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**PESTICIDE INDUCED DELAYED NEUROTOXICITY**

Proceedings of a Conference  
February 19-20, 1976  
Washington, D. C.

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## ORGANOPHOSPHATE EXPOSURE FROM AGRICULTURAL USAGE

John E. Swift, Ph.D.

This discussion is supposed to be concerned only with the exposure of humans to organophosphate compounds and the results of these exposures. However, it is not possible for me to confine this subject to just organophosphorous compounds and cover the problem of pesticide exposure and related illnesses. The type and number of injuries is most often determined by the type of work a person is doing at the time of exposure.

These remarks will be confined to the situation in California as that is where these statistics are from and also I read in a recent EPA summary that Region IX has reported the greatest number of pesticide related illnesses. The reasons for this are hard to define; is it because we are more careless than others, use more pesticides, do a better job of reporting illnesses or do we have special environmental or climatic conditions that influence some episodes of pesticide poisoning? I am inclined to believe that all of these factors may contribute to this problem.

The reporting system as directed by the California Workman's Compensation Law states that each physician who attends an employee who is ill or injured as a result of a work practice must file a report on that injury, this is with the California Department of Industrial Relations, this is called the "Doctor's First Report of Work Injury". This agency

then routes these reports to the California Department of Health who compile these statistics, assign classifications of work injury with the Department of Food and Agriculture investigate as many cases as possible they then publish an annual report. Under this system about 85 percent of the injuries in the work force are covered, but it does not include the farmer, unpaid family labor, self-employed pest control operators, those not under Workman's Compensation which may exclude some of the non-U.S. citizen field workers.

Some definitions are in order to clarify some of the points that will be covered during this discussion: for this reporting a systemic illness refers to a generalized illness that involves more tissues than eyes or skin and usually two or more body systems; however, this classification can involve only the respiratory system or a generalized allergic reaction. Skin condition or dermatitis refers to a reaction of the skin, excluding abrasions and thermal burns. Eye condition refers to any condition of the eye caused by a chemical substance. Eye and skin condition refers to cases that have both of these.

The occupation or job requirements appear to be almost as critical in injury cases as the chemicals involved. The classification of agricultural workers in regards to their potential exposure and injury is as follows: ground applicator; mixers and/or loaders; gardeners; field worker exposed to pesticide residues; nursery or greenhouse workers; soil fumigators in agriculture; tractor drivers or irrigators; cleaners and/or mechanics of application equipment; worker exposed to drift from the application site; aerial applicators (pilots), flaggers for aerial application and others.

The workers most frequently reported as being ill from pesticide poisoning are the ground applicators and the mixers and loaders. In some cases one person could be doing all of these jobs; however, for reporting purposes such injuries are divided into these two job specialties.

In order to bring out the type and incidence of poisonings as they relate to job specialties and chemicals involved, I will briefly go through some of the accidents in some of these categories in 1974. There were a total of 1,157 reported cases to the Department of Health in 1974 which was a reduction of 117 cases from 1973; however, I hardly believe this is significant. These incidences are not investigated in detail except for those workers exposed to pesticide residues at harvest or some other job involving intimate contact with the treated foliage.

Ground applicators have had more illnesses than any other agricultural occupation. The following will show some of these occurrences.

(1) GROUND APPLICATORS - 229 CASES - 1974

SYSTEMIC CASES - 92

Organophosphates 55 (Parathion or Phosdrin-37)	Roundup	1 Dowpon	1
Carbamates 8	Ansar	1 2,4-D	1
Dinitro 3	Kelthane	1 Ro-neet	1
Paraquat 2	Princep + Simazine	1 Mixtures	5
	Sulfur	1 Unknown	11

Organophosphates most commonly involved in more serious systemic illnesses. Spilling concentrate on skin while mixing is a major problem.

Other factors:

1. Drift onto operator while spraying
2. Lack of safety equipment
3. Excessive heat which causes the worker not to use the safety equipment
4. Poor training
5. Long working hours
6. Intimate contact with the spray materials and concentrates.

(2) GROUND APPLICATOR - 1974

DERMATITIS - 66 CASES

Weed Oil	13	Paraquat	3	Omite + Guthion	1
Omite	4	Eptam	1	<u>Malathion+Acaraben</u>	1
Comite	3	Alfa-tox	1	Dormant Oil +	1
Treflan	1	DD	1	Bluestone	
Dinitro	1	Zinc	1	Paraquat + Keramax	1
<u>Ansar</u>	1	Lime	1	Omite + ZNP	1
Sulfur	3	<u>Dibrom + Omite</u>	1	Mixture	3
Trysben	1	<u>Omite + Sulfur</u>	1	Unknown	20

Omite and Comite involved in a large percentage of cases in 1974 and even more in 1975.

Drift of spray on applicator caused 10 cases.

Lack of safety equipment caused 7 cases.

Material splashed on applicators.

(3)

GROUND APPLICATORS - 1974

EYE INJURIES - 67 CASES

Sulfur	10	Dow General	1	Difolatan	1
Weed Oil	8	Weed Killer		Parathion	2
Paraquat	2	Tillam	1	Diazinon	1
Contact	2	Balan	1	Omite + Benlate	1
Dinitro	3	Omite	1	Omite + Dibrom	1
Ansar	1	Toxaphene	1	Methyl bromide	1
Bravo	2	Eptam	1	Knox-out	1
2,4-D	1	Plictran	1	Mixture	3
				Unknown	20

Drift in eyes of applicator a major problem - refused goggles.

Repairing hose and adjustments while equipment in operation.

Operator rubbing eyes without washing first.

Splashing material into eyes.

(4)

GROUND APPLICATORS - 1974

EYE AND SKIN INJURY - 13 CASES

Omite	3	Enide	1
Comite	1	Omite + Sulfur	1
Weed Oil	1	Unknown	6

Common cause of injury drift of pesticide from point of application back to and on applicator.



It is obvious that the most serious illnesses are caused by the organophosphorous compounds, but carelessness with other materials causes some illnesses. It should be noted that parathion and phosdrin are the worst offenders of the organophosphorous materials. Lack of protective equipment and clothing is the basis for a number of injuries and the excessive heat certainly contributes to this. The other types of illnesses seem to be caused by almost anything that is used, and the refusal to wear long-sleeved shirts, goggles and a hat apparently is a contributing factor.

The mixer/loader group has the next highest number of illness and apparently for the same reasons as the applicator except since they do not do actual spraying they are not bothered by the spray drifting on them. Their intimate contact with the concentrates is a major factor in these illnesses.

(5) MIXER AND/OR LOADER - 142 CASES - 1974

SYSTEMIC ILLNESSES - 75 CASES

Organophosphates (Parathion & Phosdrin-39)	46	Lead Arsenate	1	Sulfur	1
		Dinitro	1	Herbicide	1
Carbamates	8	DD	1	Mixture	3
Broadside	1	Paraquat	1	Unknown	11

Organophosphates most frequently implicated in severe illnesses.

Most illnesses caused by direct contact with the concentrate.

Lack of use of safety equipment - most refuse goggles and gloves.

Inhaling dust from W. P. concentrates.

Splashing or spilling the concentrate on themselves during the mixing or loading process.

(6)

MIXER LOADER- 1974

DERMATITIS - 20 CASES

Telone	2	Ordram	1	Dyrene	1
Omite	2	Weed Oil	1	Carbamate	1
<u>Dibrom</u>	1	Nemagon	1	Paraquat	1
<u>Sulfur</u>	4	Chlordane	1	Unknown	4

Most injuries are a result of spillage on the skin.

(7)

MIXER LOADER - 1974

EYE INJURY - 40 CASES

Sulfur	2	Eptam	4	Telone	1
Lannate	1	Tillam	1	Hydrated Lime	1
Omite	3	<u>Thimet</u>	1	Toxaphene <sub>R</sub>	1
Comite	1	Copper mono-hydrate	1	Difolatan <sup>R</sup> + Sevin	1
Weed Oil	3	Urea	1	Eptam + Treflan	1
Ansar	1	Ethyl Dibromide	1	Derinol + Planivin	1
Paraquat	2	Sodium Arsenate	1	Organophosphate	1
Roundup	1	<u>Phosdrin</u>	1	Mixture	1
Dinitro	3	<u>Parathion</u>	1	Unknown	3

Herbicides caused a number of problems.

Fourteen injuries caused by splashing concentrate or dilution onto worker - refusal to wear goggles.

Inhalation W.P. concentrate - Hose malfunction and carelessness.

(8)

LOADER/MIXER - 1974

EYE AND SKIN INJURIES - 7 CASES

Weed Oil	1	Sulfur	1
Dinitro	1	Mixture	1
Thiodan	1	Unknown	2

Field workers exposed to pesticide residues may be the most difficult situation to rectify. These people are those who thin, prune and harvest the crops and have substantial contact with treated foliage. They enter a field to do a specific job and frequently they do not know that the plants have been treated with a pesticide. Even if they did, there is not too much they can do to protect themselves except to wear protective clothing, long sleeved shirts, hats and gloves. Occasionally there are a large number of people made ill at one time and we don't have an answer yet except in all recorded cases organophosphorous compounds are involved and usually ethyl parathion is the chemical usually implicated. I will discuss this later.

Excluding systemic injury as a result of organophosphorous compounds, both eye and skin injury frequently involved sulfur.

(9)

FIELD WORKERS EXPOSED TO PESTICIDES RESIDUES - 117 CASES - 1974

SYSTEMIC ILLNESSES - 11 CASES

Guthion + Zolone	2	Parathion + Malathion	2
Sevin	1	Unknown	3
Sulfur	3		

Four cases occurred during the picking of grapes.

Two cases followed a pruning operation of grapes.

Fortunately we had no serious cases of systemic poisonings during 1974.

(10) FIELD WORKERS EXPOSED TO PESTICIDE RESIDUES - 1974

DERMATITIS - 77 CASES

Sulfur	18	Benlate + Dithane	1	Cryolite	1
Benlate	1	Acaraben + Unicide	1	Dyrene	1
<u>Benlate + Cygon</u>	1	Plictran + Imidan	1	Seven + Sulfur	1
<u>Benlate + Omite</u>	1	Difolatan	1	Mixture	3
Benlate + Plictran	1	Dalpon	1	Unknown	44

Pruning and tying grape vines accounted for a number of illnesses.

Several cases of injury occurred in the harvesting of crops: 5 in vineyards; 3 strawberries; 2 lemons, 2 celery; 1 squash; 1 pear, 1 cauliflower.

(11) FIELD WORKERS EXPOSED TO PESTICIDE RESIDUES - 1974

EYE INJURY - 18 CASES

Sulfur	11	Sulfur + Captan	1
<u>Omite + Diazinon</u>	1	Unknown	3
<u>Sulfur + Sevin</u>			

Six injuries occurred during pruning and harvesting grapes and five during celery harvesting.

As noted, sulfur is involved in almost every case.

(12) FIELD WORKERS EXPOSED TO PESTICIDE RESIDUES - 1974

EYE & SKIN INJURY - 11 CASES

Dyrene	4	Sulfur + Captan	1
Sulfur	2	Unknown	4

Most occurred during harvest of fruit crops.

In unknown injuries sulfur could still be the main problem.

Gardeners are members of another occupation with a high incidence of pesticide caused illnesses. These are professional gardeners, not home gardeners. Some professional gardeners in California are quite careless or uninformed; most of them use hand operated equipment for

spraying and they usually are short on protective equipment. Fortunately, however, serious poisonings within this group do not frequently occur because they usually do not have access to the highly toxic materials such as parathion, phosdrin, other organophosphates and some carbamates. In California these chemicals are restricted-use chemicals and require a permit for purchase, possession and use (Table I). In 1974, there was no case of systemic poisoning involving organophosphate compounds; however, there was one reported case of dermatitis involving parathion (which is questionable). There were five other cases of dermatitis or eye injury involving other organophosphate compounds which are not on California's restricted-use list -- specifically diazinon, malathion and metasystox. Most of the materials available to professional gardeners are in the moderate to slightly toxic categories. However, it seems obvious that if there is a way to inflict self-injury by using a chemical, man will find it.

(13) GARDENERS - 101 CASES - 1974

SYSTEMIC ILLNESSES - 5 CASES

2,4-D	2	Weed Oil	1
Vapam	1	Mixture	1

Highly toxic organophosphorus compounds are not allowable in most work of this type.

One injury was from a spill, a second from drift of his own spray and the third from not using any safety equipment.

(14)

GARDENERS - 1974

DERMATITIS - 40 CASES

Weed Oil	5	Phytar	1	<u>Diazinon + Princep</u>	1
Roundup	1	<u>Parathion</u>	1	<u>Diazinon +</u>	1
Dibrom	1	<u>Diquat</u>	1	<u>Mercuric chloride</u>	
Dalapon	2	Paraquat	2	<u>Malathion + Kelthane</u>	1
Chlordane	1	Amizol	1	<u>Fungicide</u>	1
Dinitro	1	Isotox	1	Mixture	4
Caseron	1	Difolatan	1	Unknown	12

Four illnesses from equipment malfunction. Four from spills of concentrate. Three due to lack of safety equipment. Some from drift of application. One from contact of previously sprayed plants.

(15)

GARDENERS - 1974

EYE INJURIES - 53 CASES

Weed Oil	15	Copper sulfate	2	Amitrole	1
Paraquat	4	Sulfur	1	<u>Diazinon</u>	2
Dowpon	1	Simazine	1	<u>Carbaryl + chlordane</u>	1
Diquat	1	Amizol	1	<u>Dalapon + Weed Oil</u>	1
2,4-D	1	Aquathol	1	<u>Roundup + Pramitol</u>	1
Princep	1	Krovar	1	<u>Sodium chlorate +</u>	1
<u>Metasystox</u>	1	Benlate	1	<u>Metaborate</u>	
<u>Insect repellent</u>	1	Rololind	1	<u>Pramitol</u>	1
<u>Chlorothalonil</u>	1	Vapam	1	<u>Mixture</u>	1
(Bravo)				Unknown	8

Equipment malfunction caused a number of injuries (over 15). Drift of spray back into the eyes of the applicator accounted for several cases. Goggles were not used in most cases. Splashes or spills on the operator also caused a number of injuries.

(16)

GARDENER

EYE & SKIN ILLNESSES - 3 CASES

Oaonil	1
Sulfur	1
Unknown	1

The last category I want to discuss is the nursery and greenhouse workers. This group has a relatively high incidence of pesticide induced illnesses.

(17) NURSERY & GREENHOUSE WORKERS - 75 CASES - 1974

SYSTEMIC ILLNESSES - 11 CASES

Temik	3	Dexon	1
Dinitro	1	Malathion	1
Lannate	1	Amitrol + Lannate	1
Metasystox	1	Unknown	1
Paraquat			

Three of these cases can be attributed to lack of any protective equipment. The others are partly attributed to the mixing process and to spills.

(18) NURSERY AND GREENHOUSE WORKERS

DERMATITIS - 47 CASES

Weed Oil	3	Copper sulfate	1	Temik, Captan +	1
Benlate	3	Chlordane	1	Benlate	
Zectran	1	Actidione	1	Captan, Metasystox	1
Diazinon	2	Dithane	1	+ Dithane	
Paraquat	2	Regulain	1	Lannate + Benlate	1
2,4-D	1	Cygon	1	Benlate + Dithane	1
Kelthane	1	Dexon + Benlate	1	Mixture	1
				Unknown	22

Twelve employees became ill after handling treated plants. Several illnesses occurred after the person had been spraying the material. Benlate was frequently implicated.

(19) NURSERY OR GREENHOUSE WORKERS

EYE INJURIES - 16 CASES

Lime	1	Dibrom	1	Cygon	1
Rololind	1	Azodrin	1	Temik	1
Metasystox	1	Weed-all	1	Benlate + Dazatrol	1
Dexon	1	Banrot	1	Benlate + Omite	1
				Unknown	4

Four injuries by contacting treated plants. Four injuries associated with accidental spills.

One eye and skin injury cause not known.

Considering the conditions of work and the types of materials frequently used this group has a relatively good record and they also use restricted materials. Supervision in nurseries and greenhouses is usually better than among other areas and this may account for the relatively good record.

A number of other occupationally exposed workers are listed according to their work speciality and these are:

#### OTHER PESTICIDE ILLNESSES ACCORDING TO OCCUPATION - 1974

1. Soil Fumigators in Agriculture	29
2. Equipment Cleaners and Mechanics	28
3. Tractor Drivers and Irrigators	23
4. Workers Exposed to Drift	22
5. Pilots	17
6. Flaggers	6

Those doing soil fumigation most frequently report illness from methyl bromide and chloropicrin or other fumigants, no organophosphates were involved.

Tractor drivers and irrigators reported 22 cases of injury and 5 incidences of systemic poisoning. Four out of these 5 cases involved parathion and 1 thimet. There were no other injuries involving OP compounds. The same was true for those who clean and repair equipment. For those who are injured while cleaning equipment, for the most part it is the result of carelessness or the owner or supervisor did not advise them of the hazard involved in cleaning out the residue associated with these chemicals. If the owner of the equipment properly advised them as to the material in the equipment, there should be few accidents.

In the case of the mechanic repairing a piece of equipment the illness is the result of the applicator or equipment owner or not notifying the mechanic of the type of material that was last used in the machine.



In both cleaning and repairing equipment, 9 of the 24 cases were systemic poisonings and all involved organophosphorous compounds with parathion or phosdrin causing all but one incident. In the repair of equipment most cases involved a welding torch or some other heat source which vaporized the material and resulted in a pesticide illness almost immediately. This can be stopped if a little more respect is afforded these chemicals.

Workers exposed to drift are those who are in the area but not doing one of the jobs previously mentioned. In 1974, eight cases were as a result of aerial application and 12 cases were from ground application. Of the 10 systemic illnesses 9 were caused by organophosphorous compounds and one by a carbamate. For other types of illnesses the offending chemicals were the same as previously reported.

Amongst pilots, 13 of the 17 reported illnesses were systemic poisonings and all but 3 of these were caused by organophosphorous compounds involving parathion, phosdrin, systox, phosvel and guthion; two of the other three were carbamates; the third unknown. Most injuries were the result of equipment malfunctions in the airplane or crashes.

One would think that flaggers would be subject to many exposures and illnesses caused by pesticides, but this is not the case. There were only 6 cases of poisoning in 1974 and 3 of these were systemic caused by parathion or a combination of parathion plus something else. Organophosphorous compounds were not involved in the other three cases. Flaggers move so that drift is always away from them, they move out of the path of the plane as soon as the pilot gets on course and as a result is one of the safest jobs in agriculture where chemicals are involved.

The problem associated with most of the pesticide induced illnesses can be avoided. Of course it is recognized certain types of accident such as an airplane or truck crashes, explosion or fires cannot be anticipated but many others can and proper measures taken to reduce such illnesses. However, the problem associated with worker illnesses due to exposure to pesticide residues on various crops is one that will require considerably more research. Such cases have been recorded in California since 1949 and while re-entry intervals imposed in 1971 (Table II) have reduced the number of such poisonings. They still are occurring only. Only now are the mechanisms by which such poisonings occur, the environmental factors involved and the extent of the problem are being thoroughly studied.

Of the cases recorded since 1949 there have been a total of 26 incidences occurring in 13 different years (Table III). That is to say some years there were no cases and others 3, 4, or 5 incidences per year. The crops involved have been pears, citrus, grapes, peaches, olive, prune and lettuce. Of significance in this report is that out of 26 incidences, 17 involved parathion, 4 parathion plus some other organophosphorous compound, 4 other organophosphorous compounds and 1 unknown. To further complicate the picture, 18 of the incidences involved citrus and 8 the rest of the crops mentioned. A clue to this situation might be the distribution of these incidences in California. The first occurrence was in the Sacramento Valley, then two cases in the Riverside area and all the rest in the San Joaquin Valley.

The one factor in common here is the weather or climatic condition except for an occasional situation, occur during extremely dry conditions

from June to September, the humidity is low and usually a large build up of dust on the foliage of the crop. Dr. Spear and others have found that the weathered residue of parathion decay into paraoxon and is associated with the dust on the leaves which termed a dislodgable residues, and this gets onto the upper body of the worker as he harvests the fruit, prunes or some similar job. Paraoxon is also formed in the soil and it appears that a possible contamination of the whole body may occur. It has been determined that poisoning is a result of paraoxon being absorbed through the skin in sufficient quantities to cause intoxication. Spear et al., so far have concluded that paraoxon is the principal toxic constituent of the weathered residue. The absorbed dose is almost entirely dermal. In citrus crops the fallout of foliage residues is probably of more importance than direct foliar contact.

As a result of studies like this by Dr. Spear and others we may eventually get to the cause and solution of this problem.

As a further study regarding exposure of field workers to organo-phosphorous residues -- Peoples, Knaak & Maddy studied in 1975 -- collected blood samples of 1,166 persons during the growing season of specific crops in the San Joaquin Valley. These included male and female field workers and non-field workers, but all from the same farming community. There were 416 male and females who acted as controls. This monitoring was done at the height of the harvest season for lettuce, grapes, peaches, and citrus. The farm workers were selected by physicians at Union farm worker clinics. Or those who volunteered to a sign posted in the clinic printed in both English and Spanish saying "Obtain

a free test today for pesticide exposure". This means of selecting subjects should insure a relatively representative sample of the farm worker population. Analysis of these results are still under way but so far there is no difference in cholinesterase value between the field workers and the controls. The largest number of persons involved occurred in September at the end of the grape harvest and these did not show any difference from the controls.

Many things are going on in California and the United States in general to reduce the problem of worker injury to pesticide exposure.

Some of the significant things are the research by people like Spear, Maddy and Kahn. Injury and accident investigation, re-entry intervals that are imposed after the use of certain chemicals on certain crops, employers' responsibility for training his employees, emergency medical care and medical supervision for those working with certain organophosphorous or carbamate compounds, it is now illegal for a pilot to assist in loading operations, the future requirement of a closed mixing system, shielding of flexible hoses if they go through any vehicle used for ground or aerial application, and monitoring the farm worker population, etc.

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STATE OF CALIFORNIA  
DEPARTMENT OF FOOD AND AGRICULTURE

TABLE I

RESTRICTED MATERIALS  
Permit required for possession and use

- |  |   |
|--|---|
| (a) <u>Certain pesticides containing arsenic</u>   | (5) Monitor   |
| (1) Sodium arsenite**                              | (6) Supracide   |
| (2) Other pesticides containing inorganic arsenic* | (7) Demeton (Systox)  |
| (b) Pesticides containing cadmium*                 | (8) Disulfoton (Di-Syston)*   |
| (c) Pesticides containing mercury                  | (9) EPN   |
| (d) <u>Carbamates</u>                              | (10) Ethion   |
| (1) Aldicarb (Temik)                               | (11) Methyl Parathion   |
| (2) Carbaryl (Sevin)*                              | (12) Mevinphos (Phosdrin)   |
| (3) Carbofuran (Furadan)****                       | (13) Parathion  |
| (4) Methomyl (Lannate)                             | (14) Phorate (Thimet)   |
| (e) <u>Fumigants</u>                               | (15) Phosphamidon   |
| (1) Chloropicrin*                                  | (16) Schradan (OMPA)  |
| (2) Methyl Bromide*                                | (17) Sulfotepp  |
| (3) Aluminum phosphide                             | (18) TEPP   |
| (4) Carbon bisulfide                               | (19) Dialifor (Torak)   |
| (f) <u>Mercury treated seeds</u>                   | (k) <u>Chlorinated Hydrocarbons</u>   |
| (g) <u>Endrin treated conifer seeds</u>            | (1) Aldrin*   |
| (h) <u>Avicides</u>                                | (2) Benzene hexachloride (BHC)  |
| (1) Avitrol  | (3) Chlordane*  |
| (2) Starlicide                                     | (4) DDD (TDE)   |
| (3) Strychnine                                     | (5) DDT   |
| (i) <u>Rodenticides</u>                            | (6) Dieldrin*   |
| (1) Sodium fluoracetate (Compound 1080)            | (7) Endosulfan (Thiodan)  |
| (2) Strychnine*                                    | (8) Endrin  |
| (3) Zinc phosphide*                                | (9) Heptachlor*   |
| (j) <u>Organic Phosphorus Compounds</u>            | (10) Lindane*   |
| (1) Azinphosmethyl (Guthion)                       | (11) Toxaphene*   |
| (2) Carbophenothion (Trithion)                     | (1) All other pesticides registered for use in the form of a dust, except those products containing only exempt materials.*** |
| (3) Bidrin   | (m) <u>Other Pesticides</u>   |
| (4) Azodrin  | (1) Paraquat  |

See next page for explanation of asterisks (\*).

TABLE I

RESTRICTED HERBICIDES

Permit required for possession and use except as provided for in Section 2451 (Admin. Code)

- |             |                      |
|-------------|----------------------|
| (a) 2,4-D   | (f) 2,4-DB           |
| (b) 2,4,5-T | (g) Picloram         |
| (c) MCPA    | (h) Propanil         |
| (d) 2,4-DP  | (i) Dicamba (Banvel) |
| (e) Silvex  |                      |

PERMIT REQUIREMENTS

Restricted Materials

\* No permit required for home use, structural pest control, industrial and institutional uses, and uses by certain public agencies.

- |   |  |
|---|--|
| (A) Pesticides containing arsenic other than sodium arsenite as specified in Section 2460 (a) (1) | (I) Benzene hexachloride (BHC)   |
| (B) Pesticides containing cadmium   | (J) Chlordane  |
| (C) Pesticides containing mercury   | (K) Dieldrin   |
| (D) Carbaryl (Sevin)  | (L) Endosulfan (Thiodan)   |
| (E) Chloropicrin  | (M) Heptachlor   |
| (F) Methyl bromide  | (N) Lindane  |
| (G) Disulfoton (Di-Syston)  | (O) Strychnine (Rodenticide uses only)   |
| (H) Aldrin  | (P) Toxaphene  |
|   | (Q) Zinc Phosphide   |
|   | (R) Pesticides registered for use in the form of a dust included in (I) on reverse side. |

\*\* No permit required for ready-to-use syrups or dry baits.

\*\*\* No permit required when packaged in containers holding 25 pounds or less or for use in enclosed areas such as greenhouses.

\*\*\*\* No permit required for granular formulations containing not more than 5% carbofuran.

\*\*\*\*\* No permit required for paraquat for home use only when possessed and used in accordance with registered labeling.

TABLE I

General

- (1) Permits to possess restricted materials/herbicides shall not be required of economic poison registrants or pesticide dealers when operating under their licenses, or by governmental agencies or by commercial carriers to transport such materials.
- (2) The person in charge of the property to be treated or the pest control operator or both may apply for a permit, but no permit shall be valid for possession or use by any operator or person not named in the permit.
- (3) A permit to use restricted materials/herbicides shall have an expiration date no later than the calendar year for which issued and shall be valid for the period specified unless sooner revoked or suspended. A copy of each permit shall be retained by the issuing officer.
- (4) The person named in a restricted materials permit is authorized to possess materials for which the permit was valid after such permit expires, provided it is stored in accordance with Section 3136.

REFER TO REGULATIONS FOR SPECIFIC PERMIT REQUIREMENTS.



CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

TABLE II

Field Re-entry Safety Intervals

Safety intervals have been established by regulation between the time certain pesticides are applied to citrus, grapes, peaches, nectarines, and apples, and the time workers may be allowed to enter treated areas to engage in an activity requiring substantial body contact with treated foliage. In addition to the intervals specified by regulation, numerous other safety intervals are included in pesticide labeling and must be complied with. In cases where the safety interval specified in the pesticide labeling differs from the safety interval specified in the regulations, the longer interval must be followed.

Safety Intervals in Days for Citrus, Peaches & Nectarines, Grapes, Apples

	Citrus	Peaches & Nectarines	Grapes	Apples
Azinphosmethyl (Guthion)	30	14	21	14
Carbophenothion (Trithion)	14	14	14	--
Demeton (Systox)	5	7	7	--
Diazinon	5	5	5	--
Dimecron (Phosphamidon)	14	--	--	--
Dimethoate (Cygon)	4	--	4	--
Dioxathion (Delnav)	30	30	30	--
EPN	14	14	14	14
Ethion	30	14	14	--
Malathion	1	1	1	--
Mevinphos (Phosdrin)	4	4	4	--
Naled (Dibrom)	1	1	1	--
Parathion-ethyl	21 (a) 30 (b) 45 (c)	21	21	14
Parathion-methyl	--	21	21	14
Phosalone (Zolone)	--	21	21	--
Imidan	--	5	5	--
Sulphur	1	1	1	--
TEPP	4	4	--	--

Footnotes: (Note these must not be confused with preharvest intervals)

- (a) No more than 4 pounds of actual parathion per acre in a single application.
- (b) More than 4 pounds of actual parathion per acre, but no more than 10 pounds per acre, in the past 12 months.
- (c) More than 8 pounds of actual parathion per acre per application or more than 10 pounds per acre in the past 12 months.

TABLE III

THE  
PROBLEM

Since the introduction of the organophosphate (OP) pesticides into California agriculture in the late Forties, it has become increasingly clear that it is possible to become poisoned from sufficient exposure to residues of these pesticides on foliage and in soils. The population occupationally exposed to such residues is comprised of agricultural fieldworkers engaged in thinning, pruning or harvesting operations. OP-treated citrus crops appear to present a particular hazard but multiple poisonings have also been reported in grapes, peaches, pears, olives and lettuce crops. These incidents led to the imposition of regulations aimed at limiting the exposure of fieldworkers which came into force in the State in 1971 (California Administrative Code, Title 3, Article 2475). However, the mechanisms by which such poisonings occur, the environmental factors involved and the extent of the problem are now being studied.

Incidence of multiple systematic illness from exposure to OP-pesticides for agricultural workers in California, 1949-1974

Date	Location	No. ill	Probable no. exposed	Crop and activity <sup>a</sup>	Pesticide implicated	AIA <sup>b</sup>	Entry time <sup>c</sup>	Previous applications	
								Spray used	Interval <sup>d</sup>
7/8/49	Marysville	20-25	56	Pears	Parathion	2.50	12	—	—
6/27/51	Delano	16	24	Grapes	Parathion	1.87	33	—	—
8/27/52	Riverside	11	30	Oranges	Parathion	2.00	16	—	19
7/6/53	Riverside	7	—	Oranges	Parathion	—	17	—	—
7/ /53	Riverside	—	—	Citrus	Parathion	—	34	—	—
7/ /53	Bryn Mawr	—	—	Citrus	Parathion	—	33	—	—
7/ /59	Whole State	275	—	Citrus	Parathion	—	—	—	—
10/5/61	Terra Bella	10	—	Lemons	Parathion	3.00	17	Parathion	97
8/9/63	Hughson	94	—	Peaches	Parathion	2.00	14-38	Parathion	36-110
6/29/66	Terra Bella	9	15	Oranges	Parathion	1.87	15	—	—
7/8/66	Porterville	6	11	Oranges	Parathion	1.33	32	—	—
7/22/66	Lindsay	3	30	Oranges	Parathion	2.00	13	—	—
8/2/66	Navelencia	11	22	Oranges	Parathion-malathion	13.5p	28	—	—
8/11/66	Terra Bella	9	28	Oranges	Parathion-ethion	3.75p	46	—	—
9/2-23/67	Hughson	24	—	Peaches	Azinphosmethyl	1.5a	38-47	Dicofol	38-47
9/14-16/67	Ballico	3	—	Peaches	Azinphosmethyl	2.0e	66	TEPP	15-30
5/5/70	Porterville	3	30	Lemons (prune)	Dioxathion	6d	1	—	38
5/25/70	Lindsay	2	22	Oranges	Parathion-naled	7.5p	14	Parathion	17
5/27-28/70	Terra Bella	8-11	—	Oranges	Parathion-ethion	6.75e	8	—	—
9/14-17/70	McFarland	35	35	Oranges	Azinphosmethyl	12a	11	Azinphosmethyl	10-12
10/1/70	Orosi	11	55	Oranges	Parathion	4e	34-37	Dioxathion	120
8/16-24/71	Orange Cove	8	9	Olives (prune)	Parathion-malathion	3p	31	Azinphosmethyl	180
5/6/72	Lindcove	3	—	Oranges	Parathion	6.00	31	—	—
9/15/72	Exeter	9	22	Oranges	Parathion	2.5	21	—	—
9/9/72	Huron	4	31	Lettuce (weed)	Parathion	5.00	12	—	—
8/30/73	Fowler	27	32	Grapes	Parathion	2.50	1	Parathion	4-25
					?	—	41	—	—

<sup>a</sup> Unless otherwise indicated in "Crop" column, workers are engaged in picking operation. <sup>b</sup> Active ingredient per acre expressed in lb. Days postapplication. <sup>c</sup> Days prior to most recent application.

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DR. D. KURODA: In California, you have many lettuce fields. Suppose, for example, a field is sprayed with a delayed neurotoxin. How is a migrant worker going to know that his onset of symptoms are due to an exposure two weeks ago? Has California had any experience with gathering accident data on delayed neurotoxic pesticides?

DR. J. E. SWIFT: With delayed neurotoxic pesticides, as far as I've been able to find out, and I asked persons who should know about it, -- there are no known cases having occurred in California.

If you're asking about leptophos, yes it was used, but its usage has been stopped for the present time. EPN is a material that is no longer used. You can hardly even buy it in the state anymore. It did not prove to be effective as a pest control agent. With most of these pesticides I'm talking about -- at least the organophosphates and the carbamates, if they're used on a field, the field has to be posted in both English and Spanish in letters that can be read at least 25 yards away. It's posted on all four sides of the field and the entrance place. Until the re-entry period that has been settled upon has passed. After that they have to be taken down. This applies to any sort of a crop, if certain compounds are used. EPN was put on this category where it had to be used in posted fields. This was done as long ago as the early 1950's. EPN is just not used anymore.

DR. W. J. HAYES: I think this has been a very valuable contribution to hear about these occupationally connected cases from California. These statistics have been available for many years. There's nothing quite comparable to them in any of the other states. So, it's very valuable to hear these reports of, in most instances, very mild effects, with reporting stimulated by a compensation system.

I thought it might be of interest to you, since I've had to look into it, to get a little perspective on how this compares with the other parts of the country and the world, and even with California itself. In other statistics issued by the state, but published separately for the last several years, to give you some idea of the kind of thing that they will record, the number of cases of poisoning by poison ivy is considerably in excess of those by pesticides.

Now, in other states and countries where they count only those accidents that are of a more serious nature, and, at least in the state of New York, are compensable, what one finds is that the number of agriculturally related injuries is very much higher for equipment, and even hand tools, than it is for pesticides. The number of pesticides used are really quite small. If you take that kind of a base, then you get essentially identical statistics from places as far removed as New York State, the United Kingdom and Hungary. I have been searching for some years to get comparable figures from California, but without success.