Alternatives to Chemical Fumigation

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Chapter 3: ALTERNATIVES TO CHEMICAL FUMIGATION

**Learning Objectives:**

♦ Give three advantages for using alternatives to chemical fumigants.

♦ List three disadvantages of using alternatives to chemical fumigants.

♦ Be able to demonstrate whether alternative is cost-effective and will work for you.

♦ List the disadvantages of using carbon dioxide, fossil dusts, and Bt.

Several alternatives to chemical fumigants on the market will aid in keeping stored grain from being labeled as “infested.” While some of these alternatives have been around for years, several are relatively new for use against stored grain insects. Regardless of which solution is chosen as a tool to handle insects in grain, most of these alternatives to fumigants are effective only when used as a preventive measure for infestation and not as a solution to an existing problem.

**Carbon Dioxide**

The carbon dioxide (CO₂) that is used in Minnesota as a fumigant is the same compound that is in the air that surrounds us. Just as with human the CO₂ that is in the air is inhaled and exhaled by the insects that live in and harm stored grain. And just as with human beings, too much carbon dioxide and not enough oxygen will kill stored grain insects. But to make this happen, the content of CO₂ in the bin or storage building where the grain is kept, must be increased greatly from the normal levels in the air, which is usually about .0004%, to 40-60% of the air volume.

Anyone who has ever been inside a bin with the doors and hatches closed, quickly realizes that there is light pouring in from many different cracks and vents, some of which are there by design to aid in the circulation of air needed for aeration equipment. But these same cracks, vents, and leaks are places where carbon dioxide can easily leak out. For CO₂ to work as a fumigant, not only must the structure be made airtight, but there must also be a way out for the air that is displaced by the carbon dioxide so that the air can reach the 40-60% CO₂ content necessary for kill. This is why carbon dioxide fumigation is usually done in a commercial grain storage facility designed for “closed-loop fumigation” (air exchangers designed to remove air and introduce a fumigant that can be recirculated through the structure).
Even though CO$_2$ does not leave a residue on stored grain, there are concerns that it will change the flavor of commodities made from that grain. Usually this concern is limited to the fumigation of vegetables, but farmers should contact their grain elevator or the end user, especially when shipping malting barley or other porous grains, to find out if there is any limitation to fumigating the grain with CO$_2$.

Although fumigating with CO$_2$ is safer than with other chemical fumigants, due to its cost, bulk, difficulty in sealing bins and buildings, and the required breathing apparatus needed for reentry into the structure during fumigation, Minnesota farmers are encouraged to leave CO$_2$ fumigation to professional fumigators. Farmers who are considering fumigating with CO$_2$ should keep these factors in mind:

- All bins or buildings in which carbon dioxide is going to be used should be checked for airtightness, and all leaks need to be completely sealed; otherwise CO$_2$ fumigation will just be a waste of money. Several companies now market smoke canisters that can be discharged inside the bin to aid in finding leaks.
- **If anyone reenters a structure that contains levels of CO$_2$ higher than 5% of the air, a SCBA (self-contained breathing apparatus) must be worn!**
- **No canister gas mask works for CO$_2$!**
- CO$_2$ generally comes packaged as a compressed gas in canisters. Every precaution should be taken with CO$_2$ canisters that would be taken with any other compressed gas.
- The availability of carbon dioxide must be taken into consideration, as well as the costs of CO$_2$, the costs of all related safety equipment, and the time and effort needed to make all structures airtight.
- **CO$_2$ is a restricted use pesticide (RUP) in Minnesota.** Farmers must first possess a Private Pesticide Applicator’s Certification, then pass the Private Fumigation Endorsement exam to be able to buy CO$_2$. 

![Image of person handling CO2 canisters](image.jpg)
Fossil Dust

“Fossil dust”, also called diatomaceous earth, is simply the crushed fossilized skeletons of various animals, which are found and mined from sedimentary layers of the earth. These fossils produce a very fine and very abrasive dust when crushed. The idea behind the use of fossil dusts in stored grain is that the sharp edges of the dust will scratch the hard outer shells and/or membrane of the insect, causing death by dehydration. This has proven to be an effective non-chemical way to kill stored grain insects especially for organic farmers, but it also has some notable drawbacks.

Fossil dusts are relatively expensive and mixing them with the grain is usually cost-prohibitive. Layering the fossil dusts throughout the grain mass to make barriers that the insects must crawl through to move about in the grain may be effective, but studies and information on how best to do this and what the kill ratios would be are limited. Diatomaceous earth is most effective when used as a top-dressing for preventing insects from entering through the top of the grain mass, but it is less effective for those insects that are either already inside the empty structure before grain is added, or come in through the grain floor or aeration ducts. To combat entry through the floor or the cracks between the floor and the bin wall, it has been suggested that a layer of fossil dust be placed on the floor before the grain is added.

There may also be some problems with selling grain that has been treated with fossil dusts, as some end-users will not take delivery if dust is visible on the kernels. One concern for farmers is the very dusty environment that is created when grain containing diatomaceous earth is moved. Ordinary grain masks help in limiting irritation from these dusts. Another concern is the increased wear and tear upon grain handling equipment. Fossil dusts are not only a wonderful tool for scratching the shells of insects, they also scratch and wear down metal quite rapidly. Any farmer who is considering the use of diatomaceous earth should first carefully research its cost, usage instructions, and limitations.

Bacillus thuringiensis

Bacillus thuringiensis, or “Bt” as it is commonly called, is a bacterium that produces an endotoxin that is poisonous to surface-feeding caterpillars. In order for a top-dressing of Bt to be effective, the caterpillars must eat the grain laced with Bt. Bt has several large disadvantages to being used as an alternative to chemical fumigants. The first and most important disadvantage is that Bt will not kill the weevils, lesser grain borer, or any of the secondary grain pests. The second disadvantage is that there may be marketing concerns tied to the use of Bt when selling to organic or natural food buyers. Farmers should always be aware that they may have to give an exact accounting for any product used on stored grain, chemical or otherwise, and keep records.

“Fossil dusts... scratch and wear down metal quite rapidly.”
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accordingly. The latest major concern is the growing tolerance or resistance some insects are developing to Bt. Farmers will need to closely monitor these developments because the effectiveness of Bt against insect infestations may be reduced in the future.

**Protectant Insecticides**

“Protectant insecticides” is a term that includes both Bt (*Bacillus thuringiensis*) and fossil dusts (*diatomaceous earth*), but most farmers only associate the term with chemical insecticides with trade names such as “Reldan” and “Actellic.” The term “protectant insecticides” will be used here as meaning only those chemical treatments used for top-dressings and uniform applications to kill stored grain insects. The term “protectant” goes into the title for a very important reason; these chemicals protect against infestation. Their use is quite limited after an infestation has already started. Although protectants leave a residue on the grain that can kill for up to a year, they are contact poisons and only kill when the insect comes into contact with them. So if there is not uniform incorporation throughout the entire grain mass (or “admixture”), and stored grain insects find their way into the structure, an infestation may occur.

There are three major chemicals that are used as stored grain protectant insecticides: Chlorpyrifos-methyl (Reldan®), pirimiphos-methyl (Actellic®), and synergized pyrethrins. Reldan and Actellic are effective in killing the Indianmeal moth, the weevils, and other beetles, but can be used as a top dressing only if the grain will be stored for a short period (up to one month). If the grain will be stored for up to a year, these chemicals must be admixed with the grain mass for residual effectiveness. There are several ways in which this can be done. A gravity flow applicator can be used to steadily apply, by dripping or dusting the insecticide on the grain stream (moving grain), when the grain is being dumped from the truck into the auger hopper. Applicating tanks may also be purchased that can be pressurized after the insecticide is mixed inside and provide a positive pressure stream/spray to the moving grain. Farmers may either choose to buy these devices on the market or devise one of their own. Either way, calibrating these devices to apply the correct amount of insecticide onto the grain is of key importance.

Synergized pyrethrins, which come with various trade names, are usually shipped in foggers or spray cans, and are particularly effective in killing insects that are in the head space of a bin or storage building. They will not leave a residue adequate for an extended kill-time. Synergized pyrethrins are almost never incorporated into the grain mass because of their lack of residual control.
Little Gus applicator for applying liquid protectant insecticides as the grain is being augered into the bin.

Note: Malathion can only be used on stored grain if it is in a 6% dust formulation. Check label for the effectiveness of kill on the infesting insects and the grain on which it can be used. Because of resistance and other problems associated with Malathion, it is not recommended for use with stored grain in Minnesota.

The following things are important to consider when using protectant insecticides:

• NEVER apply a protectant insecticide to grain that will be heat dried! **ALWAYS apply protectants after drying!**

• Always read the label, so legal rates are not exceeded.

• **Protectant insecticides cannot be used on all grains!** Read the label to be sure which grains can be safely and legally treated.

References