Applied Occupational and Environmental Hygiene

ISSN: 1047-322X (Print) 1521-0898 (Online) Journal homepage: http://www.tandfonline.com/loi/uaoh20

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To cite this article: Dawn Tharr Column Editor , Minda Weldon , Mark M. Methner , Teresa Willis & Diana Salzman (1996) Case Studies: Acute Pesticide Poisoning Associated with Use of a Sulfotepp Fumigant in a Greenhouse, Applied Occupational and Environmental Hygiene, 11:9, 1105-1107, DOI: 10.1080/1047322X.1996.10389378

To link to this article: http://dx.doi.org/10.1080/1047322X.1996.10389378

Case Studies

Acute Pesticide Poisoning Associated with Use of a Sulfotepp Fumigant in a Greenhouse

Dawn Tharr, Column Editor

Reported by Minda Weldon, Mark M. Methner, Teresa Willis, and Diana Salzman

Background

On November 30, 1995, the Environmental and Occupational Epidemiology Program at the Texas Department of Health (TDH) received a fax from a poison center regarding a patient at an emergency medical facility in Texas with symptoms of acute pesticide poisoning. The patient was a pesticide applicator at a greenhouse and had applied sulfotepp fumigants (Plantfume 103 and Fulex) the previous night. Sulfotepp is an organophosphate pesticide and is a cholinesterase inhibitor.

Soon after the report was received, the 32-year-old male pesticide applicator was interviewed by telephone. The applicator stated he became ill after igniting Plantfume 103 and Fulex fumigant canisters in the first of four interconnected greenhouses where chrysanthemums, poinsettias, and other plants were raised for distribution to florists. Despite feeling ill and smelling the chemical, he and three other applicators completed fumigating all four greenhouses. He stated that his symptoms included headache, nausea, diarrhea, vomiting, cough, slight dizziness, sweating, fatigue, abdominal pain, anxiety, muscle aches, chest tightness, drowsiness, restlessness, shortness of breath, and excessive salivation. He did not go to the hospital until the following day when, still feeling ill, he was urged to do so by the greenhouse supervisor. Later review of his medical records indicated that, approximately 12 hours after exposure, his red blood cell cholinesterase level of 14,730 IU/L was within the normal range of 7700 to 17,500 IU/L. The applicator had no previously measured baseline cholinesterase level with which to compare these results. No other significant findings were noted in the medical record. He was released from the emergency department without treatment.

The individual stated he was a licensed pesticide applicator and had been employed at the greenhouse for 2 years. Although he had applied other fumigants in the past, this was the first time he had applied Plantfume 103 or Fulex. It was also the first time the greenhouse had used the product. He denied any direct contact with the chemical and during application wore personal protective equipment (PPE), including a full body suit, boots, gloves, and a full-face air-purifying respirator equipped with a pesticide prefilter. He had a qualitative (smoke) respirator fit test earlier in November, and no leaking was detected at that time. Another qualitative fit test was conducted after the incident, and the fit again appeared to be adequate.

Used interchangeably by the greenhouse, Plantfume 103 and Fulex are organophosphate insecticidal smoke fumigants containing 15 and 14 percent sulfotepp (tetraethylthiodiphosphate, CAS #3689-24-5), respectively. Both products have current U.S. Environmental Protection Agency (EPA) registrations. Sulfotepp, also marketed under the trade name Bladafum, has been previously marketed as Dithio, Dithione, and Thiotepp. Sulfotepp is classified as a "toxicity category 1" (highly poisonous) pesticide, with oral and dermal LD_{50} values of 10 and 65 mg/kg, respectively.[1] Sulfotepp is licensed for use as a greenhouse fumigant to control aphids, spider mites, thrips, and whiteflies. It is delivered to the greenhouse atmosphere via smoke particles generated by a combustible material that, when ignited, burns for a short time, fills the entire greenhouse, and settles onto all surfaces to form a residue that will effectively eradicate pests.[2] The chemical is desirable because of its efficacy, and the fact that it does not damage delicate foliage or flowers. It is one of the few chemicals that can be used on market-ready poinsettias.

Methods

On-Site Investigation

Because the applicator's symptoms were highly characteristic of organophosphate poisoning, and because he smelled the chemical during the application, it is likely that his illness was caused by exposure to the sulfotepp fumigant. Because the PPE he used during the application was the type indicated by the label instructions and therefore thought to provide adequate protection from the fumigant, and there was no other apparent explanation for exposure, a qualitative on-site investigation was conducted by two epidemiologists and an industrial hygienist from TDH and an industrial hygienist from the National Institute for Occupational Safety and Health (NIOSH). The objectives of the field investigation were to interview the other applicators, to inspect PPE used by the applicators, to observe the preparation for and application of the pesticide, and to evaluate the workers' adherence to label instructions and safety procedures.

Telephone Survey

Upon conclusion of the investigation, we became concerned that the situation experienced at this greenhouse might represent a larger problem. When the product distributor and the formulators were consulted, neither stated having received any reports of illness related to these products; however, neither had a formal system for reporting problems or illnesses. Between 1985 and 1992, the EPA received 23 reports of illness in persons occupationally exposed to sulfotepp.[3] Of these 70 percent were referred to healthcare facilities and 7 percent were hospitalized. To better assess how frequently greenhouse pesticide fumigants are used and if other applicators have experienced related health problems, TDH conducted a brief telephone survey of greenhouse operators in Texas.

Results

On-Site Investigation

On December 3, the investigators were met at the greenhouse by the greenhouse supervisor and toured the facility, which consisted of four interconnected greenhouses totaling 2,192,920 ft^3. The greenhouses were very neat and clean. The laboratory area, used for storage of PPE and chemicals, was free of debris and grime, and all products were clearly labeled. Since the purpose of the visit was to gather information and evaluate the application process, no chemical sampling (air/dermal) was performed.

The greenhouse supervisor stated that sulfotepp was being used to control a whitefly infestation. Usually he controls such infestations using other methods and chemicals; however, the poinsettias were in full color and scheduled to go to market in several days. Sulfotepp was the only chemical that would contain the problem and not damage the plants. Two applications 4 days apart were necessary.

The same four applicators who applied the fumigant previously were asked to demonstrate how they prepare for and conduct this type of pesticide application. They were also questioned on the type and severity of symptoms they experienced after the application. In addition to the sentinel applicator, two other applicators stated that they detected the odor of the chemical and felt nauseated; however, they did not vomit and did not seek medical care. The fourth applicator, a cigarette smoker, did not smell the chemical and did not feel ill.

In an effort to qualitatively evaluate the application procedure, the following was observed: late in the workday, an applicator set out the unopened canisters of Plantfume 103 and Fulex in a gridlike fashion within each greenhouse. In accordance with the label instructions, a total of 80 canisters were set out (1 canister/20,000 ft^3). After the other greenhouse workers left for the day, the internal air circulation system and the exhaust ventilation system were turned off. (The internal air circulation system had not been turned off during a previous application because the applicators mistakenly thought the instructions stated to leave it on.) While the other applicators were preparing the facility, the greenhouse supervisor inspected all PPE to be used in the application. All appeared to be appropriate and in good condition. All PPE was also inspected by the investigators and appeared to be appropriately handled, maintained, and stored. The applicators then outfitted themselves with the following PPE: Tyvek Saranex 23-P laminated full-body coverall suit with hood, rubber boots, nitrile gloves, and a full-face air-purifying respirator (North) equipped with a pesticide prefilter (#TC-23C-74, North) and an organic vapor cartridge (#TC-23C-204, North). Wrist and ankle openings were sealed with duct tape.

The four men then ignited the canisters by puncturing the top of each canister on opposite sides with the manufacturer-supplied can opener, lighting an ignitor (a slow-burning metallic wand similar to a sparkler) with a propane torch, and inserting one ignitor into each canister. It was noted that smoke was emitted from an ignited canister after a few seconds. The workers ignited the canisters sequentially as they backed out of each greenhouse in an attempt to avoid the smoke. However, these efforts proved futile due to the quick generation of smoke by each canister. After the final canister was ignited, the workers moved to a shipping area not being treated with the fumigant, removed their PPE, and left the facility. The total time necessary to complete the application was approximately 45 minutes.

It appeared that all product label instructions were followed. Nonetheless, the sentinel applicator again became ill, although his symptoms were less severe. Three of the four workers smelled the chemical, although it was less noticeable than during the previous application.

Greenhouse Telephone Survey

To estimate the frequency of fumigant use in general and sulfotepp in particular, and their effect on workers' health, investigators conducted a telephone survey. 413 Texas companies listed under Standard Industrial Classification (SIC) code 5193 (nursery stock for florists), the same SIC code as the greenhouse, were contacted. Many companies handled only artificial products or imported precut flowers. They were not asked to participate in the survey. Only 53 companies had greenhouses in which live plants were raised. All 53 companies responded to the survey questions. Forty-three (81%) reported ever using fumigants, and 30 (70%) of these had used Plantfume 103 or Fulex. Of the 43 companies using any type of fumigant, 33 (77%) stated that respirators were used during fumigant application, and 5 used supplied-air type respirators. Three companies were aware that workers had become ill during fumigant application, but none of the workers sought medical care for their illness. Workers at two of the three companies became ill despite wearing all label-advised PPE during the fumigant application. Ill workers at the third company used no PPE during the application.

Conclusions

Both the Plantfume 103 and Fulex label instructions state that applicators and other handlers must wear a "respirator with either an organic vapor-removing cartridge with a prefilter approved for pesticides [Mine Safety and Health Association (MSHA)/NIOSH approval prefix TC-23C] or a canister approved for pesticides (MSHA/NIOSH approval number TC-14G)."[4,5] Equipment meeting these criteria was used in this case, yet workers still became ill. Since there was no evidence of oral or dermal contact with the chemical, and since the workers smelled the chemical, it appears that the workers were exposed by inhalation.

There are several factors that may explain why the workers inhaled toxic doses of sulfotepp despite utilizing the label-recommended respiratory protection. First, fumigation typically results in a high ambient concentration of the chemical. Such a high concentration may exceed the assigned protection factor for the respirator. Since there is no established short-term exposure limit for sulfotepp, and we did not attempt to quantify the airborne concentration of sulfotepp, we cannot make this determination. Second, an organic vapor cartridge may not capture all organic vapors with equal efficiency, and a high vapor concentration may quickly exhaust the sorbent capacity of the cartridge. Third, the chemical was applied as a smoke, yet neither the cartridge nor the prefilter was rated for smoke. Smoke particles are very small and may have passed through the filters. The mean particle size for Plantfume 103 and Fulex is not known.

After checking with several respirator/cartridge manufacturers and other technical information sources, we have been

unable to locate a respirator cartridge and prefilter or canister that protects against pesticide fumigants. Despite respiratory equipment being labeled "for use with pesticides," such cartridges, prefilters, and canisters may not be appropriate for use with fumigants and therefore not for use with pesticide fumigants. Recently, NIOSH has acknowledged that a single type of filter may not be appropriate for all types and forms of pesticides. As a result, in July 1995, NIOSH discontinued certifying cartridges specifically for use with pesticides.

While inadequate respiratory protection was the most serious problem noted, several other factors may have contributed to the applicator's exposure. The technique employed in igniting the canisters was time consuming and possibly resulted in applicators spending additional time in the greenhouse while it was filling with fumigant. Also, the internal air circulation system was operating during a previous application. This may have contributed to the rapid dispersion of the fumigant throughout the greenhouse, and may explain the sentinel applicator's more severe symptoms and the stronger odor noted by the other applicators.

Finally, results of the greenhouse survey indicate that many greenhouses use fumigants, and that most use only a respirator for respiratory protection.

Recommendations

As a result of this investigation, TDH and NIOSH have recommended to the EPA that Plantfume 103 and Fulex labels be amended to indicate the appropriate respiratory protection (supplied air). Label instructions for other pesticide fumigants may also need to be reviewed for appropriateness. In addition, advertising material and labels for pesticide prefilters, cartridges, and canisters should clearly state "not for use with fumigants." The warning should also appear on the items themselves. Furthermore, organizations such as the EPA and TDA, which provide information to pesticide applicators, should endeavor to educate workers and provide printed materials on the safe use of fumigants. It is also recommended that licensure requirements for greenhouse pesticide applicators include training on the proper use of fumigants. Finally, the application procedure should be made as efficient as possible to reduce exposure to the pesticide. For example, canisters should be punctured prior to setting them out in the greenhouse and an unlit ignitor should be left next to each canister. When beginning the application process, each canister should be ignited as quickly as possible. Workers should not spend unnecessary time in the greenhouse while the smoke is being produced. Workers should not carry ignited canisters or attempt to talk to other workers during the application. Finally, increasing the number of workers igniting the canisters would reduce the time spent in the greenhouse by any one worker after the smoke generation begins.

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