A SURVEY OF DISLODGEABLE PESTICIDE RESIDUES ON CROP FOLIAGE AT FIELD REENTRY, 1994 - 1995

By

Bernardo Z. Hernandez, Environmental Research Scientist
Janet Spencer, Associate Environmental Research Scientist
Frank Schneider, Associate Environmental Research Scientist
Angelica Welsh, Associate Environmental Research Scientist
Scott Fredrickson, Agricultural Chemist III

HS-1728

March 1998

California Environmental Protection Agency
Department of Pesticide Regulation
Worker Health and Safety Branch
1020 N Street, Room 200
Sacramento, California 95814-5624

Executive Summary

The U.S. Environmental Protection Agency (EPA) and the California Environmental Protection Agency, Department of Pesticide Regulation (DPR) have established specific reentry intervals for many of the pesticides used on crops. Reentry intervals have been set to safeguard field workers from contacting toxic levels of pesticide residues. Some reentry intervals are incorporated into the California Code of Regulations[1]. California agricultural workers in hand-harvested and manual labor-intensive crops are considered one of the groups at risk of being exposed to potentially hazardous pesticide residues. Periodic surveys are conducted to ensure that hazardous residue levels do not exist. This study was designed to survey dislodgeable foliar residues (DFR) in a variety of crops under hand cultivation and hand picking operations.

DPR, Worker Health and Safety Branch (WH&S), in cooperation with County Agricultural Commissioners, sampled foliage in fields, orchards and vineyards. From June, 1994, through the first week of February, 1995, 946 foliage samples were collected throughout sixteen counties in California's central valley and coastal areas and 941 were analyzed for dislodgeable pesticide residues to provide an index of residue levels at the time of field entry. Five samples were either lost or broken in transit. Analysis was by gas chromatography/mass spectrometer equipped with an ion trap detector (ITD). Of the 941 samples analyzed, 939 sample results are included in this report. Two samples were collected in response to grower's request, but results were not included because there was no worker activity in the field at the time of sample collection. There were 522 two (55.6%) samples with detectable levels of at least one pesticide (minimum detectable levels = 0.002 - 0.03 ug/cm^2); a total of 23 pesticides were detected. Thirteen of the 23 detected pesticides are designated as high priority for risk assessment[/a]; two have completed risk assessments, while seven have completed exposure assessments (see Table 2). Detectable residues ranged from 0.002 ug/cm^2 to 93.8 ug/cm^2.

Prior field worker illness episode investigation suggest that DFR residues below 0.1 ug/cm^2 rarely result in illness. A total of 367 samples with detectable pesticide residues (39% of all samples) had residues of at least 0.1 ug/cm^2. This group includes thirteen of the 23 detected pesticides, six[/b] of which are designated high priority. Pesticide residues greater than 0.1 ug/cm^2 may suggest the need for evaluation of reentry intervals, especially for those pesticides DPR has designated as high priority for risk assessment.

/a - a committee consisting of eight scientists from DPR and the Office of Environmental Health Hazard Assessment designate pesticides as high priority for risk assessment.

/b - azinphosmethyl, captan, chlorothalonil, carbaryl, methyl parathion, phosmet

Introduction

The U.S. Environmental Protection Agency (EPA) and the California Environmental Protection Agency, Department of Pesticide Regulation (DPR) have established specific reentry intervals for many of the pesticides used on crops. Reentry intervals safeguard field workers from contacting toxic levels of pesticide residues. Some reentry intervals are incorporated into the California Code of Regulations[1]. This study was designed to survey dislodgeable foliar residues (DFR) in a variety of crops under hand cultivation and hand picking operations. Although the spray history or application dates were not usually known, this information will provide a current index of the identity and magnitude of pesticide residues to which field workers are exposed.

Methods & Materials

DPR, Worker Health and Safety Branch (WH&S), in cooperation with County Agricultural Commissioners, sampled fields and orchards throughout Fresno, Kern, Kings, Lake, Madera, Monterey, Napa, Sacramento, San Benito, San Joaquin, Santa Cruz, Sonoma, Sutter, Tulare, Yolo and Yuba counties. Permission was obtained from the crew supervisor or grower to sample the foliage where workers were either hand harvesting or performing hand cultivation tasks.

Foliar samples were collected using a Rabbit® leaf punch, which cut a leaf disk of either 1.78 or 2.54 cm in diameter. Crop leaf size determined the size of punch used. Samples collected using the 2.54-cm punch consisted of 40 leaf disks (405 cm^2 of surface area) and those collected with the 1.78-cm punch consisted of 85 leaf disks (423 cm^2 of surface area)[2]. Sampling was always taken from plants not contacted by the workers. This was accomplished by entering 15-20 feet into the field and then taking leaf punches (two per plant or four per tree) in an inverted V-pattern, randomly across each field or orchard. The plant region sampled was that most likely contacted during hand cultivation or hand harvested.

Samples were collected in four-ounce glass jars and capped with a Teflon-lined lid. The jars were double bagged, packed on ice in insulated coolers and shipped to the California Department of Food and Agriculture (CDFA), Center for Analytical Chemistry, in Sacramento, for next-day extraction. Dislodgeable residues were removed by three sequential washings, each consisting of a 20-minute rotation on a mechanical shaker with 50 mL of a 0.02% dioctyl sodium sulfosuccinate solution. The solution was decanted between washings and the combined wash solution dried with sodium chloride, then extracted with methylene chloride. Analysis was performed by GC/MS, equipped with an ion trap detector (ITD). The recovery was determined by comparing a diluted water/dioctyl sodium sulfosuccinate extract fortified before the methylene chloride extraction to a standard solution made at the same final concentration as a spike solution. This minimizes instrument measurement as well as other types of errors. Basically, 1 mL of fortification solution was added to water/dioctyl sodium sulfosuccinate, then extracted per the method and compared the resulting solution to 1 mL of fortification solution diluted to 10 mL with methyl chloride. Recoveries exceeded 70% with the exception of methamidophos, which

had extremely low recoveries. Methamidophos is a poor candidate for the ITD screen. The analytical recoveries for the detected pesticides are presented in Table 1. The analytical method is available upon request. All raw data was entered into Microsoft Access v7.0 database. Tables were developed using Microsoft Access queries and reports.

Results

Nine hundred forty-six foliage samples were collected and 939 sample results are reported; 522 (55.6%) had detectable levels of at least one pesticide. Seven samples were either not evaluated or results were excluded from the survey; five samples were either lost or broken in transit and two samples were collected in response to grower's request, but results were not included in the survey because there was no worker activity in the field at the time of sample collection. Table 2 shows the twenty-three pesticides identified and the pesticide category classification of each. There were 855 total detections, including multiple pesticides on some samples. Insecticides represented 52% of the total detects; followed by fungicides with 32%; acaricides with 12% and organochlorines with 4%. About 65% of insecticide residues were organophosphates (approximately 33% of total detects). Carbamates and pyrethroids were present in 17% and 11% respectfully, of the insecticides detected.

Table 3 displays the frequency and percent of samples collected by task. Harvest and pruning activities represented 79% and 9%, respectively, of the samples collected. The remainder of the samples represented field activities such as thinning, weeding, irrigating, leaf pulling, vine tying, banding and roguing. Table 4 shows the identity and frequency of the pesticides detected, as well as the number of samples with no residues detected. The mean and maximum levels of dislodgeable foliar residues, with respective standard deviations, are reported in Table 4.

Discussion

Previous branch investigations[3] were conducted from 1975 through 1985. A total of 2,558 samples were collected for analysis of organophosphates and organochlorines, of which 174 samples (6.8%) were positive for pesticide residues. Within this ten to twenty year span, the minimum detection levels ranged from 0.0001 ug/cm^2 for parathion and aldrin[4] to highs of 1.0 and 2.5 ug/cm^2 for phosalone and azinphosmethyl, respectively[5]. This high MDL for azinphosmethyl alone would have eliminated all but eleven of the 91 positives in the current study. Past methodology would not have detected chlorothalonil, iprodione, permethrin or propargite. Between 1975 and 1985, it was not standard procedure to report sulfur results[6] which account for 91 positives in our study. Today's technology using GC/MS, equipped with an ion trap detector (ITD) is sensitive to a wider range of chemicals at consistently lower detection limits. Due to this increased sensitivity, change in use patterns and new compounds, direct comparisons with the older studies are difficult. Many of the organochlorines are no longer registered.

Several pear DFR samples from Sacramento County contained relatively high concentrations of azinphosmethyl, averaging 5.3 ± 1.5 ug/cm^2. A re-sampling of the orchards three weeks later showed that residues had declined to approximately 2.0 ± 0.5 ug/cm^2, which still represented a higher level than expected compared to previous WH&S studies[7,8]. This phenomenon is poorly

understood at present. A DFR study was launched in 1995 to further investigate azinphosmethyl residue decay on pear foliage[9]. Other Branch studies[10,11] conducted in peaches, suggest that environmental conditions, such as temperature, humidity, rainfall, sunlight, as well as cultural practices, can greatly affect the rate of pesticide decay.

DPR completed risk assessments for two pesticides detected in this study, phosmet and mevinphos. An adequate margin of safety exists for workers exposed to phosmet residues at one day post-application in pears, grapes and oranges[12,13]. Although there is a completed risk assessment report on mevinphos, it is no longer legal to use mevinphos in California. In this survey, phosmet residues were found on apples, Asian pears, broccoli, grapes, nectarines, olives, peaches, pears and plums. Assuming the pear residues are representative of average reentry residues, the residues found in this survey were below those used to calculate margins of safety in the phosmet risk assessment. Safe working levels have been determined for propargite on citrus, grapes, nectarines and strawberries[14]. All propargite residues detected in this study were below those found to provide an adequate margin of safety.

In 1994, 109 total cases of field worker illness/injury were reported in California[15]. Physicians reported 76 illness/injuries of field workers exposed to residue of the pesticides detected in this study (Table 2). Of those 76 cases, 12 were related to the insecticide mevinphos; workers began harvesting lettuce prior to the expiration of the reentry interval. Mevinphos is no longer registered for use in California. Another 14 were related to sulfur exposure and 28 field workers were exposed to sulfur in combination with other pesticides. Sulfur, frequently reported as a skin irritant source, has been associated with 15% of all cases suspected of pesticide contact dermatitis[16,17]. Exposure to either propargite or iprodione led to 6 incidents. Minimum detection levels (MDLs) varied, depending on column conditioning, and the compound. In general, an MDL of 2 to 12 ug/sample was claimed, except when the system was running very well for some compounds, such as diazinon, propargite, etc. This translates to a level equal to the lowest standard, which after the ITD was upgraded with the wave board meant that virtually all standards were detected at that level (iprodione was an exception). During the last month of the project, the real MDL was less than 0.5 µg/sample for most compounds. Thirteen of the 23 detected pesticides are designated as high priority for risk assessment[/a]; two have completed risk assessments, while seven have completed exposure assessments (see Table 2). Detectable residues ranged from 0.002 ug/cm^2 to 93.8 ug/cm^2. Prior field worker illness episode investigation suggest that DFR residues below 0.1 ug/cm2 rarely result in illness[18,19]. A total of 367 samples with detectable pesticide residues (39% of all samples) had residues of at least 0.1 ug/cm^2. This group includes thirteen of the 23 detected pesticides, six[/b] of which are designated high priority. Pesticide residues greater than 0.1 ug/cm^2 may suggest the need for evaluation of reentry intervals, especially for those pesticides DPR has designated as high priority for risk assessment.

/a - a committee consisting of eight scientists from DPR and the Office of Environmental Health Hazard Assessment designate pesticides as high priority for risk assessment.

/b - azinphosmethyl, captan, chlorothalonil, carbaryl, methyl parathion, phosmet

Conclusion

California agricultural workers in hand-harvested and manual labor intensive crops are considered to be one of the groups at risk of being exposed to potentially hazardous pesticide residues. Periodic surveys are conducted to ensure that hazardous residue levels do not exist. Such surveys also serve to assess the effectiveness of reentry intervals and aid in identifying pesticides that require re-evaluation of chemical degradation data. In general, it appears that established reentry intervals generally provide safeguards for workers contacting treated foliage. Current WH&S studies will focus on residues present on crop foliage at the expiration of the legal restricted entry interval. Many of the high DFR residues are pesticides in the high priority crop for risk assessment. Survey results may be used to further prioritize risk assessment.

Table 1
Analytical Recoveries for Compounds Detected

Compound	Fortification (ug)	Level Detected	% Recovery
Azinphosmethyl	2.02	1.71	84.65
Captan	12.14	11.29	93.00
Carbaryl	1.98	1.69	85.35
Chlorothalonil	6.02	5.08	84.39
Chlorpyrifos	2	1.58	79.00
Cis-permethrin	6.32	4.70	74.37
Diazinon	1.96	1.53	78.06
Dimethoate	3.76	3.30	87.76
Endosulfan I	4	3.00	75.00
Endosulfan II	3.98	3.14	78.89
Endosulfan III	4	2.95	73.75
Iprodione	2.02	1.65	81.68
Malathion	2	1.62	81.00
Methamidophos	2	0.00	0.000
Methidathion	2	1.75	87.50
Methyl parathion	2.06	1.75	84.95
Mevinphos	2	1.54	77.00
P,P'-Dicofol	4	3.23	80.75
P,P'-Methoxychlor	2.02	1.62	80.20
Phosmet	1.96	1.61	82.14
Propargite	1.3	0.98	75.39
Trans-Permethrin	2.02	1.45	71.78
Vinclozolin	2.02	1.55	76.73

Table 2

Frequency of Detected Residues by Pesticide Category

PESTICIDE CATEGORY, CLASS, (n)	PESTICIDE	NUMBER OF DETECTS
ACARICIDES, (106)	Dicofol	22
	Propargite[1,2]	84
FUNGICIDES, (289)	Captan[1,2]	33
	Chlorothalonil[1,2]	46
	Iprodione	114
	Sulfur	91
	Vinclozolin[1]	5
INSECTICIDES (460)		
Carbamates (78)	Carbaryl[1]	78
Organophosphates, (298)	Azinphosmethyl[1,2]	81
	Chlorpyrifos[1,2]	3
	Diazinon[1]	22
	Dimethoate	11
	Malathion	31
	Methamidophos[1]	1
	Methidathion	7
	Methyl-Parathion[1]	68
	Mevinphos[1,2,3,4]	3
	Phosmet[1,4]	67
	Profenofos	4
Pyrethroids, (49)	Permethrin	49
Organochlorine, (35)	Endosulfan[1,5]	33
	Methoxychlor	2
TOTAL DETECTS = 855		

1 Designated high priority for risk assessment
2 Completed exposure assessment for these pesticides
3 Designated high priority until registration canceled in 1994; approved use through 1995
4 Completed risk assessment for this pesticide
5 Endosulfan is the sum of Endosulfan I, II, III.

Table 3
Tasks: Frequency and Percent of Total Samples

Worker Activity	Number	Percent
Banding	2	0.21%
Harvest	742	79.02%
Harvest/Irrigation	4	0.43%
Harvest/Mechanical	4	0.43%
Harvest/Sorting	4	0.43%
Harvest/Weeding	2	0.21%
Irrigating	16	1.70%
Leaf Pulling	2	0.21%
Leaf Thinning	2	0.21%
Pruning	82	8.63%
Re-Sampled	10	1.06%
Rouging	4	0.43%
Thinning	10	1.06%
Turning Vines	2	0.21%
Tying Vines	2	0.21%
Weeding	48	5.11%
Weeding/Pruning	2	0.21%
Weeding/Thinning	2	0.21%
Total Samples	939	100%[1]

[1] Excludes two samples taken at grower's request; no worker activity involved

Table 4
DAY OF REENTRY SUMMARY

CROP	ACTIVITY	TOTAL SAMPLES	ND (n)	DETECTED (n)	PESTICIDES DETECTED	RESIDUES (n)	RESIDUE (ug/cm^2)[1] min	max	avg	SD
Apple	Harvest	16	0	16	Azinphosmethyl	4	0.077	0.617	0.303	0.256
					Captan	1	0.016	0.016	0.016	
					Carbaryl	8	0.002	0.048	0.017	0.017
					Permethrin	1	0.010	0.010	0.010	
					Phosmet	5	0.494	1.037	0.825	0.200
					Propargite	7	0.009	0.071	0.024	0.022
	Pruning	6	0	6	Carbaryl	2	0.007	0.008	0.008	0.000
					Phosmet	6	0.014	1.160	0.353	0.511
					Propargite	4	0.022	0.032	0.028	0.004
Apple-juice	Harvest	4	0	4	Azinphosmethyl	4	0.175	0.331	0.248	0.064
					Iprodione	2	0.001	0.002	0.002	0.000
Apricot	Harvest	6	4	2	Iprodione	2	0.022	0.059	0.041	0.026
Artichoke	Harvest	2	2	0	No Pesticide Detected					
	Weeding	2	0	2	Methidathion	2	0.005	0.006	0.005	0.001
Asian Pear	Harvest	4	0	4	Azinphosmethyl	2	0.415	0.484	0.449	0.049
					Dicofol	2	0.311	0.321	0.316	0.007
					Phosmet	4	0.005	0.012	0.009	0.003
					Propargite	2	0.003	0.003	0.003	0.000
Bell Pepper	Harvest	8	8	0	No Pesticide Detected					
	Weeding	2	2	0	No Pesticide Detected					
Broccoli	Harvest	61	56	5	Chlorothalonil	2	0.009	0.014	0.012	0.003
					Iprodione	2	0.002	0.003	0.002	0.000
					Malathion	1	0.001	0.001	0.001	

[1] Residue data do not include the non-detects (ND)

Table 4
DAY OF REENTRY SUMMARY

CROP	ACTIVITY	TOTAL SAMPLES	ND (n)	DETECTED (n)	PESTICIDES DETECTED	RESIDUES (n)	RESIDUE (ug/cm^2)[1] min	max	avg	SD
Broccoli	Harvest	1	0	1	Phosmet[2]	1	0.016	0.016	0.016	
					Propargite[2]	1	0.002	0.002	0.002	
Cabbage	Harvest	10	2	8	Chlorothalonil	8	0.169	0.541	0.360	0.132
Cantaloupe	Harvest	12	6	6	Endosulfan	6	0.013	0.156	0.062	0.053
Casaba	Harvest	2	2	0	No Pesticide Detected					
Cauliflower	Banding	2	2	0	No Pesticide Detected					
	Harvest	40	38	2	Methoxychlor[3]	2	0.07	0.011	0.009	0.003
Celery	Harvest	2	0	2	Permethrin	2	0.005	0.007	0.006	0.002
Cotton	Irrigation[4]	2	2	0	No Pesticide Detected					
	Weeding	10	4	6	Profenofos	4	0.173	0.449	0.319	0.130
					Propargite	2	0.025	0.075	0.063	0.016
Crenshaw	Harvest	4	3	1	Dicofol	1	0.014	0.014	0.014	
					Endosulfan	1	0.074	0.074	0.074	
Eggplant	Leaf Thinning	2	2	0	No Pesticide Detected					
Fig	Pruning	4	4	0	No Pesticide Detected					
Grape-juice	Harvest	2	0	2	Dicofol	2	0.041	0.064	0.053	0.016
					Sulfur	2	0.998	2.568	1.783	1.110

[1] Residue data do not include the non-detects (ND)
[2] Possible drift from vineyard across field road
[3] Possible drift from feedlot treatment for fly control
[4] Sprinkler pipe mover in field

Table 4
DAY OF REENTRY SUMMARY

CROP	ACTIVITY	TOTAL SAMPLES	ND (n)	DETECTED (n)	PESTICIDES DETECTED	RESIDUES (n)	RESIDUE (ug/cm^2)[1] min	max	avg	SD
Grape-raisin	Harvest	64	12	52	Azinphosmethyl	1	0.005	0.005	0.005	
					Carbaryl	2	0.065	0.128	0.098	0.044
					Iprodione	1	0.003	0.003	0.003	
					Phosmet	1	0.003	0.003	0.003	
					Propargite	17	0.002	0.036	0.013	0.011
					Sulfur	49	0.006	8.765	1.130	1.675
Grape-table	Harvest	24	0	24	Azinphosmethyl	2	0.175	0.195	0.185	0.014
					Carbaryl	8	0.003	0.060	0.015	0.020
					Dicofol	2	0.096	0.099	0.098	0.002
					Endosulfan	1	0.004	0.004	0.004	
					Iprodione	18	0.015	0.494	0.158	0.145
					Phosmet	1	0.005	0.005	0.005	
					Propargite	5	0.002	0.009	0.006	0.003
					Sulfur	4	2.025	15.926	7.475	6.553
	Irrigation	2	0	2	Endosulfan	2	0.156	0.172	0.164	0.011
Grape-wine	Harvest/Hand	34	4	30	Dicofol	2	0.057	0.059	0.058	0.002
					Phosmet	2	0.230	0.272	0.251	0.030
					Sulfur	30	0.519	93.827	17.632	24.043
	Mechanical	2	0	2	Sulfur	2	7.160	14.568	10.864	5.238
	Irrigation	2	2	0	No Pesticide Detected					
	Vine Tying	2	2	0	No Pesticide Detected					
Grapefruit	Harvest	2	2	0	No Pesticide Detected					

[1] Residue data do not include the non-detects (ND)

Table 4
DAY OF REENTRY SUMMARY

CROP	ACTIVITY	TOTAL SAMPLES	ND (n)	DETECTED (n)	PESTICIDES DETECTED	RESIDUES (n)	RESIDUE (ug/cm^2)[1] min	max	avg	SD
Honeydew	Harvest	40	16	24	Carbaryl	12	0.051	0.593	0.237	0.163
					Chlorothalonil	15	0.005	2.444	0.915	0.923
					Endosulfan	2	0.030	0.040	0.035	0.008
					Methamidophos	1	0.006	0.006	0.006	
Lettuce-butter	Harvest	4	1	3	Chlorothalonil	2	0.002	0.011	0.006	0.006
					Diazinon	1	0.001	0.001	0.001	
					Permethrin	2	0.004	0.009	0.007	0.003
-green leaf	Harvest	4	2	2	Diazinon	1	0.001	0.001	0.001	
					Endosulfan	1	0.011	0.011	0.011	
-head	Harvest	22	9	13	Dimethoate	4	0.003	0.017	0.008	0.007
					Mevinphos	2	0.003	0.003	0.003	0.000
					Permethrin	14	0.002	0.056	0.023	0.018
-red leaf	Harvest	10	6	4	Carbaryl	2	0.006	0.010	0.008	0.003
					Mevinphos	1	0.002	0.002	0.002	
					Permethrin	4	0.005	0.012	0.007	0.003
-romaine	Harvest	18	4	14	Dimethoate	5	0.003	0.011	0.007	0.003
					Endosulfan	1	0.023	0.023	0.023	
					Permethrin	3	0.003	0.023	0.011	0.006
Napa Cabbage	Harvest	2	2	0	No Pesticide Detected					
Navel Orange	Harvest	46	42	4	Carbaryl	1	0.004	0.004	0.004	
					Methidathion	3	0.003	0.008	0.006	0.002
Nectarine	Leaf Pulling	2	0	2	Methyl Parathion	2	0.034	0.122	0.078	0.062
					Propargite	2	0.004	0.006	0.005	0.001
	Pruning	6	4	2	Chlorothalonil	1	0.010	0.010	0.010	
					Propargite	2	0.003	0.005	0.004	0.001

[1] Residue data do not include the non-detects (ND)

Table 4
DAY OF REENTRY SUMMARY

CROP	ACTIVITY	TOTAL SAMPLES	ND (n)	DETECTED (n)	PESTICIDES DETECTED	RESIDUES (n)	RESIDUE (ug/cm^2)[1] min	max	avg	SD
Nectarine	Thinning	4	0	4	Iprodione	2	1.267	1.319	1.293	0.037
					Methyl Parathion	4	0.022	0.526	0.293	0.241
					Phosmet	2	1.956	2.242	2.099	0.203
					Propargite	2	0.235	0.398	0.316	0.115
	Harvest	53	8	44	Azinphosmethyl	2	0.420	0,827	0.623	0.288
					Carbaryl	6	0.005	0.025	0.017	0.008
					Diazinon	4	0.002	0.003	0.002	0.001
					Iprodione	25	0.003	1.926	0.722	0.481
					Methyl Parathion	22	0.002	0.862	0.158	0.213
					Phosmet	8	0.014	1.328	0.745	0.512
					Propargite	20	0.002	0.173	0.028	0.042
					Vinclozolin	2	0.003	0.005	0.004	0.002
Olives	Harvest	6	4	0	No Pesticide Detected					
	Pruning	2	1	1	Phosmet	1	0.013	0.013	0.013	
					Propargite	1	0.002	0.002	0.002	
Peach	Harvest	34	6	28	Carbaryl	3	0.385	1.314	0.900	0.472
					Diazinon	4	0.001	0.001	0.001	0.000
					Iprodione	15	0.002	2.963	0.720	0.897
					Methidathion	2	0.012	0.014	0.013	0.001
					Methyl Parathion	14	0.007	0.790	0.305	0.280
					Permethrin	2	0.005	0.005	0.005	0.000
					Phosmet	10	0.003	2.617	1.196	0.979
					Propargite	14	0.002	0.099	0.032	0.039
	Pruning	24	8	16	Carbaryl	4	0.005	0.033	0.017	0.011
					Chlorothalonil	2	0.008	0.011	0.010	0.002
					Methyl Parathion	12	0.005	0.045	0.017	0.012
					Phosmet	2	0.004	0.011	0.007	0.005

[1] Residue data do not include the non-detects (ND)

Table 4
DAY OF REENTRY SUMMARY

CROP	ACTIVITY	TOTAL SAMPLES	ND (n)	DETECTED (n)	PESTICIDES DETECTED	RESIDUES (n)	RESIDUE (ug/cm^2)[1] min	max	avg	SD
Pear	Harvest	48	4	44	Azinphosmethyl	43	0.019	7.901	1.805	2.185
					Phosmet	12	0.005	0.667	0.197	0.229
	Irrigation	2	2	0	No Pesticide Detected					
	Re-Sample	10	0	10	Azinphosmethyl	10	1.210	2.568	2.039	0.455
					Azinphosmethyl Oxon	10	0.010	0.036	0.025	0.009
					Phosmet	2	0.009	0.010	0.010	0.001
Peppers	Harvest	2	2	0	No Pesticide Detected					
Pistachio	Pruning	16	0	16	Azinphosmethyl	8	0 004	0.020	0.012	0.006
					Carbaryl	16	0.000	0.002	0.001	0.000.
					Iprodione	1	0.003	0.003	0.003	
					Permethrin	11	0.002	0.006	0.005	0.001
					Vinclozolin	1	0.001	0.001	0.001	
Plum	Harvest	30	22	8	Carbaryl	2	0.277	0.360	0.319	0.059
					Iprodione	4	0.004	0.267	0.122	0.138
					Methyl Parathion	6	0.003	0.281	0.090	0.118
					Phosmet	5	0.006	1.230	0.461	0.624
					Propargite	1	0.010	0.010	0.010	
	Pruning	18	8	10	Iprodione	4	0.028	0.075	0.047	0.021
					Methyl Parathion	6	0.002	1.983	0.480	0.815
					Phosmet	3	0.001	0.004	0.002	0.001
	Thinning	2	0	2	Methyl Parathion	2	1.284	1.760	1.522	0.337
Pomegranate	Harvest	12	8	4	Azinphosmethyl	4	1.284	1.760	1.522	0.337
	Pruning	2	2	0	No Pesticide Detected					
Prunes	Harvest	4	4	0	No Pesticide Detected					
	Pruning	2	2	0	No Pesticide Detected					

[1] Residue data do not include the non-detects (ND)

Table 4
DAY OF REENTRY SUMMARY

CROP	ACTIVITY	TOTAL SAMPLES	ND (n)	DETECTED (n)	PESTICIDES DETECTED	RESIDUES (n)	RESIDUE (ug/cm^2)[1] min	max	avg	SD
Pumpkins	Irrigation	2	0	2	Dicofol	2	0.063	0.134	0.090	0.050
					Endosulfan	2	0.079	0.162	0.120	0.058
	Thinning	2	0	2	Dicofol	2	0.053	0.059	0.056	0.005
					Endosulfan	2	0.069	0.100	0.084	0.021
Raspberries	Harvest	10	6	4	Azinphosmethyl	1	0.004	0.004	0.004	
					Carbaryl	2	0.054	0.193	0.123	0.098
					Iprodione	2	0.375	0.390	0.383	0.010
Squash	Weeding	2	2	0	No Pesticide Detected					
-acorn	Harvest	2	2	0	No Pesticide Detected					
-banana	Harvest	10	9	1	Carbaryl	1	0.002	0.002	0.002	
					Dicofol	1	0.013	0.013	0.013	
-zucchini	Harvest	2	2	0	No Pesticide Detected					
Stone fruit	Pruning	2	0	2	Captan	2	0.420	0.469	0.444	0.035
					Iprodione	2	0.533	0.533	0.533	0.000
Strawberry	Harvest	46	10	36	Captan	30	0.086	2.963	1.198	0.757
					Carbaryl	2	0.007	0.013	0.010	0.004
					Iprodione	31	0.004	0.259	0.077	0.065
					Malathion	28	0.003	0.240	0.074	0.088
	Weeding	2	0	2	Iprodione	2	0.519	0.523	0.521	0.003
					Malathion	2	0.013	0.116	0.064	0.073
					Sulfur	2	1.802	7.827	4.815	4.260
Sugar beet	Irrigation	2	0	2	Chlorpyrifos	2	0.005	0.006	0.006	0.000
	Thinning	2	0	2	Carbaryl	2	0.021	0.0779	0.050	0.041
	Weeding	12	4	8	Carbaryl	4	0.057	0.101	0.079	0.022
					Chlorpyrifos	1	0.006	0.006	0.006	
					Dicofol	2	0.015	0.016	0.015	0.001
					Sulfur	2	10.519	15.309	12.914	3.387

[1] Residue data do not include the non-detects (ND)

Table 4
DAY OF REENTRY SUMMARY

CROP	ACTIVITY	TOTAL SAMPLES	ND (n)	DETECTED (n)	PESTICIDES DETECTED	RESIDUES (n)	RESIDUE (ug/cm^2)[1] min	max	avg	SD
Sunflower	Irrigation	2	2	0	No Pesticide Detected					
	Roguing	4	3	1	Carbaryl	1	0.008	0.008		
Sweet Potato	Irrigation	2	2	0	No Pesticide Detected					
Tatsoy	Harvest	2	2	0	No Pesticide Detected					
Tomato										
-fresh mkt.	Harvest/Hand	38	22	16	Chlorothalonil	16	0.528	2.528	1.268	0.555
					Diazinon	10	0.001	0.002	0.001	0.000
					Endosulfan	11	0.002	0.061	0.020	0.019
					Iprodione	1	0.003	0,003	0.003	
	Turning Vines	2	2	0	No Pesticide Detected					
-processing	Harvest/Mech.	2	2	0	No Pesticide Detected					
	Weeding	12	12	0	No Pesticide Detected					
Watermelon	Harvest	4	0	4	Dicofol	4	0.019	0.074	0.048	0.024
					Endosulfan	2	0.009	0.025	0.017	0.012
					Propargite	2	0.005	0.011	0.008	0.004
	Irrigation	2	0	2	Dicofol	2	0.074	0.094	0.084	0.014
					Endosulfan	2	0.037	0.046	0.042	0.007
	Weeding	4	4	0	No Pesticide Detected					
Yams	Harvest									
	-Hand sorting	4	4	0	No Pesticide Detected					

[1] Residue data do not include the non-detects (ND)

References

1. State of California: Pesticide Worker Safety Regulation Extracts-CCR Title 3, Food and Agriculture, Chapter 6, Pesticides and Control Operations, Subchapter 3 Pesticide. Worker Health and Safety Series HS-036. Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1993).

2. Edmiston, S., O'Connell, L., Bissell, S. and Conrad, D.: Guidance For Determination of Dislodgeable Foliar Residue. Worker Health and Safety Series HS-1600. Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1990).

3. Staff: Summary for Analysis of Residues of Organophosphates and Organochlorine Pesticides on the Foliage of Plants Which Were Collected When Hand-Labor Operations Were in Progress from 1975 through 1985. Worker Health and Safety Series HS-1337. Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1990).

4. Maddy, K., Fong, H., and Au, C.: A Survey of Central and Southern California Crops for Detection of Dislodgeable Pesticide Residues at Day of Harvest During 1982. Worker Health and Safety Series HS-1056. Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1983).

5. Maddy, K., Smith, C., Brittain, Y., Alcoser, D., Wanjiru, J. and Margetich, S.: A Survey Of Dislodgeable Organophosphate Residue On Selected Crops In Fresno and Merced Counties At The Time Of Harvest During Fall Of 1985. Worker Health and Safety Series HS-1369. Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1986).

6. Schneider, F: Personal communication. Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1996).

7. Maddy, K., Meinders, D., Saiz, S. and Margetich, S.: A Survey of Pear Orchards in Yolo, Solano and Sacramento Counties for Dislodgeable Foliar Organophosphate Residues at Harvest in July, 1985. Worker Health and Safety Series HS-1345. Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1986).

8. Rech, C., Bisbiglia, M. and Margetich, S.: Degradation of Azinphosmethyl Residue on Pear Foliage, 1986. Worker Health and Safety Series HS-1402. Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1986).

9. Schneider, F. and Benson, C,: Dislodgeable Azinphosmethyl Residues on Treated Pear Foliage. Worker Health and Safety Series HS-1735. Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1995).

10. Maddy, K.: Guthion Residue On Peach Trees Sutter County, June 1975. Worker Health and Safety Series HS-179. Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1975).

11. Maddy, K., Meinders, D, Saini, N. K. and Quan, V.: Degradation of Dislodgeable Azinphosmethyl (Guthion®) Residue on Peach Foliage After Low Volume Application in Stanislaus County, California, 1983. Worker Health and Safety Series HS-1402. Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1983).

12. Medical Toxicology Branch: Phosmet (Imidan) Risk Characterization Document. Cal/EPA, Dept. of Pesticide Regulation, Medical Toxicology Branch, Sacramento, CA. (1988).

13. Blewett, T.C. and Krieger, R.I.: Estimation of Exposure of Persons in California to Pesticide Products that Contain Phosmet and Estimation of Effectiveness of Exposure Reduction Measures. Worker Health and Safety Series HS-1476. Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1988).

14. Ross, J.H.: Memorandum to K. Pfeifer entitled "Propargite Mitigation Proposal". Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (September 11, 1989).

15. Worker Health & Safety: California Pesticide Illness Surveillance Program Summary Report - 1994. Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1996).

16. O'Malley, M., Rodriguez, P. and Maibach, H. I.: Pesticide Patch Testing: California Nursery Workers and Controls. *Contact Dermatitis* 32: 61-63 (1995).

17. O'Malley, M., Mathias, C.G.T. and Coye, M.J.: Epidemiology of Pesticide-Related Skin Disease in California Agriculture: 1978-1983. Principles of Health and Safety in Agriculture, Boca Raton, FL., CRC Press, Inc., 301-304 (1989).

18. O'Malley, M., Smith C., O'Connell L., Ibarra M., Acosta I., Margetich S., and Krieger R.I.: Illness Among Grape Girdlers Associated with Dermal Exposure to Methomyl. Worker Health and Safety Series HS-1604. Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1991).

19. O'Malley, M.: Priority Investigation Involving Phosalone in Fresno and Madera Counties, 1987. Worker Health and Safety Series HS-1487. Cal/EPA, Dept. of Pesticide Regulation, Worker Health & Safety Branch, Sacramento, CA. (1988).