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SUMMARY

On December 16, 1993, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from the Florida Department of Agriculture and Consumer Services (DACS), Division of Plant Industry (DPI). DACS officials asked NIOSH to evaluate exposure risks of employees in the Fruit Fly Detection Program (FFDP). There are 120 DACS employees in the FFDP responsible for routinely servicing approximately 13,000 fruit fly traps baited with the pesticide Dibrom® and various attractants. Although adverse health effects associated with this task had not been reported, some employees had expressed concerns, and DACS requested this HHE in response to these concerns.

On January 31, 1994, NIOSH investigators met with DACS representatives, including members of the DACS Cholinesterase Testing Program Committee (formed to determine appropriate medical monitoring for DPI employees). The objectives for this visit were to review fruit fly trapping procedures and Dibrom® handling activities. Bulk samples of the various Dibrom®-attractant mixtures and baited cotton wicks were obtained, and the Dibrom®-attractant mixing operation was reviewed.

On February 15, 1994, NIOSH investigators monitored 12 DPI employees from three South Florida field offices to assess exposure to Dibrom®. Personal breathing zone (PBZ) air samples were collected from workers during the preparation (applying the Dibrom®-attractant mixture to baits) and servicing of traps. Sampling glove monitors worn by workers during the preparation of baits were analyzed for Dibrom® to assess the potential for skin exposure. Six workers wore the glove monitors underneath disposable latex gloves, and six workers wore the glove monitors on the outside of the latex gloves. Bulk samples of freshly prepared and spent cotton wicks were collected and analyzed for Dibrom®. To help resolve discrepancies between the expected and detected amounts of Dibrom® on the cotton wicks, additional bulk samples were obtained on April 18, 1994.

Measurable amounts of Dibrom® were not found on any of the PBZ air samples. All results were below the limit of detection (LOD) for the analytical method. The NIOSH recommended exposure limit (REL) for Naled (the active ingredient in Dibrom®) is 3 milligrams per cubic meter (mg/m^3) as a full-shift time-weighted average. The NIOSH REL includes a skin notation, indicating that airborne or direct exposure by the cutaneous route contributes to overall exposure.

Dibrom® was found on the glove monitors of all six workers who wore the glove monitor on the outside of their latex gloves, indicating that skin contact is possible during the preparation of baits. No Dibrom® was found on any of the glove monitors from the six workers who wore the monitors underneath their latex gloves, suggesting that the disposable latex gloves provided a sufficient barrier against Dibrom® for the duration of the task. NIOSH or regulatory agencies have not established exposure limit recommendations for Dibrom® on work clothes or skin. Observation of work practices indicated that the containers used for the Dibrom®-attractant mixture were not sealing properly, resulting in leaks which

contaminated the outside of the container. Contact with the container was likely the greatest source of skin contact with Dibrom®.

The ventilation system used during preparation of the Dibrom®-attractant mixture was not adequate because the contaminant generating activities were not enclosed. The worker preparing the mixtures used a half-mask air-purifying respirator; however, a respiratory protection program was not established and the wearer had a beard. Facial hair in the face-to-facepiece sealing area will prevent a good seal.

No measurable levels of Dibrom® were found in the personal breathing zone air samples obtained during the baiting and servicing of fruit fly traps. Skin exposure monitoring showed that Dibrom® was detected on all workers wearing glove monitors on the outside of their latex gloves, and was not found on any of the glove monitors worn underneath latex gloves. The greatest potential source of skin contact was leaking containers. A respirator was used during the Dibrom®-attractant mixing process, although the user was not clean shaven and a respiratory protection program had not been established. Recommendations concerning the use of gloves, ventilation, and chemical containers are provided in the recommendation section of this report.

KEYWORDS:
SIC 9641 (Regulation of Agricultural Marketing and Commodities) Fruit Fly Detection, Dibrom®, Naled, Methyl Eugenol, Cue-lure, pesticides, skin exposure monitoring.

INTRODUCTION

NIOSH received a request on December 16, 1993, from the Florida Department of Agriculture and Consumer Services (DACS), Division of Plant Industry, to evaluate health risks to employees in the Fruit Fly Detection Program (FFDP). NIOSH was asked to evaluate exposure to the pesticide Dibrom® and to attractants used as baits in fruit fly traps.

On January 31, 1994, NIOSH industrial hygienists met with DACS representatives in Gainesville, Florida, to review fruit fly trapping procedures and to obtain bulk samples of the bait material from the Miami DACS facility. Exposure monitoring was not conducted during this site visit because inclement weather curtailed trapping activities. NIOSH investigators conducted a second site visit to the Miami facility on February 15, 1994 to evaluate DACS employee exposures (both skin and inhalation) during fruit fly trap baiting and servicing activities at three locations in Dade County, Florida.

Information regarding protective gloves, chemical containers, and ventilation modifications were provided to DACS management on March 4, 1994.

BACKGROUND

The FFDP is a joint DACS and United States Department of Agriculture (USDA) program that has been ongoing since the 1956 Florida Mediterranean Fruit Fly Eradication Campaign. The purpose of the FFDP is to detect early infestations of economically important fruit flies. The program involves 120 DACS employees who routinely service (bait and inspect) approximately 13,000 fruit fly traps baited with attractants, some of which include the pesticide Dibrom®. The FFDP is a state-wide program, although the majority of the traps are located in the southern portion of the state and near international ports of entry (e.g., Tampa and Miami). Depending on the location, a DACS employee may have responsibility for as few as 9 or as many as 350 traps, in addition to other duties (i.e., plant inspections, outreach assistance, etc.).

Jackson and McPhail traps are used in the FFDP (Figures 1 and 2). The choice of trap and bait depends on the species of the target fruit fly. Three types of baits used with the Jackson traps are (1) tri-medlure plugs (no Dibrom® or other pesticide), (2) methyl eugenol attractant with 1% Dibrom®, and (3) cue-lure attractant with 5% Dibrom®. The McPhail trap, used for detection of the Mexican fruit fly, uses a yeast, borax, and water mixture, with no Dibrom® or other pesticide added.

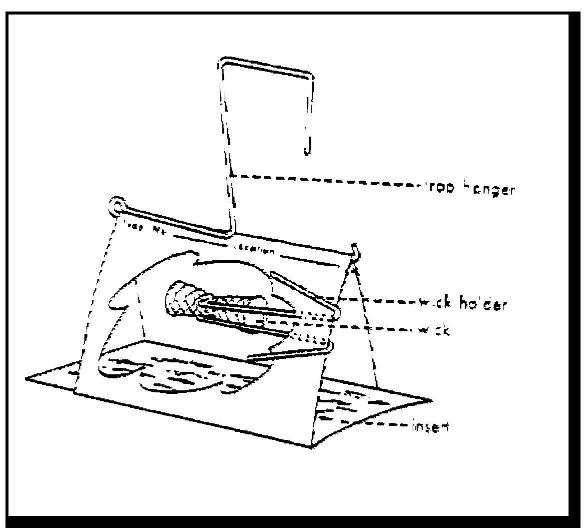

FIGURE 1: JACKSON FRUIT FLY TRAP

Specific written procedures, including safety precautions and requirements, have been developed by DACS for the

FFDP program. The safety procedures associated with mixing and handling the Dibrom®-attractant mixture were revised in May and October 1993. Procedures for proper clean up of bait-mixture spills have also been developed.

Twelve DPI employees in the Miami (Kendall) DACS office are responsible for servicing fruit fly traps in the Dade County and Southeast Florida area. These survey specialists work out of field offices in Oppalocka, Kendall, and Homestead, Florida.

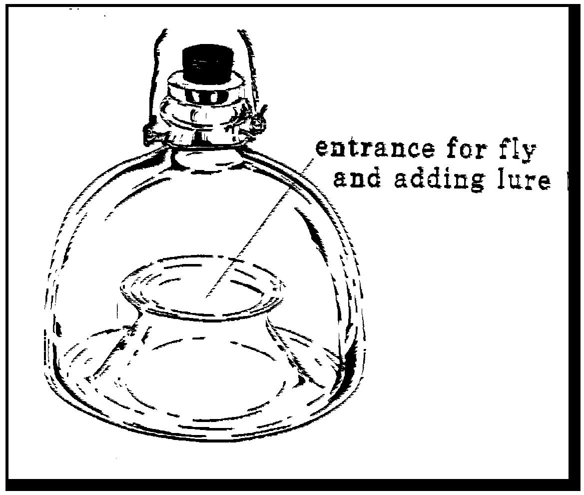

FIGURE 2: MCPHAIL FRUIT FLY TRAP

Process Description

The inspection frequency for fruit fly traps varies from less than 1 week to 21 days, depending on the type of trap and target fly. Trap baits are replaced every 9 weeks, and a FFDP survey specialist is responsible for preparing fresh baits and servicing assigned traps.

Batches of the Dibrom®-attractant mixture, or lure, are prepared 2-3 times a year in an aluminum storage shed located at the Kendall facility. This activity did not occur during the NIOSH survey and was not evaluated. The shed is equipped with lighting and ventilation. An emergency eye wash station is located outside. The ventilation consists of a wall-mounted centrifugal fan located on one side of the mixing table. The lure is mixed by one agricultural technician. Dibrom® 14 concentrate (85% Naled) stored in one gallon bottles is used with a graduated cylinder to prepare the lures in one-liter batches. Thirty 1-liter containers are prepared at one time. Green dye is added to the 1% Dibrom® and methyl eugenol mixture. The mixtures are then placed in labeled 250 milliliter (ml) polyethylene bottles and provided to each survey specialist. These bottles have been modified by boring a hole in the cap to fit a 2-ml bulb pipette.

The traps are baited outside on the tailgate of the survey specialists' truck. Each survey specialist is equipped with a trap kit and will prepare enough baits for that day prior to leaving the field office. The trap kit consists of tri-medlure plugs, two 250 ml containers of lure, a plastic container with liner, water in 5-gallon containers for rinsing, cotton wicks with wires, trap bodies with sticky inserts, neoprene gloves, and goggles. Although procedures call for wearing neoprene gloves when handling the lure, workers had experienced dexterity problems, and industrial-grade, disposable latex gloves provided by NIOSH were used during the NIOSH evaluation. The cotton wicks and wire holder are placed on a hanger inside the lined plastic container so any spilled lure would fall into the lined container. Six ml of lure is applied to each wick (1% or 5% Dibrom®, depending on need), and the wicks are placed into the trap body. The prepared traps are stored in a box in the bed of the truck until used. Gloves are rinsed in water. In the field, expired wicks from traps are placed in plastic bags for disposal, and the trap bodies are re-used with fresh baits and inserts. Recent modifications to the procedures now call for discarding the entire trap and expired bait, to reduce contact with the cotton wick.

Field inspection of traps consists of removing the trap from the host tree and inspecting the sticky insert for fruit flies. Occasionally, the trap may be relocated, or may have to be replaced if it is lost or destroyed.

EVALUATION PROCEDURES

Air Sampling

Environmental monitoring was conducted to assess personal breathing zone (PBZ) exposures to Dibrom® during fruit fly baiting and servicing activities. Calibrated air sampling pumps were attached to the survey specialists and connected via tubing to sample collection media placed in an employees' breathing zone. Monitoring was conducted for the duration of the task being assessed, as well as the work shift. After sample collection, the pumps were post-calibrated and the samples submitted to the NIOSH contract laboratory (Data Chem, Salt Lake City, UT) for analysis. Field blanks were submitted with the samples.

The PBZ air samples for Dibrom® were collected using OVS-2 (OSHA Versatile Sampler) sorbent tubes at a flow rate of 1 liter per minute (Lpm). The samples were desorbed and analyzed according to the draft NIOSH analytical method #5600.[(1)] Front and back sections of the OVS-2 tubes were separately desorbed and analyzed via a gas chromatograph equipped with an electron capture detector. The analytical limit of detection (LOD) and limit of quantification (LOQ) for this method are
0.007 micrograms per sample (µg/sample) and 0.02 µg/sample, respectively. Independently prepared quality control samples were analyzed and sample recovery efficiencies were determined. The thermal breakdown of Dibrom® into dichlorvos (a related compound) was found to be constant over the concentration range of standards used.

Dermal Exposure Assessment

Sampling glove monitors made of 65% cotton and 35% polyester were used to assess the potential for skin contact to Dibrom® during baiting activities. Six of the survey specialists wore the glove monitors over the disposable latex gloves, and six workers wore the glove monitors under the latex gloves, to assess the effectiveness of the latex glove as a barrier. The glove monitors were worn during an entire baiting process. The survey specialists were asked to record the sampling time and the number and type of wicks they prepared. After sampling, the glove monitors were placed in labeled amber jars and sealed with teflon®-lined caps. NIOSH investigators wore latex gloves to remove the sampling glove monitors to avoid cross-contamination of the monitors. Left and right glove monitors were placed in separate jars for each test subject. The samples and field blanks were then shipped to the NIOSH contract laboratory (Data Chem) for analysis.

At the laboratory, glove monitors were desorbed and analyzed using gas chromatography and electron capture detection as described above. The LOD for this analysis was 0.3 µg/sample, and the LOQ was 0.6 µg/sample. Independently prepared quality control samples, spiked with known concentrations of Dibrom®, were analyzed and the sample recovery efficiency was determined.

Bulk Samples

On February 2, 1994, a spent cotton wick baited on December 13, 1993, with a 1% Dibrom® and methyl eugenol mixture, a blank wick, and aliquots of the 1% and 5% Dibrom®-attractant mixtures were obtained. The samples were placed in 120 ml amber jars with teflon-lined lids and shipped to the NIOSH contract laboratory for analysis. On February 15, 1994, additional bulk samples of spent and freshly prepared cotton wicks were obtained using these procedures. These samples were desorbed and analyzed for Dibrom® in the same manner as described above. To resolve questions concerning discrepancies between the expected and detected amount of Dibrom® on the cotton wicks, additional samples of wicks and bulk liquid attractant mixtures were obtained on April 18, 1994.

EVALUATION CRITERIA

General

As a guide to the evaluation of the hazards posed by work place exposures, NIOSH field staff use established environmental criteria for the assessment of a number of chemical and physical agents. These criteria suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It should be noted, however, that not all workers will be protected from adverse health effects if their exposures are below the applicable limit. A small percentage may experience adverse health effects due to individual susceptibility, pre-existing medical conditions, or hypersensitivity (allergy).

Some hazardous substances or physical agents may act in combination with other workplace exposures or the general environment to produce health effects even if the occupational exposures are controlled at the applicable limit. Due to recognition of these factors, and as new information on toxic effects of an agent becomes available, these evaluation criteria may change.

The primary sources of environmental evaluation criteria for the workplace are (1) NIOSH Criteria Documents and recommendations, (2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), and (3) the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) standards.[2-4] Often, NIOSH recommendations and ACGIH TLVs may be different than the corresponding OSHA standard. Both NIOSH recommendations and ACGIH TLVs are usually based on more recent information than OSHA standards due to the lengthy process involved with promulgating federal regulations. OSHA standards also may be required to consider the feasibility of controlling exposures in various industries where the hazardous agents are found; the NIOSH recommended exposure limits (RELs), by contrast, are based primarily on concerns relating to the prevention of occupational disease.

Skin Exposure Assessment

Skin exposure to pesticides is often considered to be a more significant portion of total exposure than inhalation.[5-7] An evaluation of the amount of material potentially available for absorption can provide estimates of skin exposure to contaminants. In some cases, where there is information on skin permeability and there is inhalation and biological monitoring data, dermal assessments can provide more quantitative information on absorption or dose via the dermal route. There are numerous techniques available to estimate the potential for skin contact; however, there is no general protocol for the assessment of the degree of skin contact, or the interpretation of data. These types of assessments are also useful from the standpoint of evaluating the efficacy of control measures, as well as personal protective equipment. Exposure standards, guidelines, or recommendations by NIOSH or regulatory agencies have not been established for the concentration of Dibrom® on skin or work clothes.

Dibrom®

Dibrom® is a light-sensitive, corrosive straw-colored insecticide that is a severe eye and skin irritant.(8) In addition to the acute corrosive effects from skin contact, Dibrom® is also a potential skin sensitizer and is only slightly less toxic via the percutaneous route than by the oral route.(9) Dermatitis has been reported in workers exposed directly (aerial application) and indirectly (picking flowers sprayed with Dibrom®).(9-11) Dermatological signs and symptoms have included a papular dermatitis on the arm, glazing on the skin of the cheek, and a burning sensation followed by vesiculating blistering. Dibrom® 14 Concentrate contains 85% Naled, with lesser concentrations (1%-3%) of phosphoric acid, 2,2-dichloroethyenyl dimethyl ester, methyl bromide, carbon tetrachloride, and trimethyl benzene.(8)

Dibrom® is an organo-phosphate pesticide, a class of compounds (along with carbamate pesticides) referred to as cholinesterase inhibitors. Acetylcholinesterase is an enzyme critical to normal control of nerve impulses from nerve fibers to other cells. Loss of this enzyme function allows for the accumulation of acetylcholine (the impulse-transmitting substance) at these junctions.(11-13) Signs and symptoms of acute poisoning include abdominal cramps, nausea, respiratory and ocular effects (often within a few minutes of exposure), and excessive bronchial secretions and salivation.(10-11) The most significant consequence of severe exposure is paralysis of the respiratory muscles. Chronic animal studies with technical grade Naled showed no increased incidence of neoplasms in treated animals when compared to controls.(9)

NIOSH has established an REL with a skin notation for Naled of 3 milligrams per cubic meter (mg/m^3) as a full-shift time-weighted average (TWA).(2) The REL was adopted by concurrence with the OSHA PEL.(14) This limit was established to prevent cholinesterase inhibition. NIOSH has also established an immediately dangerous to life and health value of 1800 mg/m^3 for Naled. The skin notation indicates that airborne or direct exposure by the cutaneous route contributes to overall exposure. The ACGIH has established a TLV-TWA of 3 mg/m^3 for Naled, based on analogy to dichlorvos (a related pesticide).(9) Because of the toxicity of Naled via the skin route, and reports of clinical sensitization, the ACGIH also established a skin notation for this substance. Because of the low vapor pressure of Naled (2×10^{-3} mmHg @ 20° C), inhalation is not a likely route of exposure unless the material is agitated or aerosolized. The Chevron corporation has established their own exposure limit for Naled of 0.2 mg/m^3.(8)

Early reports indicated Dibrom® was not a highly toxic organophosphate since the acute oral toxicity of Dibrom® is 40 times less than that of parathion;

however, because cholinesterase inhibition was observed in laboratory rats at 3.4 mg/m^3, Dibrom® is currently under review by the ACGIH TLV committee.[9]

Dibrom® is completely hydrolyzed within 48 hours at room temperature in the presence of water.[9,10] It is degraded by sunlight and should be stored in lightproof containers. In the presence of metals and reducing agents, Dibrom® will lose bromine and revert to dichlorvos.[10]

Attractants

Chemical insect attractants are usually highly specific, attracting only one or a few related species, and rely on an insect's specialized sense of smell.[15] Attractants are classified as sex (e.g., naturally occurring pheromone), food, or oviposition (egg laying) lures. Occupational exposure guidelines or standards have not been established for the three types of attractants used in the FFDP (cuelure, methyl eugenol, tri-medlure), and there is a lack of occupational exposure data for these chemicals. Toxicological data regarding human health effects associated with exposure to these attractants, particularly from the standpoint of chronic, low-level exposures, are sparse or non-existent.

Cuelure is a clear, colorless to pale yellow liquid aromatic ketone with a faint musty odor that is used to attract both Melon and Queensland fruitflies. According to one manufacturer, cuelure may be irritating to the skin, and may cause allergic skin reactions.[16] Toxicological studies found the acute oral LD_{50} (dose that is lethal to 50% of the tested animals) in rats to be 3038 milligrams per kilogram of body weight, and the LC_{50} (inhalation concentration that is lethal to 50% of the tested animals) was found to be greater than 2800 mg/m^3.[17] Based on this acute toxicity testing, cuelure is categorized as a slightly toxic material.[12]

Methyl eugenol, a liquid constituent of citronella and Huon pine oil with a delicate clove-carnation odor, is a powerful lure for the male Oriental fruit fly.[10,15] Acute toxicological studies in laboratory animals found methyl eugenol to be slightly toxic by the oral and inhalation route.[17] Methyl eugenol was negative in tests for mutagenicity using a standard protocol established by the National Toxicology Program.[10]

Tri-medlure, a light-colored liquid with a fruity odor, is a mixture of butyl ester isomers used to attract the Mediterranean fruit fly (medfly).[15] The Florida FFDP purchases tri-medlure bound in an acrylate polymer plug, and liquid tri-medlure is not used. No Dibrom® is used with the tri-medlure. As with the other attractants, acute toxicological testing in laboratory animals (oral and inhalation) places tri-medlure in the slightly toxic category. According to one manufacturer, exposure to vapors (no concentrations provided) may be moderately irritating to the eye and upper respiratory tract, and prolonged skin contact may result in dermatitis.[18]

RESULTS AND DISCUSSION

Air Sampling

Twenty-nine PBZ air samples from 12 DPI employees were collected and analyzed for Dibrom®. Samples were collected to assess task-specific exposure during bait preparation (a 30-60 minute activity), as well as full-shift exposures during trap inspection and bait replenishment activities. No detectable Dibrom®

was found on any of the samples. With an analytical sensitivity of 0.007 micrograms per sample (µg/sample), the sample with the smallest collection volume (16.3 liters of sampled air) showed that if Dibrom® was present, it was at a concentration of less than
0.4 $\mu g/m^3$ (the REL is 3000 $\mu g/m^3$ or 3 mg/m^3). These results are not surprising given that Dibrom® is not a volatile chemical, the baiting and tending activity does not entail agitation of the chemical mixture, and all tasks are conducted outside, where any generated contaminants would quickly disperse.

Skin Monitoring

Twenty-four sampling glove monitors (right and left hand) were collected to assess the potential for dermal contact with Dibrom® during the baiting activity. During this task, industrial-grade (5 mil thickness) 11-inch length disposable latex gloves were worn by the DPI employees in lieu of the specified neoprene gloves. The more flexible latex gloves were used because employees had reported problems with the reusable neoprene gloves during the application of attractants to the trap wicks. These reported problems included a lack of dexterity, having to deal with bulky, contaminated gloves (touching other non-contaminated articles, etc.), and the need to wash and decontaminate the gloves between uses.

The glove monitoring results are shown in Table 1. As noted in the table, measurable concentrations of Dibrom® were found on the glove monitors from all six workers who wore the monitor on the outside of their latex gloves. These results indicate that skin contact is possible during the preparation of baits. Although the sample size was somewhat limited, the results also suggest the concentration of Dibrom® increases proportionately with the number of wicks baited (e.g., workers H and I). Dibrom® was not found on any of the glove monitors from the six workers who wore the monitors underneath their latex gloves. These results indicate the disposable latex glove provided a sufficient barrier against Dibrom® for the duration of the baiting activity.

Bulk Samples

Bulk samples of the attractant mixtures, freshly baited cotton wicks, and expired cotton wicks were obtained and analyzed to confirm the presence and amount of Dibrom®. Determining the amount of Dibrom® remaining on expired wicks would provide useful information concerning potential handling hazards, and disposal procedures. The expected amount of Dibrom® on the wicks was calculated, and used to determine the percent remaining on the spent wicks. Because of discrepancies between the expected amount of Dibrom®, and the amount detected on the freshly baited cotton wicks, a detailed discussion is provided. The expected amount was determined as follows:

<u>1% Dibrom® and methyl eugenol</u>

This mixture is prepared by adding 12 milliliters (ml) of Dibrom® 14 concentrate (85% Naled) to 988 ml of methyl eugenol in a 1000 ml graduated cylinder. Six ml of this mixture is then added to each wick using a bulb pipette. The specific gravity of Dibrom® is 1.96 grams/ml.

(12 ml)(0.85)(1.96) = 20 grams (gm) of Naled in the 1000 ml mixture.

$\frac{20 \text{ gm}}{1000 \text{ ml}} \times 6$ ml = 0.12 gm Naled expected on each freshly prepared wick.

<u>5% Dibrom® and cuelure</u>

This mixture is prepared by adding 59 ml of Dibrom® 14 concentrate to 941 ml of cuelure to make a 1000 ml batch. Six ml of this mixture is added to each wick using a bulb pipette.

(59 ml)(0.85)(1.96) = 98 gm of Naled in the 1000 ml mixture.

$\frac{98 \text{ gm}}{1000 \text{ ml}} \times 6$ ml = 0.59 gm Naled expected on each freshly prepared wick.

An expired cotton wick treated on December 13, 1993, with 6 ml of the 1% Dibrom®-methyl eugenol mixture was collected on February 2, 1994, and found to contain 36 mg of Naled, or 30% of the original amount applied. Analysis of bulk liquid samples of the attractant mixtures also obtained on February 2, 1994, found the 1% attractant mixture contained 1% Naled, and 7.4% Naled was measured in the 5% attractant mixture.

The results of the 12 cotton wicks collected on February 15 are shown in Table 2. All fresh wicks were baited on February 15 and immediately placed in labeled amber jars for shipment to the laboratory. All expired wicks were baited on December 13, 1993.

As noted in Table 2, the detected amount of Naled on the freshly baited wicks was four times less than expected for the 1% Dibrom® mixture, and approximately five times less than expected for the 5% Dibrom® mixture. Additionally, the amount of Naled measured on expired 1% wicks was greater than the amount detected on the freshly baited cotton wicks.

The discrepancy between the expected and measured amounts of Naled on the freshly prepared cotton wicks could have occurred for the following reasons:

- The original mixtures were prepared incorrectly, or they were not adequately mixed prior to placing the solutions in the 250 ml bottles.

- The wicks were not baited properly (e.g., less than 6 ml of the mixture actually adhered to the cotton wick).

- An analytical error occurred at the laboratory during analysis (e.g., a sample dilution miscalculation).

- The original Dibrom® 14 concentrate had degraded due to exposure to sunlight, or possibly hydrolyzed due to contact with moisture.

- Possible sample loss during collection or shipment.

To help resolve this discrepancy, additional bulk samples (freshly baited cotton wicks and bulk liquid samples of the attractant mixture used to bait the wicks) were obtained on April 18, 1994. Analysis of bulk liquid samples found the 1% attractant mixture contained 0.9% Naled, and 6.5% Naled was measured in the 5% attractant mixture. The results of the cotton wick analysis is shown in Table 3. As noted in this table, all analyses showed the cotton wicks to contain less than the expected amount of Dibrom®, with only 50% of the expected amount found on cotton wicks baited with the 1% attractant mixture, and approximately 80% of the expected amount found on wicks baited with the 5% solution. Based on the bulk liquid analyses, it does not appear that an improperly prepared or mixed solution explains this discrepancy. As such, it is likely that one or more of the other hypothesized reasons noted above may be responsible.

Workplace Observations

A high level of awareness and concern for safety among DPI employees and management was noted. This was evidenced by the committee established to determine medical monitoring protocols for employees. Employees were also aware of the safety and health issues associated with the use of the attractants.

Personal Protective Equipment

During the preparation of the attractant mixture, procedures call for the agriculture technician to wear a half-mask negative pressure air-purifying respirator equipped with organic vapor cartridges and pre-filters when mixing the lure. Additionally, neoprene gloves and goggles are required to be worn. However, there were no air monitoring data to support the use of a respirator, and a respirator program (training, fit-testing, medical evaluation, written program, etc.) had not been established. Also, because the agricultural technician had a beard, a proper fit could not be achieved. Facial hair between the wearer's skin and the sealing surfaces of the respirator will prevent a good seal, allowing leakage to occur.

As previously noted, current procedures call for fruit fly trappers to wear reusable neoprene gloves during the application of attractants to the trap wicks. Reported problems associated with these gloves include lack of dexterity, having to deal with bulky, contaminated gloves (touching other non-contaminated articles, etc.), and the need to wash and decontaminate the glove between uses.

One alternative is to use disposable gloves. Disposable gloves could be discarded immediately after use into the same plastic bag used to line the container when baiting the wicks. Many disposable gloves have excellent dexterity characteristics and are available in several sizes at a relatively low cost. However, due to the disposable light-weight nature of these gloves, resistance to chemicals is generally not as good as many of the more durable reusable gloves. Quantitative glove resistance (permeation, degradation) data for the Dibrom® mixtures (cue-lure, methyl eugenol) was not available.

Lure Containers and Dispensing

DACS personnel have investigated numerous options to identify a suitable container for the attractant mixtures. The containers currently used by trappers to bait wicks have been modified by gluing a bulb pipette to the container cap. These containers routinely leak both at the cap and the cap and pipette seal. Employees baiting the wicks must therefore deal with contaminated gloves as soon as they touch the containers. The potential also exists for unprotected personnel to inadvertently contact the attractant mixture. A container and dispensing system that does not leak will eliminate the highest potential for contact in the baiting process.

Ventilation

In the Miami DACS facility, a centrifugal fan has been placed adjacent a work bench to provide ventilation when preparing attractant mixtures. This fan is essentially providing general room ventilation as opposed to the more desirable local exhaust ventilation. In general, to maximize ventilation effectiveness, the contaminant generating process should be enclosed as much as possible within the ventilation system, and the contaminant source located close to the exhaust. The current mixing process requires placing the 1000 ml graduated cylinder on the floor in order to measure the attractant. The exhaust fan will not effectively capture the contaminant at this location.

CONCLUSIONS

An evaluation to assess the use of the pesticide Dibrom® during fruit-fly trap baiting and servicing found no measurable inhalation exposures. Assessment of the potential for skin contact, however, found measurable quantities of dibrom on eleven out of twelve (92%) of the sampling glove monitors worn outside the workers' latex gloves. The containers used by the survey specialists to bait the cotton wicks were not sealing properly, resulting in leaks and subsequent contamination of the container surface. This is likely the greatest source of skin contact with the Dibrom®-attractant mixture. For the six survey specialists who wore glove monitors underneath their latex gloves, no detectable Dibrom® was found, indicating that the latex gloves provided a sufficient barrier for the duration of this task. Use of a disposable glove would help resolve the dexterity and decontamination issues associated with the reusable neoprene gloves currently specified in the trapping procedures.

Analyses of freshly baited cotton wicks found less than the expected amount of Dibrom®, and in some cases the spent wicks were found to contain more Dibrom® than wicks which were freshly baited. Attempts to explain this discrepancy by obtaining additional samples of freshly baited wicks, and bulk samples of the liquid Dibrom®-attractant mixture used to bait these wicks, were unsuccessful in resolving this issue.

The existing ventilation system used when the Dibrom®-attractant mixture is prepared was not being efficiently used. This system could be improved by enclosing the work bench with flanges or baffles, and possibly a hood.

Although a respiratory protection program has not been implemented, a respirator was being used during the preparation of the Dibrom®-attractant mixture. Additionally, the respirator wearer was not clean shaven and thus cannot achieve a good face to facepiece seal. Respirator use should be considered a "last resort" control (e.g., engineering controls such as ventilation should be utilized as a first priority), and should never be used without a complete respiratory protection program. Because the burden of protection is on the user, untrained personnel who improperly use a respirator, or use the wrong type of respirator, may inadvertently place themselves in situations where high exposures could occur. Although no attractants were mixed during our site visit and this activity was not evaluated an efficient local exhaust ventilation system will likely negate the need for respiratory protection.

RECOMMENDATIONS

1. Use alternative gloves to overcome the dexterity and decontamination issues. With certain stipulations, a disposable glove may be the most appropriate alternative since only small quantities of the Dibrom®-attractant mixtures are handled for a relatively short period on an infrequent basis. The stipulations include training all trappers on the proper use and limitations of disposable gloves and ensuring that gloves are immediately removed and disposed of if contact with the attractant mixture occurs. Disposable nitrile, latex, and vinyl gloves are available in several different sizes. Note that some individuals may experience an allergic skin reaction to latex. There are many vendors that offer disposable gloves, and it may be worthwhile to have a local safety supplier demonstrate several types prior to making a purchasing decision.

2. Modify the existing ventilation system in the mixing room to provide more efficient collection of generated contaminants. In addition to flanges and baffles, it may also be necessary to provide a plenum at the back of the table to ensure adequate capture exhaust distribution. Modification of the mixing process to accomodate conducting this work on the table is probably necessary. It may be worthwhile to utilize an industrial hygienist or engineer with experience in designing and constructing ventilation for contaminant control when addressing this item.

3. If respirators are used, a respiratory protection program as defined in 29 CFR 1910.134 (OSHA General Industry Regulations), must be developed and implemented. Employees must be properly trained and fit-tested. A facial hair policy requiring respirator users to be clean shaven is necessary. This applies even if employees are using respirators for comfort reasons.

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For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1
Glove Monitoring Results: Baiting Cotton Wicks
Dibrom® + Attractant: February 15, 1994
HETA 94-0096

Worker	Glove Location	Sampling Period	Duration (min)	# Wicks Baited	Dibrom® Concentration (µg/hr)	
					LEFT	RIGHT
A	Sampling glove monitor worn **under** latex glove	08:51-09:32	41	6 - ME 4 - CL	ND	ND
B	Sampling glove monitor worn **under** latex glove	08:45-09:35	50	4 - ME 1 - CL	ND	ND
C	Sampling glove monitor worn **under** latex glove	08:53-09:18	25	7 - ME 3 - CL	ND	ND
D	Sampling glove monitor worn **under** latex glove	08:49-09:42	53	7 - ME 3 - CL	ND	ND
E	Sampling glove monitor worn **under** latex glove	08:40-09:27	47	7 - ME 4 - CL	ND	ND
F	Sampling glove monitor worn **under** latex glove	08:48-10:27	39	7 - ME 5 - CL	ND	ND
G	Sampling glove monitor worn **over** latex glove	08:58-09:18	20	4 - ME 4 - CL	15.9	(3.96)
H	Sampling glove monitor worn **over** latex glove	08:56-09:27	31	15 - ME 4 - CL	611.6	916.3
I	Sampling glove monitor worn **over** latex glove	08:55-09:40	45	14 - ME 7 - CL	421.3	108.8
J	Sampling glove monitor worn **over** latex glove	08:56-0:918	22	7 - ME 4 - CL	ND	244.1
K	Sampling glove monitor worn **over** latex glove	08:59-09:31	32	6 - ME 2 - CL	7.3	(1.48)
L	Sampling glove monitor worn **over** latex glove	08:52-09:50	58	9 - ME 6 - CL	38.1	46.2

NOTE: µg/hr = micrograms of Dibrom® detected per hour
ME = attractant solution contained 1% Dibrom® + methyl eugenol
CL = attractant solution contained 5% Dibrom® + cue-lure
() = values in parentheses represent concentrations between the analytical level of detection (LOD) and level of quantification (LOQ)
ND = none detected (the analytical LOD was 0.3 micrograms per sample
All samples were blank corrected and adjusted for a desorption/recovery efficiency of 38%

Each wick was baited with 6 ml of the Dibrom®/attractant solution dispensed from a 250 ml container with a bulb pipette.

Table 2
Dibrom® Concentrations: Cotton Wicks
February 15, 1994
HETA 94-0096

Sample #	Bait Characteristic	Expected Amount (mg)	Detected Amount (mg)	Percent Remaining
B-1	1% Dibrom® FRESH	120 mg	30 mg	N/A
B-1A	1% Dibrom® FRESH	120 mg	30 mg	N/A
B-2	5% Dibrom® FRESH	590 mg	120 mg	N/A
B-2A	5% Dibrom® FRESH	590 mg	110 mg	N/A
B-3	1% Dibrom® EXPIRED	N/A	42	35
B-3S	1% Dibrom® EXPIRED	N/A	35	29
B-3A	1% Dibrom® EXPIRED	N/A	35	29
B-3AS	1% Dibrom® EXPIRED	N/A	42	35
B-4	5% Dibrom® EXPIRED	N/A	71	12
B-4S	5% Dibrom® EXPIRED	N/A	53	9
B-4A	5% Dibrom® EXPIRED	N/A	54	9
B-4AS	5% Dibrom® EXPIRED	N/A	40	6.8

NOTE: N/A = not applicable
mg = milligrams Naled

All fresh wicks were baited and collected on February 15, 1994.
All expired wicks were baited on December 13, 1993, and collected on February 15, 1994.

Table 3
Dibrom® Concentrations: Cotton Wicks
April 18, 1994
HETA 94-0096

Sample #	Bait Characteristic	Expected Amount (mg)	Detected Amount (mg)
BW-1	1% Dibrom® FRESH	120 mg	52 mg
BW-1A	1% Dibrom® FRESH	120 mg	46 mg
BW-2	5% Dibrom® FRESH	590 mg	460 mg
BW-2A	5% Dibrom® FRESH	590 mg	480 mg

NOTE: All wicks were baited and collected on April 18, 1994.