UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAY 5 1994

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: Worker and Residential Exposure Assessment Of Metam-Sodium.

TO: Tom Myers, PM 51
Accelerated Review Branch
Special Review and Reregistration Division 7508W

FROM: Ameesha Mehta, Chemist Ameesha Mehta

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Health Effects Division 7509C

Please find below, the OREB review of:

DP Barcode: D196502; D182720; D192044; D189267

Pesticide Chemical Code: 039003 Metam-sodium

EPA Reg. No.: 039003-010182

EPA MRID No.: **42968402**: Worker M/L/A Study- Arizona
42440501: Interim Report (Worker M/L/A Study- Arizona)
42968401: Worker M/L/A Study- Washington
42791701: Interim Report (Worker M/L/A Study- Washington)
42659901: Field Volatility/Downwind Sampling Study

Review Time: 4 months

PHED: NO

I. INTRODUCTION

A. Background:

Metam-sodium (Vapam) is a non-selective pre-plant fumigant for control of weeds, soilborne diseases, and nematodes infesting field and vegetable crops. It is applied at least 14 to 21 days prior to planting by some of the following methods: shank injection, rotary tiller, solid set sprinkler, and center pivot chemigation. The formulated product is a water miscible concentrate containing 3.18 lbs ai/gallon. Metam-sodium when mixed with water metabolizes to Methyl isothiocyanate (MITC), the chemical that exhibits the primary pesticidal activity. Other metabolites of metam-sodium include Carbon disulfide (CS_2) and Hydrogen sulfide (H_2S). Methyl isothiocyanate and Carbon disulfide in air are the toxic compounds to which workers and bystanders are potentially exposed.

B. Purpose:

In September 1991, the Environmental Protection Agency negotiated a settlement agreement with the Metam-sodium Task Force (MSTF). As per the agreement, the MSTF was required to conduct M/L/A Studies at two sites, and a downwind sampling/residential exposure study at one site. Therefore, Special Review and Reregistration Division (SRRD) has requested that OREB review the studies and assess both worker and residential exposure.

II. MIXER/LOADER/APPLICATOR STUDIES

A. Study Site: Yuma County, Arizona

Metam-sodium, minimum 32.7% active ingredient, was applied to ground that has been disked (predisked) at the maximum label rate of 100 gallons per acre (356 kg ai/ha). A total of 1,590 gallons (2293 kg ai) and 3530 gallons (5092 kg ai) Busan 1020 (water miscible concentrate, common name metam-sodium, manufactured by Buckman Laboratories, Inc.) was applied through shank injection and sprinkler injection, respectively.

1. Experimental Design

a) Shank Injection Method: The shank injector trials were conducted in Yuma County, Arizona, from February 21 through 22, 1992. The first nine replicates of the shank injection trial were conducted in an 18 to 20 acre field. Replicate 10 was conducted at a separate field, measuring approximately 30 acres. The predominant soil type in this area is classified as Holtville Clay. A total of four male volunteers (two mixer/loaders and two applicators) were monitored during the shank trial. Both the mixer/loaders and applicators wore long-sleeved shirts and long pants during the study. In addition, mixer/loaders wore rubber boots, goggles, respirators, and chemical-resistant gloves while working with metam-sodium as required on the label. Applicators were provided with goggles, respirators, and chemical-resistant gloves to wear at their own discretion or when a pungent, rotten egg odor is detected.

Two tractors, a John Deere 4455 equipped with a closed-cab and air conditioning and an open-cab John Deere 4430, were used to pull the shank injection rig. A charcoal air filter (Model JD30V, manufactured by Clean Air Filter Company, Iowa) was used in the closed-cab during replicates 1-2, and a standard cellulose air filter was used during replicates 3-6. Replicates 7-10 were conducted using the open-cab tractor. The shank injector was manufactured by Buckman Labs and consisted of a 200 gallon capacity tank secured above three tool bars. A total of seven shanks, 12 inches apart, were attached to the tool bars, four on the first tool bar and three on the second tool bar, for a total swath width of 7 feet. Each shank consisted of three horizontal blades to cut through the soil and there were two nozzles (Tee-Jet 8003) per shank. The test substance was applied at 40 psi at an application speed of 2.57 mph.

Each mixer/loader replicate consisted of the length of time it took to load a minimum of 100 gallons of metam-sodium. Wearing protective clothing, the mixer/loader attached the one end of a hose to a fitting located at the lower right side of the shank spray tank. Using wire cutters, he then opened the seal on the tanker, screwed the coupler into place, and attached the free end of the hose to the coupler. When the tank was full, the valves at the tanker and spray tank were closed, and the mixer/loader uncoupled the hose from the spray tank. Each time he performed this maneuver, metam-sodium remaining in the hose would spill onto his gloves and the ground. While the spray tank was filling up, the mixer/loader sat either on the tool bar of the sprayer or on the back of the tank trailer.

Application replicates for shank injection took approximately one hour. The applicator stayed in the cab during the whole application replicate unless he performed maintenance work on the tractor or shanks. The applicator waited until the shanks were fully inserted in the ground before applying the test substance. When turning around at the end of the pass, he shut off the spray before lifting the shanks out of the ground. During the first seven replicates, the applicator started at the downwind edge of the field and moved across the field in an east-west direction. For replicates 8 and 9, the test substance was applied in a north-south direction along the edges of the field. The last replicate was made in a north-south orientation in a different field.

Inhalation exposure to carbon disulfide and methyl isothiocyanate was measured using two personal air-sampling pumps, each attached to a charcoal vapor-collection tube. A drying tube and cassette containing a glass fiber filter and support pad were placed in front of each vapor-collection tube to trap moisture and screen out dust particles.

b) Sprinkler Injection Method: The line sprinkler trials were conducted in Yuma City, Arizona from February 24 to 28, 1992. The site was located in a predisked, 40 acre field near Gadsen, Arizona. A water pump was located near the irrigation canal, midway up the west side of the field. Metal sprinkler pipes, each measuring 1,260 feet, were orientated in a north-south direction across the field with approximately 40 feet between lines. There were a total of 32 sprinkler lines in the field with 42 sprinkler heads per line. The outer-most line on both the west and east sides were not used in the trial. An injector pump was used to pump the test substance from the nurse tank into the sprinkler line. Water was applied at the rate of 1/10 inch per hour.The predominant soil type in this area is classified as an Indio Silt Loam.

The sprinkler trial utilized a total of five male volunteers (3 mixer/loaders and two applicators). Both the mixer/loaders and applicators wore long-sleeved shirts and long pants during the study. In addition, mixer/loaders wore rubber boots, goggles, respirators, and chemical-resistant gloves while working with metam-sodium as required on the label. Applicators were provided with goggles, respirators, and chemical-resistant gloves to wear at their own discretion or when a pungent, rotten egg odor is detected.

Wearing protective clothing, the mixer/loader attached one end of a hose to a coupler on the tank. The other end was dropped through the circular opening of the 200 gallon capacity holding tank located in the bed of a pickup truck. He then opened the valve on the tanker, allowing metam-sodium to fill the holding tank. When the correct amount of test substance had filled the tank, the valve on the tanker was closed and the hose was pulled out of the holding tank (leaving the other end attached to the tanker). The mixer/loader then drove the pickup truck, carrying the holding tank, to the field. He attached one end of a new hose to a fitting at the bottom of the holding tank and placed the other end through the circular opening at the top of the nurse tank. During this procedure, some metam-sodium would drip onto the mixer/loader's gloves and onto the ground. Since a minimum of 345 gallons metam-sodium was required for one sprinkler application replicate, the holding tank was filled twice during each mixer/loader replicate.

At the beginning of each replicate, the applicator walked into the field and manually turned on three new sprinkler lines and closed off the previous three. He would then walk down the field checking for blocked or broken sprinkler heads. At this time, only water was running through the lines; however, metam-sodium fumes from the previously applied replicates were present and could be detected by the applicator. Water was applied to the soil for the first 30 minutes of each replicate. Following irrigation, the applicator would start the injector pump that pumped the test substance from the nurse tank into the sprinkler line, open a valve to release the chemical from the tank, and open the valve to the main irrigation line. It took approximately two hours to apply the 345 gallons of metam-sodium during each replicate. The amount of test substance applied was determined by reading a digital flow meter attached to the chemical line. During most of the replicate, the applicator sat in his car which was parked 10 to 50 feet from the nurse tank. Approximately every half hour he would check the flow meter to verify that the correct amount of chemical (3 gallons/min) was being pumped into the sprinkler line. Occasionally the applicator would get out of his car to check the irrigation pump and the water line in the irrigation canal. When 345 gallons of metam-sodium had been applied to the field, the applicator turned off the injection pump and closed the two valves. Water was applied to the field for the remainder of the replicate (approx. 1.5 hrs).

Inhalation exposure to carbon disulfide and methyl isothiocyanate was measured using two personal air-sampling pumps, each attached to a charcoal vapor-collection tube. A drying tube and cassette containing a glass fiber filter and support pad were placed in front of each vapor-collection tube to trap moisture and screen out dust particles.

B. Study site: Grant County, Washington

Metam-sodium, minimum 32.7% active ingredient, was applied to bare ground using the rotary tiller application method at 100.6 gallons per acre, and to dormant alfalfa using a sprinkler injection application method at 91.2 gpa. The target application rate was 100 gpa (356 kg ai/ha), the maximum label rate. A total of 1920 gallons (2769 kg ai) and 3123 gallons (4505 kg ai) of Vapam, a water miscible concentrate, were applied through the rotary tiller and sprinkler injection methods respectively.

1. Experimental Design

a). **Rotary Tiller Injection:** The rotary tiller injector trials were conducted in Grant County, Washington, on Nov. 7 through the 10th, 1992. Ten replicates of two work functions were monitored for this application method. Application replicates using the rotary tiller injector lasted approximately one hour.

The first four replicates of the rotary tiller trial were conducted in a predisked, approximately 10 acre field. Replicates 5-10, were conducted at a separate predisked field, measuring 65 acres. The predominate soil type in these areas is classified as Quincy Loamy Fine Sand.

A John Deere 4640 tractor equipped with a closed-cab and air-conditioning was used to pull the rotary tiller injection rig. A charcoal air filter (Model JD30V, manufactured by Clean Air Filter Company, Iowa) was used in the John Deere 4640 during replicates 1-5, and a standard cellulose air filter was used during replicates 6-10. The rotary tiller was manufactured by Northwest and consisted of a 220 gallon capacity tank secured above a tool bar. Six blades designed to cut through the soil hung from the tool bar. A total of six nozzles, 20 inches apart, were attached in front of each blade for a total swath width of 10 feet. Nozzles were Teejet SS4 manufactured by Spraying Systems, Inc. A large roller which sealed the soil was attached behind the tool bar. The test substance was applied at 38 psi and an application speed of 1.79 mph. Nozzle output and tractor speed were calibrated prior to applying the test substance.

Inhalation exposure to carbon disulfide and methyl isothiocyanate was measured using two personal air-sampling pumps, each attached to a charcoal vapor-collection tube. A drying tube and cassette containing a glass fiber filter and support pad were placed in front of each vapor-collection tube to trap moisture and screen out dust particles. Wearing long sleeved shirts,long pants, rubber boots, goggles, respirators,and chemical resistant gloves, the loader attached one end of a hose to a fitting located at the top of the spray tank. He opened two valves on the tanker which allowed the metam-sodium to flow from the tanker into the spray tank. When the tank was full, the valves at the tanker and the spray tank were closed and the loader then removed the hose from the spray tank. He then placed the hose on the ground where it stayed until the next replicate. Since the hose remained attached to the tanker for the rest of the trial, the loader only needed to attach the hose to and from the spray tank after the first replicate. While the spray tank was filling up with metam-sodium, the loader sat either on the tool bar of the sprayer or on the back of the tanker trailer.

Wearing long-sleeved shirts, and long pants, the applicator stayed in the cab during the whole application replicate unless he performed maintenance work on the tractor. The applicator waited until the blades were fully inserted in the ground before applying the test substance. When turning around at the end of the pass, he shut-off the spray before lifting the blades out of the field. Replicates 1 through 4 were conducted in one field while the remaining six replicates were done in another field.

b). Center Pivot Chemigation: The center pivot sprinkler injection site was located in a 145 acre field containing dormant alfalfa. Water was supplied from a well approximately 100 feet from the center of the field. The sprinkler was a full size center pivot sprinkler system equipped with 72 low angle impact nozzles manufactured by Nelson. The predominant soil types in this area are classified as Timmerman Coarse Sandy Loam and Quincy Loamy Fine Sand.

The Valley center pivot sprinkler system, Model 1975, was filled with water (pH 6) supplied from a well located approximately 100 ft from the center of the field. The test substance was injected into the system at the center pivot. The 1266 foot boom was constructed with 6 inch galvanized overhead spans, equipped with 72 variably spaced low impact Nelson nozzles. Nozzles were located 14 ft above ground. Pressure at the nozzles was 80 psi and the tank capacity was 3800 gallons. The injector pump was a John Blue High Capacity piston pump. The sprinkler system had a corner attachment that contained 32 sprinklers plus an end gun to irrigate corners.

Inhalation exposure to MITC and to CS2 was measured utilizing charcoal vapor-collection tubes (400/200 mg, SKC Model Number 226-09). A drying tube to trap moisture was placed in front of each charcoal tube. The drying tubes used in front of the CS2 sampling tubes contained sodium sulfate; silica gel drying tubes were used for the MITC samples. Each worker wore two personal air-sampling pumps (MSA Model S,G or Flow-Lite H or SKC Model 224-43XR) on his belt, one to trap CS2 and the other to trap MITC. Tygon tubing attached the pump to the charcoal vapor-collection tube, which, in turn, was attached to the drying tube and clipped to the worker's collar or lapel near his breathing zone. Prior to the start of each replicate, each air-sampling pump connected to the sampling media was calibrated using a Kurz Mass Flow Meter to an airflow rate of 1.0 liters per min for samples analyzed for MITC and to 0.5 lpm for samples analyzed for CS2. The pumps were placed on the worker and turned on at the start of each sampling replicate.

Wearing protective clothing, the loader attached one end of a hose to a coupler on the tanker. The other end was dropped through the circular opening of one of the nurse tanks located next to the center pivot and secured with a wire. He then opened the valve on the tanker, allowing the metam-sodium to fill the nurse tank. When approximately 750 gallons had been transferred, the valve on the tanker was closed and the hose was pulled out of the nurse tank and laid on the ground leaving the other end still attached to the tanker. Some replicates involved loading a portion of the chemical into a partially full nurse tank and the remainder into an empty one. This was repeated five times until all three nurse tanks (capacity varied from 1000 gallons to 1500 gallons) were full. While the nurse tank was being filled, the loader would stand next to the tanker truck.

At the beginning of each replicate, the applicator walked to the injector pump to check the injection flow rate using a calibration tube. When the nurse tank was nearly empty, the applicator flipped a lever to close the line and another lever to open the next tank. During most of the replicate, the applicator sat in his car which was parked 10 to 50 feet from the center pivot. Approximately every half hour he would check the flow rate by performing a calibration check to verify that the correct amount of chemical (371.8 oz/min) was being pumped into the sprinkler line.

C. Quality Assurance/Quality Control

Field fortifications were prepared and positioned upwind from the mixing/loading areas and application zones. Pumps used for MITC and CS_2 fortifications were calibrated at 1.0 lpm and 0.5 lpm, respectively. Samples were left out for the duration of one application replicate (one hour for rotary tiller, and four hours for sprinkler injection application). The fortification rates were as follows:

MITC: 1.0 ug, 100.0 ug, 1000.0 ug
CS_2: 1.0 ug, 50.0 ug, 100.0 ug

The minimum quantitative limit (MQL) values for MITC and CS_2 were 1.0 ug per sample section (i.e., charcoal collection tube, drying tube, and cassette containing a glass fiber filter). Recoveries of MITC were between 70 - 105 %, and CS_2 were in the range of 60 - 70%.

D. Worker Exposure

1. Use Information

BEAD provided the following use and usage information:

Metam sodium is primarily used on the following major (> 1000K lbs ai usage per crop) sites: potatoes; row crops and vegetables (including carrots, eggplant, leafy vegetables); peanuts; and cole crops. It is applied with either tractor-driven, shank injection machinery or through chemigation equipment. The chemical is delivered by the company to the grower (who may use storage containers ranging from 700 to 4000 gallons), or to bulk storage tanks (up to 7700 gallon capacity) near fields. When Metam-sodium is applied, tarping is not conducted. Instead, the soil is "water-sealed." The remaining use/usage information is categorized by site.

For crops (e.g.: peanuts) treated via either the shank or rotary tiller method, the chemical is pumped with an electric pump (and metered) into the applicator tank. Overflow is checked with orifice disks and check valves. Applications are made with a 4-row or 8-row injector (w/ an average 120 gallon tank) on a field with 36" row spacing. One or two workers can treat about 25-30 acres of peanuts in a 6 - 8 hr workday. After 2 or 3 weeks, growers plant peanuts on top of bed.

For row and vegetable crops, the 3000-4000 gallon tanks are commonly used for loading purposes. The tanks are placed near the wells; a booster pump is then placed near the water source. The distributor will do the calibration and helps the grower with the loading. The grower can treat 10-15 acres in an 8-10 hr day, using a stationary (solid set) sprinkler. Note that the range of "hrs-day" depends upon amount of water that needs to be applied. For the shanking applications; a grower will pre-irrigate the field and the distributor/custom applicator will deliver and inject the chemical 12 to 14" deep into the soil. A bed shaper follows to shape and seal the soil. Carrots, for example, are then planted 14 days to 1 month after application.

For crops treated via the center pivot chemigation method, metam-sodium is delivered by the custom applicator to a bulk storage tank (5500 gallon capacity) that is located on site. The entire mixing/loading and application is via a closed system; one worker is necessary, but usually two are available to monitor the chemigation. (Memo. from G. Tomimatsu/BAB to A. Mehta/OREB, 1/21/93)

2. Assumptions

Since the route of exposures for both MITC and CS_2 is inhalation, OREB assumes 100% absorption. From the use information provided by BEAD, OREB assumes that there are two people involved in the mixing/loading and application. Since the toxicity endpoints for both MITC and CS_2 are developmental, OREB has provided exposure estimates for females whose body weight is assumed to be 60 kg, and the ventilation rate is assumed to be 0.96 m^3/hr for moderate work. The number of hours exposed for the mixer/loader is 0.5 hr/day, and for the applicator is 8 hrs/day. Although there are insufficient data to determine the distribution, environmental data are often lognormal; hence, OREB assumes that personal air monitoring concentrations do follow a lognormal distribution. Therefore, the geometric mean is used to estimate average exposure.

3a. Exposure Estimates and Sample Calculation

TABLE 1: Estimates of Handler Exposure to MITC for Each Application Method

		MIXER/LOADER			***APPLICATOR***	
Application Type	**No. of Reps.**	**Inhal. Conc. Geometric Mean (ug/m^3)**	**Exposure (mg/kg/day) MITC (females)**	**No. of Reps.**	**Inhal. Conc. Geometric Mean (ug/m^3)**	**Exposure (mg/kg/day) MITC (females)**
SHANK INJECTION	10	326.42	2.61×10^{-3}	8*	1034.20	1.32×10^{-1}
ROTARY TILLER INJECTION	10	452.56	3.62×10^{-3}	5*	600.92	7.69×10^{-2}
SOLID SET SPRINKLER (chemigation)	10	440.19	3.52×10^{-3}	10	892.75	1.14×10^{-1}
CENTER PIVOT SPRINKLER (chemigation)	5	203.60	1.63×10^{-3}	5	89.82	1.15×10^{-2}

Replicates that were run with Charcoal Filtered Cabs were not included.

Sample Calculation:

(Shank Injection): Mixer/loader: MITC (female only) Exposure (mg/kg/day) =

$$= \frac{(\text{Inhal. Conc. ug/M}^3) * (\text{Ventil. Rate}) * (1\ \text{mg}/1000\ \text{ug}) * (\text{Exp.dur. hrs/day})}{60\ \text{kg}}$$

$$= \frac{(326.42\ \text{ug/m}^3) * (0.96\ \text{m}^3/\text{hr}) * (1\ \text{mg}/1000\ \text{ug}) * (0.5\ \text{hrs/day})}{60\ \text{kg}}$$

$$= 2.61 \times 10^{-3}\ \text{mg/kg/day}$$

(Shank Injection): Applicator: Exposure (mg/kg/day) =

$$= \frac{(\text{Inhal. Conc. ug/M}^3) * (\text{Ventil. Rate}) * (1\ \text{mg}/1000\ \text{ug}) * (\text{Exp.dur. hrs/day})}{60\ \text{kg}}$$

$$= \frac{(1034.20\ \text{ug/m}^3) * (0.96\ \text{m}^3/\text{hr}) * (1\ \text{mg}/1000\ \text{ug}) * (8.0\ \text{hrs/day})}{60\ \text{kg}}$$

$$= \mathbf{1.32 \times 10^{-1}\ mg/kg/day}$$

TABLE 2: Estimates of Handler Exposure to CS_2 for Each Application Method

		MIXER/LOADER			***APPLICATOR***	
Application Type	**No. of Reps.**	**Inhal. Conc. Geometric Mean (ug/m^3)**	**Exposure (mg/kg/day) CS_2**	**No. of Reps.**	**Inhal. Conc. Geometric Mean (ug/m^3)**	**Exposure (mg/kg/day)C S_2**
SHANK INJECTION	10	519.37	4.15×10^{-3}	8*	50.23	6.42×10^{-3}
ROTARY TILLER INJECTION	10	594.05	4.75×10^{-3}	5*	68.74	8.79×10^{-3}
SOLID SET SPRINKLER (chemigation)	10	43.94	3.51×10^{-4}	10	10.69	1.36×10^{-3}
CENTER PIVOT SPRINKLER (chemigation)	5	417.62	3.34×10^{-3}	5	17.90	2.29×10^{-3}

Replicates that were run with Charcoal Filtered Cabs were not included.

Sample Calculation:

(Shank Injection): Mixer/loader: CS_2 (female only) Exposure (mg/kg/day) =

$$= \frac{(\text{Inhal. Conc. ug/M}^3) * (\text{Ventil. Rate}) * (1\ \text{mg}/1000\ \text{ug}) * (\text{Exp.dur. hrs/day})}{60\ \text{kg}}$$

$$= \frac{(519.37\ \text{ug/m}^3) * (0.96\ \text{m}^3/\text{hr}) * (1\ \text{mg}/1000\ \text{ug}) * (0.5\ \text{hrs/day})}{60\ \text{kg}}$$

$$= \mathbf{4.15 \times 10^{-3}\ mg/kg/day}$$

(Shank Injection): Applicator: Exposure (mg/kg/day) =

$$= \frac{(\text{Inhal. Conc. ug/M}^3) * (\text{Ventil. Rate}) * (1\ \text{mg}/1000\ \text{ug}) * (\text{Exp.dur. hrs/day})}{60\ \text{kg}}$$

$$= \frac{(50.23\ \text{ug/m}^3) * (0.96\ \text{m}^3/\text{hr}) * (1\ \text{mg}/1000\ \text{ug}) * (8.0\ \text{hrs/day})}{60\ \text{kg}}$$

$$= \mathbf{6.42 \times 10^{-3}\ mg/kg/day}$$

III. DOWNWIND SAMPLING/BYSTANDER EXPOSURE STUDY

A. Study Site: Madera County, California

1. Experimental Design:

Pan-Agricultural Laboratories, Inc. of Madera, California was contracted by the MSTF to conduct the field portion of an off site movement study using metam-sodium. The study was conducted to provide dissipation and volatility data for the principle decomposition product/metabolite, methyl isothiocyanate(MITC), during and after application. These data were gathered in order to assess exposure to bystanders/residents near fields treated with metam-sodium.

The trial was conducted in Madera County near Firebaugh, California on May 2 through May 4, 1992, using solid set sprinklers. Busan 1020 (water miscible concentrate, minimum 32.7% metam-sodium, manufactured by Buckman Laboratories, Inc.) was applied to bare ground at the maximum label rate of 100 gallons per acre (347 kg ai/ha) to a field of 6.69 acres for a four hour period. A total of 669 gallons (941 kg ai) were applied. The 6.69 acre field was located in a 40 acre fallow field. A 40 acre cotton field was located to the south side of the site and the entire 80 acre block was surrounded by pasture land. Prior to the study initiation, the test site was cultivated with a spring-tooth cultivator and diced. The predominant soil type in this area was classified as Calhi Loamy Sand, and was considered to be moderately alkaline.

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The water pump and chemical nurse tank were situated at the north west corner of the field. A booster pump was used to provide the extra pressure needed to run the full set of sprinklers. The main line of the sprinkler system ran from the booster pump diagonally across the field in a southeast direction. Four rows of sprinkler pipe, each row separated by 45 feet, were placed perpendicular to the main pipe.

Temperature data were collected by the DataLynx weather station at 1.5 and 7 meters above the ground; wind direction and speed, relative humidity, and barometric pressure were collected at 1.5 meters only. Hourly soil temperatures at 3 inches were collected by placing a soil thermometer 3 inches into the soil at the 5 meter sampling station and reading the value every hour.

Application of metam-sodium was initiated at 16:52 on May 2, 1992, at the highest label rate of 100 gallons per acre. The test site was pre-irrigated with water at a rate of 0.20 inch per hour for 90 minutes prior to application of the test substance. Approximately 669 gallons of metam-sodium and 0.8 inch of water were applied to the test site during the four hour application period. After the application, the injector pump was switched off and the sprinkler line was flushed with water for 15 minutes.

Fortifications were prepared in an area approximately two to three miles upwind from the application zone. Duplicate sets of charcoal vapor-collection tubes, attached to operating personal air-sampling pumps calibrated to 1.0 lpm, were fortified using a 10 ul syringe, at the following three rates: 0.986 ug, 98.6 ug, and 986 ug. Fortification was performed from the lowest rate to the highest rate to minimize the risk of contamination. A glass fiber filter and a drying tube were placed in front of each charcoal collection tube immediately after fortification. Samples were exposed to the environment for four hours, the duration of one sampling interval. At the end of the sampling period, pump flow rates were checked and recorded, the charcoal tubes were removed from the tubing, capped, labeled, and placed in an ice chest containing dry ice.

Average recoveries ranged from 80% to 120%. The minimum quantitative level was considered to be the lowest validated level of 1.0 ug.

Downwind sampling stations were established perpendicular to the prevailing northwest wind direction at 5, 25, 125, and 500 meters from the downwind edge of the application swath. Each station consisted of three T-posts and a high volume air sampling pump (SKC catalog number 228-501) connected by flexible tubing to two charcoal vapor collection tubes (400/200 mg, SKC catalog number 226-09). The charcoal tube was preceded by a silica gel drying tube (200/100 mg, SKC catalog number 226-10-06) and a plastic cassette containing a glass fiber filter and support pad; these were used to trap moisture and to screen out dust particles, respectively. The charcoal and silica gel tubes were placed inside a hollow plastic pipe to protect them from physical damage and hung from the T-posts at a height of 1.5 meters.

The pumps were set to operate at 1.0 liter per minute (lpm). The flow rate was checked with a Kurz Mass Flow Meter and recorded after attaching new charcoal tubes and again, prior to removing them. At the end of each sampling period, the charcoal vapor-collection tubes were removed from the tubing and their orifices capped.

B. Bystander/Residential Exposure

1. **Use Information provided by BEAD**

The solid set sprinkler chemigation method is primarily used for row crops and vegetables, including carrots, eggplant, and leafy vegetables. A grower can treat 10 to 15 acres in an 8-10 hrs-work day, using a stationary sprinkler. The range of hrs-day depends upon the amount of water that needs to be applied.

2. **Assumptions**

OREB's assumptions are the following:

Ventilation Rate (females): 0.81 m^3/hr (20 m^3/day) (adult, average; EPA 1989d)
Exposure Duration: 24 hrs or 1 day
Concentration: ug/m^3, indoor = outdoor
Inhalation Absorption: 100%
Female body weight: 60 kg

3. **Exposure Estimates and Sample Calculations**

The following table provides MITC exposure estimates to residents living downwind from the field.

Sample Calculation: Avg. Daily Exposures (500 meters)

(Sample Interval: 0-24): Bystander/Resident Exposure (mg/kg/day) =

$$\frac{(\text{inhal. conc. ug/m}^3) * (\text{Ventil. rate}) * (1\ \text{mg}/1000\ \text{ug}) * (\text{Exp.dur. hrs/day})}{60\ \text{kg}}$$

$$= \frac{(68.32\ \text{ug/m}^3) * (0.81\ \text{m}^3/\text{hr}) * (1\ \text{mg}/1000\ \text{ug}) * (24\ \text{hrs/day})}{60\ \text{kg}}$$

$$= 2.21 \times 10^{-2}\ \text{mg/kg/day}$$

TABLE 3: Bystander/Residential Exposure Estimates to MITC using Downwind Sampling Data

Sample Interval (hrs)	Soil Type	Distance (meters)	Inhal. Conc. Range (ug/m^3)	Inhal. Conc. Arith. Mean (ug/m^3)	Exposure (mg/kg/day) (females)
0-24	Loamy Sand	5.0	50.75-1254.50	564.88	183×10^{-3}
0-24	Loamy sand	25.0	38.25-1042.50	511.20	165.6×10^{-3}
0-24	Loamy sand	125.0	60.40-818.00	354.32	114.8×10^{-3}
0-24	Loamy sand	500.0	8.77-163.00	68.32	22.14×10^{-3}

IV. CONCLUSIONS/RECOMMENDATIONS

OREB has provided the exposure estimates for both the worker and residential population. The applicator estimates (MITC) for three out of the four types of application methods were high. It is worth noting that during the worker exposure study # 1, two out of the 10 applicator replicates during shank injection, were taken in a positive pressure charcoal filtration enclosed cab. The average daily exposures using those two replicates were lower by a factor of 5; However, in study # 2, five out of the 10 replicates were measured in a charcoal filtered enclosed cab; and, two out of five replicates provided lower exposure estimates. Although there is no Enclosed Cab Tractor Standard that requires manufacturers to meet certain performance criteria, at the present time; the use of this mitigation technique must be encouraged in the agricultural industry as it has the potential of reducing exposures to MITC.

The exposures for mixer/loaders were generally lower than those measured for the applicators. Since the loading is done through a somewhat closed system (dry break couplers), exposure to this worker is generally lower.

The Carbon disulfide exposures were lower than those measured for MITC.

The residential exposure estimates during solid set sprinkler injection method were provided for the following distances: 5, 25, 125, and 500 meters downwind. The exposure estimates decreased at each distance. Note that this application method was chosen since it represents the worst case scenario with respect to off site drift.

Attachments

cc: A. Mehta/OREB w/ attach. 7509C
J. Ellenberger/ARB w/ attach. 7508W
L. Engstrom/SRB w/ attach. 7508W
M. Iannou/Tox II 7509C
J. Housenger/SRB 7508W
A. Medici/OGC w/ attach. 2333R
S. Zavolta/BAB 7503W
K. Whitby/CCB w/ attach. 7509C
Chemical file
Correspondence
Circulation

X. APPENDIX

1. Metam Sodium Use Information from BEAD
2. RAW DATA for all Three Exposure Studies