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DISSIPATION OF DISLODGEABLE FOLIAR CYFLUTHRIN RESIDUE

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Executive Summary

Illness Incident - In early May 1997, physicians reported an outbreak of respiratory irritation among orange harvesters exposed to cyfluthrin residues in Tulare County. The workers experienced symptoms involving primarily respiratory irritation; these symptoms included runny nose, sneezing, coughing and sore throat. Other symptoms included headache, nausea, and skin and eye irritation. The workers picked in groves recently treated with cyfluthrin (Baythroid® 2). Physicians treated the workers at a local hospital and released them; most returned to work the next day.

Methods – The registration status of cyfluthrin changed just prior to this episode. In California, application of cyfluthrin to oranges close to harvest had not been legal prior to April 1997.
As part of the episode investigation, Department of Pesticide Regulation (DPR) staff conducted an inhalation exposure study[1] and collected citrus foliage from eight orange groves to characterize residue dissipation. Pest control operators treated all groves sampled with cyfluthrin at 0.1lb. active ingredient in 100 - 250 gallons of water per acre. All tank mixes also included nutrients or buffers. This report documents the methods and results of the residue dissipation efforts

Results - Using nonlinear regression analysis, the model *ln* DFR = a + b * √(Days) was the lowest-order model that fit well for most of the fields. The dissipation rates in the eight fields seem to fall into two distinct decay patterns. Decay was more rapid in fields 1, 2, 3 and 16 and considerably longer in fields 4, 6 and 7. (In field 5 there was no apparent dissipation; researchers suspect application errors.)

Discussion - The reasons for the differences in decay are unknown; but may be related to the use of urea and/or potassium nitrate in the tank mix with cyfluthrin. The half-life for fields 4, 6 and 7 under the fitted model is not constant, as it would be with a first-order exponential decay model. Instead, each half-life is longer than the preceding one. The first two half-lives for fields 4, 6 and 7 can be approximated; they are 11 and 32 days, respectively. At 65 days post-application, approximately 10-20% of the initial residue is still present.

[1] Edmiston, S., J. Spencer, B. Hernandez and A.S. Fredrickson. 1998. Inhalation exposure of orange harvesters to cyfluthrin residue. California Environmental Protection Agency, Department of Pesticide Regulation, Worker Health and Safety. Report No. HS-1765

Introduction

On May 6, 1997, the Department of Pesticide Regulation (DPR) received notice that numerous citrus harvesters had received medical care on May 3, 1997. The workers experienced symptoms involving primarily respiratory irritation; these symptoms included runny nose, sneezing, coughing and sore throat. Other symptoms included headache, nausea, and skin and eye irritation. The workers picked in a grove treated three days earlier with cyfluthrin (Baythroid® 2). Physicians treated the workers at a local hospital and released them; most returned to work the next day. A second group of workers experienced similar symptoms on May 7, 1997, and were taken for medical evaluation. The second crew worked in a grove treated with cyfluthrin 10 days earlier. Later that afternoon, a single worker from a third harvest crew received medical care for similar symptoms. That worker was in a grove treated 11 days earlier. These incidents occurred in employees from a single packing company in Tulare County, California.

The following information summarizes some California registration information that may have been a factor in these illness episodes. On April 2, 1997, DPR issued a Section 18 registration (emergency exemption) for cyfluthrin on navel oranges with a 150-day preharvest interval (PHI). (The PHI was set at 150 days in lieu of evaluation of citrus residue data.) On April 10, 1997, following U.S. EPA approval of a time-limited tolerance, that Section 18 registration was amended and the PHI changed to “up to day of harvest.” On April 28, 1997, the Section 18 was again amended to include all citrus. Finally, on April 30, 1997, again following U.S. EPA approval, a Section 3 registration (full registration) was issued for use on all citrus with a PHI of "up to day of harvest." The Section 3 registration restricted entry interval is 12 hours. Thus, in California, application of cyfluthrin to oranges close to harvest had not been legal prior to April 10, 1997.

California law requires physicians to report pesticide-related illnesses and injuries. These incidents are investigated and the data entered into a database, the Pesticide Illness Surveillance Program. From 1990-1995, 108 illness/injury cases were recorded in PISP as related to cyfluthrin exposure[1]. Of those 108 cases, use of cyfluthrin in agricultural settings led to 15 cases. Only two of the 15 involved field workers exposed to residue. One worker, irrigating plants in a greenhouse 24 hours after application, developed a rash on his arms. Another worker developed a rash while pruning trees. The orchard had been treated the same day, but the spray was dry so reentry was legal at that time.

Technical cyfluthrin [(RS)-α-cyano-4-fluoro-3-phenoxybenzyl (1RS, 3RS:1RS, 3SR)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate] is a viscous, partly crystalline, amber oil with a molecular weight of 434.3. Baythroid® 2 is a non-systemic pyrethroid insecticide formulated as an emulsifiable concentrate. The primary use on citrus is to control thrips. Numerous cyfluthrin food residue studies are on file with DPR. However, citrus dislodgeable foliar residue dissipation studies are not available.

Methods

The study was conducted according to the Cluster Illness Episode Action Plan[2] and followed applicable standard operating procedures related to project identification, sample identification,

dislodgeable foliar residue (DFR) sample collection, record keeping, shipping and storage, and report preparation. There was no study-specific protocol as the study was conducted as part of a worker illness investigation, which did not allow adequate time for required reviews.

Study Dates:

Study initiation date:	May 9, 1997
Experimental start date:	May 9, 1997
Experimental termination date:	July 17, 1997
Study completion date:	March 31, 1998

Application Information: Study staff monitored DFR dissipation in eight fields. All fields were treated with 6.4 oz (0.1 lb. active ingredient) Baythroid® 2 (U.S. EPA registration #3125-351 AA) in 100 - 250 gallons per acre. Appendix 1 contains specific treatment and field condition information for the eight fields monitored in this study. Study staff were unable to observe any of the applications completed for this study, as 6 of 8 were treated prior to study initiation. The other two were treated on short notice and staff could not be present. To confirm the application, study staff obtained either the notice of intent to apply or the application use record. There is some question about the application to field 5; part of the field may not have been treated. Investigators were unable to confirm the application to a portion of field 5.

Dislodgeable Foliar Residue Sampling: Foliage samples were collected with a Rabbit Tool[3] U.S.A., Inc. precision leaf sampler for analysis of DFR. Each sample consisted of 40 leaf discs, each 2.523 cm in diameter, for a total sample surface area of 400 cm^2. Leaf discs were taken at a height of 4-7 feet.

Pre-application samples were collected from one grove. Generally, samples were collected at 1, 2, 4 and 7 days post-application, then weekly, thereafter. Since the fields were treated on different days, the sampling schedule varied slightly to consolidate sample collection, shipping and analysis. Samples were collected until DFR dropped below the limit of detection. DFR samples were shipped to the analytical laboratory chilled on ice (not frozen). DFR residue washing and extraction occurred within 24 hours of sample collection.

DFR Analytical Method: Each leaf disk sample was washed three times with a surfactant/distilled water solution. The washes were combined, extracted three times with ethyl acetate and concentrated to near dryness. The extract was analyzed on a Hewlett-Packard (HP) 1050 liquid chromatograph system using a 15-cm Econosphere C8 Alltech cartridge system and water/acetonitrile gradient at 1 mL/min. Thirty microliters were injected. The detector was a HP 1050 Variable Wavelength Detector at 223 nm. Under these conditions, cyfluthrin eluted in 15 minutes. Recoveries were in the 80-120% range[4].

DFR Calculations: DFR sample results were reported in micrograms per sample and recorded in a relational database (Microsoft Access®[5]). The results were then converted to $\mu g/cm^2$ by dividing the sample result by the total sample surface area of 400 cm^2.

Following logarithmic transformation of the DFR, some nonlinearity was still evident and nonlinear models were investigated. The statistical software package TableCurve©[6] was used to

look for an optimal model to describe dissipation in all eight fields. The model was fit using SAS©PROC REGRESSION[7].

Results

Cyfluthrin DFR (ug/cm^2) is plotted against day post-application for each of the eight fields in Figures 1 and 2 (fields are separated by pattern of dissipation). In these figures, the plotted points represent individual samples. The model $ln\ DFR = a + b*\sqrt{(Days)}$ was chosen because it was the lowest-order decay model that fit well for most of the fields. Although somewhat better fits could be obtained using higher-order (i.e., more parameters) models and/or a different model for each field, doing so risks letting the fit be overly influenced by the noise in each dataset. Table 1 summarizes the fit of the model. Appendix 2 contains the raw data collected from the eight fields.

Figure 1: DFR dissipation in Fields 1, 2, 3 and 16

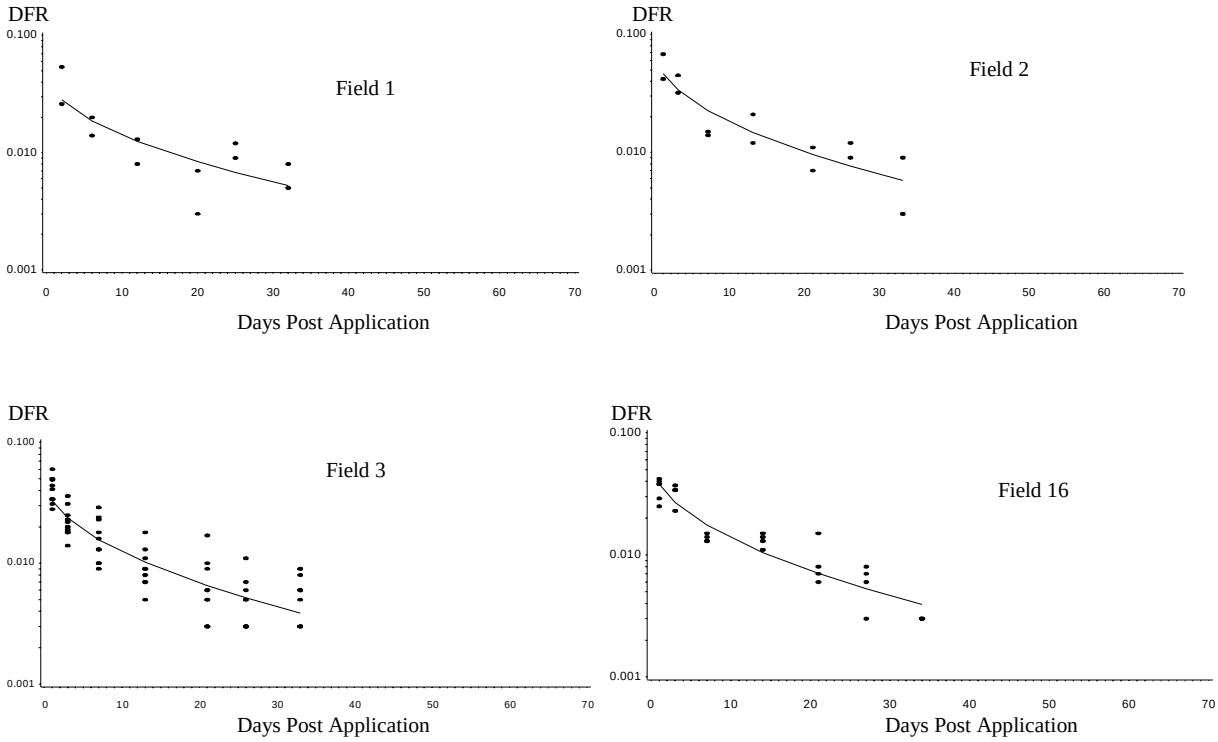

Figure 2: DFR dissipation in Fields 4, 6, 7 and 5

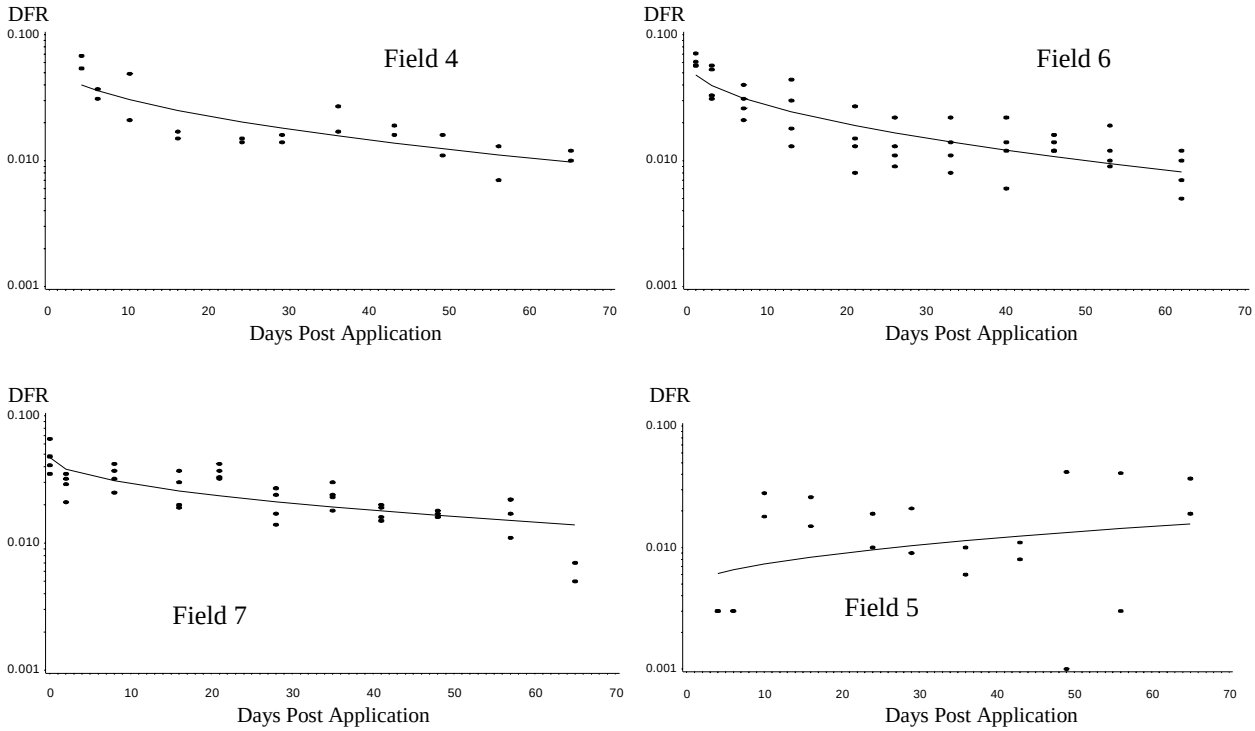

Table 1: Fit of the model *ln DFR = a + b*√(Days after application)* in eight fields

Field	Intercept (*a*)	Slope (*b*)	R^2
1	-3.009	-0.397	0.63
2	-2.625	-0.441	0.81
3	-2.969	-0.450	0.75
4	-2.754	-0.233	0.67
5	-5.405	0.155	0.09
6	-2.782	-0.258	0.69
7	-3.050	-0.152	0.55
16	-2.802	-0.470	0.89

Except for field 5, initial deposition (as reflected by the model intercept) was similar across fields. In addition, dissipation rates (as reflected by the model slope) fall into two distinct groups, consisting of fields 1, 2, 3 and 16, and fields 4, 6 and 7. Dissipation was more rapid in the first group. The reasons for the difference are unknown; but the use of urea and /or potassium nitrate may be associated with longer half-lives.

In field 5 there was no apparent dissipation. It appears, in fact, that DFR increased. These anomalous results are suspected to be due to application errors. Therefore, field 5 was excluded from further analysis.

Fields 4, 6 and 7 were pooled to estimate the overall dissipation rate, which would be the conservative basis for determining restricted entry intervals. The unit for this analysis was the mean *ln* DFR of the samples taken on a given day in each field. The model $ln\ DFR = -2.8698 - 0.2157 * \sqrt{Days}$ ($R^2 = 0.75$) was fit to the combined fields using SAS© PROC REGRESSION[7].

Predicted mean DFR by day post-application (fields 4, 6, and 7) was back calculated from predicted mean *ln* DFR using the Bradu-Mundlak unbiased estimate of the mean of a lognormal distribution[8]. Predicted and actual mean DFR are plotted in Figure 3. Table 2 gives predicted mean DFR and upper 90 and 95% prediction limits by day after application. The 90% upper prediction limit for a given day is the value of mean DFR below which 90% of fields should fall on that day. Half-life under the fitted model is not constant, as it would be for a first-order exponential decay model. Instead, each successive half-life is longer than the preceding one. The first two half-lives for fields 4, 6 and 7 can be approximated from Table 2 at 11 and 32 days, respectively.

Figure 3: Predicted and actual mean DFR (µg/cm²) in Fields 4, 6 and 7

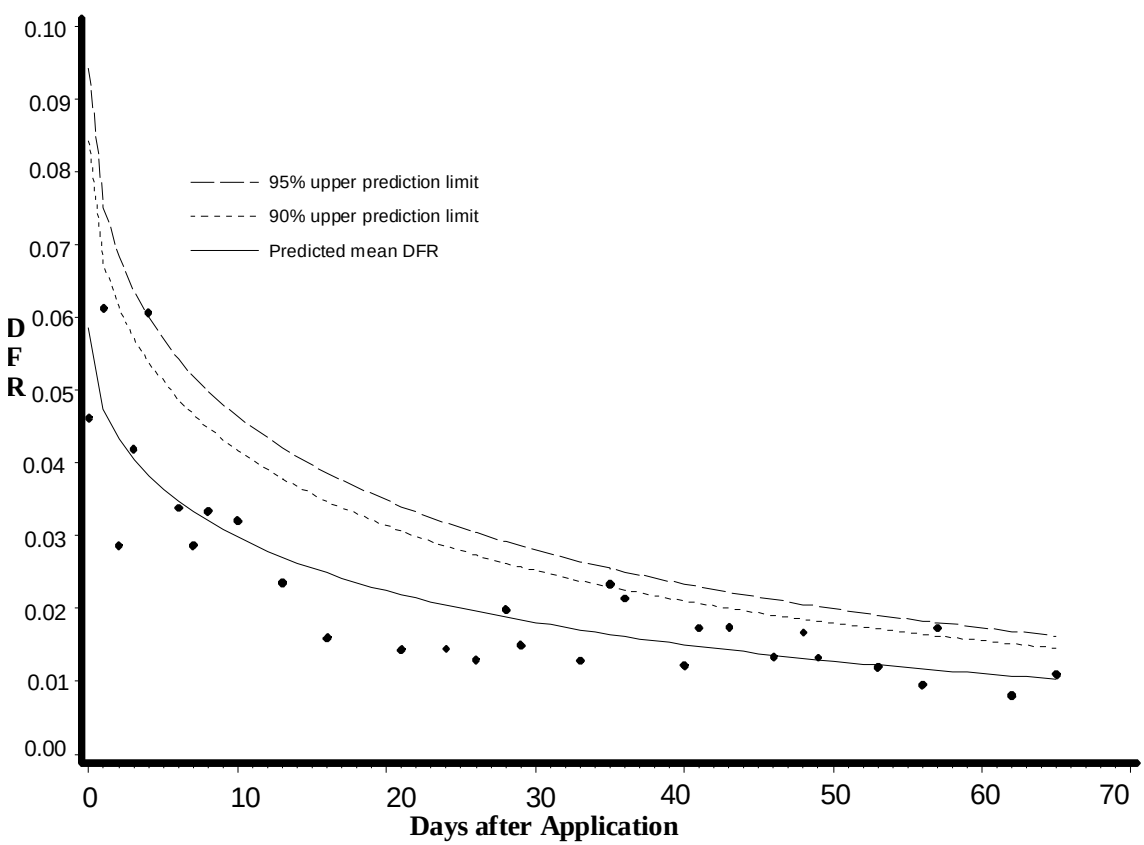

Table 2: Predicted mean DFR (µg/cm²) and upper prediction limits by day after application.

Days	Mean	90% limit	95% limit	Days	Mean	90% limit	95% limit
0	0.059	0.084	0.094	36	0.016	0.023	0.025
1	0.047	0.067	0.075	37	0.016	0.022	0.025
2	0.043	0.061	0.068	38	0.016	0.022	0.024
3	0.040	0.057	0.064	39	0.015	0.021	0.024
4	0.038	0.054	0.060	40	0.015	0.021	0.023
5	0.036	0.051	0.057	41	0.015	0.021	0.023
6	0.035	0.049	0.054	42	0.015	0.020	0.023
7	0.033	0.047	0.052	43	0.014	0.020	0.022
8	0.032	0.045	0.050	44	0.014	0.020	0.022
9	0.031	0.043	0.048	45	0.014	0.019	0.021
10	0.030	0.042	0.046	46	0.014	0.019	0.021
11	0.029	0.041	0.045	47	0.013	0.019	0.021
12	0.028	0.039	0.043	48	0.013	0.019	0.021
13	0.027	0.038	0.042	49	0.013	0.018	0.020
14	0.026	0.037	0.041	50	0.013	0.018	0.020
15	0.026	0.036	0.040	51	0.013	0.018	0.020
16	0.025	0.035	0.039	52	0.012	0.017	0.019
17	0.024	0.034	0.038	53	0.012	0.017	0.019
18	0.024	0.033	0.037	54	0.012	0.017	0.019
19	0.023	0.032	0.036	55	0.012	0.017	0.018
20	0.022	0.032	0.035	56	0.012	0.016	0.018
21	0.022	0.031	0.034	57	0.012	0.016	0.018
22	0.021	0.030	0.033	58	0.011	0.016	0.018
23	0.021	0.029	0.032	59	0.011	0.016	0.017
24	0.021	0.029	0.032	60	0.011	0.016	0.017
25	0.020	0.028	0.031	61	0.011	0.015	0.017
26	0.020	0.027	0.030	62	0.011	0.015	0.017
27	0.019	0.027	0.030	63	0.011	0.015	0.017
28	0.019	0.026	0.029	64	0.010	0.015	0.016
29	0.018	0.026	0.029	65	0.010	0.015	0.016
30	0.018	0.025	0.028	66	0.010	0.015	0.016
31	0.018	0.025	0.027	67	0.010	0.014	0.016
32	0.017	0.024	0.027	68	0.010	0.014	0.016
33	0.017	0.024	0.026	69	0.010	0.014	0.015
34	0.017	0.023	0.026	70	0.010	0.014	0.015
35	0.016	0.023	0.026				

Discussion

In this study we found that dissipation rate (as reflected by the model slope) fell into two distinct groups, consisting of fields 1, 2, 3 and 16, and fields 4, 6 and 7; dissipation was more rapid in the first group. The observation that a pesticide may exhibit distinctly different dissipation patterns in the same crop has been noted previously. Reeve and O'Connell (1990)[9] found the half-life of methomyl residue dissipation from grape foliage increased throughout the growing season. In June 1989, the dissipation half-life was 2.07 days and gradually increased to 4.39 days in October 1989. In the current work, the different dissipation profiles were observed at approximately the same time in the growing season; all eight groves were treated between May 5 and May 27. In addition, the 8 groves were in fairly close proximity to one another (range = approximately 50 miles). All groves were well maintained, except for field 3. Between the fields, the only obvious difference is the tank mixes applied. Fields 4, 6, and 7 were all treated with a manganese sulfate, potassium nitrate and/or urea in addition to cyfluthrin. Addition of these chemicals was associated with slower dissipation. The tank mix for fields 1 and 2 contained a buffer and fertilizer, for field 3 only a buffer and for field 16 zinc sulfate.

No cyfluthrin DFR studies were found in the public literature. The registrant for cyfluthrin did not submit citrus DFR studies to DPR. However, the pesticide registrant did report a study of cyfluthrin DFR dissipation on cotton[10]. Using linear regression analysis, we calculated a half-life of approximately 5.3 days for the cotton study.

Bellows *et al*, (1993)[11] followed DFR dissipation of two pyrethroids on citrus foliage in Riverside, California. They found the half-life for both esfenvalerate and fluvalinate to be 6.2 days. Giles *et al*, (1992)[12] found half-lives of 6.9-18.2 days following application of permethrin to chrysanthemums in greenhouses. Other pyrethroid "DFR studies" are reported in the literature, but the leaf samples were either frozen prior to residue extraction or the leaves were "washed" with organic solvents, both of which disrupt the integrity of the leaf surface.

It is apparent from this dissipation study that cyfluthrin residues may linger. The factors involved in the increased half-life are not known, but may be related to urea and/or potassium nitrate. It is interesting to note that approximately 10-20% of the initial residue was still present at 65 days post application.

Quality Assurance Statement

Since this study was conducted in response to an illness episode investigation, a protocol was not written and sample collection audit could not be performed. The work followed the Worker Health and Safety Cluster Illness Episode Action Plan. The resulting data and study report were audited on December 22-23, 1998 and reported to the study director and branch management on December 23, 1998.

[Original signed by K. Orr]

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Kathy Orr, Quality Assurance Officer Date
Worker Health and Safety Branch

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Appendix 1: DFR Field Information

Field No.	Acres	Variety	Application Date	Application Rate (lb/acre)	Dilution Rate (gal/acre)	Other Chemicals Applied	No. Samples per Interval	Pre-Application Sample?	Date Harvest Noted	Field Condition
1	6	Navels	5/9/97	0.1	125	Buffer 10-12-0	2	No	5/21/97	Trees to 12 ft; well maintained
2	12	Navels	5/8/97	0.1	125	Buffer 10-12-0	10	No	5/21/97	Trees to 12 ft; well maintained
3	113	Valencias	5/8/97	0.1	250	Buffer	2	No	6/10/97	Old trees to 25 ft; field in poor condition, steep slope
4	10	Valencias	5/5/97	0.1	250	Manganese sulfate, zinc sulfate, urea	2	No	5/10/97	Trees 6-12 ft
5	20	Valencias	5/5/97	0.1	250	Manganese, zinc, K-Nite, 10-12-0	2	No	6/23/97	Trees 15-18 ft; very full foliage
6	25	Valencias	5/8/97	0.1	250	Manganese, K-Nite, zinc sulfate, urea	4	No	6/17/97	Trees to 20 ft
7	10	Valencias	5/13/97	0.1	250	Urea	6	Yes	6/23/97	
16	21	Valencias	5/27/97	0.1	100	Zinc sulfate	2	No	6/10/97	Trees to 15 ft; very full foliage

Appendix 2: DFR Dissipation Results

Field No	Block	Sample Date	Result (µg/sample)	Field No	Block	Sample Date	Result (µg/sample)
1		5/11/97	21.40	2		5/9/97	16.70
		5/11/97	10.40			5/9/97	27.10
		5/15/97	5.40			5/11/97	17.90
		5/15/97	7.93			5/11/97	12.90
		5/21/97	5.07			5/15/97	5.95
		5/21/97	3.21			5/15/97	5.48
		5/29/97	ND			5/21/97	4.75
		5/29/97	2.67			5/21/97	8.27
		6/3/97	4.82			5/29/97	2.95
		6/3/97	3.40			5/29/97	4.47
		6/10/97	3.28			6/3/97	3.47
		6/10/97	2.18			6/3/97	4.62
						6/10/97	3.71
						6/10/97	ND
3	N1	5/9/97	11.00	3	N2	5/9/97	13.60
	N1	5/9/97	17.40		N2	5/9/97	19.90
	N1	5/11/97	7.28		N2	5/11/97	9.86
	N1	5/11/97	9.31		N2	5/11/97	12.20
	N1	5/15/97	3.82		N2	5/15/97	9.10
	N1	5/15/97	5.14		N2	5/15/97	9.53
	N1	5/21/97	2.83		N2	5/21/97	4.38
	N1	5/21/97	3.33		N2	5/21/97	3.63
	N1	5/29/97	ND		N2	5/29/97	4.07
	N1	5/29/97	2.00		N2	5/29/97	2.50
	N1	6/3/97	ND		N2	6/3/97	ND
	N1	6/3/97	ND		N2	6/3/97	ND
	N1	6/10/97	ND		N2	6/10/97	ND
	N1	6/10/97	2.36		N2	6/10/97	2.00
3	N3	5/9/97	12.30	3	N4	5/9/97	13.40
	N3	5/9/97	16.20		N4	5/9/97	19.60
	N3	5/11/97	8.11		N4	5/11/97	7.67
	N3	5/11/97	7.12		N4	5/11/97	5.41
	N3	5/15/97	5.23		N4	5/15/97	3.60
	N3	5/15/97	6.20		N4	5/15/97	7.00
	N3	5/21/97	3.50		N4	5/21/97	2.00
	N3	5/21/97	5.38		N4	5/21/97	2.62
	N3	5/29/97	2.20		N4	5/29/97	3.48
	N3	5/29/97	2.10		N4	5/29/97	ND
	N3	6/3/97	ND		N4	6/3/97	2.88
	N3	6/3/97	2.05		N4	6/3/97	2.41
	N3	6/10/97	3.68		N4	6/10/97	3.36
	N3	6/10/97	2.25		N4	6/10/97	ND

ND = <LOQ (2.0 µg/cm²)

Field No	Block	Sample Date	Result (µg/sample)	Field No	Block	Sample Date	Result (µg/sample)
3	N5	5/9/97	23.80	3	N5	5/9/97	13.50
	N5	5/11/97	8.84		N5	5/11/97	14.30
	N5	5/15/97	3.96		N5	5/15/97	11.70
	N5	5/21/97	7.20		N5	5/21/97	3.43
	N5	5/29/97	ND		N5	5/29/97	6.83
	N5	6/3/97	2.03		N5	6/3/97	4.43
	N5	6/10/97	3.45		N5	6/10/97	2.45
4	Unk.*	5/9/97	27.30	4	Unk.	5/9/97	21.40
	Unk.	5/11/97	12.40		Unk.	5/11/97	14.70
	Unk.	5/15/97	19.40		Unk.	5/15/97	8.52
	E	5/21/97	6.64		W	5/21/97	6.06
	E	5/29/97	5.81		W	5/29/97	5.43
	E	6/3/97	5.41		W	6/3/97	6.42
	E	6/10/97	10.90		W	6/10/97	6.95
	E	6/17/97	6.32		W	6/17/97	7.62
	E	6/23/97	4.42		W	6/23/97	6.58
	E	6/30/97	2.88		W	6/30/97	5.04
	E	7/9/97	4.73		W	7/9/97	4.13
5	Unk	5/9/97	ND		Unk	5/9/97	16.80
	Unk	5/11/97	1.22		Unk	5/11/97	16.40
	Unk	5/15/97	7.7		Unk	5/15/97	14.60
	N	5/21/97	ND		S	5/21/97	11.10
	N	5/29/97	ND		S	5/29/97	7.11
	N	6/3/97	ND		S	6/3/97	5.96
	N	6/10/97	ND		S	6/10/97	10.50
					S	6/17/97	7.53
					S	6/17/97	4.17
					S	6/23/97	3.74
					S	6/23/97	8.30
					S	6/30/97	4.02
					S	6/30/97	2.46
					S	7/9/97	3.24
					S	7/9/97	4.32

* Unk - Field block not known

ND = <LOQ (2.0 µg/cm², except for the sample collected on 5/9/97 where the LOQ=1.0 ND µg/cm²)

Field No	Block	Sample Date	Result (µg/sample)	Field No	Block	Sample Date	Result (µg/sample)
6	Unk*	5/9/97	22.80	6	Unk	5/9/97	28.20
	Unk	5/9/97	22.80		Unk	5/9/97	24.50
	Unk	5/11/97	13.20		Unk	5/11/97	22.70
	Unk	5/11/97	12.50		Unk	5/11/97	21.00
	Unk	5/15/97	10.40		Unk	5/15/97	16.10
	Unk	5/15/97	8.28		Unk	5/15/97	12.30
	E	5/21/97	17.50		W	5/21/97	7.07
	E	5/21/97	12.00		W	5/21/97	5.20
	E	5/29/97	10.60		W	5/29/97	5.06
	E	5/29/97	5.87		W	5/29/97	3.34
	E	6/3/97	8.98		W	6/3/97	4.32
	E	6/3/97	5.25		W	6/3/97	3.70
	E	6/10/97	5.45		W	6/10/97	3.39
	E	6/10/97	8.74		W	6/10/97	4.45
	E	6/17/97	4.76		W	6/17/97	2.54
	E	6/17/97	8.78		W	6/17/97	5.49
	E	6/23/97	4.82		W	6/23/97	5.65
	E	6/23/97	4.85		W	6/23/97	6.38
	E	6/30/97	7.74		W	6/30/97	3.66
	E	6/30/97	4.14		W	6/30/97	4.62
	E	7/9/97	3.96		W	7/9/97	2.76
	E	7/9/97	4.93		W	7/9/97	2.15
7	Unk	5/12/97	ND	7	Unk	5/12/97	ND
	Unk	5/13/97	26.4		Unk	5/13/97	14.10
	Unk	5/13/97	19.2		Unk	5/13/97	16.40
	Unk	5/15/97	13.8		Unk	5/15/97	12.60
	Unk	5/15/97	8.50		Unk	5/15/97	11.70
	N	5/21/97	14.70		S	5/21/97	9.83
	N	5/21/97	12.70		S	5/21/97	16.60
	N	5/29/97	11.90		S	5/29/97	14.70
	N	5/29/97	7.88		S	5/29/97	7.76
	N	6/3/97	16.90		S	6/3/97	13.20
	N	6/3/97	14.70		S	6/3/97	12.80
	N	6/10/97	10.90		S	6/10/97	5.71
	N	6/10/97	9.40		S	6/10/97	6.63
	N	6/17/97	9.21		S	6/17/97	11.90
	N	6/17/97	9.76		S	6/17/97	7.03
	N	6/23/97	6.15		S	6/23/97	7.85
	N	6/23/97	7.46		S	6/23/97	6.52
	N	6/30/97	6.36		S	6/30/97	6.36
	N	6/30/97	6.96		S	6/30/97	7.20
	N	7/9/97	8.88		S	7/9/97	4.56
	N	7/9/97	6.83		S	7/9/97	8.82
	N	7/17/97	2.62		S	7/17/97	2.12

* Unk - Field block not known
ND = <LOQ (1.0 µg/cm²)

Field No	Block	Sample Date	Result (µg/sample)	Field No	Block	Sample Date	Result (µg/sample)
16	W3	5/28/97	11.40	16	W3	5/28/97	16.90
	W3	5/28/97	15.30		W3	5/28/97	9.80
	W3	5/28/97	15.20		W3	5/28/97	16.10
	W3	5/30/97	14.90		W3	5/30/97	9.05
	W3	5/30/97	13.50		W3	5/30/97	13.40
	W3	6/3/97	5.20		W3	6/3/97	6.14
	W3	6/3/97	5.48		W3	6/3/97	5.13
	W3	6/10/97	5.66		W3	6/10/97	5.80
	W3	6/10/97	5.14		W3	6/10/97	4.39
	W3	6/17/97	2.51		W3	6/17/97	2.93
	W3	6/17/97	3.09		W3	6/17/97	5.93
	W3	6/23/97	2.52		W3	6/23/97	2.69
	W3	6/23/97	ND		W3	6/23/97	3.39
	W3	6/30/97	ND		W3	6/30/97	ND
	W3	6/30/97	ND		W3	6/30/97	ND

ND = <LOQ (2.0 µg/cm²)