

Exposure of Seed Pelleting Plant Workers to Methiocarb

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Methiocarb is a carbamate insecticide, acaricide and molluscicide, used to control some soil pests attacking field crops. It is used on all sugar beet in Ireland as a seed dressing, because it has been found to give more consistent control than any other insecticide with a moderate mammalian toxicity. Pelleting of beet seed for the Irish sugar crop is carried out at one central pelleting plant, and the system used, which is designed to apply 45 ug methiocarb per seed, has proved efficient (O'KEEFFE 1977).

Pelleting is a labour-intensive operation involving exposure of workers to the insecticide. Seed is pelleted in 4 rotating drums, of which 2 or 3 are in operation simultaneously. Two workers work in the area between the two pairs of drums, which are positioned about 8 feet apart. Pelleting, which requires a full workday, consists of moistening the seed (300 lb of unpelleted seed per drum) with water and adding clay - Filtrol Grade 2 (Bentonite clay) - by shovel. When a layer of clay is applied to the seed, methiocarb is sprayed on to the coated seed as an aqueous solution to a concentration of 0.5% by weight of the seed. Additional clay is added to the seed to a specified size of pellet and the pelleted seed is dried overnight, graded by size and packed.

Relatively dusty conditions were caused by the addition of clay to the seed. The Institute was asked by the pelleting plant to investigate the exposure of the workers to methiocarb and to dust, and to recommend changes in the procedures which would reduce such exposure. An extraction system was fitted over the drums, which reduced the dust level, and the potential exposure of the workers to methiocarb was determined both before and after fitting the extraction system.

MATERIALS AND METHODS

Atmosphere sampling Complete workday samples of the pelleting plant air were taken with "Casella" personal samplers. The personal sampler consisted of a sampling head connected by flexible tubing to a diaphragm pump, carried on the worker's belt, which drew air through the sampling head at the rate of 1.9 L/min (0.11 m³/h). The sampling

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head used was a filter head, containing a 37-mm diameter glass fibre (Type A) filter disc, attached to the worker's collar. The sampling time was recorded by the pump.

Analysis Direct gas chromatographic analysis of carbamate insecticides is difficult because of thermal decomposition. Determination of the methiocarb on the filter discs was by alkaline hydrolysis and chloroacetylation of the phenol to give a thermally stable derivative (ARGAUER 1969).

The glass fibre filter discs were taken from the filter heads and placed in sealed 125-mL Erlenmeyer flasks for transport to the laboratory. 25 mL 0.25 N NaOH were added to each flask and the flasks incubated in the dark at room temperature for 18 h to effect complete hydrolysis of methiocarb. 10 mL Chloroacetylation reagent (1.0 g chloroacetic anhydride per 200 mL benzene) were added to each flask containing the sodium hydroxide solutions. The flasks were shaken mechanically for 5 min. Part of the benzene layer from each flask was transferred to test-tubes containing sodium sulphate.

Standards were prepared from a stock solution of 100 ug/mL methiocarb (98.2% purity, Bayer) in benzene by adding aliquots representing 10, 20, 30, 40, 50 ug methiocarb to 125-mL Erlenmeyer flasks. 25 mL 0.25 N NaOH were added to these flasks and the hydrolysis and chloroacetylation steps were carried out along with the samples.

Samples and standards were analysed on a gas chromatograph with an electron capture detector. Separation was on a 1.2 m x 4 mm i.d. glass column containing 10% (w/w) SE-30 coated on 100 to 120 mesh AW-DMCS-treated Chromosorb W. The column oven was maintained at 210°C, the detector at 250°C, and the nitrogen flow at 40 mL/min at the column outlet. 5 μ L Aliquots of samples and standards were injected on the column.

RESULTS

Table 1 gives the average daily methiocarb level in the pelleting atmosphere with and without the extraction system in operation. The extraction system caused a significant reduction ($P < 0.05$) in the mean methiocarb level in the atmosphere, from 0.094 mg/m³ to 0.016 mg/m³.

TABLE 1. Potential Exposure of Pelleting Plant Workers to Methiocarb, Series 1

Extraction system in operation	Number of workdays sampled	Average daily methiocarb level in atmosphere		
		Mean (mg/m ³)	S.D.	Range
No	10	0.094	0.074	0.014 - 0.23
Yes	5	0.016	0.007	0.011 - 0.029

Table 2 compares the exposure of two workers to methiocarb over a total of 13 workdays, with the extraction system in operation. There is no significant difference between the overall exposure of the two workers to methiocarb, a mean level of 0.041 mg/m³ for worker X and of 0.040 mg/m³ for worker Y. Within a single day, differences between the methiocarb levels recorded by the two samplers worn by the workers was generally less than twofold. Only on 2 of the 13 days were differences of more than threefold observed, when eightfold and tenfold differences were recorded.

TABLE 2. Potential Exposure of Pelleting Plant Workers to Methiocarb, Series 2

Worker	Number of workdays sampled	Average daily methiocarb level in atmosphere		
		Mean (mg/m ³)	S.D.	Range
X	13	0.041	0.044	0.002 - 0.15
Y	13	0.040	0.038	0.003 - 0.14

Considerable daily variation in the methiocarb level in the atmosphere was found for both series of sampling. This daily variation is not related to particular days of the working week; exposure data obtained with the extraction system in operation show no significant differences between the mean methiocarb levels recorded for each day of the week (Table 3).

TABLE 3. Potential Exposure of Pelleting Plant Workers to Methiocarb, Daily Variation

Working day	Number of workdays sampled	Average daily methiocarb level in atmosphere		
		Mean (mg/m ³)	S.D.	Range
Monday	6	0.058	0.054	0.007 - 0.15
Tuesday	6	0.031	0.018	0.007 - 0.055
Wednesday	6	0.050	0.055	0.002 - 0.14
Thursday	6	0.045	0.049	0.005 - 0.14
Friday	6	0.047	0.029	0.014 - 0.091

DISCUSSION

Atmosphere sampling The use of filter systems for determining air levels of pesticides has been criticised because of their low efficiency for some vapours (MILES et al. 1970) and because of the potential loss of particulate matter (LEE 1976). More complete and direct systems for determining dermal and respiratory exposure of

workers to pesticides have been described (DURHAM & WOLFE 1962, WOLFE et al. 1978).

The filter system, on personal samplers, was chosen for this survey as the best compromise between estimating the real level of exposure of workers to methiocarb and restrictions to the survey on time and work interference considerations. The sampling heads were positioned on the workers' collars in such a way as to reduce the possibility of gross deposition of particulate matter on the filters (VAN DYK & VISWESWARIAH 1975). Placing the sampling head close to the worker's face gave the most accurate estimation of his exposure to the insecticide. Apart from ingestion of insecticide by oral and respiratory routes, the worker's head is normally the greatest area of exposed skin through which dermal absorption may occur.

One area of dermal exposure, not specifically monitored by the sampling procedure used, may be the hands and forearms of the workers. During the pelleting operation they handle the seed to determine the progress of the pelleting. This factor could be particularly important in hot weather when clothing cover may be reduced.

Exposure to methiocarb Under normal working conditions, with the extraction system in operation, potential exposure of the workers to methiocarb averages 0.04 mg/m^3 , and can be as high as 0.15 mg/m^3 on a single day (Table 2). Since a tolerance limit value (TLV) for methiocarb has not been set, an approximate TLV has been estimated by relating toxicity data for methiocarb with toxicity data for other carbamate insecticides for which TLV's are specified (Table 4). Methiocarb has an LD₅₀ (oral) approximately 10 times that of carbofuran and 1/5 times that of carbaryl. On the basis of these comparisons, a TLV of 1.0 mg/m^3 for methiocarb might be set.

TABLE 4. Toxicity Data and Tolerance Limit Values (TLV)¹ for Carbamate Insecticides

Insecticide	LD ₅₀ (Oral) (mg/kg)	LD ₅₀ (Dermal) (mg/kg)	TLV (mg/m ³)
Carbaryl	540	4,000	5.0
Carbofuran	8 - 14	10,000	0.1
Methiocarb	100	500	?

¹Health & Safety Executive, Guidance Note EH15/76, HMSO London, 1977.

The dermal toxicity data for these three carbamate insecticides indicate that methiocarb is, approximately, 8 times and 20 times more toxic by this route of absorption than carbaryl and carbofuran, respectively. The relatively high dermal toxicity of methiocarb suggests that its estimated TLV should be reduced from the 1.0 mg/m^3 , calculated from the oral toxicity data. The TLV is related to total exposure, the sum of the dermal exposure of the usually unclothed body parts and the respiratory/oral exposure. A weighting factor of 10 has been adopted empirically to take into account the more rapid and complete absorption

of respiratory/oral as compared with dermal doses of toxicant (LEE 1976). Therefore, the higher dermal toxicity of methiocarb compared with carbaryl and carbofuran might increase its toxicity by 2 and 3 times, respectively, thus reducing the TLV for methiocarb to 0.3 - 0.5 mg/m³.

On the basis of this estimated TLV for methiocarb (0.3 - 0.5 mg/m³), the level of insecticide to which the workers were exposed, during the sampling period when the extraction system was in operation, never exceeded this allowed level (Table 2). With the extraction system not in operation, higher levels of methiocarb, but still not in excess of the estimated TLV, were detected (Table 1). Such an estimated TLV, based on comparisons of toxicity data, is at best a rough indicator of allowed levels and must be used with caution when relating exposure levels to potential health hazards.

Carbofuran has a much greater efficiency in protecting sugar beet seed than methiocarb (Feeney 1976). However, the results of this study suggest that a seed pelleting operation to incorporate carbofuran might constitute a health hazard for workers. If the levels of carbofuran in the pelleting plant atmosphere would be similar to the levels of methiocarb found in this study, the low TLV of 0.1 mg/m³ for carbofuran might be exceeded.

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