Foliar Field Dissipation of Triallate

Report:	MRID 51481102. Wyatt, D.R., and S.J. Carringer. 2008. Terrestrial Field Dissipation of Triallate and its Metabolite, TCPSA, Following One Granular Application to Bareground Soil in California. Unpublished study directed by The Carringers, Inc., Apex, North Carolina; performed by Morse Laboratories, Inc., Sacramento, California, and AGVISE Laboratories, Northwood, North Dakota; sponsored and submitted by Gowan Company, Yuma, Arizona. TCI Study No.: TCI-06-154. Study initiation October 24, 2006, and completion October 6, 2008 (pp. 6, 12). Experiment Completion September 19, 2008.
Document No.:	MRID 51481102
Guideline:	OCSPP 835.6100
Statements:	The study was conducted in compliance with U.S. EPA FIFRA (40 CFR Part 160) GLP standards with exceptions related to weather data, maintenance pesticides, test system maintenance, irrigation, pesticide histories, test site slope, sample weights, GPS coordinates, field notes, and characterization of the triallate analytical standard (p. 3). Signed and dated Data Confidentiality, GLP Compliance, Quality Assurance, and Authenticity Certification statements were provided (pp. 2-6).
Classification:	This study is classified as **supplemental**. Day 0 sampling could not confirm that the distribution of test substance was uniform. The methods used to generate the dissipation curve and calculate DT_{50} values by the registrant produced different results from the reviewer. Triallate was applied at 110% of the label rate. An independent laboratory validation was not conducted.
PC Code:	078802
Final EPA Reviewer:	He Zhong, Ph.D. Biologist	**Signature:** **Date:** 8/25/2021

CDM/CSS-Dynamac JV Reviewers:	Richard Lester Environmental Scientist	Signature: Date: 4/28/21
	Teresa Nelis, M.S. Environmental Scientist	Signature: Date: 4/29/21

This Data Evaluation Record may have been altered by the Environmental Fate and Effects Division subsequent to signing by CDM/CSS-Dynamac JV personnel. The CDM/CSS-Dynamac Joint Venture role does not include establishing Agency policies.

Executive Summary

Soil dissipation of triallate and its metabolite TCPSA under US field conditions was examined on bare ground plots at one site near Porterville, California. The nominal application rate was 1.7 lbs a.i./A (1,906 g a.i./ha). An untreated control plot was established *ca.* 238 m away from the treated plot. The experiment was conducted for 271 days after application.

Under field conditions at the California test site, total triallate (including triallate and metabolite parent equivalents) had a DT_{50} value in soil of 25.2 days calculated in accordance with the harmonized NAFTA kinetics guidance (NAFTA, 2012), the Standard Operating Procedure (SOP) for using the NAFTA Guidance to calculate representative half-life values (USEPA, 2015), and EFED Contractor Technical Direction: Recommendations for Environmental Fate DERs (USEPA, 2020). All residues declined by >90% at the 271-day sampling interval. Residues primarily remained in the 0-15 cm layer of soil. Only four replicate samples in the 15-30 cm segment and two replicate samples in the 30-45 cm segment contained quantifiable triallate. All measured concentrations of triallate in samples collected from depths greater than 15 cm were below the LOQ.

The major route of dissipation of triallate was biodegradation to TCPSA and subsequent biodegradation to non extractable residues and mineralization to carbon dioxide.

Table 1. Dissipation Synopsis – Terrestrial Field Dissipation of Triallate in Soil[A]

Test System	Major Dissipation Route	Maximum Concentrations (lbs a.i./A) in Media (cm soil) at Time Period (days after application)
California Bare ground Sandy loam pH 7.8	Biodegradation to TCPSA	**Soil** Triallate: 1.93 lbs a.i./A (0-15 cm depth; day 0) TCPSA: 0.0425 lbs a.i./A (0-15 cm depth; day 61)

[A] Data in lbs a.i./A are mean values per sampling interval and are reviewer-calculated from concentration data provided in the study report.
TCPSA = 2,3,3-Trichloroprop-2-ene-1-sulfonic acid.

Table 2. Results Synopsis: Terrestrial Field Dissipation of Total Triallate in Soil[A]

Total Soil Profile	Observed (d)		Kinetic Model Fitted Value [B] (d)		Representative Half-life for Modeling[B] (d)	C_0	Parameters	Transformation Products Common Name (maximum %, observed, associated interval)
	DT_{50}	DT_{90}	DT_{50}	DT_{90}				
Total Soil Profile (0-90 cm) California Bare ground Sandy loam pH 7.8 EOS = 271 days	1-30	14-271	**25.2 (SFO)**	**83.6 (SFO)**	**NA**	1.11	k = 0.0275 S_{SFO} = 2.97	**Minor** TCPSA (2.5%, 61 d)
			19.4 (DFOP)	167 (DFOP)	NA	1.16	k_0 = 0.0609 k_1 = 0.00745 f = 0.654	
			20.9 (IORE)	145 (IORE)	NA	1.15	k = 0.0393 N = 1.77 S_C = 3.13	

Single First Order (SFO); Double First Order in Parallel (DFOP); and Indeterminate Order Rate Equation (IORE).

d = days; EOS = End of Study; NA = Not applicable.

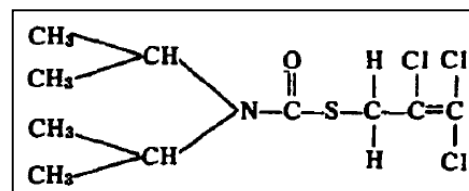TCPSA = 2,3,3-Trichloroprop-2-ene-1-sulfonic acid.

[A] Data were obtained from Table 16, pp. 37-44 of the study report and calculations in the attached Excel workbook. See Attachment 3 for calculations. Total triallate includes triallate and metabolite TCPSA as parent equivalents.

[B] The kinetic model recommended to describe the persistence (shown in **bold**) is consistent with the recommendations on calculating degradation kinetics (NAFTA, 2012: USEPA, 2015). The representative half-life for modeling is not used to derive model inputs in field dissipation studies (USEPA, 2020). The reviewer does not recommend a different model input or kinetic result from the standard recommendations.

I. Materials and Methods

A. Materials:

1. Test Material: Product Name: Far-GO® Granular Herbicide (p. 15; Table 3, p. 26; Appendix A, p. 57)
Formulation Type: Granular
CAS #: 2303-17-5
Storage stability: The study reports that the stability of the test substance under the conditions of use have been verified.

2. Storage Conditions: The granular formulation was stored at ambient temperature from receipt until use (p. 16).

B. Test Sites:

The test site was located in Terra Bella near Porterville, California (p. 13; Table 1, p. 25). A site description is provided in **Table 3**.

Table 3. Site Description

Parameter		Value					
Site: Porterville, California							
Geographic Coordinates	Latitude	36°00.492'N					
	Longitude	119°4.525'W					
	County	Tulare					
	Province/State	California					
	Country	United States					
Hydrologic setting - Location within watershed		Not reported					
Slope/Gradient		<1%					
Depth to Ground Water Table (m)		78					
Distance from weather station used for climatic measurements		19.7 miles					
Indicate whether the meteorological conditions before starting or during the study were within 30 year normal levels (Yes/No). If no, provide details.		Weather conditions were within 10 year normal levels.					
Field Surface (e.g. bare soil, trees, or crops)		Bare ground					
Other Details, if any		None					
Property		Depth (cm)					
		0-15	15-30	30-45	45-60	60-75	75-90
Textural classification		Sandy Loam	Sandy Loam	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand
% sand		65	56	75	83	85	84
% silt		28	37	20	12	10	11
% clay		7	7	5	5	5	5
pH (1:1 soil:water)		7.8	8.2	8.7	8.9	8.7	8.8
Total organic carbon (%)[1]		0.47	0.41	0.17	0.12	0.12	0.12
CEC (meq/100 g)		8.3	9.2	6.9	5.7	6.0	5.9

Parameter	Value					
AEC (meq/100 g)	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Bulk density (g/cm^3)	1.29	1.24	1.41	1.44	1.41	1.41
Soil Moisture at 0.1 bar (%)	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Soil Moisture at 1/3 bar (%)	11.0	12.6	6.7	4.4	5.4	5.2
Taxonomic classification	Soil Series: Nord Soil Order: Millisol Great Group: Haploxeroll Mineralogy: Mixed					
Site Usage	Previous Year (2006)		2 years previous (2005)		3 years previous (2004)	
Crops Grown	Fallow, Fallow, Bareground		Fallow, Cotton, Bareground		Fallow, Fallow, Bareground	
Pesticides Used	Gramoxone Extra, Propanamid		Cotton Quick, MFX Cotton Harvest, Gramoxone Extra		Gramoxone Extra	
Fertilizers Used	None		None		Calcium Nitrate	
Cultivation Methods	Disked *ca.* 12 in. deep; disked and floated *ca.* 6 in.; rototilled *ca.* 25 min. after application					
Comments	None					

Data were obtained from Table 1, p. 25; and Tables 4-7, pp. 27-30 of the study report.
[1] Reviewer calculated as: organic carbon (%) = organic matter (%)/1.72.

C. Experimental Design:

Specifications on the design for the field dissipation study are shown in **Table 4**.

Table 4. Study Design

Details		Terra Bella, California Treated plot
Pesticides used during study [a.i., % a.i., and product]: name of product/a.i concentration: amount applied: application method:		Far-Go Herbicide with 10% triallate a.i.
Amount applied (lbs. a.i./A)		1.71 lbs. a.i./A
Number of applications		One
Maximum single labelled application rate? (yes/no)		*ca.* 110% of the label rate
Application method		Broadcast granular
Application Dates(s) (dd mm yyyy)		07/02/2007
Duration of study		271 days
Control used (Yes/No)		Yes
No. of replications	Controls	One
	Treatments	Three replicate plots

Details		Terra Bella, California Treated plot
Plot size (L x W m)	Control	6.1 × 22.9
	Treatment	91.4 × 6.1
Distance between control plot and treated plot		*ca.* 238 m
Distance between treated plots		0 m
Type of spray equipment, if used		Gandy Model 42 EQP #9-2
Total volume of spray solution applied/plot or total amount broadcasted/plot		1066.18 g
Identification and volume of carrier (e.g., water), if used		Formulated granular (10% a.i.)
Name and concentration of co-solvents, adjuvants, and/or surfactants, if used		NA
Indicate whether the following was submitted: Hourly/Daily/Monthly Precipitation Daily/Monthly average minimum and maximum air temperature Daily/Monthly average minimum and maximum soil temperature Average annual frost-free periods		 Daily and monthly precipitation Daily and monthly average minimum and maximum air temperature Daily and monthly average soil temperature No
Indicate whether the pan evaporation data were submitted		Daily and monthly evapotranspiration were reported
Meteorological conditions during application	Cloud cover	60%
	Temperature (ºF)	68
	Humidity	55%
Indicate if any extreme climatic events occurred during the study (e.g., drought, heavy rainfall, flooding, storm, etc.)		None.
Supplemental irrigation used (Yes/No) If yes, provide the following details: No. of irrigation: Interval between irrigation: Amount of water added each time: Method of irrigation:		Yes 92 As needed 0.25-0.75 inches Sprinkler solid set
Indicate whether water received through rainfall + irrigation equals the 30-year average rainfall (Yes/No)		Greater than 10-year average rainfall
Were the application rates verified?		Yes
Were field spikes used?		Yes
Were good agricultural practices followed (Yes or No)		Yes

Details	Terra Bella, California Treated plot
If cropped plots were used, provide the following details: Plant - Common name/variety: Details of planting: Crop maintenance (e.g., fertilizers used):	NA
Was volatilization included in the study? (Yes/No)	No
Was leaching included in the study? (Yes/No)	Leaching assessed using residue data from 36-inch soil cores.
Was runoff included in the study? (Yes/No)	No
Was plant uptake or canopy monitoring included in the study? (Yes/No)	No

Data were obtained from p. 16; Table 6, pp. 28-29; and Appendix F, pp. 324-334 of the study report.
NA = Not Applicable.

D. Sampling:

Specifications on the methods used for the field dissipation study are shown in **Table 5**.

Table 5. Sampling

Details	Treated Plot
Method of sampling (random or systematic)	Random subsections
Sampling intervals	-1, 0, 1, 7, 14, 30, 61, 118, 180, and 271 days after application
Method of collection (e.g., soil cores)	Soil cores taken with a Giddings Hydraulic 2-Stage Probe equipped with acetate liners.
Sampling depths or heights	0-6-inch core on the day of application. 0-6-inch and 6-36-inch cores during subsequent sampling events.
Number of cores collected per plot	15 (five per subplot)
Number of segments per core (if applicable)	Up to six
Length of soil segments (if applicable)	6 inches
Core diameter (Provide details if more than one width) (if applicable)	2.31 inches (0-6 in); 1.81 inches (6-36 in)
Method of sample processing, if any	The 0-6-inch core was not segmented. The 6-36-inch core was segmented into 6-inch pieces from bottom to top. Segments from the same depth were composited into one sample from each subplot. The composited samples from each sampling interval were homogenized from the deepest to the shallowest depth. Composited samples were mixed with a Hobart food chopper (GR-14-92) or by hand to a homogeneous consistency at the time of weigh-out. The mixed sample was labeled and returned to frozen storage pending analysis.

Details	Treated Plot
Shipping time to Storage Facility (hours)	*ca.* 24 to 72
Storage conditions	All samples were placed in freezer storage within four hours of collection and stored frozen except during analysis.
Storage length (days)	Maximum treated sample storage length was 169 days.

Data obtained from p. 22; Table 9, p. 31; and Appendix D, pp. 301-320 of the study report.

E. Analytical Procedures:

One sample was analyzed from each subplot composite sample during each sampling interval (p. 17). Selected 0-6-inch composite samples were analyzed three or four times to confirm the results (pp. 20-21; Table 16, pp. 37-44).

The analytical method used to quantify triallate and TCPSA residues in soil samples was Monsanto method LLN-R/M-ASOP-063-2, entitled "*Analytical Standard operating Procedure for Triallate and TCPSA Residues,*" as updated by Morse Laboratories (Monsanta, 1992; Morse Laboratories Inc., 2007a, 2007b; pp. 17-18; Appendix B, pp. 80-85,173-210).

Triallate and TCPSA residues were extracted from soil with 80% acetone/water. An aliquot of the crude extract was centrifuged. For triallate analysis, 5% aqueous sodium sulfate and 40-50% aqueous sodium hydroxide were added to an aliquot of the supernatant. Triallate was partitioned into isooctane using 2 extractions. The isooctane extracts were dried through sodium sulfate, combined, concentrated (if necessary), diluted with isooctane, and submitted to GC analysis.

For TCPSA analysis, residues were isolated from the aqueous phase remaining following isooctane partition for triallate. The aqueous phase was acidified with sulfuric acid and extracted with dichloromethane (DCM). The DCM (wash) was discarded. Tetrabutylammonium hydrogen sulfate was added to the remaining aqueous phase, and TCPSA was partitioned into DCM using 2 extractions. The DCM extracts were combined and evaporated to dryness. The residue was reconstituted in deionized water and the solution was further purified by means of ion exchange chromatography. The resulting purified extract was submitted to LC-MS/MS analysis. Later in the study, the method was modified to eliminate the DCM wash and ion-exchange chromatographic cleanup. An aliquot of the supernatant from the original centrifuged crude extract was concentrated and then diluted in HPLC solvents for direct analysis by LC-MS/MS.

Triallate extracts were analyzed by an HP chromatograph Model 6890 equipped with an HP 5973 mass selective detector (EI mode), a Hewlett-Packard 7683 autosampler, and an HP G1701BA MS ChemStation. The column was a 10 m × 0.18 mm i.d. fused silica column crossbonded with 0.40-µm film thickness, RTX-35. Helium was used as the carrier gas (Appendix B, pp. 80-85).

TCPSA samples were analyzed by HPLC employing mass spectrometric (MS/MS) detection using a PE Sciex API 2000 LC/MS/MS system in negative ionization mode. The column was a HyPurity C8 (Hypersil or Thermo Electron) column measuring 150 mm × 3.0 mm with a 5

micron particle size. Mobile phase A was acetonitrile:water:acetic acid (10:90:1,v:v:v), and Mobil Phase B was acetonitrile:water:acetic acid (50:50:1,v:v:v).

The limit of quantitation (LOQ) was 0.01 ppm for triallate and TCPSA (p. 14). The limit of detection (LOD) was defined as one-third the LOQ or 0.003 ppm for both analytes.

F. Verification of the Extraction Method and Storage Stability:

1. Field and Laboratory Spike Recoveries:

Three sets of field spikes were prepared during the course of the study at 0, 30 and 180 days after application, including soil samples for the 0-6 inch depth interval and 6-12 inch depth interval (p. 288). Field spikes were shipped to the laboratory in the same shipment as the regular samples. All field spike recoveries from 0 days after application and 30 days after application were within the acceptable range of 70 to 120%. Overall triallate recoveries at fortification levels of 0.1 ppm (10×LOQ, n = 12) and 0.5 ppm (50×LOQ, n = 12) ranged from 75 to 113% (Table 12, p. 33 and Appendix B, Tables 7-8, pp. 123-126). The average triallate recovery at 0 days after application was 95% ± 6.3% (SD) and at 30 days after application was 96% ± 15%. Overall TCPSA recoveries at fortification levels of 0.1 ppm (10×LOQ, n = 12) and 0.5 ppm (50×LOQ, n = 12) ranged from 90 to 105%. The average TCPSA recovery at 0 days after application was 98% ± 4.6% and at 30 days after application was 99% ± 2.8%. The field spike samples prepared at 180 days after application were not analyzed.

Mean Field Spike Recoveries

Analyte	Fortification Level (ppm)		
	0.1 (n = 12)	0.5 (n = 12)	Overall (n = 24)
Triallate	94.1%	96.8%	95.4%
Analyte	Fortification Level (ppm)		
	0.0911 (n = 12)	0.456 (n = 12)	Overall (n = 24)
TCPSA	98.9%	98.4%	98.7%

Data were obtained from Table 12, p. 33 and Appendix B, Tables 7-8, pp. 123-126 of the study report. Average recoveries were reviewer-calculated (Field Spikes worksheet of the accompanying spreadsheet).

The method was verified at 0.01 (LOQ) and 0.50 ppm fortification levels on 0-12 inch soil samples collected from the test plots prior to sample analysis (p. 19). Method verification recoveries ranged from 70 to 91% (mean = 79% ± 7.0, n=6) and 98 to 109% (mean = 103% ± 4.7, n=6) for triallate and TCPSA, respectively (Table 10, p. 32).

Procedural control samples were analyzed in conjunction with each analytical set for quality control purposes (p. 19). All laboratory procedural recoveries were within the acceptable range of 70 to 120%. Triallate recoveries (n = 48) ranged from 73 to 113% (Table 11, p. 32). The average triallate recovery was 91% ± 8.4% (SD). Triallate fortification levels were 0.01 (n = 23), 0.05 (n = 1), 0.1 (n = 2), 0.5 (n = 18), 3.0 (n = 1), 5.0 (n = 1), 10 (n = 1), and 20 ppm (n = 1). TCPSA recoveries (n = 50) ranged from 71 to 108%. The average TCPSA recovery was 93% ± 10%. TCPSA fortification levels were 0.01 (n = 23), 0.05 (n = 1), 0.1 (n = 2), 0.5 (n = 21), 2.0 (n = 1), 3.0 (n = 1), and 5.0 ppm (n = 1).

Mean Laboratory Spike Recoveries

Analyte	Fortification level (ppm)	n	Recoveries (%)	
			Range	Mean
Triallate	0.01	23	73-113	91.0
	0.05	1	94	94.0
	0.1	2	86-89	87.5
	0.5	18	77-107	90.1
	3.0	1	86	86.0
	5.0	1	100	100.0
	10	1	96	96.0
	20	1	84	84.0
TCPSA	0.01	23	71-104	92.8
	0.05	1	71	71.0
	0.1	2	72-74	73.0
	0.5	21	71-108	97.2
	2.0	1	87	87.0
	3.0	1	84	84.0
	5.0	1	84	84.0

Data were obtained from Table 11, p. 32 of the study report. Average recoveries were reviewer calculated (Laboratory Spikes worksheet of the accompanying spreadsheet).

2. Storage Stability Study:

Composited soil samples were placed in freezer storage within four hours of collection, stored frozen, and shipped via ACDS freezer truck to the analytical laboratory (p. 17). Freezer stability of triallate and TCPSA residues in soil was determined in a previous study (MRID 40730605) and has been shown to be stable for more than 3 years (p. 22). The maximum storage interval from collection to analysis was 169 days for treated soil samples. One replicate of the zero day field fortification samples was stored in frozen storage for 222 days prior to analysis and demonstrates frozen stability at 222 days.

II. Results and Discussion

A. Application Verification:

Five disposable aluminum pans (12.8 inches × 8.7 inches) containing 800 g of sieved, air-dried soil were placed in each subplot prior to application (p. 16). Immediately after application, soil from the pans was transferred to a plastic bag and stored frozen until analysis. Recoveries from application monitors ranged from 49.1% to 183.0% of the expected value (p. 20 and Table 13, p. 34). The average recovery was 115.2% of the 1.7 lbs a.i./A application rate.

B. Findings:

Concentrations of triallate and its metabolite TCPSA in soil samples are shown in **Table 6** below.

Table 6. Concentration of Triallate and Metabolites in Soil, Expressed as ppm Parent Equivalents

Compound	Depth (cm)	Replicate	Concentration (ppm)								
			Sampling Interval (days)								
			0	1	7	14	30	61	118	180	271
Triallate	0-15	A	0.309	0.786	0.553	0.279	0.152	0.174	0.0992	0.0312	0.0302
		B	1.12	0.795	0.150	0.401	0.0615	0.340	0.0422	0.0618	0.0248
		C	0.391	0.500	0.871	0.682	0.126	0.165	0.0599	0.0302	0.00180
	15-30	A	NA	NA	ND	ND	0.00184	ND	ND	ND	ND
		B	NA	NA	ND	ND	0.00220	0.00319	ND	0.0329	ND
		C	NA	NA	ND	ND	ND	ND	ND	ND	ND
	30-45	A	NA	NA	ND	ND	ND	ND	ND	ND	ND
		B	NA	NA	0.00165	ND	ND	ND	ND	0.00508	ND
		C	NA	NA	ND	ND	ND	ND	ND	ND	ND
	45-60	A	NA	NA	NA	NA	NA	NA	NA	NA	NA
		B	NA	NA	NA	NA	NA	NA	NA	ND	NA
		C	NA	NA	NA	NA	NA	NA	NA	NA	NA
	60-75	A	NA	NA	NA	NA	NA	NA	NA	NA	NA
		B	NA	NA	NA	NA	NA	NA	NA	ND	NA
		C	NA	NA	NA	NA	NA	NA	NA	NA	NA
	75-90	A	NA	NA	NA	NA	NA	NA	NA	NA	NA
		B	NA	NA	NA	NA	NA	NA	NA	NA	NA
		C	NA	NA	NA	NA	NA	NA	NA	NA	NA

Compound	Depth (cm)	Replicate	Concentration (ppm)								
			Sampling Interval (days)								
			0	1	7	14	30	61	118	180	271
TCPSA	0-15	A	ND	ND	ND	0.00478	0.00823	0.0165	0.00711	ND	ND
		B	ND	ND	ND	0.00330	0.00656	0.0246	0.00679	0.00207	ND
		C	ND	ND	ND	0.00371	0.00908	0.0238	0.0141	0.00160	ND
	15-30	A	NA	NA	ND	ND	ND	ND	ND	ND	ND
		B	NA	NA	ND	ND	ND	ND	ND	ND	ND
		C	NA	NA	ND	ND	ND	ND	0.00191	ND	ND
	30-45	A	NA	NA	ND	ND	ND	ND	ND	ND	ND
		B	NA	NA	ND	ND	ND	ND	ND	ND	ND
		C	NA	NA	ND	ND	ND	ND	ND	ND	ND
	45-60	A	NA	NA	NA	NA	NA	NA	NA	NA	NA
		B	NA	NA	NA	NA	NA	NA	NA	ND	NA
		C	NA	NA	NA	NA	NA	NA	NA	NA	NA
	60-75	A	NA	NA	NA	NA	NA	NA	NA	NA	NA
		B	NA	NA	NA	NA	NA	NA	NA	ND	NA
		C	NA	NA	NA	NA	NA	NA	NA	NA	NA
	75-90	A	NA	NA	NA	NA	NA	NA	NA	NA	NA
		B	NA	NA	NA	NA	NA	NA	NA	NA	NA
		C	NA	NA	NA	NA	NA	NA	NA	NA	NA

Data were obtained from Table 16, pp. 37-44 of the study report. LOQ = 0.01 ppm; LOD = 0.003 ppm.
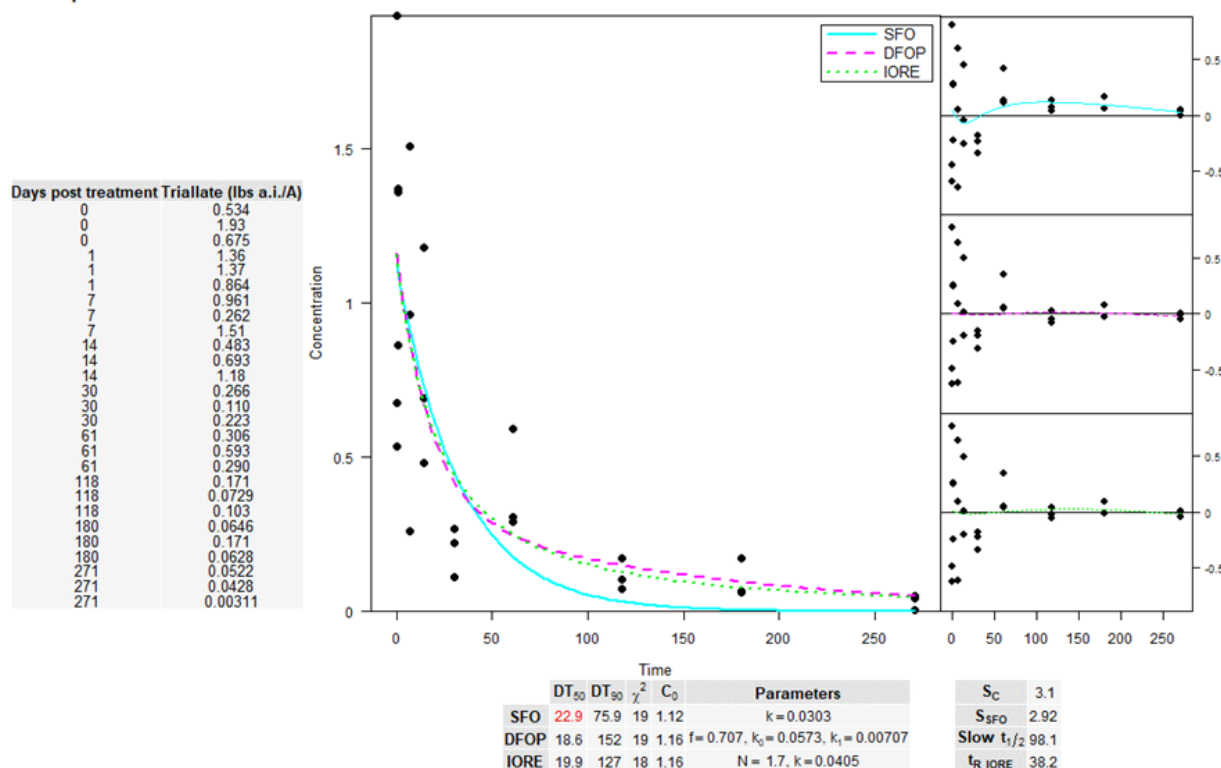TCPSA = 2,3,3-Trichloroprop-2-ene-1-sulfonic acid.
ND = not detected; NA = not analyzed.

C. Dissipation of Test Compound:

Under field conditions at the California site, triallate had a DT_{50} value of 22.9 days (SFO) in soil, calculated in accordance with NAFTA kinetics guidance (NAFTA, 2012), the SOP for using the NAFTA Guidance to calculate representative half-life values (USEPA, 2015), and EFED Contractor Technical Direction: Recommendations for Environmental Fate DERs (USEPA, 2020). The observed DT_{50} occurred between the 1- and 30-day sampling intervals. The study author reported a DT_{50} of 53.7 days based on an SFO model developed using a non-linear regression function of Excel (pp. 14, 21). Differences between the reviewer and study author's DT_{50} value is the result of the study author using average soil concentrations of triallate (Table 15, p. 36) instead of replicate concentrations as the reviewer did, and the study author using a different method for calculating DT_{50}.
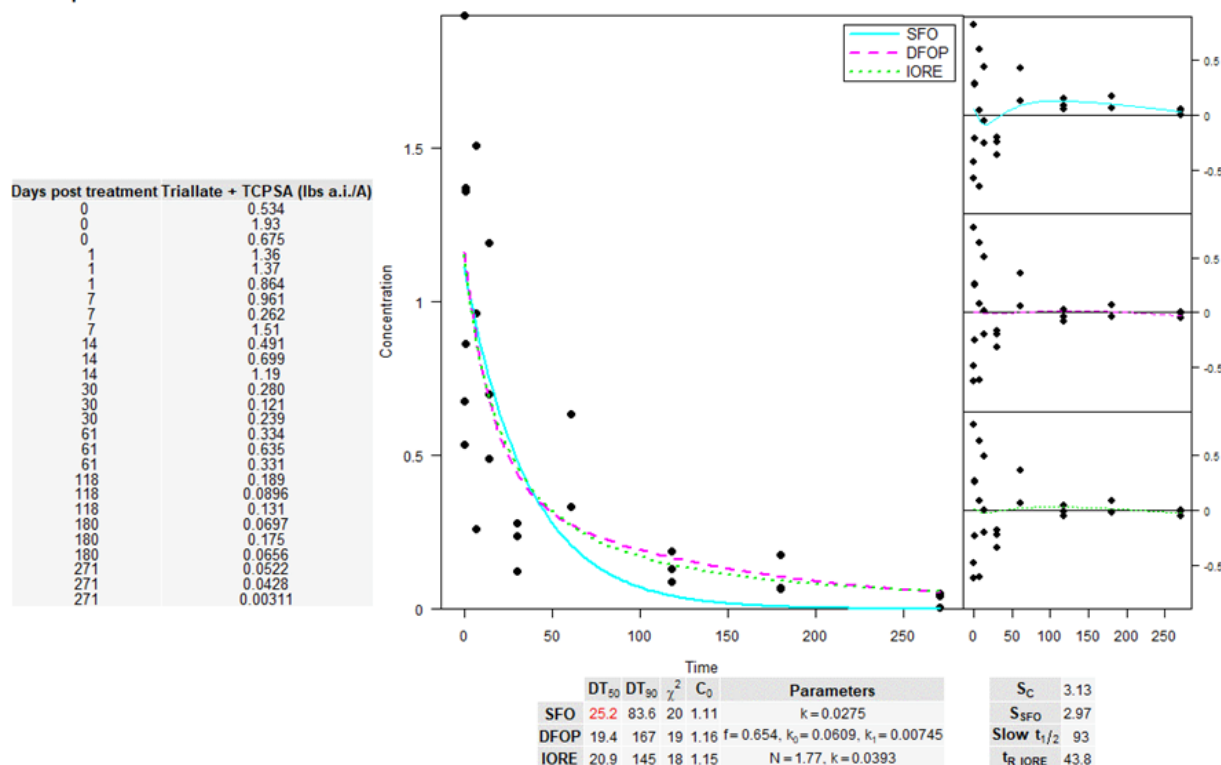
Under field conditions at the California site, total triallate (triallate plus TCPSA parent equivalents) had a DT_{50} value of 25.2 days (SFO) in soil. The observed DT_{50} occurred between the 1- and 30-day sampling intervals. The study author did not report a DT_{50} for total triallate.

Dissipation of Triallate from Soil - California

Days post treatment	Triallate (lbs a.i./A)
0	0.534
0	1.93
0	0.675
1	1.36
1	1.37
1	0.864
7	0.961
7	0.262
7	1.51
14	0.483
14	0.693
14	1.18
30	0.266
30	0.110
30	0.223
61	0.306
61	0.593
61	0.290
118	0.171
118	0.0729
118	0.103
180	0.0646
180	0.171
180	0.0628
271	0.0522
271	0.0428
271	0.00311

	DT_{50}	DT_{90}	χ^2	C_0	Parameters
SFO	22.9	75.9	19	1.12	$k = 0.0303$
DFOP	18.6	152	19	1.16	$f = 0.707, k_0 = 0.0573, k_1 = 0.00707$
IORE	19.9	127	18	1.16	$N = 1.7, k = 0.0405$

S_C	3.1
S_{SFO}	2.92
Slow $t_{1/2}$	98.1
$t_{R\ IORE}$	38.2

Kinetics models: Single First Order (SFO); Double First Order in Parallel (DFOP), and Indeterminate Order Rate Equation (IORE).

Dissipation of Combined Triallate and TCPSA from Soil - California

Days post treatment	Triallate + TCPSA (lbs a.i./A)
0	0.534
0	1.93
0	0.675
1	1.36
1	1.37
1	0.864
7	0.961
7	0.262
7	1.51
14	0.491
14	0.699
14	1.19
30	0.280
30	0.121
30	0.239
61	0.334
61	0.635
61	0.331
118	0.189
118	0.0896
118	0.131
180	0.0697
180	0.175
180	0.0656
271	0.0522
271	0.0428
271	0.00311

	DT_{50}	DT_{90}	χ^2	C_0	Parameters
SFO	25.2	83.6	20	1.11	$k = 0.0275$
DFOP	19.4	167	19	1.16	$f = 0.654, k_0 = 0.0609, k_1 = 0.00745$
IORE	20.9	145	18	1.15	$N = 1.77, k = 0.0393$

S_C	3.13
S_{SFO}	2.97
Slow $t_{1/2}$	93
$t_{R\ IORE}$	43.8

Kinetics models: Single First Order (SFO); Double First Order in Parallel (DFOP), and Indeterminate Order Rate Equation (IORE).

Table 7. Transformation Products of Triallate in the Field

Location	Transformation Product(s)	Maximum %Applied Observed	Associated Interval	Final %Applied Observed	Final Interval
California Bare ground Sandy loam pH 7.8	TCPSA	2.5%	61-day	ND	271-day

Data obtained from Table 16, pp. 37-44, of the study report and DER Attachment 2.
The Maximum %Applied Observed and Final %Applied Observed are fractions of the total triallate applied (reviewer calculated, spreadsheet 078802_51481102_DER-FATE_835.6100_ Calculations.xlsx).
TCPSA = 2,3,3-Trichloroprop-2-ene-1-sulfonic acid.
ND indicates the transformation product was not detected in the sample.

D. Mass Accounting:

The mass accounting was based primarily on the analysis of soil samples for triallate. Air samples were not collected to determine a more complete mass accounting of the dissipation pathways, but volatilization is believed to be minimal because triallate was applied as a granular product that was incorporated with a rototiller within *ca.* 25 minutes after application (p. 20; Table 17, p. 45). Runoff is likely to be minimal because the slope of the plot was <1%. The

initial mass balance recovery (triallate and TCPSA) from soil was 61.5% of the nominal applied triallate (based on the target rate). The maximum recovery of 70.5% occurred one day after application and declined to 1.9% by the end of the study 271 days after application. The study concluded after reviewing radiolabeled soil metabolism studies that biodegradation to TCPSA and subsequent biodegradation to non extractable residues and mineralization to carbon dioxide are the major dissipation pathways for triallate (p. 14). Detailed mass balance data for soil are provided in Appendix 1 of the DER.

Table 8. Summary of Mass Accounting for Dissipation Pathways[A]

Field Study Module	Percentage of Applied Mass at Time 0 (%)	Maximum Percentage of Applied Mass (%) and Time After Application (days)	Percentage of Applied Mass at Study Termination (%) and Time After Application (days)
Soil Profile	61.5%	70.5% (1 day)	1.9% (271 days)
Volatilization[B]	Minimal	Minimal	Minimal
Runoff or Water Body (Water and Sediment)[C]	Not measured	Not measured	Not measured
Plant and Canopy Residue or Plant Uptake (Shoots and Roots)	Not applicable	Not applicable	Not applicable

[A] Percentages of the applied values are reviewer-calculated based on the target application rate. N/A = Not applicable.
[B] The study reports volatilization to be minimal because triallate was applied as a granular material and incorporated with a rototiller *ca.* 25 minutes after application (p. 20; Table 17, p. 45).
[C] Runoff was not measured because the test plot had a slope of less than 1% (Table 17, p 45).

E. Residue Carry-Over:

The observed DT_{90} values for total triallate in soil at the California site occurred between the 61- and 271-day sampling intervals (reviewer calculated, spreadsheet 078802_51481102_DER-FATE_835.6100_Calculations.xlsx). At the end of the study, after 271 days posttreatment, 1.9% of the total triallate at application was detected in soil.

III. Study Deficiencies and Reviewer's Comments

1.   Recoveries from soil pan application verification monitors were variable, ranging from 49.1% to 183.0% of the expected value (p. 20 and Table 13, p. 34). The average recovery was 115.2% of the 1.7 lbs a.i./A application rate. Likewise, recoveries of triallate from soil on Day 0 and Day 1 after application were variable, ranging from 17.6% to 328.5% (mean 75.3 ± 86.2 %) on Day 0 and 35.2% to 252.3% (mean 94.3 ± 69.3%) on Day 1 (Table 14, p. 35). The study reported variability was due to the granular test substance formulation, and it being very difficult to obtain uniform distribution of a granular material on the soil surface (p. 21). Less variability was observed with the Day 1 results, indicating that the test substance had become more uniformly distributed in the soil after one day. USEPA guidance states that time zero sampling is recommended to verify residue concentrations reaching the target and confirm uniformity of its distribution. Based on soil pan recoveries and Day 0 recoveries from soil, time 0 sampling could not

confirm that residue concentrations reached the target of 1.7 lbs a.i./A or that the distribution of test substance was uniform.

2.   The study author generated dissipation curves and DT_{50} values for triallate based on the average of the three replicate samples during each sampling period instead of including each replicate independently as the reviewer did. In addition, the study author used a non-linear regression function of Excel to calculate the DT_{50} value while the reviewer follows EPA Guidance (USEPA, 2015) and utilizes the PestDF tool. The study author's DT_{50} value was almost two times higher than the reviewer-calculated value, and the reviewer determined the method for calculating the DT_{50} was the primary reason for the discrepancy between the reviewer and study author's DT_{50} value.

3.   The study applies triallate at *ca.* 110% of the proposed label rate, which equates to 1.7 lbs a.i./A (p. 13). The study calculated percent recoveries based on 1.7 lb a.i./A. It should be noted that recoveries expressed as % of target (Table 14, p. 35) and % of maximum application rate and maximum label rate (p. 14) are based on 1.7 lbs a.i./A.

4.   The study assumes a concentration of 0 ppm (page 88) instead of LOD if triallate or TCPSA was detected in some, but not all replicates during a sample period. EPA guidance recommends using the LOD.

5.   The analytical method was verified prior to sample analysis by testing soil samples at fortification levels of 0.01 and 0.5 ppm (pp. 17, 19; Table 10, p. 32). An independent laboratory method validation, however, was not indicated. A method validation study should be completed from an independent laboratory separate from and prior to the analysis of the test samples to verify the analytical methods.

6.   The study identifies the volume of the carrier for triallate as being "Formulated granular (10% a.i.), 5716 g" (Table 6, p. 28). This is not a volume. It is unclear how the value of 5,716 g was calculated.

7.   The study reports that average annual frost-free periods was reported (Table 6, p. 28). Average frost-free periods, however, are not reported in the study report.

8.   The study reports "*Gramoxone Extra 2.5SL/paraquat, 0.625 lbs a.i./A, Broadcast Ground (5 applications)*" was reported in Table 6, p. 29, but the correct formulated product is Far-Go Herbicide with 10% triallate a.i. in the study.

IV. References

1.   NAFTA. 2012. *Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media*. December 2012. NAFTA Technical Working Group on Pesticides. Available at: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/guidance-calculate-representative-half-life-values.

2.   Monsanto, 1992. *Analytical Standard Operating Procedure for Triallate and TCPSA Residues*. Document Number LLN-R/M-ASOP-063-2. Last update: November 16, 1992. Louvain-la-Neuve, Belgium.

3.   Morse Laboratories, Inc., 2007a. *Morse Laboratories, Inc. Method Modifications to Monsanto LLN-R/M-ASOP-063-2, "Analytical Standard Operating Procedure for Triallate and TCPSA Residues," November 16, 1992*. Sacramento, California. March 29, 2007.

4.   Morse Laboratories, Inc., 2007b. *Morse Laboratories, Inc. Method Modifications to Monsanto LLN-R/M-ASOP-063-2, "Analytical Standard Operating Procedure for Triallate and TCPSA Residues," November 16, 1992*. Sacramento, California. August 2, 2007.

5.   U.S. Environmental Protection Agency (USEPA). 2008. Fate, Transport and Transformation Test Guidelines, OCSPP 835.6100, Terrestrial Field Dissipation. Office of Chemical Safety and Pollution Prevention, Washington, DC. EPA 712-C-08-020.

6.   USEPA. 2015. *Standard Operating Procedure for Using the NAFTA Guidance to Calculate Representative Half-life Values and Characterizing Pesticide Degradation*. Office of Pesticide Programs Environmental Fate and Effects Division, Washington, DC. March 23, 2015. Available at: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/guidance-calculate-representative-half-life-values.

7.   USEPA. 2020. EFED Contractor Technical Direction: Recommendations for Environmental Fate DERs. Office of Pesticide Programs Environmental Fate and Effects Division, Washington, DC. August 6.
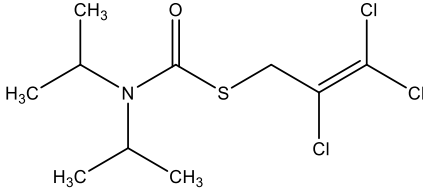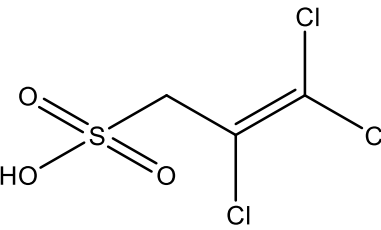
Appendix 1: Mass Accounting Calculations

Table 9. Residues of triallate and TCPSA in soil expressed as percent of the nominal application rate – California bare ground

Compound	Depth (cm)	Replicate	Concentration (% of Applied)								
			Sampling Intervals (days)								
			0	1	7	14	30	61	118	180	271
Triallate	Total	Mean	61.5%	70.5%	53.6%	46.2%	11.7%	23.3%	6.8%	5.9%	1.9%
TCPSA	Total	Mean	0.0%	0.0%	0.0%	0.4%	0.8%	2.2%	1.2%	0.2%	0.0%
Total			61.5%	70.5%	53.6%	46.6%	12.6%	25.5%	8.0%	6.1%	1.9%

Reviewer-calculated (see Excel file). Percent of the applied is based on the target application rate.

Attachment 1: Chemical Names and Structures

DER ATTACHMENT 1. Triallate and Its Environmental Transformation Products. [A]

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Maximum %AR (day)	Final %AR (study length)
PARENT						
Triallate	**IUPAC:** S-2,3,3-trichloroallyl diisopropyl(thiocarbamate) **CAS:** S-(2,3,3-trichloro-2-propen-1-yl) N,N-bis(1-methylethyl)carbamothioate **CAS No.:** 2303-17-5 **Formula:** $C_{10}H_{16}Cl_3NOS$ **MW:** 304.6 g/mol **SMILES:** CC(C)N(C(C)C)C(=O)SCC(Cl)=C(Cl)Cl		835.6100 Terrestrial field dissipation	51481102	PRT	PRT
TRANSFORMATION PRODUCTS						
TCPSA	**IUPAC:** 2,3,3-Trichloroprop-2-ene-1-sulfonic acid **Formula:** $C_3H_3Cl_3O_3S$ **MW:** 225.46 g/mol **SMILES:** O=S(C/C(Cl)=C(Cl)/Cl)(O)=O		835.6100 Terrestrial field dissipation	California (Bare ground) 51481102	2.5% (61 d)	ND (271 d)
REFERENCE COMPOUNDS NOT IDENTIFIED						
All compounds used as reference compounds were identified.						

[A] AR means "applied radioactivity". MW means "molecular weight". PRT means "parent". NA means "not applicable". ND means "not detected".

Attachment 2: Statistics Spreadsheets and Graphs

Attachment 3: Calculations

Calculations were performed by the reviewer using R (version 3.6.0), PestDF (version 0.8.13), and the following equations.

Single First-Order (SFO) Model

$$C_t = C_0 e^{-kt}$$

(eq. 1)

where,

C_t = concentration at time t (%)
C_0 = initial concentration (%)
e = Euler's number (-)
k = SFO rate constant of decline (d^{-1})
t = time (d)

The SFO equation is solved [with the Excel Solver] by adjusting C_0 and k to minimize the objective function (S_{SFO}) shown in equation 9.

DT$_{50}$ = natural log (2)/k   (eq. 2)

DT$_{90}$ = ln (10)/k   (eq. 3)

Indeterminate Order Rate Equation (IORE) Model

$$C_t = \left[C_0^{(1-N)} - (1-N)k_{IORE}t \right]^{\left(\frac{1}{1-N}\right)}$$

(eq. 4)

where,

N = order of decline rate (-)
k_{IORE} = IORE rate constant of decline (d^{-1})

This equation is solved [with the Excel Solver] by adjusting C_0, k_{IORE}, and N to minimize the objective function for IORE (S_{IORE}), see equation 9. Half-lives for the IORE model are calculated using equation 5, which represents a first-order half-life that passes through the DT$_{90}$ of the IORE model. (Traditional DT$_{50}$ and DT$_{90}$ values for the IORE model can be calculated using equations 6 and 7.)

$$t_{IORE} = \frac{\log(2)}{\log(10)} \frac{C_0^{1-N}\left(1 - 0.1^{(1-N)}\right)}{(1-N)k_{IORE}}$$

(eq. 5)

$$DT_{50} = \frac{(C_0/2)^{(1-N)} - C_0^{(1-N)}}{k(N-1)}$$

(eq. 6)

$$DT_{90} = \frac{(C_0/10)^{(1-N)} - C_0^{(1-N)}}{k(N-1)}$$

(eq. 7)

Double First-Order in Parallel (DFOP) Model

$$C_t = C_0 g^{-k_1 t} + C_0 (1 - g)^{-k_2 t}$$

(eq. 8)

where,

g = the fraction of C_0 applied to compartment 1 (-)
k_1 = rate constant for compartment 1 (d^{-1})
k_2 = rate constant for compartment 2 (d^{-1})

If C_0 x g is set equal to *a* and $C_0(1\text{-}g)$ is set equal to *c*, then the equation can be solved [with the Excel Solver] for *a*, *c*, k_1, and k_2 by minimizing the objective function (S_{DFOP}) as described in equation 9.

DT_{50} and DT_{90} values can be calculated using equations 2 and 3, with k_1 or k_2 in place of k.

Objective Function: SFO, IORE, and DFOP are solved by minimizing the objective function (S_{SFO}, S_{IORE}, or S_{DFOP}).

$$S_{SFO}, S_{IORE}, \text{or } S_{DFOP} = \sum \left(C_{model}, t - C_{d,t} \right)^2$$

(eq. 9)

where,

S_{SFO} , S_{IORE}, or S_{DFOP} = objective function of kinetics model fit ($\%^2$)
n = number of data points (-)
$C_{model,t}$ = modelled value at time corresponding to $C_{d,t}$ (%)
$C_{d,t}$ = experimental concentration at time t (%)

Critical Value to Determine Whether SFO is an Adequate Kinetics Model

If S_{SFO} is less than S_C, the SFO model is adequate to describe kinetics. If not, the faster of t_{IORE} or the DFOP DT_{50} for compartment 2 should be used.

$$S_c = S_{IORE} \left(1 + \frac{p}{n-p} F(\alpha, p, n - p) \right)$$

(eq. 10)

where,

S_c = the critical value that defines the confidence contours ($\%^2$)
p = number of parameters (3 in this case)
α = the confidence level (0.50 in this case)
$F(\alpha, p, n\text{-}p)$ = F distribution with α level of confidence and degrees of freedom p and n-p