Statement of the

National Institute for Occupational Safety and Health

on

Exposure of Employees to Organophosphorus Pesticides

Presented by

Jon R. May, Ph.D.

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Due to the nature of the agricultural operation being performed, it is necessary for a great many field workers to come into intimate and prolonged contact with pesticide containing foliage. In tree-fruit thinning operations, the pesticide may have been applied a few days before, while in harvesting operations it may have been applied a month before. Mechanization may indeed ultimately replace the need for human hands in the cultivation and harvesting of crops; however, in harvesting celery, oranges, peaches, apples, cherries, and a great many other fruits and vegetables, human hands are essential today. Considering the number of pesticides available for use, the cultural practices to be performed, the nature and extent of insect infestation, and the peculiarities of weather, the potential for hazard to the health of the workers coming into intimate and prolonged contact with pesticide laden foliage varies greatly. However, the potential for harm is real and present.

In the pesticide emergency standard of June 29, 1973, as published in the Federal Register, pp 17214-16, June 29, 1973, the Department of Labor followed the recommendation of the Standards Advisory Committee on Agriculture and restricted coverage to 12 organophosphorus (OP) insecticides with acute dermal LD50's of 250 mg/kg or less. In other words, only the most toxic OP's were included in the emergency field reentry standard. However, DOL simultaneously proposed in the Federal Register their intent to include an additional 9 OP compounds of lesser toxicity in the permanent standard, which by law must replace

the emergency standard within 6 months of the effective date. As almost everyone in this room is aware, both the revised and the initial emergency standards were somewhat less-than-well received by the agricultural community. The revised standard of June 29th has been ordered stayed by the 5th Circuit Court of Appeals in New Orleans.

The OP insecticides contained in the revised emergency standard are: azinphosmethyl (Guthion*), carbophenothion (Trithion*), demeton (Systox*), disulfoton (DiSyston*), EPN, methyl parathion, mevinphos (Phosdrin*), monocrotophos (Azodrin*), oxydemetonmethyl (Meta-Systox R*), parathion, phosphamidon (Dimecron*) and TEPP.

Each of these insecticides is toxic to humans as well as to the target insects. In humans, OP insecticide poisoning is due to the inhibition of tissue, or functional, acetylcholinesterase (AChE), resulting in the accumulation of acetylcholine, the chemical mediator of the parasympathetic nervous system, at various sites throughout the body. Consequently, the build-up of acetylcholine produces the classical cholinergic syndrome responsible for the signs and symptoms of OP poisoning. The twelve insecticides vary widely in acute dermal toxicity, from 2.4 mg/kg for the extremely toxic TEPP to 230 mg/kg for EPN (male rats).[1] Several of the group, including parathion, ethion, and Guthion*, have previously been implicated in episodes of mass agricultural worker poisoning.[2-4] Many of the so-called cases of

"picker poisoning" have occurred in arid areas of California, and have involved crops previously treated with parathion. However, since all of these compounds inhibit cholinesterase(s) in humans they are all inherently hazardous to exposed workers.

Nine other OP insecticides, namely: diazinon, dimethoate (Cygon*), dioxathion (Delnav*), ethion, prolate (Imidan*), malathion, naled (Dibrom*), phosalone (Zolone*), and trichlorfon (Dylox*), were included in the May 1st emergency standard (Federal Register, pp 10715-17, May 1, 1973) but deleted from the revised standard of June 29th. These compounds exhibit dermal LD50's in excess of 250 mg/kg. However, the inherent toxicity of a compound is only one factor in determining what constitutes a safe exposure to workers. Concentration of the toxicant and the duration of exposure are also important considerations. In essence, consecutive daily 8-hour exposures to 50 ppm of parathion on foliage may be just as hazardous to a workers health as a single 1-hour exposure to 400 ppm on foliage. Concentration times time is a proven concept in establishing occupational health standards.

OP insecticides, including those covered in the emergency standard, dissipate and degrade after application to crops for insect control. Rainfall, wind, and volatilization result in dissipation of the insecticide residues on foliage and fruits while moisture, temperature, and other factors result in a chemical breakdown (i.e.,

degradation) of the applied insecticide. The degradation products in some cases are less toxic while in others they are more toxic. Normally, there is a rapid initial decline in residue levels on foliage followed by a less rapid, prolonged, disappearance. Therefore, levels of the insecticide on foliage are initially high, depending on the amount of active ingredient applied per acre, followed by a continuous disappearance of the residues with the passage of time. The reduction in the foliar insecticide residues with the passage of time to levels so low that workers having prolonged and intimate contact with the foliage will not be adversely affected is the basis for pesticide field reentry intervals. Workers entering fields treated with any of the specified OP insecticides (i.e., those included in the revised emergency standard) immediately after application, for cultural practices requiring prolonged and intimate contact with the insecticide-laden foliage, may be at hazard. The degree of hazard depends on many factors, including the inherent dermal and oral toxicities and the chemical stability (i.e., persistence) of the applied material, as well as the concentration of the pesticide on the crop and in the air, and the duration of exposure. In the case of high residue levels of relatively weak cholinesterase inhibitors, the worker may experience tightness of the chest and a little difficulty in breathing, difficulty in focusing the eyes, and a feeling of light-headedness or headache. With potent inhibitors, such as methyl and ethyl parathion or TEPP, the symptoms are likely to be more severe. Under normal conditions, OP insecticide

residues on foliage will degrade to safe levels within a certain period of time. That period of time, in days, is the acceptable reentry interval. For unknown reasons there have been reported episodes of residue poisoning occurring long after the application of certain insecticides. Instead of following expected degradation curves, the insecticide deviated and its residues persisted for a very long period. Binding to dust or other dislodgable particles on the foliage plus arid weather conditions might have been responsible for such behavior. Workers entering on or after the reentry date will not be at hazard providing the reentry interval is valid. Exposure to "unsafe" levels of insecticide on the crop foliage due to premature reentry into OP insecticide-treated fields may result in either acute or chronic poisoning. Acute poisoning may occur if the worker enters soon after application and is exposed to high concentrations of the applied insecticide; chronic episodes may occur when workers, in continuous and intimate contact with residues in excess of the safe level are being subjected to a slow but continuous decline in their tissue cholinesterase activity. In humans, plasma and RBC cholinesterase recover at approximately 4% and 1-2% per day, respectively, while tissue AChE is regenerated/replaced at approximately 1% per day.

Therefore, if the vital tissue, or functional, AChE is being inhibited by an OP insecticide at a daily rate exceeding 1%, ultimately signs and symptoms of OP poisoning will probably occur.

The exact number of workers exposed to pesticide residues on crops is unknown; however, we do know that the number is large. It is estimated that several hundred thousand agricultural workers are potentially exposed to pesticide residues on crops annually. During July, 1971, 1,010,491 "seasonal hired agricultural workers" were employed in agriculture in the US, according to statistics from the Manpower Administration, US Department of Labor.[5] North Carolina, California, and Texas employed the most with 158,550, 137,220, and 117,130 workers, respectively. The majority of workers were local in origin and were involved in harvesting fruits, vegetables, tobacco, hay, and grains. One of the controversial aspects of the promulgation by DOL of field reentry safety intervals was the estimate of the number of workers killed and injured yearly. The estimates of 800 deaths and 80,000 non-fatal poisonings per year due to pesticides, although developed during a Congressional hearing, are not substantiated by the evidence. However, the controversy over the mortality and morbidity estimates has served a useful purpose in focusing attention on the need for beter reporting. Exactly what is the true picture of occupational pesticide poisonings in the United States? In 1964 Dr. W. J. Hayes Jr. estimated,[6] from his study of the subject, that pesticides caused approximately 1 death per 1,000,000 population in the US. His estimate was based on data collected between 1939 and 1964. Today, most scientists quote a range of 120-200 pesticide deaths per year, in agreement with Hayes' estimate. However, it must be stressed that these figures are based

on a less-than-adequate pesticide morbidity/mortality reporting system. We agree, as Hayes stated in 1964, that information on pesticide morbidity is neither gathered nor recorded as systematically as that on mortality. Hayes further stated that the extent of pesticide morbidity must be extrapolated from the incidence of fatal poisoning. Based on his observations of the ratio of non-fatal to fatal cases, he estimated that a ratio of 100 to 1 for the entire population was the most accurate estimate possible. That ratio is considered the Gospel by many individuals today. However, it should be considered as a very rough estimate based on insufficient information. Hayes stated that "the records of poison control centers often show a ratio much greater than 100 to 1, but over 90% are unhospitalized and as many as 70% may show no symptoms of illness." However, according to Hayes own calculations, 30% may show symptoms, a rather significant percentage. The point is simple and clear--we don't know the true extent of pesticide related death and illness.

A significant number of pesticide poisonings occur among children, especially in the age group 5 and under, according to published information from the National Clearinghouse for Poison Control Centers.[7] In addition, pesticides are involved in suicides and murders. Clearly, such poisonings represent missuse of pesticides and should not be used in establishing a need for occupational standards. California requires under Section 6407 of the California Labor Code that a report of an occupational disease, as well as any work injury,

be made by the employer and attending physician to the California Division of Labor Statistics and Research when disability results in medical attention or loss of work for at least one full shift.

Physicians' reports of occupational disease attributed to pesticides and other agricultural chemicals for the 17-year period, 1954-70, shows the incidence of occupational disease among those in agriculture as compared to other industries in the State of California.[4] In every year agriculture has experienced a greater incidence of occupational disease than all other industries. Agriculture includes farms, pest control, and other services while other industries includes manufacturing, construction, transportation, communication and utilities, trade, structural pest control, state and local government, and other and unspecified. Of the 938 cases of pesticide-related occupational disease reported for agriculture in 1970, 711 occurred on farms, 200 in pest control, and 27 while performing other services. 244 out of 938, or 26%, of the pesticide related illnesses were caused by OP pesticides, with parathion, Phosdrin*, and Guthion* involved most frequently, in descending order. Malathion was implicated in 9 cases of occupational disease, with 5/9 occurring in agriculture, and 4/5 on farms. No pesticide-related deaths occurred during 1970. Farm laborers accounted for the largest proportion, 52%, of the 1,493 cases, while nonfarm laborers accounted for 15%. In the farm laborer category, 782 cases of pesticide-related illness were recorded. Of these, 155 involved sprayers, 80 involved pickers, and

547 were listed as other and unspecified. The 1970 report [4] of the California Department of Public Health states that the pesticide morbidity data presented "undoubtedly understate the amount of occupational disease caused by agricultural chemicals."

Moore [8] reported on the results of a pesticide morbidity/mortality survey in Kentucky at the 2nd conference on Environmental Chemicals held at Colorado State University in July, 1973. The results emphasize the apparent under reporting of the Poison Control Center network. During the four year period 1968-71, 387 incidents of pesticide exposures serious enough to require physician attention were uncovered through a review of 1.8 million in-patient and emergency treatment room records at 40 Kentucky hospitals. The National Clearinghouse for Poison Control Centers revealed that less than 50 cases were reported from Kentucky's 7 centers during the time period of the study. It should be stated that oral ingestion of the pesticides was involved in 79.1% of all incidents, occurrring predominantly in the urban setting. However, the study dramatically supports our belief that pesticide morbidity is under reported.

The inadequacy of our pesticide accident reporting system is clear to anyone who has taken the time to check into it. It is a credit to the Office of Pesticide Programs, EPA, that they recognized this some time ago and undertook the upgrading of their pesticide accident reporting system. PASS, an abbreviation for Pesticide Accident Surveillance

System, or PARS, or whatever it will eventually be called, is a step in the right direction. We need more accurate information concerning the extent and severity of pesticide poisonings. The National Institute for Occupational Safety and Health believes, on the basis of available information, that occupationally-related pesticide mortality is not grossly under reported and that the figure of 800 pesticide deaths per year is too high. However, we also believe that morbidity due to occupational exposure to pesticides is under reported, although we can provide no estimate as to the degree of under reporting. As the occupational disease reports from California and elsewhere demonstrate, many workers become ill from exposure to pesticides. It is also reported that a significant number of field laborers experience signs and symptoms of illness similar to those induced by cholinesterase inhibiting pesticides. NIOSH therefore believes that action should be taken to protect field workers from the potentially harmful effects of toxic pesticide residues on crops. In order to provide protection to exposed workers, various strategies have been proposed. These include:

1. Use of non-cholinesterase inhibiting pesticides.

2. Use of biological control.

3. Use of shorter lived OP and carbamate compounds that will degrade in sufficient time to permit workers to come in contact with treated crops shortly after application.

4. Use of pesticides with self-destructing materials added to them that would render them non-toxic in a given period of time.

5. Use of encapsulated pesticides that would release only small amounts of the active chemical over an extended period of time commensurate with pest control, but with residues at such low levels that workers are not adversely affected.

6. Use of better protective clothing during periods of exposure to residues.

7. Require that workers improve personal hygiene, including frequent showers and changes of clothing.

8. Require frequent cholinesterase activity level check of workers and provide appropriate antidotes.

9. Use of mechanical harvesters to eliminate worker exposure.

10. Use of decontaminating agents to remove pesticide residues from leaves before worker exposure.

11. Establishment of field reentry safety intervals for those crops where there is intimate and prolonged worker exposure to pesticide residues.

We have studied and evaluated all of these strategies for protecting field workers from potentially harmful effects of pesticides and believe that several have merit. For example, the use of better protective clothing during periods of exposure has merit. However, when crops are being harvested in many areas of the country, it is usually too hot to wear much protective clothing. Experience has shown that field workers in hot climates are usually adverse to the wearing of adequate protective clothing and equipment. Improved personal hygiene, including frequent showers and changes of clothing, would be helpful but is of extremely limited practicability during the work day. The use of decontaminating sprays may prove valuable in the future. Integrated pest management, which encompasses biological control and altered pesticide usage patterns, appears to have merit and may well be the wave-of-the-future. However, despite the advantages of many of these strategies, the concept of field reentry safety intervals appears most valid and useful at this time. Reentry intervals are based on the concept of making the workplace safe. Through this mechanism, combined with better personal hygiene and more adequate work clothing, we can provide a high level of worker protection while permitting the use of pesticides, so vital to the production of our nations food and fiber. We thus support the

establishment of scientifically valid field reentry safety intervals. Through my membership on the Federal Working Group on Pest Management (FWGPM) Task Group on Occupational Exposure to Pesticides, NIOSH has been actively involved in the attempt to determine the extent and severity of occupational pesticide poisoning and in developing a protocol for performing controlled field studies to establish safe field reentry intervals for various pesticides and crops. The final report of the Task Group is expected by the end of calendar year 1973. The National Institute for Occupational Safety and Health has no studies of its own upon which to base field reentry safety intervals. As stated previously, the degradation of pesticides on crops depends on a number of factors, including, temperature, rainfall, humidity, wind, and binding to some component of dust/dirt on the foliage. Because of the tremendous variation in climatic conditions existing throughout the United States, we support the concept of regional field reentry safety intervals based on the weather and other regionally differing conditions. However, although the actual intervals in days may vary from region to region, they must all provide the same degree of worker protection. In addition to variations in climatic conditions, regional standards should permit shorter intervals based on lower rates of application. The initial foliar residue burden is dependent primarily on the rate of application; therefore, the greater the rate of application the greater the initial residue level on the foliage and the greater the level at any subsequent point in time. Under normal conditions 8-pounds/acre of parathion applied to orange

trees will give greater foliar residue levels, both initially and subsequently, than 0.5 pounds/acre applied to similar trees, under identical circumstances. A safe no-effect level will be obtained first in the latter case. In the above example I am referring to different rates of application of the same formulation. The formulation, such as emulsifiable concentrate versus wettable powder, is also suspected to play an important role in the initial residue burden as well as the rate of degradation. Pesticide field reentry intervals should reflect differences in the rate of application. In the Federal Register (volume 38, pp 20362-65) of July 31, 1973, the Environmental Protection Agency published a notice of public hearings on proposed occupational safety requirements for pesticides. Reentry intervals were proposed for agricultural operations. EPA proposed that in place of current product-by-product standards, reentry standards be generally applied based upon four currently used and generally known categories of toxicity.

A series of 8 regional hearings are to be held for the purpose of securing comments from interested parties on the question of farm worker protection and on the proposed standards. EPA's proposal covers the same 21 OP insecticides originally covered in DOL's emergency pesticide standard of May 1, 1973. As stated in the Federal Register, it is EPA's intention to issue, based upon the OSHA and EPA hearing records, standards for the OP chemicals deemed, as a result of the hearings, to require such action prior to the 1974 growing season.

The announcement further states that EPA will, in consultation with OSHA, USDA and other interested Agencies, promulgate such standards.

I have been directly involved in the development of the reentry standards promulgated by the Occupational Safety and Health Administration, Department of Labor, as a member of both the DOL Standards Advisory Committee on Agriculture and the Subcommittee on Pesticides. In large part the recommendations of EPA agree with draft recommendations, eventually withdrawn, of the FWGPM Task Group on Occupational Exposure to Pesticides, of which I am a member. Therefore, NIOSH, through me, has been actively involved in the development of an effective and practical system to protect the health of agricultural field workers exposed to pesticide residues on crops. As I stated previously, we believe that field reentry safety intervals provide such a system. In light of the previous discussion NIOSH recommends the following course of action:

The results of the OSHA and EPA hearings should be jointly evaluated by OSHA, NIOSH, and EPA. Reentry intervals, for at least the 12 OP insecticides listed in DOL's emergency standard of June 29, 1973, jointly agreed to by OSHA, NIOSH, and EPA, should be promulgated as Federal standards by December 29, 1973. The intervals should (1) reflect regional variations in climatic conditions and cultural practices and (2) data and/or suggestions obtained in the hearings and accepted for inclusion in the standard. It is obvious that field

reentry standards for pesticides cross Departmental/ Agency lines. The highest level of cooperation between OSHA, NIOSH, and EPA is required in order to provide an adequate level of protection for workers exposed to pesticide residues on crops while at the same time producing a minimum of confusion and disruption in agriculture. We have always maintained that the concept of field reentry safety intervals is compatible with continued pesticide use. We are fully aware that the scientific data on which both OSHA's and EPA's reentry intervals are based is minimal. We intend to support controlled field studies as a means of confirming the intervals established. Any reentry intervals promulgated as Federal standards should be subject to revision as the results of controlled field studies become available.

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