A Monitoring Study of Workers in a Central Washington Orchard

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Introduction

Much concern has recently been generated over possible adverse health effects which might result from occupational exposure of agricultural workers to pesticide residues remaining on plant surfaces. Several approaches to evaluating the potential problem have been made. WOLFE et al. (1966), evaluated exposure of workers in 31 pesticide related activities using absorbent cellulose pads strategically placed for measurement of dermal exposure and the contamination of filter pads from respirators as a measure of exposure due to inhalation. They found dermal exposure to be a much more significant route than respiratory exposure.

Another approach which has been used is the measurement of pesticide residues on plant surfaces. For example, WOODHAM et al. (1974), measured and compared residues of dimethoate and its oxygen analog resulting from helicopter spraying of citrus leaves using ultra low volume and high volume sprays. Higher initial deposits resulted from ultra low volume application but the difference was small after fourteen days.

Absorption of parathion by orchard spraymen was measured by DURHAM et al. (1971), by measuring excretion of parathion metabolites. These investigators found that the dermal route of exposure presents a potentially greater source of absorption than the respiratory route for orchard spraymen using liquid parathion under the conditions of their study.

Direct observation of agricultural workers has also been utilized. BOGDEN et al. (1975) performed a health survey and cholinesterase determinations on migrant workers in southern New Jersey. They found evidence of some health problems in this group which were attributed to their occupational exposure to pesticides.

An epidemiological approach was used by SANDIFER et al. (1972), who reported on a four year study of occupational exposure and its effects on industrial and agricultural workers in South Carolina. A total of one hundred twenty workers were studied. They found no greater incidence of mortality or

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morbidity than in a control population and no evidence of overt disease attributable to the occupational exposures which they studied.

A study reported by WHITING (1975), of occupational injury and illness in California agricultural workers came to the conclusion that no objective evidence exists to support the contention of massive pesticide poisoning among agricultural workers.

This report will describe monitoring observations made on a crew of orchard workers in a large, well-managed, central Washington orchard to determine if measurable or observable effects could be detected which were attributable to their normal occupational exposure.

Study Description

A crew of orchard workers originally consisting of thirty persons, twenty-four of whom listed agriculture as their usual or principal occupation and six of whom were local residents employed for the summer only, was selected on a volunteer basis and the planned monitoring program was explained to them in detail. No one refused to participate when they were initially approached. A Spanish-speaking translator assisted in the explanations in the case of Spanish-speaking workers. Each volunteer was interviewed by our staff field investigator to determine his or her recent work history, especially with regard to possible pesticide exposure, and a brief medical history was taken. Blood samples for cholinesterase were collected by standard venipuncture techniques and urines were collected for analysis for alkyl phosphate metabolites. Samples of blood and urine were again collected on the next day for a total of two consecutive baseline samples prior to significant exposure of the crew to pesticides. Additional samples of blood and urine were taken on the schedule shown in Table 1.

Each volunteer was observed by the field investigator at the time samples were taken for signs of excessive exposure. Observation parameters included dizziness, nausea, headaches, tightness in chest and constricted pupils. Observation of field activities was also carried out during the working day.

The orchard spray schedule is shown in Table 2. Application of sprays was by Speed Sprayer except as noted in the table.

TABLE 1
Sampling and Work Schedule

Sample Date	Number of Volunteers	Occupation	Crop Contact
June 17	30	pre-exposure	none
June 18	27	pre-exposure	none
June 24	21	thinning	apples
June 26	20	thinning	apples
	3	shed	none
June 30	20	picking	cherries
	3	swamping	cherries
	1	packing	cherries
July 3	18	picking	cherries
	3	swamping	cherries
	1	shed	cherries
July 7	18	picking	cherries
	4	swamping	cherries
	1	packing	cherries
July 14	9	picking	apricots
	9	thinning	apples
	2	shed	apricots
	1	swamping	apricots
July 17	18	picking	apricots
	4	shed	apricots
July 22	16	picking	apricots
	3	swamping	apricots
	2	shed	apricots

TABLE 2
Spray Application Schedule

Date	Crop	Compound	Application Rate - lbs/acre
May 10	Apples	Elgetol-318 (DNBP)	5
May 20	Apples	Amid Thin-W	0.1
		Ethrel	5
May 27	Apples	Zolone	5
		Boron	3
May 31	Apples	Sevin	1.33
June 19	Apples	Zolone	5
		Omite	5
July 9	Apples	Plictran	2
July 14	Apples	Plictran	2
May 15	Apricots	Thiodan	5
June 4	Cherries	Parathion	5
		Boron	3
June 13	Cherries	Giberellic Acid	0.03
June 21	Cherries	Malathion	1 (ulv, aerial)

The sampling period covered the time of maximum exposure of the workers to plant surfaces which had been recently sprayed, i.e., during the apple thinning and cherry and apricot harvesting. Several kinds of typical activities were carried on during the sampling period. These were:

1. Thinning: Removing part of the immature fruit from the trees. This operation results in physical contact with fruit, leaves, twigs, and branches.

2. Picking: Harvesting of fruit from the trees. Contact with fruit, leaves, twigs, and branches is again seen here.

3. Swamping: Movement of harvested fruit from the orchard to the packing shed. Minimal, if any, contact with plant surfaces is seen here. The operation involves transportation of bins of fruit.

4. Packing: Sorting and placement of fruit into boxes. Manual contact with fruit is the primary activity here.

5. Shed Work: Maintenance of the sorting and packing area, sweeping, moving of boxes and related work. Minimal contact with fruit is seen here.

Methods of Analysis

Cholinesterase determinations were by the pH Stat method which is a continuous, automatic titration of the acetic acid formed by the action of cholinesterase on acetylcholine substrate at constant temperature. The procedure yields a reaction rate in micromoles of substrate hydrolyzed per minute per milliliter of sample.

Urine alkyl phosphates were determined by the method of SHAFIK et al. (1973).

Results and Discussion

By the end of the study period the number of volunteers had declined to twenty-three, seventeen of whom were in the group which listed agriculture as their principal occupation. Reasons for leaving the study were: three persons were discharged by the orchard management as a result of a party which they held on orchard property, one person moved to another orchard and three persons dropped out because of fear of the blood drawing procedure. Illness was not a factor in any study member dropping out of the study.

Absenteeism during the study period was not remarkable and was due to dental appointments and colds (self-diagnosed).

Only one of the volunteers reported any medical problems when we interviewed them at the beginning of the study period. This report was from a woman who said that she was under treatment with an anticoagulant for "thick blood."

None of the workers reported any contact with cholinesterase inhibiting compounds for six months prior to this study.

Seventy observations of field activities conducted during the course of the sampling period yielded the information shown in Table 3 regarding clothing of the workers. In no instance was any special protective clothing used. Only one instance was noted of a worker going shirtless. However, T-shirts which provide no protection for the neck and only minimal protection of the arms, were noted in 39% of the observations. Forty-eight percent of the observations showed head coverings being worn but only 23% were brimmed hats.

TABLE 3
Field Observations of Workers' Clothing

Observation	% Observed
Bareheaded	51
Baseball cap	21
Brim hat	23
Bandana	4
No shirt	1
T-shirt	39
Long sleeved shirt	60
Coveralls	1
Long pants	87
Shorts	11
Barefoot	0
Tennis shoes	46
Leather shoes	54
Cloth gloves	31
Cloth or paper mask	0

Alkyl phosphate residues in urine were used as one index of exposure. No residues were detected in any of the urines examined.

Cholinesterase activity was determined for plasma and red blood cells as a second exposure index. Group means and standard deviations for plasma and red blood cells are shown for both groups of workers in Tables 4 and 5.

TABLE 4

Plasma Pseudo Cholinesterase

Group Means and Standard Deviations

Micromoles of Substrate Hydrolyzed/Min/ml of Sample

Agricultural Workers

	Pre-exposure					Post Exposure					
Date	6/17	6/18	6/24	6/26	6/30	7/3	7/7	7/10	7/14	7/17	7/22
Mean	4.5	4.7	4.3	4.3	4.1	4.0	4.3	4.3	4.3	4.4	4.4
Std. Dev.	0.99	0.74	0.90	0.91	0.75	0.66	0.74	0.86	0.81	0.70	0.67

"Summer Only" Employees

	Pre-exposure					Post Exposure					
Date	6/17	6/18	6/24	6/26	6/30	7/3	7/7	7/10	7/14	7/17	7/22
Mean	4.1	4.0	4.1	4.0	3.8	3.8	4.1	3.9	4.1	4.1	4.2
Std. Dev.	0.43	0.53	0.48	0.23	0.33	0.21	0.25	0.43	0.25	0.33	0.54

TABLE 5

Red Blood Cell Cholinesterase

Group Means and Standard Deviations

Micromoles of Substrate Hydrolyzed/Min/ml of Sample

Agricultural Workers

	Pre-exposure					Post Exposure					
Date	6/17	6/18	6/24	6/26	6/30	7/3	7/7	7/10	7/14	7/17	7/22
Mean	14.1	13.9	14.0	13.7	14.2	13.7	13.9	14.3	13.8	14.1	13.9
Std. Dev.	2.24	1.81	1.56	2.25	1.43	1.74	1.53	1.32	1.40	1.28	1.67

"Summer Only" Employees

	Pre-exposure					Post Exposure					
Date	6/17	6/18	6/24	6/26	6/30	7/3	7/7	7/10	7/14	7/17	7/22
Mean	14.1	14.6	14.2	13.4	13.9	13.8	13.2	12.8	13.7	14.2	14.5
Std. Dev.	2.21	1.61	2.92	1.79	2.38	2.39	2.32	1.96	1.53	2.01	1.69

The normal ranges of values of cholinesterase in this laboratory are: plasma 2.4 - 6.6 and red blood cells 12.0 - 16.7. No plasma values fell below this range and only one person's red blood cell values were below the normal range. It should be noted that the single post exposure value which we have for this person was midway between his pre-exposure red blood cell values and there is no indication of excessive exposure as a result of his work during the period of this study.

If values of cholinesterase for those workers who indicated that their principal occupation is agriculture are separated from the "summer only" employees, plasma cholinesterase levels are significantly higher at the 5% level (as determined by an analysis of variance) for the agricultural workers than for the "summer only" employees. Values of red blood cell cholinesterase are also higher, but do not reach significance at the 5% level. These findings are contrary to expectation if the agricultural workers are receiving a significant exposure to cholinesterase inhibiting compounds on a continuing basis. The mean plasma cholinesterase value for the study period for the agricultural workers was 4.33. For the "summer only" employees it was 4.02. Mean red blood cell acetyl cholinesterase for the agricultural workers was 13.96 and for the "summer only" employees it was 13.85. A related result was reported by BURNS and PARKER (1975), in a study of cotton scouts entering fields after treatment with organophosphates. Although the cause is unclear they suggest a possible induction of enzymes by an unspecified feedback system triggered by the exposure.

The results of this study indicate that this group of orchard workers, employed by a well-managed large orchard, suffered no ill effects due to their occupation which were discernible by interview, direct observation or the analytical methodology employed.

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