaho clay loam soil, and ranged

16

from 0.0 to 1.4% of the applied in the Illinois silt loam soil and was 0.0-4.3% in the North Dakota loam soil (Table 12, p. 33).

NONEXTRACTABLE AND EXTRACTABLE RESIDUES: The concentrations of extractable and nonextractable [^{14}C]residues in the California clay loam soil and the North Dakota loam soil were similar (34.5-49.5% of the applied for extractables and 36.6-44.9% for nonextractables; Tables 7-10, pp. 28-31). Those in the Idaho clay loam soil and the Illinois silt loam soil were similar (62.3-64.3% for extractables and 23.8-25.7% for nonextractables). This pattern reflected the relative rates of degradation of BAS 510 F, because the formation of nonextractable residues was the primary way in which the parent compound concentration was decreased.

In the California clay loam soil extractable [^{14}C]residues decreased from 98.0% of the applied at day 0 to 34.5% at 371 days posttreatment, while nonextractable residues increased from 2.2% at day 0 to 36.6% at 371 days (Table 7, p. 28). At 371 days, 4.1% of the applied was associated with the fulvic acids, 7.1% with humic acid and 29.8% with humins (Table 11, p. 32). HPLC analysis of the fulvic acid at 371 days posttreatment found that BAS 510 F, M510F49 and CNA were each ≤2.6% of the applied (Table 13, p. 34).

In the Idaho clay loam soil, extractable [^{14}C]residues decreased from 98.7% of the applied at day 0 to 64.3% at 371 days posttreatment, while nonextractable residues increased from 1.3% at day 0 to 23.8% at 371 days (Table 8, p. 29). At 371 days, 4.7% of the applied was associated with the fulvic acids, 6.4% with humic acid and 10.5% with humins (Table 11, p. 32). HPLC analysis of the fulvic acid on day 371 posttreatment found that BAS 510 F, M510F49 and CNA were each ≤2.8% of the applied (Table 13, p. 34).

In the Illinois silt loam soil, extractable [^{14}C]residues decreased from 95.4% of the applied at day 0 to 62.3% at 371 days posttreatment, while nonextractable residues increased from 1.6% at day 0 to 25.7% at 371 days (Table 9, p. 30). At 371 days, 5.0% of the applied was associated with the fulvic acids, 9.5% with humic acid and 7.1% with humins (table 11, p. 32). HPLC analysis of the fulvic acid on day 371 posttreatment found that BAS 510 F, M510F49 and CNA were each ≤2.0% of the applied (Table 13, p. 34).

In the North Dakota loam soil extractable [^{14}C]residues decreased from 99.0% of the applied at day 0 to 49.5% at 371 days posttreatment, while nonextractable residues increased from 2.1% at day 0 to 44.9% at 371 days (Table 10, p. 31). At 371 days, 5.1% of the applied was associated with the fulvic acids, 8.2% with humic acid and 26.1% with humins (Table 11, p. 32). HPLC analysis of the fulvic acid on day 371 posttreatment found that BAS 510 F, M510F49 and CNA were each ≤4.0% of the applied (Table 13, p. 34).

VOLATILIZATION: Volatiles totaled 8.3 ± 1.1%, 2.6 ± 0.2%, 2.2 ± 0.4%, and 2.8 ± 0.1% of applied radioactivity at 371 days in the California clay loam, Idaho clay loam, Illinois silt loam and North Dakota loam soils, respectively (Tables 7-10, pp. 28-31). There was no evidence that the volatile compounds were identified in this study. However, it is likely that $^{14}CO_2$ was the only compound volatilized from the soil, since NaOH was the only trapping solution used in this study and since organic volatiles have not been identified as a transformation product in other aerobic soil metabolism studies in this data package.

TRANSFORMATION PATHWAY: An aerobic biotransformation pathway of [^{14}C]BAS 510 F was not proposed by the registrant in this study. In MRID 45405208, it was proposed that BAS 510 F degrades to M510F49 and/or M510F50 (Unknown 2). The parent and these transformation products are degraded to CO_2 and are converted to soil bound residues.

Table 11: Chemical names and CAS numbers for the transformation products of ^{14}C-BAS 510 F.

Applicant's Code Name	CAS Number	CAS and/or IUPAC Chemical Name(s)	Chemical formula	Molecular weight	SMILES string
M510F49		2-hydroxy-N-(4'-chlorobiphenyl-2-yl)-nicotinamide		324.77	
CNA		2-chloronicotinic acid		157.56	

Data obtainer from Table 1, p. 22 of the study report.

D. SUPPLEMENTARY EXPERIMENT-RESULTS: Supplementary experiments were not performed.

III. STUDY DEFICIENCIES: No deficiencies were noted that would affect the results and conclusions for the study.

IV. REVIEWER'S COMMENTS:

1. The [^{14}C]residues trapped in the NaOH trapping solution were not identified. The study author frequently refers to these residues as CO_2, but the presence of CO_2 in the solution was not confirmed. It is very likely that CO_2 was the only volatile compound, since NaOH is most effective as a CO_2 trap and since CO_2 was the only volatile detected in other aerobic soil metabolism studies (MRIDs 45405208, 45405209).

2. The conditions under which volatile trapping occurred were not described in detail, and the efficiency of the NaOH traps was not reported.

3. Although two samples were collected at each sampling interval, only single samples were analyzed at most intervals. Replicate sampling at each sampling interval is necessary, so that normal variability can be quantified and outliers can be identified.

4. The registrant determined linear regression half-lives using Origin 6.0 Scientific Graphics Software. The Hamaker equation was used to describe dissipation kinetics using a linear fit. The natural log of 2 (0.693) was then divided by the slope of the line for determination of the

rate constant, to determine the half-life value (p. 19). The registrant-calculated half-lives were 159 days for the California clay loam soil, 573 days for the Idaho clay loam soil, 378 days for the Illinois silt loam soil, and 277 days for the North Dakota loam soil (p. 21). These values are comparable to the half-lives obtained by the reviewer using linear regression with Excel 2000 software.

5. BAS 510 F chemical name 2-chloro-*N*-(4'-chlorobiphenyl-2-yl)-nicotinamide, as presented in the study report, was identified as the IUPAC name by the Compendium of Pesticide Common Names (http://www.hclrss.demon.co.uk/nicobifen.html). The CAS name 2-chloro-*N*-(4-chloro[1,1-biphenyl]-2-yl)-3-pyridinecarboxamide was also obtained from the Compendium of Pesticide Common Names. The following BAS 510 F synonyms were obtained from USEPA/OPP Chemical Databases (http://www.cdpr.ca.gov/cgi-bin/epa/chemidetriris.pl?pccode=128008 and (http://www.cdpr.ca.gov/cgi-bin/mon/bycode.pl?p_chemcode=5790): 2-chloro-*N*-(4'-chlorobiphenyl-2-yl)-nicotinamide, nicobifen, and BAS 516 02 F.

V. REFERENCES: The following reference was cited in this study

1. Microcal Software, Inc., Origin 6.0, One Roundhouse Plaza, Northampton, MA 01060.

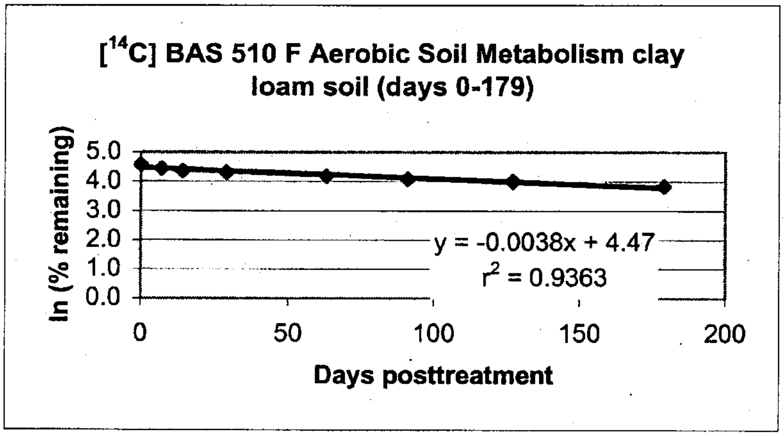
Attachment 1

Excel Spreadsheets

162-1, Aerobic biotransformation of BAS 510 F
MRID 45643802
California soil

Half-life (days) =	182.41	DT90 =	605.94

Days posttreatment	% BAS 510 F remaining	LN (%remaining)
0	97.2	4.577
0	95.9	4.563
7	85.1	4.444
14	77.7	4.353
29	73.2	4.293
29	74.4	4.309
63	65.5	4.182
91	59.7	4.089
127	54.3	3.995
127	55	4.007
179	46.3	3.835
273	41.7	3.731
371	35.3	3.564
371	30.9	3.431

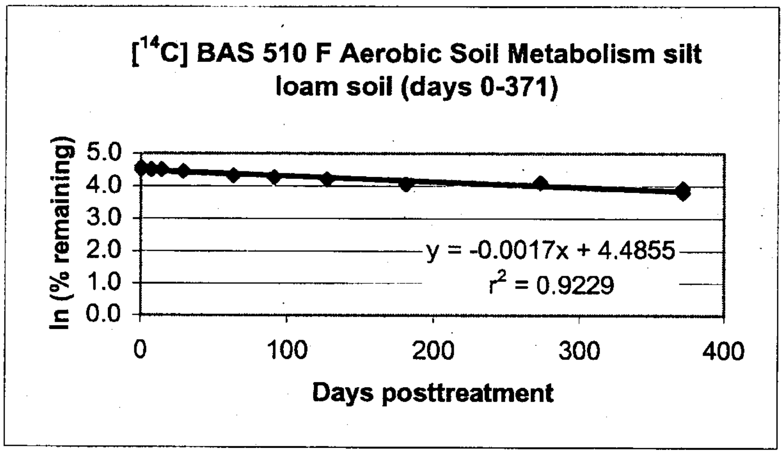


Constant	4.47
r2	0.94
x (slope)	-0.0038

162-1, Aerobic biotransformation of BAS 510 F
MRID 45643802
Illinois

Half-life (days) =	407.73	DT90 =	1354.46

Days posttreatment	% BAS 510 F remaining	LN (%remaining)
0	96.1	4.565
0	91.4	4.515
7	90.5	4.505
14	90.1	4.501
29	85.5	4.449
29	85.7	4.451
63	74.8	4.315
91	71.4	4.268
127	66.8	4.202
127	66.9	4.203
181	57.8	4.057
273	61.1	4.113
371	50.6	3.924
371	44.5	3.795



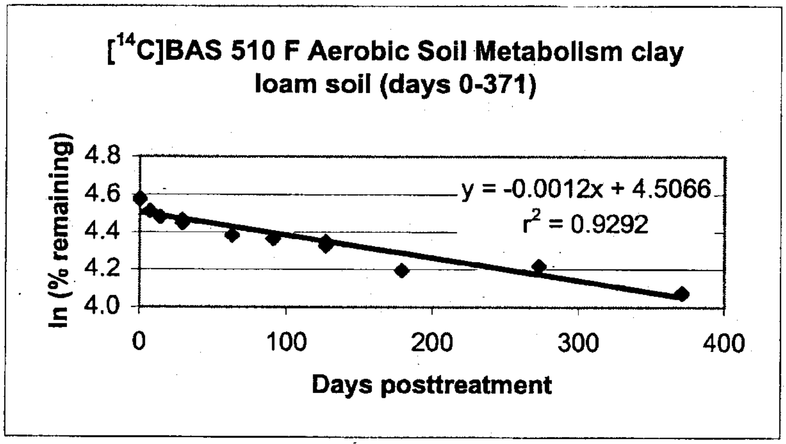
Constant	4.4855
r2	0.9229
x (slope)	-0.0017

22

162-1, Aerobic biotransformation of BAS 510 F
MRID 45643802
Idaho

Half-life (days) =	577.62	DT90 =	1918.82

Days posttreatment	% BAS 510 F remaining	LN (%applied)
0	96.9	4.574
0	97.3	4.578
7	91.2	4.513
14	88.3	4.481
29	85.4	4.447
29	86.8	4.464
63	80	4.382
91	78.7	4.366
127	77.4	4.349
127	75.7	4.327
179	66.3	4.194
273	67.9	4.218
371	58.6	4.071
371	58.8	4.074

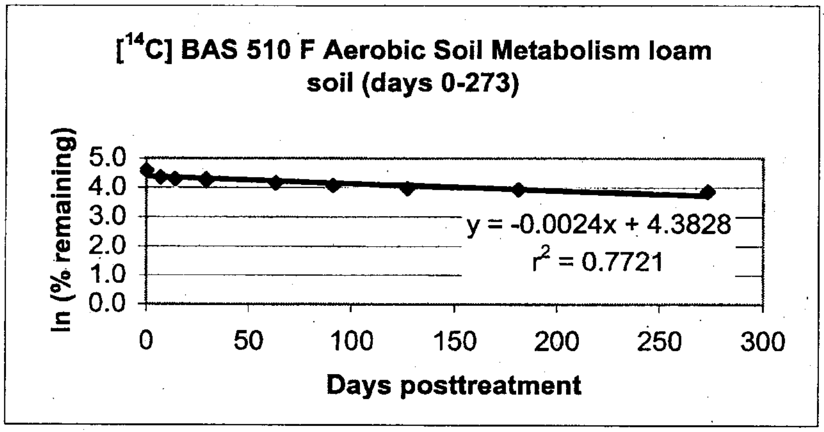


Constant	4.5066
r2	0.9292
x (slope)	-0.0012

162-1, Aerobic biotransformation of BAS 510 F
MRID 45643802
North Dakota

Half-life (days) =	288.81	DT90 =	959.41

Days posttreatment	% BAS 510 F remaining	LN (%remaining)
0	97.9	4.584
0	96.5	4.570
7	77	4.344
14	73	4.290
29	69	4.234
29	72.4	4.282
63	64	4.159
91	59.1	4.079
127	53.3	3.976
127	53.1	3.972
181	51.3	3.938
273	47.9	3.869
371	42.4	3.747
371	47.2	3.854



Constant	4.3828
r2	0.7721
x (slope)	-0.0024

		CA						
CA	100.7		510 F	M510F49	Extractable	Volatiles	Bound	Recovery
	99.6	1	97.2	1.4	98.6		2.1	100.7
	99.1	1	95.9	1.4	97.3		2.3	99.6
	95.9	Ave	96.55	1.40	97.95		2.20	100.15
	96.5	stdev	0.92	0.00	0.92		0.14	0.78
	98.8							
	97.9	29	73.2	1	74.2	0.2	22.1	96.5
	96.4	29	74.4	0.9	75.3	0.2	23.3	98.8
	93.5	Ave	73.80	0.95	74.75	0.20	22.70	97.65
	94.4	stdev	0.85	0.07	0.78	0.00	0.85	1.63
	91.7							
	90.2	127	54.3	0.6	55.9	2.4	35.2	93.5
	81.4	127	55	0.7	56.4	2.1	35.9	94.4
CA	77.4	Ave	54.65	0.65	56.15	2.25	35.55	93.95
ID	99.7	stdev	0.49	0.07	0.35	0.21	0.49	0.64
	100.3							
	99.5	371	35.3	0.9	37	9.1	35.3	81.4
	99.3	371	30.9	30.9	32	7.5	37.9	77.4
	98.7	Ave	33.10	15.90	34.50	8.30	36.60	79.40
	99.3	stdev	3.11	21.21	3.54	1.13	1.84	2.83
	97.6							
	100.5	ID						
	100		510 F	M510F49	Extractable	Volatiles	Bound	Recovery
	97.7	1	96.9	1.5	98.4		1.3	99.7
	92.3	1	97.3	1.7	99		1.3	100.3
	95.8	Ave	97.10	1.60	98.70		1.30	100.00
	91.7	stdev	0.28	0.14	0.42		0.00	0.42
ID	89.7							
IL	99.7	29	85.4	1.4	86.8	1.1	10.8	98.7
	94.2	29	86.8	1.4	88.2	0.6	10.5	99.3
	99.3	Ave	86.10	1.40	87.50	0.85	10.65	99.00
	101.2	stdev	0.99	0.00	0.99	0.35	0.21	0.42
	102.9							
	102	127	77.4	3	80.6	1.7	17.7	100
	95.5	127	75.7	2.6	78.6	1.8	17.3	97.7
	100.3	Ave	76.55	2.80	79.60	1.75	17.50	98.85
	99.9	stdev	1.20	0.28	1.41	0.07	0.28	1.63
	100.6							
	93.6	371	58.6	6.3	65.1	2.5	24.1	91.7
	99.8	371	58.8	4.5	63.5	2.8	23.4	89.7
	96.1	Ave	58.70	5.40	64.30	2.65	23.75	90.70
IL	84.2	stdev	0.14	1.27	1.13	0.21	0.49	1.41
ND	101.7							
	100.5							
	102.3							
	99							
	97.3							
	104.9							
	99.6							
	98							
	99.6							
	97.6							

	98.3
	100
	94.9
ND	99.3
AVE	97.11
SD	5.04

IL

	510 F	M510F49	CNA	Extractable	Volatiles	Bound	Recovery
1	96.1	1.5	0	97.6		2.1	99.7
1	91.4	1.8	0	93.2		1	94.2
Ave	93.75	1.65	0.00	95.40		1.55	96.95
stdev	3.32	0.21	0.00	3.11		0.78	3.89
29	85.5	2.8	1.4	89.7	0.6	12.6	102.9
29	85.7	2.8	1.3	89.9	0.4	11.7	102
Ave	85.60	2.80	1.35	89.80	0.50	12.15	102.45
stdev	0.14	0.00	0.07	0.14	0.14	0.64	0.64
127	66.8	8.6	1.5	77.5	0.8	21.8	99.9
127	66.9	9.4	1.2	78.1	0.7	21.6	100.6
Ave	66.85	9.00	1.35	77.80	0.75	21.70	100.25
stdev	0.07	0.57	0.21	0.42	0.07	0.14	0.49
371	50.6	15.8	0	66.7	2.5	26.9	96.1
371	44.5	13.1	0	57.8	1.9	24.5	84.2
Ave	47.55	14.45	0.00	62.25	2.20	25.70	90.15
stdev	4.31	1.91	0.00	6.29	0.42	1.70	8.41

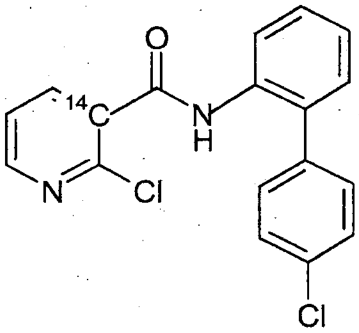
ND

	510 F	M510F49	CNA	Extractable	Volatiles	Bound	Recovery
1	97.9	1.9	0	99.8		1.9	101.7
1	96.5	1.7	0	98.2		2.3	100.5
Ave	97.20	1.80	0.00	99.00		2.10	101.10
stdev	0.99	0.14	0.00	1.13		0.28	0.85
29	69	1.2	0	70.2	0.8	26.3	97.3
29	72.4	1.2	0.9	74.4	0.5	30	104.9
Ave	70.70	1.20	0.45	72.30	0.65	28.15	101.10
stdev	2.40	0.00	0.64	2.97	0.21	2.62	5.37
127	53.3	0.8	2.6	56.9	1.3	41.4	99.6
127	53.1	0.9	1.8	57.1	1.2	39.3	97.6
Ave	53.20	0.85	2.20	57.00	1.25	40.35	98.60
stdev	0.14	0.07	0.57	0.14	0.07	1.48	1.41
371	42.4	1.4	3.3	47.4	2.8	44.7	94.9
371	47.2	1.3	2.8	51.6	2.7	45	99.3
Ave	44.80	1.35	3.05	49.50	2.75	44.85	97.10
stdev	3.39	0.07	0.35	2.97	0.07	0.21	3.11

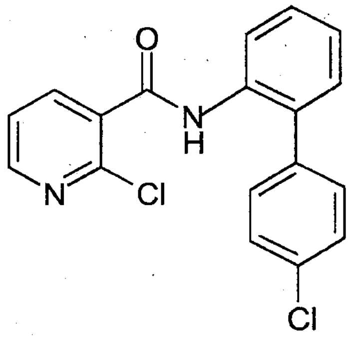
Attachment 2

Structure of Parent and Degradate

BAS 510 F (pyridine label)



Structure of BAS 510F (without radiolabel)



2-chloronicotinic acid-[pyridine-3-^{14}C]