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Exposure of Formulating Plant Workers to Ethion and Malathion

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The organophosphorus insecticides, ethion (0,0,0,0'-tetraethyl S,S'-methylene bisphosphorodithioate) and malathion [0,0-dimethyl S-1,2-di(ethoxycarbonyl)ethyl phosphorodithioate] have been used for pest control for many years. Evaluation of the hazard to health of workers exposed to these insecticides requires knowledge of the amount of exposure they receive while performing various jobs related to the preparation and use of these compounds.

For measurement of exposure, both direct and indirect methods are available. The direct methods are those which utilize techniques to determine potential dermal and respiratory exposure by either entrapping the toxic material as it comes in contact with the workman, or removing the retained toxicant from exposed body areas at the end of an exposure period. The amount of toxicant trapped or removed is then a direct measurement of the potential exposure during a given period of time.

The indirect methods usually reflect absorption into the body. They involve the detection of a pesticide or its metabolites in body tissue or body excreta, or the measurement of some pharmacologic effect of the toxicant on the exposed individual.

Although earlier publications from this laboratory have included direct exposure measurements of workers applying ethion and malathion in the field (WOLFE et al. 1967 and 1972), there is little if any published information on direct exposure studies to estimate potential dermal and respiratory exposure to these compounds in pesticide formulating plants; thus, the purpose of the present study was to determine the potential dermal and respiratory exposure of workers to ethion and malathion in such plants.

MATERIALS AND METHODS

Exposure studies were conducted in two plants that were considered to be somewhat typical of formulating plant operations in the Pacific Northwest. Studies were carried out during formulation of 25% water-wettable powder ethion and 5% malathion dust. In order to determine the potential exposure in different work situations, exposure pad studies were carried out on (1) workers who inserted the proper proportions of ingredients into the formulating machine (mixer), (2) workers who filled bags with

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the formulated pesticide at the filler spout (bagger), (3) workers who stacked full bags onto storage pallets (stackers), or (4) workers who performed a combination of jobs such as packing bags into cartons for shipment or alternately working at the mixing and bagging stations (mixer-bagger-carton packer).

The amount of pesticide to which a worker potentially would be subjected during work activities was estimated by the techniques and procedures described by DURHAM and WOLFE (1962). Dermal contamination was measured primarily by attaching layered-gauze absorbent pads to various parts of the worker's body or clothing and allowing them to be exposed during a timed period of work. Respiratory exposure was estimated from the contamination of special filter pads used in place of the usual outer absorbent filter pads which cover the filter cartridges of the respirators worn by the subjects. The filter pads were covered with plastic funnels modified to a specific aperture size to reproduce as nearly as possible the aerodynamics of air flow through nostrils. The funnels also prevented direct impingement of particles onto the pad except for those carried through the apertures by respiratory action. This technique renders it unnecessary to measure total air volume because all inhaled air passes through the filter pads.

Potential exposure calculations were based on the use of minimum protection (no respirator, shirt with short sleeves and open collar, no hat, no gloves, with the assumption that the clothing worn gave complete protection of body areas covered). This was to arrive at values that might reflect the maximum potential exposure that could occur in different work situations where proper protective gear was not utilized. Values obtained were used to calculate the milligrams of potential exposure per man per hour of work activity.

Respirator and dermal exposure pads were extracted with benzene in a Soxhlet apparatus and these samples, as well as air sample extracts, were analyzed for pesticide content by electron-capture gas liquid chromatography.

RESULTS AND COMMENT

As can be seen in Table 1, mean values for potential dermal and respiratory exposure for all workers were approximately the same regardless of which compound they had been handling. Calculated exposure to ethion was found to be 126 mg/hr dermally and 1.71 mg/hr by the respiratory route. Potential exposure to malathion was found to be 150 mg/hr dermally and 1.29 mg/hr respiratorily. It will be noted, however, that exposure values for individual work stations did vary between the compounds. Values for individual work locations indicate that, for either pesticide, potential exposure at the bagging station was greater than at the mixing station. It is of interest to note that, during ethion formulation activities, higher exposure values

were obtained for workers who moved from one work station to another than for those who remained at one work station. We were not able to determine the reason for this. Similar results have been noted in earlier studies by this laboratory (WOLFE et al., in press). Considerable variation was found in the range of exposure values for each work activity. This was expected, based on our earlier research in formulating plants during mixing of carbaryl (COMER et al. 1975) and DDT (WOLFE and ARMSTRONG 1971). Such variations may be due to several factors including worker carelessness and bagging equipment malfunction.

TABLE 1

Potential Dermal and Respiratory Exposure of Workers to Ethion and Malathion in Pesticide Formulating Plants

Compound and Subject	No. Exposure Periods Tested	Calculated Exposure (mg/hr of work activity)[a] Dermal	Respiratory
1. Ethion[b]			
All workers	45	126[c] ± 233	1.71 ± 1.75
Mixer	11	70[d] ± 121	1.15 ± 1.60
Bagger	26	116 ± 234	1.63 ± 1.56
Mixer-bagger-carton packer	8	237 ± 324	2.67 ± 2.32
2. Malathion[e]			
All workers	17	150 ± 148	1.29 ± 1.40
Mixer	4	40 ± 50	0.05 ± 0.03
Bagger	9	244 ± 143	2.19 ± 1.38
Stacker	4	50 ± 53	0.50 ± 0.34

[a]Mean ± S.D.
[b]25% WP (3-lb bags)
[c]Mean of 44 values
[d]Mean of 10 values
[e]5% dust (50-lb bags)

The above results indicate that, in most cases, workers in pesticide formulating plants exposed to ethion or malathion under conditions similar to those found in the present study would not be subjected to amounts of pesticides that would represent very great hazard. However, a few individual high values obtained for ethion exposure indicate that occasional lapses in adherence to safety precautions might result in considerable increase in hazard to workers exposed to that compound.

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