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(2,4-Dichlorophenoxy)acetic Acid Exposure Received by Aerial Application Crews during Forest Spray Operations

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In three helicopter spray operations, forest workers were monitored for exposure to and internal dose of (2,4-dichlorophenoxy)acetic acid (2,4-D). Levels of 2,4-D were measured in air near the breathing zone, on denim patches to estimate dermal exposure, and in the urine excreted for 2 days before and 5 days after the spraying to determine internal dose. Each crew made two applications about 1 week apart to compare exposure from crew members wearing customary clothing and following normal precautions (T-1) with that of the same crew members wearing protective apparel and following special hygienic practices (T-2). External exposure was low with the highest level at 0.0911 mg/kg of body weight for a batchman in T-1. The total internal dose determined by urine analyses ranged from nondetectable to 0.0557 (in T-1) or 0.0237 (in T-2) mg/kg of body weight. Those crewmen working most closely with the spray concentrate or handling spray equipment (pilots, mechanics, and batchman–loaders) showed the highest doses. Protective clothing and good hygienic practices limited exposure. On the basis of analyses of toxic levels of 2,4-D in laboratory animals, human exposure levels in these tests were well below that which might endanger health.

Considerable research has shown the effectiveness, economic importance, toxicological effects, and environmental behavior of herbicides. However, only a limited number of studies have measured amounts and disposition of herbicide actually absorbed by applicators (Sauerhoff et al., 1977; Kolmodin-Hedman et al., 1979). Such knowledge is important for the safety of those whose use herbicides and for the understanding of those who regulate their use [e.g., U.S. Environmental Protection Agency (1978)]. This kind of information was recently acquired for the herbicide (2,4,5-trichlorophenoxy)acetic acid (2,4,5-T) (Lavy, 1978; Lavy et al., 1980a,b; Ramsey et al., 1978). The purpose of this study was to provide similar information for (2,4-dichlorophenoxy)acetic acid (2,4-D).

The rapid degradation of 2,4-D makes it one of the least persistent herbicides in the environment (Norris, 1966, 1970; Lavy et al., 1973; WSSA Herbicide Handbook Committee, 1979). Furthermore, the long history of 2,4-D use with no reports of ill effects to applicators suggested that harmful levels were probably not being absorbed. Nevertheless, scientific data were needed to document the extent of exposure occurring to workers under actual field conditions. The results of this study, when used in conjunction with toxicological data, provide a meaningful evaluation of applicator safety during use of 2,4-D under various conditions.

Techniques have been developed in recent years to measure external exposure to pesticides (Durham and Wolfe, 1962) and internal phenoxy herbicide dose as measured in the urine excreted (Sauerhoff et al., 1977; Lavy et al., 1980a). The 2,4,5-T present in the urine has been shown to be a reliable indicator of the dose received during application of 2,4,5-T spray (Lavy, 1978; Gehring et al., 1973). Since 2,4-D is quite similar structurally, and since it is metabolized in a similar fashion (Sauerhoff et al., 1977), the same technique has been used to ascertain the dose of 2,4-D absorbed by workers during application (Kolmodin-Hedman et al., 1979).

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The objectives of this study were (1) to measure both external exposure and internal dose received by helicopter crews spraying 2,4-D in the forest, (2) to determine whether protective clothing significantly altered these measurements, and (3) to evaluate the relationship between exposure or dose and the worker's duties.

MATERIALS AND METHODS

Measurements Taken. Tests were designed to determine the quantity of 2,4-D in the ambient air of the worker's breathing zone, the quantity of 2,4-D that came into contact with denim patches attached to the worker's clothing, and the quantity and rate of 2,4-D that was subsequently excreted in the urine of each worker.

Air Samples. Battery-powered air sampling monitors were attached to all workers involved in the spraying program to provide an estimate of respiratory exposure to 2,4-D ester. The monitors contained amberlite XAD-2 resin, which is effective in trapping airborne vapors and spray droplets of 2,4-D esters (Johnson et al., 1977). After the air monitors were exposed during the treatment period, the tubes containing the resin were removed and placed in small, airtight containers until analysis.

For these analyses, the total volume of air inhaled was estimated by multiplying the rate (1740 L/h) at which a person doing this kind of work breathes (Durham and Wolfe, 1962) by the total time of the exposure period (148 min). The total volume of air inhaled multiplied by the concentration of 2,4-D (micrograms per liter) from the resin of the air monitors gives the total amount of 2,4-D inhaled. This amount is expressed on a basis of micrograms per kilogram of body weight.

Patches. Before the spray operation, denim patches were attached to crew members' clothing near bare skin areas. For estimation of exposure to the wrist area, a 2.5 × 15 cm strip was stapled to each shirt cuff. So that exposure to the bare skin of the head and neck could be estimated, one 2.5 × 40 cm strip was stapled to the back of the collar of the shirt, extending to the points of the collar on each side, and another 2.5 × 40 cm strip was similarly attached to the hat band, extending from the front and around both sides toward the back. The patches were attached to and removed from workers by persons not exposed to the spray material and were then shipped to the analytical laboratory in individual glass containers

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