12-1980

Insect Control in Farm Stored Grain

Cooperative Extension South Dakota State University

Follow this and additional works at: https://openprairie.sdstate.edu/extension_circ

Recommended Citation
South Dakota State University, Cooperative Extension, "Insect Control in Farm Stored Grain" (1980). SDSU Extension Circulars. 896.
https://openprairie.sdstate.edu/extension_circ/896

This Circular is brought to you for free and open access by the SDSU Extension at Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange. It has been accepted for inclusion in SDSU Extension Circulars by an authorized administrator of Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange. For more information, please contact michael.biondo@sdstate.edu.
Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.
Fumigation is an expensive and very dangerous method of controlling insect problems. Preventative measures taken earlier can help prevent or limit infestations, and are easier and less expensive methods of control. Use the preventative measures discussed in the preceding Farm Stored Grain section of this booklet to reduce infestation risks, and the possible need to fumigate. However, there may come a time when fumigation is necessary as the only practical method of control. When it does, it should be approached with great caution, and only by certified applicators.

Private vs Commercial Applicators

Farmers have the choice of either doing it themselves, or hiring a commercial applicator. However, it is usually less expensive and more effective to hire a commercial fumigation company, particularly with quantities of over 10,000 bushels. This is so because the cost is normally figured on a per bushel basis, and includes the expense of necessary application equipment and safety equipment, in addition to the fumigants, and your time, labor and training.

Fumigation

Before the fumigator begins, he first checks the condition of the grain, its intended use, the type of bin structure, and the pest to be controlled. These factors will determine the type and amount of fumigant to be applied.

There are many varieties of fumigants on the market from which to choose (Figure 2). Available in liquid, gas, and solid forms, all fumigants must become a gas to be effective. All are poisonous—toxic to humans and other warm-blooded animals—as well as to insects and other pests. Some fumigants are highly explosive, and corrosive. Others may injure seed germination or reduce milling quality. And if not properly used, fumigants may leave undesirable chemical residues.

Fumigants: Liquid, Gas, Solid

Liquid Liquid formulations usually contain a mixture of two or more compounds. Carbon Tetrachloride is commonly mixed with ethylene dichloride, ethylene dibromide, and/or carbon disulfide. However, carbon disulfide is highly explosive and flammable and should not be used alone. Tear gas or sulfur dioxide are sometimes added to these combinations as warning agents, to prevent accidental exposure from undetected leaks in the bin structure or your safety mask. Because they are heavier than air, liquid fumigants are usually sprayed on the surface. As it vaporizes, it settles down through the grain to the bottom of the holding structure.

Gas Gaseous fumigants are usually released from pressurized containers into the grain mass. Some are extremely hazardous, and require special equipment and precautions in handling.

Methyl bromide is one of the more commonly used gaseous fumigants currently on the market. While it probably is not necessary to actually wear a safety mask during the introduction of this gas (if the cylinders and applicators are outdoors), a mask should be readily available. Aprons should be worn to protect against any liquid methyl bromide. Gloves, including rubber gloves, should not be worn. Any liquid methyl bromide trapped in the gloves will cause a burn. Protective clothing or safety devices made of rubber should not be exposed to methyl bromide. The rubber will absorb the gas during exposure and slowly release it after—into your skin or lungs if you are close or in contact with it. Also, repeated exposure to low doses will accumulate in body tissue. If methyl bromide should be spilled on shoes or other clothing take them off. Methyl bromide trapped in shoes and clothing will cause serious blistering.

In checking for leaks, you will have no trouble finding them with odorized formulations. But with non-odorized formulations it is essential to check for leaks with a halide gas detector. With this device, a flame heats a copper ring. Methyl bromide, and fluoride, chlorine, and freon gasses passing over the heated ring will be colored. The depth of color will depend upon the gas concentration. A very light green indicates a low gas concentration, while a royal blue color indicates a high gas concentration. Repair all leaks immediately when found. Applications of these gasses should be done only by
experienced applicators equipped to handle these materials.

Solid

Solid fumigants, in pellet or tablet form, are strategically placed in the grain mass, and are activated by moisture in the air. Atmospheric moisture reacts with these, such as Phostoxin which releases highly toxic phosphene gas, or hydrogen phosphide, the active ingredient. This and other solid fumigants are designed to release gases at moisture levels normally found in air. Water from rain or accidental spills will trigger violent reactions that make these pellets or tablets explosive.

Hydrogen phosphide does not accumulate within body tissues in the same manner as methyl bromide. Any gas entering the body will be completely eliminated within 48 hours. Hydrogen phosphide is very toxic to humans. The threshold limit is only 0.35 ppm. Mathematically, this would indicate that the gas is about 60 times as toxic as methyl bromide. However, because of the manner in which hydrogen phosphide is liberated, because of the ease with which the gas is contained by fumigation films, and because of the odor characteristics, the gas is far safer to handle than methyl bromide. This is a prime example of a highly toxic material with low user hazard. As the formulated aluminum phosphide does not start to break down and liberate hydrogen phosphide for one to two hours after introduction into the fumigation facility, respirators are usually not needed during fumigation introduction. Nevertheless, respiratory protection must be immediately available. If the respiratory protection consists of safety masks, they should be equipped with yellow canisters having a gray stripe around them. Rubber gloves must be worn when handling either the aluminum phosphide, or the residue that remains following fumigation.

Again, fumigants are very dangerous and should be applied by experienced applicators thoroughly familiar with their proper use.

Dosage

Whatever the type of fumigating material you choose, follow label instructions and re-

Figure 2. Characteristics of several grain fumigants.

<table>
<thead>
<tr>
<th>Fumigant</th>
<th>Heavier than air</th>
<th>Grain penetration</th>
<th>Flammability</th>
<th>Warning odor</th>
<th>Germination effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbon disulfide</td>
<td>Yes</td>
<td>Good</td>
<td>High</td>
<td>Rotten egg</td>
<td>Depresses</td>
</tr>
<tr>
<td>carbon tetrachloride</td>
<td>Yes</td>
<td>Poor</td>
<td>None</td>
<td>Pungent odor</td>
<td>Depresses</td>
</tr>
<tr>
<td>ethylene dibromide</td>
<td>Yes</td>
<td>Poor</td>
<td>None</td>
<td>Sweet odor</td>
<td>Depresses</td>
</tr>
<tr>
<td>ethylene dichloride</td>
<td>Yes</td>
<td>Good</td>
<td>High</td>
<td>Ether odor</td>
<td>Little</td>
</tr>
<tr>
<td>chloropicrin</td>
<td>Yes</td>
<td>Good</td>
<td>None</td>
<td>Tear gas</td>
<td>Depresses</td>
</tr>
<tr>
<td>sulfur dioxide</td>
<td>Yes</td>
<td>---</td>
<td>None</td>
<td>Irritating, sulfur</td>
<td>Destroys</td>
</tr>
<tr>
<td>methyl bromide</td>
<td>Yes</td>
<td>Good</td>
<td>Little</td>
<td>None</td>
<td>Depresses</td>
</tr>
<tr>
<td>aluminum phosphide</td>
<td>Slightly</td>
<td>Good</td>
<td>In Presence Of Moisture</td>
<td>Carbide-like</td>
<td>None</td>
</tr>
</tbody>
</table>
commendations for determining the safe and proper dosage for your needs.

Some of the factors that must be considered for establishing the fumigant dosage are: the types and sizes of the bins, their relative structural tightness, the condition of the grain, the amount of dockage and other foreign matter, the grain moisture level, moisture condensation, grain temperature, insect crusting or other damage that may affect results, etc. It is essential that the proper dosage is determined and applied for two reasons. First, insufficient fumigation will bring poor results requiring the entire fumigation process to be repeated, at additional expense and risk. Second, fumigation overdose increases the risks and hazards for the applicators, could possibly damage the grain, and adds to fumigation costs.

Bin Preparation

Before applying any fumigant, the grain and its bin structure must be prepared to insure an effective treatment of your pest problem. Most new metal storage bins require little preparation

Figure 3.

<table>
<thead>
<tr>
<th>Atmospheric contaminants to be protected against</th>
<th>Colors assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid gases</td>
<td>White</td>
</tr>
<tr>
<td>Hydrocyanic acid gas</td>
<td>White with ½-inch green stripe completely around the canister near the bottom.</td>
</tr>
<tr>
<td>Chlorine gas</td>
<td>White with ½-inch yellow stripe completely around the canister near the bottom.</td>
</tr>
<tr>
<td>Organic vapors</td>
<td>Black</td>
</tr>
<tr>
<td>Ammonia gas</td>
<td>Green</td>
</tr>
<tr>
<td>Acid gases and ammonia gas</td>
<td>Green with ½-inch white stripe completely around the canister near the bottom.</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>Blue</td>
</tr>
<tr>
<td>Acid gases and organic vapors</td>
<td>Yellow</td>
</tr>
<tr>
<td>Hydrocyanic acid gas and chloropicrin vapor</td>
<td>Yellow with ½-inch blue stripe completely around the canister near the bottom.</td>
</tr>
<tr>
<td>Acid gases, organic vapors, and ammonia gases</td>
<td>Brown</td>
</tr>
<tr>
<td>Radioactive materials, excepting tritium and noble gases</td>
<td>Purple (Magenta).</td>
</tr>
<tr>
<td>Particulates (dusts, fumes, mists, fogs, or smokes) in combination with any of the above gases or vapors</td>
<td>Canister color for contaminant, as designated above, with ½-inch gray stripe completely around the canister near the top.</td>
</tr>
<tr>
<td>All of the above atmospheric contaminants</td>
<td>Red with ½-inch gray stripe completely around the canister near the top.</td>
</tr>
</tbody>
</table>

Note: Orange shall be used as a complete body, or strip color to represent gases not included in this table. The user will need to refer to the canister label to determine the degree of protection the canister will afford.
to make them gas-tight. However, wood bins allow an excessive amount of fumigant to escape because of their porous structure. Dosages are often doubled for these, and sometimes a gas-tight tarpaulin is required to retain the fumigant for a sufficient length of time. Then level the grain for even penetration.

After sealing the structure, spray the outside of the bin with a residual pesticide to kill insects forced out by the fumigant. Also, remove old grain lying around the bin. Insects from here could quickly reinfest the grain after the fumigant disappears.

Just prior to application, make sure gas and electrical connections are turned off. Never fumigate alone. Always have someone else with you properly fitted with safety equipment to help if you should get into trouble.

Follow label instructions, apply liquid fumigants in a course, even spray. Avoid getting them on your skin or clothing. If this should happen, remove the wetted clothing at once and wash your skin thoroughly with soap and water.

Application

Stay on the outside of the bin if at all possible when spraying. With large volumes of grain, use power equipment and diaphragm or brass gear pumps with a nozzle that disperses the liquid in an even, course spray.

Bins with grain deeper than 10-12 feet may require both liquid and solid fumigants for best results. Since liquid forms settle to the bottom quickly, the top 2-3 feet may not be exposed long enough for good control. To prevent this, probe solid pellets or tablets throughout the top 2-5 feet, then spray the required dosage of your liquid fumigant.

As soon as the chemicals have been applied, close and seal the bin. Keep it closed for recommended exposure times. Post signs at all entrances warning that the bin contains poisonous fumigants. List these fumigants, and provide the name, address, and phone number of a responsible person to contact in case of an emergency.

After the recommended time, the bin may be opened and aired, then topdressed with recommended grain protectants. Make certain the bin is completely aired before using the grain for feed, or placing it on the market.

Safety Masks

Canister type masks, regardless of make, can only be worn safely in relatively low concentrations of gas and in atmospheres where a flame safety lamp will burn. Suitable canisters of proper design will ordinarily afford protection for limited periods in concentrations well above the levels imposed by manufacturers. Of course, the manufacturers must reckon with widely varying gas and temperature conditions and a highly uncertain human equation. Nevertheless, the aforementioned precautions, with many others, add up to a very uncertain degree of protection. Moreover, the precautions given above are expressed in terms which cannot be translated or measured in a practical sense. For example, how can you tell whether oxygen content is below 16% before you're in trouble? What is a 2% gas concentration? How do you measure it?

Devices for measuring gas concentrations are generally impractical or unsafe for use inside storage units. Even if their use were feasible, their findings would be virtually meaningless from a standpoint of practical safety because of high variation and rapid changes in concentrations from one point to another.

A mask is useful for protection in galleries, bin floors and other locations where some degree of ventilation will dissipate limited volumes of gas. It may be used for relief from discomfort or uncertainty in prolonged exposure to low concentrations. But it should not be relied on for entry or descent into confined, inaccessible locations of unknown concentration, or any area away from quick escape to fresh air. Probably more fumigation fatalities have occurred where the victims were wearing safety masks than otherwise. Therefore, you can trust a safety mask—but not too far.

The same restrictions apply with equal emphasis to self-contained (air tank) breathing apparatus and to masks equipped with canisters for generating oxygen—activated by the moisture of the breath. Without special training many people have difficulty regulating their breathing with the latter device—especially under exertion.

Such devices are reliably manufactured and, when used with proper training and discipline, ordinarily work well. They are well suited to emergencies, such as rescue work. But considering their time limitations (15 to 50 minutes) and the possible consequences of their malfunctioning, together with the chance of miscalculation by untrained users, their regular employment in routine flat storage fumigation is an unwarranted hazard to personnel. There are too many things that can go wrong to justify placing absolute reliance on vulnerable safety
devices. Besides, the potential sorptive and desiccant action on the skin of combined high concentrations and high temperatures has not been adequately studied for the various fumigant mixtures. Yet, such special equipment encourages working under more severe conditions than would otherwise be contemplated.

Therefore, keep all personnel out of flat storage units—with or without safety equipment—during and after fumigation. If available vents or openings will not permit reaching all parts of the grain surface with pressure equipment, study the feasibility of seeking authorization to cut additional openings. Do not permit application from "just inside" openings or vantage points when previous experience or forethought can predict the probability of high concentrations being dispelled by vapor pressure from such openings.

Common experience in flat storage fumigation shows a pattern of gradual build-up of massive concentration. Then, hourly increases in temperature under the roof expand this large volume of gas until a high concentration issues from every available opening.

This often necessitates safety mask protection for a person spraying through a vent. There have been many instances when such concentrations have exceeded or exhausted the protective capacity of canisters. If this can happen in the open air, one can imagine the chances for a person relying on safety mask protection if he were inside on the grain.

When you need to use safety mask protection for any fumigation job, be certain to identify the composition of all fumigants you will be using from the labels, and seek authoritative advice on the proper type of canister to use (see figure 3).

Then read and carefully consider all precautionary advice accompanying the mask and canister. And anticipate canister exhaustion rather than trying to rely on sensory warnings. Change canisters for any extended exposure.

Safe Fumigant Use

The principal dangers in the use of grain fumigants concern the hazards of application. These include risk of asphyxiation from either rapid or accumulative effects of highly toxic fumigants, or similar consequences from overexposure to the less toxic fumigants, as when a man enters a flat storage unit to fumigate and exposes himself either to an immediate gas concentration, or to a gradual build-up of such over a period of time.

The second category concerns hazards involved in entering elevator bins, country elevator pits, or flat storage units following fumigation, or in handling treated grain, especially where the fumigant used was either highly toxic or of such low volatility as to be strongly persistent on the grain, or both.

Transferring such grain in poorly ventilated basements or tunnels, or shoveling such grain in bin bottoms, ship holds or box cars have led to many incidents involving dizziness, illness and unconsciousness, with hospitalization in some cases.

Generally speaking, these various effects have been produced by the highly toxic fumigants rather than by those of lower toxicity. But no fumigant which will kill insects is without potential danger to man.

The chief precautions for using a fumigant of this type in conventional elevator treating, where bins (of ordinary size) may be treated selectively as need arises, are to refrain from entering bins to apply fumigant; to avoid more than momentary exposure to any appreciable concentration of vapors; and to use a mask to prevent any discomfort from fumes.

With reasonable ventilation, application of the smaller portions of dosage typical in the standard layer method is often made without a mask by taking advantage of favorable air currents. But where ample ventilation is lacking, as in areas away from windows and in narrow passages where a tripper or conveyor spout creates close quarters or, again, where two-phase or top treating requires continuous application for several minutes at a time, wearing a mask is a "must". This is not only for safety, but also in order that a man can do a proper job of application. He may otherwise resort to hurried or faulty procedure in his desire to avoid undue exposure to fumes.

The major interest in safe use of fumigants concerns flat storage fumigation, both during and after application and, in most instances, long after the lapse of the exposure period, especially when cool or cold grain (which has therefore retained a strong residual concentration) is first pulled for transfer or loading, requiring presence of personnel in the bin. Under such conditions gas, desorbing from the grain may concentrate dangerously in a funneling crater or other low spot, displacing the air.

Regarding safe practice in treating flat storage units, there is only one safe rule, namely, to
apply the fumigant from outside—generally from roof vents, temperature terminal inlets, ventilators, probe holes or other openings. Over the years there have been exceptions to this rule, often on individual initiative with the conscientious motive of getting the job done. However, in view of increasing knowledge of the potential hazards under widely varying conditions of temperature and gas behavior and the limitations of masks and other safety equipment, regardless of type, one cannot justify risking human life or health in grain fumigation by recommending or endorsing entry inside a flat storage bin to make application.

**Accidents**

All materials used as fumigants are volatile, penetrating and toxic chemicals by the very nature of the job the fumigant is expected to do—kill pests. If the fumigants are not used with proper precautions, the fumigants can poison human beings before, during and after the fumigation process. However, if proper care is exercised, the fumigation process is no more hazardous than other industrial processes using potentially harmful chemicals or products.

Man is affected when the fumigant is inhaled, ingested or absorbed.

The following general instructions apply to inhalation or spilling accidents and are suggested for fumigants in common use. The general instructions are taken from pertinent sections of first aid recommendations for poisoning published by the Committee on Toxicology, American Medical Association.

First aid must be started at once. If possible, one person should begin treatment while another calls a physician. When this is not possible, the nature of the poison will determine whether to call a physician first or begin first-aid measures and then notify a physician. Measures to be taken before arrival of a physician:

**Inhaled poisons**
1. Carry patient (do not let him walk) to fresh air immediately.
2. Open all doors and windows.
3. Loosen all tight clothing.
4. Apply artificial respiration if breathing has stopped or is irregular.
5. Prevent chilling (wrap patient in blankets).
6. Keep patient as quiet as possible.
7. If patient is convulsing, keep him in bed in semidark room; avoid jarring or noise.
8. Do not give alcohol in any form.

**Skin contamination**
1. Drench skin with water (shower, hose, faucet).
2. Apply stream of water on skin while removing clothing.
3. Cleanse skin thoroughly with water; rapidity in washing is most important in reducing extent of injury.

**Eye contamination**
1. Hold eyelids open, wash eyes with gentle stream of running water immediately. Delay of a few seconds increases extent of injury.
2. Continue washing until physician arrives.
3. Do not use chemicals; they may increase extent of injury.

**Conclusion**

Since fumigation is a costly and very dangerous method of controlling insect problems, it should be used with great caution, and only when necessary.

Prevention is still the best and least expensive method of control. Yet, in spite of your best efforts at prevention there very likely may come a time when you will need to fumigate. When it does, follow the guidelines outlined in your fumigation booklet, use proper safety equipment and procedures, and read and follow label instruction for safer and more effective fumigation results.