



Rubber gloves should be worn, especially when handling concentrate pesticides. Leather shoes dry out and crack with repeated exposure to spray, allowing penetration by toxic materials.



Good protection from downward spray drift is afforded by wearing a waterproof wide-brimmed hat. Lighter-colored jackets reflect more heat than dark colors.

Workers Should Be Protected From Pesticide Exposure

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EVEN THOUGH there has been some progress in recent years toward the development of pesticides that are not only low in toxicity to warm-blooded animals but also relatively nonpersistent in the environment, we should not expect such changes to be accomplished in a very short period of time.

Replacement of certain persistent so-called "hard pesticides" with compounds that are relatively non-toxic to all but the target pest is a difficult, costly, and time-consuming order. In fact, this may never be accomplished to the complete satisfaction of all concerned. Thus, for some time to come we may find it

necessary to utilize compounds that are more acutely toxic to man and animals than we would eventually like to see developed.

A good example is the utilization of the more highly toxic methyl parathion as a DDT substitute in certain crop uses.

Also, a few of the new relatively nonpersistent compounds that have reached the point of registration during the last few years have acute oral LD₅₀ values of less than 50, which indicates that they are highly toxic. With this in mind, we should not become lax in our concern about protection of the worker.

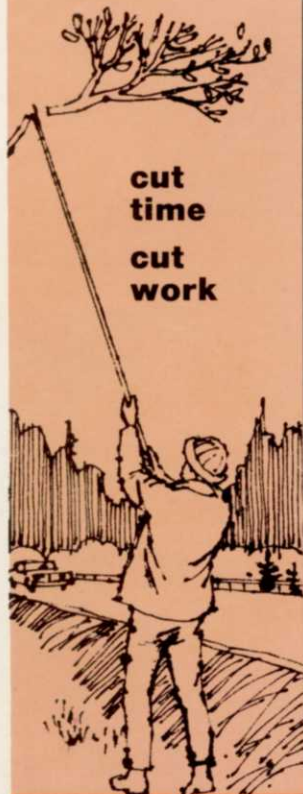
Even though experience has shown that more caution is warranted when working with highly toxic compounds, the need for protection from exposure to less toxic pesticides should not be ignored. Unless there

is good evidence that a compound will not have any subtle adverse effects as a result of prolonged exposure, it does not seem wise to allow excess exposure even to pesticides that are considered relatively nonhazardous.

Much of the pesticide usage today involves insecticides, fungicides, and herbicides. The acute toxicity of the organophosphorus compounds that are used primarily as insecticides is, on the average, somewhat greater than that of most other types of pesticides. This class of compounds has caused many poisonings in pesticide applicators.

Most of the newer synthetic fungicides are less acutely toxic to man than other pest control compounds. However, certain fungicides may occasionally cause local irritations or
(continued on page 36)

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PROTECTION FROM EXPOSURE (from page 12)

dermatitis.

Most herbicides are also generally less toxic than other types of pesticides. A dinitro compound (dinitro-cresol) used for weed control for many years has caused illnesses of workers in Europe. In contrast, our exposure studies have indicated that under the conditions of use in the Pacific Northwest area of this country there is no significant hazard associated with the application of dinitro compounds for weed control. This conclusion has been corroborated by use experience.

One herbicide, paraquat, is of considerable interest because only a very small oral dose may produce irreversible lung fibrosis which usually leads to death. There is little if any response to antidotal procedures. Although many of the recorded deaths from paraquat have been due to voluntary ingestion with suicidal intent, there have been deaths following accidental ingestion of very small amounts of the liquid concentrate. In one case it was estimated that the quantity of fluid consumed could not have exceeded three quarters of a teaspoon. This compound is also somewhat caustic and may cause chemical damage to the eyes.

This emphasizes the importance of avoiding splashing the concentrate into the mouth or eyes during measuring and mixing operations.

Although illnesses resulting from overexposure to pesticide compounds

do occur among applicators and other workers, most are a result of carelessness or accident. Experience has shown that if proper precautionary measures are observed and directions on the pesticide label are followed, even the more toxic compounds can be used safely.

The best insurance against illness from pesticides is to protect the various routes of entry into the body. There are three main routes: dermal, respiratory, and oral.

Dermal Route

Absorption through the skin is the most important route of entry of pesticide into the body during most exposure situations, especially where liquid sprays and emulsifiable concentrate formulations are involved. This route is one that has undoubtedly been responsible for a great many poisonings of workers, especially from the more toxic organophosphorus compounds.

We have conducted exposure studies on several hundred pesticide applicators. *Our results indicate that over 97% of the pesticide to which the body is subjected during most exposure situations, and especially to applicators of liquid sprays, is deposited on the skin.*

It should be understood that any given amount of pesticide is more rapidly and more completely absorbed by the oral or respiratory routes. However, absorption of pesticides by these two routes is probably

too small a fraction of the total potential exposure to be considered the main factor in most poisoning cases of workers in the field.

Although the rate of absorption of different pesticide compounds through human skin is difficult to measure with any degree of accuracy, researchers have made some progress along that line. Using radioactive labeled pesticides, Maibach and co-workers at the University of California School of Medicine were able to determine approximately what fraction of an applied dose would be absorbed. They were not only able to compare degree of dermal absorption for certain pesticides but also they compared absorption of a single pesticide for different parts of the human body. The results obtained indicate that in the past sufficient importance may not have been attached to protection of certain body areas.

In checking dermal penetration of parathion at different body areas these researchers found that the area of greatest absorption on man is the scrotum where approximately 100% of an applied dose was absorbed. The possibility of pesticide on this body area being completely absorbed emphasizes the need for increased

concern about providing protection for the area. This is of utmost importance where spillage of highly toxic pesticides, and especially the liquid concentrate formulations, is concerned.

The head-neck area was found to be an area of greater absorption than the arms or hands.

Of particular interest was the finding that absorption in the ear canal is relatively efficient (46.6% of an applied dose of parathion). Exposure in this area could occur through drift of fine pesticide mists or dusts or by digging in the ear with the tip of a contaminated finger.

When pesticide application is by hand spray gun on target areas below waist level the area of greatest potential contamination from drift may be the lower trunk, legs, and feet. Cloth coveralls or trousers provide a reasonable amount of protection for most of these areas in work situations where contamination does not easily penetrate clothing. However, where there is chance of soaking by continued contact with liquid sprays or penetration of clothing through excessive contact with dry pesticides, waterproof trousers and boots provide the best protection. *In fact, we feel that waterproof*

footgear should be worn during most any type of pesticide application. They should be washed and dried thoroughly, inside and out, as frequently as needed to remove any contamination.

If application involves directing spray upward, the downward drift can often produce relatively high dermal and respiratory exposure. The best protection of the face-neck area from downward drift is afforded by the wearing of a waterproof wide-brimmed hat. This also reduces respiratory exposure to some extent by preventing small droplets or particles from getting near the nose where they may be drawn into the nasal orifice.

Protection of the upper trunk and arms is especially important where heavy spray drift may thoroughly wet cloth shirts, coveralls, and underclothing. A waterproof jacket or raincoat provides the best protection for this general body area.

Waterproof gear is usually worn during cooler conditions, but as the temperature rises and the clothing becomes unbearably hot to wear, workers tend to discard them and work with much less protection — perhaps only a short-sleeved, T-
(continued on page 52)



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PROTECTION FROM EXPOSURE (from page 37)

shirt-type undershirt.

Under such conditions workers should be encouraged to at least wear a long-sleeved cloth jacket, overalls, or tightly-woven heavy grade shirt that will not be easily penetrated by pesticide, and preferably one that can be properly washed.

Clothing should be changed and laundered daily.

If shirts, jackets, or coveralls used during application are merely hung up to dry after work and used repeatedly, as is often the practice, it doesn't take long for the pesticide material to work through where it will make contact with underclothes or skin.

Although waterproof protective clothing, and especially jackets, are often kept close at hand by pesticide applicators, it has been our observation that they usually will not put on the clothing until drift of pesticide increases to the point where they feel protection is necessary. Unfortunately, by this time there is often considerable contamination of skin and conventional clothing. *Covering contaminated skin by impermeable*

protective gear may create conditions which lead to increased absorption.

Whether or not there would be less absorption under these conditions than if the protective clothing were left off entirely, depends upon the potential exposure which might occur after the worker puts on the clothing. Although the amount of increase in absorption of pesticides by covering contaminated skin with various items of protective clothing is not known, it is certainly sound advice to put on protective gear before the skin has been contaminated to any great degree.

High exposure to hands is usually the result of contact with the more concentrated formulations during mixing and loading. The hands are more subject to cuts and abrasions which allow a more direct route into the body.

This brings to attention the need for wearing gloves. Some feel it is better not to wear gloves that are somewhat contaminated on the inside; something which invariably occurs to some degree. This sounds logical; however, our research indicates that, unless there is gross con-

tamination of the inside of the gloves, the potential exposure is less when wearing gloves than when not wearing them, regardless of a certain amount of inside contamination.

Gloves should be kept clean on the inside; thus, cloth linings are undesirable because of the difficulty in decontamination. *Unlined rubber gauntlet gloves provide the best protection.* Heavyweight gloves, although durable, do not allow adequate freedom of movement, especially finger flexibility, and they are also difficult to turn inside-out for cleaning. On the other hand, some lightweight gloves, although flexible enough to allow freedom of finger movement, wear out rapidly and are easily torn. Therefore, it is advisable to secure gloves of a grade that is somewhat durable but yet light enough to be acceptable to the worker.

Comfort and acceptability by the worker is also important when selecting protective jackets and trousers. Heavy grade clothing is not very flexible and dark-colored materials absorb more heat. During recent years several jackets, jacket-trouser combinations, and gloves that are lighter in color and weight have been available. Although less dur-

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able, they are less costly to replace. Our tests have shown that a light yellow or white waterproof jacket may reflect enough heat to cause the temperature at the skin surface underneath to be as much as 8 to 10°F lower than when wearing a black jacket when worn under conditions of intense sunlight when ambient temperature is around 90°F. Nevertheless, there is still considerable discomfort in wearing any waterproof clothing during hot weather because of the trapping of body heat.

Disposable paper jackets have been tested and found suitable for use only under conditions where heavy wetting does not occur. Such paper jackets were found to be much cooler and thus more comfortable than other jackets tested.

Respiratory Route

Protection of the respiratory route is especially important where toxic dusts and vapors or very small spray droplets are prevalent, or where application is in confined spaces. We have found that when applying dilute sprays with conventional application equipment respiratory exposure is usually relatively low, probably due to the large droplet sizes produced. Where low volume equipment is used, smaller particles or droplets are produced, increasing respiratory exposure.

Respiratory protection for most types of outdoor application can be provided by use of cartridge-type respirators, or, in certain cases, gas mask-type respirator devices with special cannisters which have greater absorbent capacity than cartridges. Proper care of respirators is important, especially the regular replacement of filter cartridges and regular cleaning of the face-piece with soap and water. Solvents should not be used for they may damage certain parts of the respirator. When fumigating or applying highly toxic pesticides in confined spaces it is

advisable to use a respirator with a special compressed air supply tank so that none of the contaminated ambient air is inhaled.

Oral Route

The most serious oral exposure may be brought about by splashing of liquid concentrate into the mouth while pouring and measuring pesticides. Contamination may also occur through licking the lips, by rubbing the mouth with contaminated arms or hands, by careless actions such as attempting to blow out clogged spray nozzles with the mouth, or by eating, smoking, or drinking while hands are contaminated. Pesticide label precautionary statements to the effect that hands should be washed before smoking or eating is sound advice.

Discussion

Regardless of how specifically the measures for protection of workers from pesticide exposure may be stated for any particular situation, people who work with such compounds must realize that there is some element of risk involved. Accidents occur, even among workers who are careful. The importance of

dermal and respiratory exposure certainly warrants the use of some type of protective gear. Improvements in protective equipment are needed to bring about better protection of workers. We at the Environmental Protection Agency, Wenatchee Research Station laboratory are continuing with studies on protective gear to determine effectiveness and acceptability. □

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