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Potential Exposure of Workers During Seed Potato Treatment with Captan

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In 1978 the U. S. Environmental Protection Agency accepted captan [N-(trichloromethyl)thio 4-cyclohexene 1,2-dicarboximide] as a possible candidate for rebutable presumption against continued registration (RPAR) (ANONYMOUS 1978). Risk assessment for the use of materials chosen for RPAR include estimates of worker exposure during various agricultural operations. Observations during earlier field studies in the Columbia Basin Irrigation Project, led us to believe that there was considerable use of captan as a fungicide for seed potatoes. During the spring of 1979 we undertook a study of the potential for exposure to captan of workers involved with various aspects of potato planting.

Workers filling the hoppers of seed dusting machines with captan, workers cutting and sorting potatoes on seed cutting machines in the vicinity of the dusters, a tractor driver planting the treated seed potatoes, and planter observers who rode behind a planter containing treated seed potatoes were all monitored. Estimates were made for potential dermal and respiratory exposures. These exposures were termed potential rather than actual because no estimates were made for dermal absorption or for the fractions of the material collected on respirator pads which would be of the correct size to be retained in the lungs.

MATERIALS AND METHODS

Potential dermal and respiratory exposures were estimated using multiple layered gauze dermal pads and gauze-faced pads in modified dust respirators as described by DURHAM and WOLFE (1962). In order to estimate the potential dermal exposure for areas other than the hands, gauze pads were attached to both shoulders and to the upper centers of the back and chest. Hand exposures were estimated using the alcohol hand rinse technique which was also developed by DURHAM and WOLFE (1962). Hourly exposure rates were calculated by the procedure described by DAVIS (1980).

The exposure periods between changes of monitoring media and between hand rinses varied with the work situation but averaged approximately one hour for all subjects. For two workers who filled the hoppers of seed dusting machines and 14 workers sorting potatoes on the seed cutting machines these periods were determined by the time it took to treat a truck load of seed potatoes. This ranged from 3/4 h to 2 h. For the tractor driver and two planter observers studied, the exposure periods ranged from 3/4 h (two filling and planting cycles) to 1 1/2 h (four cycles).

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Exposure pads were stored in an ice chest containing a frozen gel refrigerant until the investigators could return to the laboratory and transfer them to a refrigerator. Pads were extracted within 24 hours of returning to the laboratory. Entire respirator pads or 25 sq cm portions cut from the center of the dermal pads were extracted by shaking for 15 min on a wrist action shaker with 50 mL of toluene. The extract was decanted and the process was repeated with an additional 25 mL of toluene. Anhydrous Na_2SO_4 was added to the extracts which were stored at room temperature pending analysis. Alcohol hand rinses were refrigerated pending analysis.

Eight portions of authentic 5% Captan Seed Protectant (Wilbur-Ellis Co., Fresno, CA), ranging from 79 to 580 µg of active ingredient, were placed in the center of 10 x 10 cm (4 x 4 in.) 8-ply gauze surgical sponges which had been folded in half to produce 5 x 10 cm (2 x 4 in.) 16-ply pads. The pads were again folded in half then stapled to produce 5 x 5 cm (2 x 2 in.) mini-pads with the fungicide in the center of 32 plys of gauze. These fortified pads were extracted in the same manner as pads from the field studies and the extracts were analyzed to determine the efficiency of the extraction procedure. These extracts were also reanalyzed periodically to determine the stability of captan residues in stored extracts from field samples.

Residues were quantified by gas chromatography using an electron capture detector. The column was 1.83 m x 6.3 mm (outside diameter) glass packed with 10% DC-200 on 80/100 mesh Gas Chrom Q. Column, detector, inlet, and transfer line temperatures were 200, 305, 205, and 215°C respectively.

DESCRIPTION OF WORK PRACTICES OBSERVED

Residues were collected so as to reflect, as nearly as possible, the actual potential exposure of the observed workers. Two separate seed potato treatment operations were observed. In both operations, 5% Captan Seed Protectant was being applied at a rate of 1 1/2 lb (0.68 Kg) of the dust per 100 lb (45.4 Kg) of cut potatoes. This was the maximum rate allowed by the label. Both operations also employed 50 lb (22.7 Kg) bags of dust for filling the hoppers of the dusting machines.

In the first operation the potato cutting machine was located inside the building used for seed potato storage and the captan dusting machine was located outside. People working at the cutting machine were protected from blowing captan dust by the installation of a plastic sheet in half of the double door of the building. The conveyor belt from the cutting machine to the dusting machine ran through a slot in the plastic sheet. There were four workers employed on the cutting machine, two at approximately one meter and two at approximately three meters from the dusting machine. The workers could have received some exposure on occasions when the half of the door not covered by plastic was left open. They also

swept around the cutting machine between loads. Since some captan dust usually sifted back onto this area of the floor, the workers were undoubtedly exposed while sweeping.

During approximately half of our study at this first operation, seed potatoes were being cut which contained numerous stones. Stones in the cut seed potatoes would have damaged the planter, so they had to be removed. Small stones were almost indistinguishable from small potatoes until they fell into the drum of the dusting machine. When a stone was heard to fall into the drum, the foreman, who also filled the hopper with captan dust, would turn off the line and search inside the drum for the stone. This resulted in abnormally high exposures. Two other operations by the foreman could also have led to exposure. When a truck was full, he climbed on top of the treated potatoes to install a tarp over the load. Prior to processing a new lot of seed, he climbed around on the truck in order to rinse the inside with a bleach solution.

No one at this operation normally wore respiratory protection, so all workers were monitored for potential respiratory exposure. Since the workers on the cutting machine always wore rubber gloves, their hands were not monitored. The dusting machine filler's hands were monitored because he wore canvas-backed leather gloves rather than rubber gloves.

Potato planting in the Columbia Basin and other areas of the northern United States takes place in early spring, which is normally quite cool. Workers, therefore, are nearly always fully clothed with head coverings and long-sleeved shirts or jackets. For this reason, no potential dermal exposure was estimated for areas other than the face, neck, and hands.

In the second operation the dusting and cutting machines were both located inside a building which was large enough to also contain the seed potato stock and the truck being loaded with treated potatoes. Whenever the wind was not excessive, large doors were left open to expedite changing trucks. This provided some breeze that could disperse dust from the dusting machine within the building. This cutting machine required 6 workers located approximately one, three, and five meters from the dusting machine. One of the workers closest to the dusting machine periodically adjusted the position of the conveyor belt carrying treated potatoes to the truck. Dust often fell from this conveyor, providing a possible source of extra exposure for this worker. The workers on the cutting machine, along with the dusting machine filler, also swept the floor between truck loads.

The worker who filled the dusting machine also checked untreated potatoes for disease. While doing this, he was located approximately five meters from the dusting machine but only about one meter from the conveyor carrying treated potatoes into the trucks.

Some of the workers on the cutting machine wore disposable dust

masks while working. These were replaced by modified dust respirators to monitor potential respiratory exposure. All of the workers at this location wore rubber gloves. The dusting machine filler removed his occasionally, so his hands were monitored.

Workers involved in planting were also monitored at the second operation. These were a tractor driver and planter observers. The driver was protected by an enclosed cab while actually planting. However, he also distributed treated potatoes into the hoppers of the planter using a moveable conveyor, his hands, and his feet. A planter observer rode on the back of the planter to ensure proper operation. At times this is a very dusty operation and captan mixed with soil dust may be a source of additional exposure. Soil dust was minimal during our study because of plentiful moisture. The observers could also have received exposure during transfer of treated potatoes from the truck to the planter. As the truck became empty, they would get inside the truck box and kick down potatoes onto the conveyor that ran the length of the truck bed.

The driver and observers were completely clothed except for the face and neck. They wore canvas-backed leather gloves but no respirators. They were monitored for potential exposure of the hands, other exposed body areas, and for potential respiratory exposure.

RESULTS AND DISCUSSION

The mean $\pm$ standard deviation for recovery of captan from the fortified mini-pads used to determine the efficiency of the extraction procedure was 97.7 ± 2.7%. No significant loss of captan residue was detectable in these extracts which were stored in the same manner as extracts from field samples. The captan residues were stable in the extracts for 18 months. However, actual field sample extracts were analyzed before six months of storage. These results indicated that no corrections were necessary for extraction or storage losses.

Potential exposures for the workers filling the dusting machines are shown in Table 1. Exposures obtained when processing rocky seed potatoes, as in the first operation studied, cannot be considered typical. When rocky seed potatoes are processed, the entire operation is seriously slowed. For this reason, potato growers will avoid buying any more seed from a supplier who has provided them with such seed in the past. The incidence of this unusual exposure is therefore, self limiting.

Table 2 shows the potential exposures determined for workers employed on the cutting machines. Isolation of the dusting machine had little effect on exposure. In fact, exposures were somewhat higher when the dusting machine was located outside. This was probably because of the opportunity for captan dust to be blown around more when the dusting machine was not protected from the wind.

TABLE 1. Potential Exposure of Workers to Captan while Filling Seed Potato Dusters[a]

Operation	mg/h[b] Dermal Exposure not Including Hands	Hand Exposure	Total Dermal Exposure	Respiratory Exposure
Filling Duster Located Outside (Rocky Seed)	7.2 ± 2.2 (3)	7.6 ± 5.5 (3)	15 ± 6 (3)	1.7 ± 0.6 (5)
Filling Duster Located Outside (Clean Seed)	4.5 ± 0.2 (3)	3.0 ± 2.0 (3)	7.5 ± 2.0 (3)	0.61 ± 0.23 (3)
Filling Duster Located Inside (Clean Seed)	0.95 ± 0.41 (9)	0.093 ± 0.068 (7)	1.2 ± 0.4 (7)	0.15 ± 0.12 (7)

[a]See Description of Work Practices Observed section for other sources of possible exposure for these workers.

[b]Mean ± standard deviation for the number of replicates indicated in parentheses.

TABLE 2. Potential Exposure of Workers to Captan while Cutting and Sorting Seed Potatoes[a]

Operation	Total Dermal Exposure[c] mg/h[b]	Respiratory Exposure mg/h[b]
Cutter Inside and Duster Outside	0.70 ± 0.42 (12)	0.042 ± 0.034 (12)
Complete Operation Inside	0.40 ± 0.41 (18)	0.037 ± 0.036 (18)

[a]See Description of Work Practices Observed section for other sources of possible exposure for these workers.

[b]Mean ± standard deviation for the number of replicates indicated in parentheses.

[c]Hand exposure not included.

TABLE 3. Potential Exposure of Workers to Captan while Involved with Planting Treated Seed Potatoes[a]

	mg/h[b]			
Operations	Dermal Exposure not Including Hands	Hand Exposure	Total Dermal Exposure	Respiratory Exposure
Driver of Tractor Pulling Planter	0.34 ± 0.21 (5)	0.033 ± 0.016 (5)	0.37 ± 0.21 (5)	0.037 ± 0.020 (10)
Observer Riding on Rear of Planter	0.31 ± 0.14 (5)	0.015 ± 0.012 (5)	0.33 ± 0.13 (5)	0.027 ± 0.031 (10)

[a]See Description of Work Practices Observed section for other sources of possible exposure for these workers.

[b]Mean ± standard deviation for the number of replicates indicated in parentheses.

Potential exposures for workers involved in the planting operation are shown in Table 3. The generally low exposures these workers received was probably due to the fact that by the time the potatoes reached the field the captan dust had been dampened by potato juice, then dried. This entrapped the captan in a starch matrix on the potato surface so there was little material free to cause exposure.

This study confirms the results obtained in previous studies where use of dust formulations was found to result in a relatively high percentage of the total exposure taking the form of respiratory exposure (WOLFE 1967; OUDBIER et al. 1974). In this study, respiratory exposure as percent of total exposure was 8.6% for the dusting machine fillers, 7.0% for the workers on the cutting machines, 9.1% for the tractor driver, and 7.7% for the observers riding the planter. Due to lack of a satisfactory system for the production of a captan dust containing atmosphere, no study was carried out to determine the trapping efficiency of the respirator pads. The respiratory values given could, therefore, be somewhat low.

Because of the possibility that most inspired material may be absorbed into the blood stream or swallowed, the respiratory exposure to captan should be of particular concern. This route of exposure probably could be essentially eliminated by use of simple disposable dust respirators, which are lightweight, inexpensive, and do not offer much resistance to breathing.

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