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Insect Control For Farm-Stored Grain



On-farm storage facilities give the producer some advantages in marketing grain crops. However, when the crop is moved to market, top prices will be based on clean, dry, wholesome grain and any factor that lowers the quality of the grain will also lower the price. One of these factors is insects. Insects affect both the quality and quantity of stored grain. They can (1) cause heating, (2) lower germination of seeds, (3) destroy food value, (4) reduce grain weight, and (5) lower grade.

Stored-grain pests may be either beetles or moths. Examples of the beetles are granary weevils, maize weevils, or rice weevils. These weevils are small chestnut-brown or black beetles with long slender snouts. Maize and rice weevils have four light-reddish or yellow spots on the back. The females of these insects will eat a small hole in the grain kernel. An egg is laid in the hole and covered with a gelatinous fluid. The egg hatches and the larva completes its development within the kernel.



Granary weevil

3.5 mm I



Maize weevil

3 mm I



Rice weevil

2.5 mm I

An example of a moth pest in this group is the Angoumois grain moth which is a small buff or yellowish brown colored moth. Eggs are laid on the surface of stored grain. After hatching, the larva will bore into the kernel and feed on the endosperm until development is complete.



Angoumois grain moth 16 mm

Protection Guidelines

To protect grains from insects, follow these guidelines:

1. Sanitize Storage Bins

To protect grains from insects, especially scavengers, follow a good sanitation program. Scavengers can survive on fungi, dockage, broken kernels and flour that may remain in the bin from the last storage season. Clean the bins with brooms, or with wet-dry shop vacuum cleaners. Inside the storage bin, carefully clean the walls, floors, and, if possible, the area under louvered floors. Also, be sure to clean grain handling equipment such as augers, grain buggies, and combines. Infested grain from these sources could be carried into the storage bin. Collect and remove the refuse from the storage area. To keep from contaminating newly harvested grain, **do not store it on top of old grain.**

Sanitation is a year-round effort. Periodically pick up spills and dispose of unwanted grain to eliminate sources of infestations.

2. Treat Bins Before Filling

After you have completed the sanitation program, apply a residual insecticide to the bin walls. Spray all surfaces until just before runoff. Give particular attention to cracks and crevices where insects hide. Spray area under the louvered floor at the time of cleaning. To give insects sufficient time to come in contact with treated surfaces, spray the bin two to three weeks before filling. Spraying may be done with a 3-gallon compressed-air sprayer,

depending on the size of the storage area. Select one of the insecticides from Table 1:

Table 1. Recommended Insecticides

Insecticide	Rate	Coverage (square feet)
Malathion (premium grade, p.g.) 57% E.C.	13 oz/2.5 gal	1250/2.5 gal
Methoxychlor 25% E.C.	1 qt/2.5 gal	1250/2.5 gal
Methoxychlor 50% W.P.	1 lb/2.5 gal	1250/2.5 gal
Reldan 4E	1/2 pt/6.5 gal	650-1250/1 gal

3. Use Protective Sprays

Stored grain may be protected by applying an insecticide (Tables 1 and 2) to grain as it is augered into a storage bin followed by a surface treatment after grain is in the bin.

Auger Treatment. Any low pressure sprayer that can be calibrated to deliver a known volume of liquid is suitable, including compression, electric, and gasoline driven sprayers. The garden type compression sprayer is useful for treating small lots of grain.

Be careful to use the correct orifice size in the sprayer nozzle because orifice size and pressure regulate the rate of insecticide flow. Every manufacturer of spray nozzles has nozzle charts giving the capacity in gallons per minute and the spray angle for each size of orifice.

Calibration example: If the turning rate (the amount of grain passing a point in a given time) of the grain is 5000 bushels per hour, and the amount of insecticide to be applied is 2 gallons per 1000 bushels, then a nozzle with a capacity of 10 gallons per hour at 15 p.s.i. is required.

Surface Treatment. Immediately after the bin is filled and the grain leveled, apply a surface treatment. A surface treatment may also be applied when the grain is going to be stored through a warm season or after a general fumigation to help prevent insect reinfestation. The surface treatment will help control insects that enter grain through roof openings and will kill insects found in the surface areas. Surface treatments are effective if the following limitations are understood:

- Surface treatments will not control insects already in the storage bin; thus, the grain must not be infested prior to surface treatment.
- The storage structure must be insect tight below the treated 2 inches of grain.
- The surface treatment should not be disturbed since it provides the protective barrier against insect infestations.

Malathion surface treatment will probably not control or prevent an infestation of the Indian meal moth or the almond moth because of resistance.

4. Manage Temperature and Humidity

Proper management of temperature and humidity helps prevent stored grain pests. Insects require a temperature higher than 60°F for normal growth and reproduction. Even if the temperature is not cold enough to kill insects directly, it may decrease feeding enough to cause starvation. A grain mass temperature of less than 60°F (50-55°F would be ideal) is difficult to obtain when wheat and early season soybeans and rice are cut. However, if the grain is to be kept through the fall and winter, the grain mass temperature can be lowered as temperatures decrease in the fall. Aeration fans can be run when temperatures are in the 50's and the humidity below 60 percent. Cooling the grain mass reduces insect development and provides a good storage environment for the grain.

Insects get their moisture from the grain, so it is easy to see the role that grain moisture can play in insect survival. The potential for insect growth and reproduction increases when grain moisture rises above 12 percent.

5. Monitor Grain Throughout Storage Period

Monitor the crop after it is stored just as you do during the growing season. This is more difficult because of the inaccessibility of the grain, but with the right equipment it can be done. To properly inspect the grain you will need a grain probe, section of gutter or canvas, screening pan, and thermometer.

To determine the temperature, securely fasten a thermometer to a rod and push it into the grain mass. Take several readings at different depths and at different locations within the bin.

Inspect monthly during the cooler months to determine the general condition of the grain, and to detect early

insect infestations, dampness, or grain heating. Make inspections twice monthly during the warmer months. Grain monitoring is particularly important for grains that have been in storage for more than six months.

During each inspection, particularly during the cooler months, watch for heating within the grain mass. A temperature higher than 65°F would indicate an area favorable for insect growth. Finish the inspection by looking for insects on exposed inner bin surfaces, around doors, aeration ducts, and joints in the walls.

6. Fumigate If Necessary

Fumigate the grain if it becomes infested with insects. Fumigation is the only way to control these pests once the grain has been stored. Fumigants are available as liquids, pressurized liquids, and solid materials.

Liquid fumigants are usually mixtures of two or more compounds, and they release gases when exposed to air. Voluntary cancellations, effective December 31, 1985, of carbon tetrachloride, ethylene dichloride, and carbon disulfide, following the enactment of the label improvement program for fumigants under FIFRA, has significantly reduced the number of liquid fumigants now available.

The pressurized liquids, such as methyl bromide, form gas when released from a pressurized container. Solid fumigants are distributed as tablets or pellets. The active ingredient is aluminum phosphide. The solids produce the gas when exposed to moisture (See Table 3 for fumigation recommendations).

Suggestions for Effective Fumigant Application

- Temperature — Most fumigation is done at temperatures between 50-95°F. Even though fumigation has been done at lower temperatures, the lower the temperature, the lower the volatility of the fumigant. Insect respiration is also reduced at lower temperatures. Low temperature fumigation usually calls for longer exposure times at higher concentrations of the fumigant. Check labels for information that would be helpful in these situations. Do not fail to check the internal temperature of the grain mass to see if it corresponds to the outside temperature.
- Application will be based on the number of bushels of grain in the bin, so be sure you know the amount stored.
- The surface of the grain mass should be level. Break any crust that may be present on the surface.
- Seal the junction between the side wall and roof with masking tape. If doors do not fit tightly, seal them with tape. Fumigants do not have any residual action, so once the gas has dissipated below the recommended concentration, all potential for control is lost.
- If a liquid fumigant is applied from the roof, avoid concentrating the spray directly under the openings. About 50-60 percent of the total grain in circular bins is located in the outer 2-3 feet of grain next to bin walls.
- Do not apply alone.
- After you have applied the fumigant, be sure the bin is properly marked so farm workers will know that fumigation is in progress.

Crop-Specific Recommendations When Using Insecticide Protectants

Corn

Apply malathion at the loading auger using rates listed in Table 2. Reldan is not registered for use on corn. Do not apply malathion before high-temperature drying because extreme heat will result in rapid volatilization and loss of malathion. For malathion residues to persist on corn at effective levels through the summer following harvest, corn must be dried to approximately 12 percent moisture.

Malathion will not control Indian meal moth. Use *Bacillus thuringiensis* (B.t.) of dichlorvos resin strips to prevent Indian meal moth infestations. Apply B.t. or hand dichlorvos strips at harvest or before May of the following year.

Soybeans

Only Indian meal moth will infest soybeans stored at moisture levels that prevent mold growth. To protect against Indian meal moth infestations, use dichlorvos resin strips or B.t. at harvest or before May of the following year. No other protectant insecticides are registered for application to stored soybeans.

Wheat

Wheat is especially vulnerable to insect infestation because it is harvested in mid-summer when stored-product

insects are active within and outside storage facilities. Warm temperatures in summer-harvested wheat also contribute to the rapid development and reproduction of insects within bins.

Apply malathion or chlorpyrifos-methyl (Reldan) at the loading auger to all wheat that is to be stored for 1 month or more. Where malathion is used, also incorporate B.t. in the top 4-6 inches of grain or hand dichlorvos resin strips to prevent Indian meal moth infestations. Chlorpyrifos-methyl controls Indian meal moth and the weevils and "secondary" beetles that infest grain.

Sorghum

Apply malathion or chlorpyrifos-methyl at the loading auger, but not before high-temperature drying. For malathion residues to persist at effective levels through the summer following harvest, grain must be dried to 12 percent moisture content; chlorpyrifos-methyl (Reldan) will persist for 12 months or more on 14 percent moisture sorghum. Where malathion is applied, also use B.t. or dichlorvos strips at harvest or before May to control Indian meal moth.

Table 2. Registered Insecticide Protectants and Recommendations for Stored Grain

Insecticide	Registered for Use on	Rate/1,000 Bu	Restrictions and Comments
malathion 57%EC, 6% D, 4% D, and 2% D	corn, wheat, oats, barley, rye, sorghum, sunflower, rice	1 pt 57% EC in 2-5 gal water; 10 lb 6% dust; 15 lb 4% dust; or 30 lb 2% dust. Use the same amount/1,000 sq ft of grain surface as a "cap-off" treatment if the entire grain mass is not treated.	Do not apply to soybeans. Malathion will not control Indian meal moth. Dry grain to 12% moisture for malathion to persist for 1 year or more. Do not apply prior to high-temperature drying.
chlorpyrifos-methyl (Reldan 4E)	wheat, oats, barley, rye, sorghum, sunflower, rice	barley - 9.2 fl oz; oats - 6.2 fl oz; rice - 8.6 fl oz; sorghum - 10.7 fl oz; wheat - 11.5 fl oz. Apply in 1-5 gal water.	Do not apply to corn or soybeans. Controls weevils, "bran bugs," and Indian meal moth. Dry grain to 14% moisture for chlorpyrifos-methyl to persist for 1 year or more. Do not apply prior to high-temperature drying.
pirimiphos-methyl (Actellic 5E)	corn, grain sorghum	corn: 9.2-12.3 fl oz; grain sorghum: 9.2-12.3 fl oz.	Do not make more than one application per crop. Do not store diluted Actellic in spray tank more than 48 hours before use. Avoid severely dusty application sites.
<i>Bacillus thuringiensis</i> (Bactospeine, Dipel, SOK-B.T. and Thuricide)	corn, soybeans, wheat, oats, barley, rye, sorghum, sunflower	Rate depends on product concentration. Follow label directions.	Use to control Indian meal moth larvae. Controls only larval stages; must be ingested. Apply to top 4-6 inches of grain as it is augered into the bin or incorporate by raking once the bin is filled.
pyrethrins plus piperonyl butoxide	corn, wheat, oats, barley, rye, sorghum, sunflower	Rate depends on product concentration. Follow label directions.	Do not apply to soybeans. Short-term residual activity. Useful mainly as a surface spray to control larval and adult Indian meal moths as well as other pests at the grain surface.
dichlorvos 20% resin strip (Farm Strips, Vapona Strips, etc.)	corn, soybeans, wheat, oats, rye, barley, sorghum, sunflower	1 strip/1,000 cu ft of space above the grain mass.	Install once bin is filled or by May 15. Replace every 6-8 weeks from May to October. Effective only in closed bins; controls adult moths only.

New Label Restrictions for Aluminum and Magnesium Phosphide Fumigants

Refer to the label or product manual for all requirements that must be followed when using aluminum and magnesium phosphide. Some of these changes (as of January 31, 1988) on the label include:

- There must be two trained persons present when fumigating an enclosed space or during reentry after fumigation.
- Products can only be purchased by certified applicators and used by certified applicators or persons trained and working under direct supervision and in the physical presence (on site or premises) of the certified applicator.
- Monitoring must be conducted with a low-level-detector device. Exposure during or after application may not

exceed 0.3ppm phosphine gas. If monitoring shows that exposure is less than the standard, no respirator is required. If more than 0.3ppm is encountered, a full-face NIOSH/MSHA-approved-canister respirator is required up to 15ppm phosphine. If more than 15ppm or unknown levels of phosphine are present, a NIOSH/MSHA-approved, self-contained breathing apparatus (SCBA) is required.

- Fumigated spaces must have a sign posted warning of fumigation, and it may not be removed until monitoring indicates the level of phosphine is below 0.3ppm in the fumigated space.

Table 3. Fumigants For Use on Stored Grain (*Fumigants are highly toxic. Use extreme caution.*)

Insecticide	Registered Use	Rate/1000 Bushels
aluminum and magnesium phosphides (Détia, Fumitoxin, Gastoxin, Phostek, Phostoxin)	corn, rice, sorghum, soybeans, oats, wheat	120-300 pellets or 60-180 tablets

Restrictions and Comments

Highly toxic to humans. Do not allow water to come in contact with tablets or pellets, because of explosive or fire hazard. Atmospheric moisture is required to activate pellets and tablets; gas reaches dangerous levels in 1-4 hours (much shorter time on warm, humid days). Decomposition is completed in about 3 days when grain temperatures are above 60°F. If grain moisture is below 10 percent and if temperature is lower, gas may evolve for at least 5 days. Gas is slightly heavier than air, so it diffuses rapidly through grain mass. Not strongly sorbed by grain. No adverse effects on seed germination; used on processed food; corrosive reaction with copper and alloys (brass, gold, silver). Wear neoprene or cotton gloves to prevent perspiration from reaching the dry material.

chloropicrin*	wheat, barley, rice	2.5 lb	Read the label before use
(Chlor-o-pic, Larvacide 100, Quasar)	corn	3.0 lb	
	oats	3.5 lb	
	sorghum	4.5 lb	

*Not labeled for use on agricultural commodities for human consumption (effective as of January 1, 1988).

Restrictions and Comments

Highly toxic and causes irritation of eyes because of "tear gas" effect. Heavily sorbed by grain and may require long periods of ventilation or aeration to eliminate "tear gas" effect. Allow 72 hours before airing out facility. May adversely affect seed germination. Especially effective against immature stages of grain pests and Indian meal moth. Non-flammable liquid marketed in pressurized or non-pressurized container. Packaging: compressed, liquid gas in cans (1.0 and 1.5 lb) and in cylinders (50, 100, and 200 lb). Wear protective clothing or respirator during application.

methyl bromide (Meth-O-Gas)	shelled corn	2 lb
100% methyl bromide (Brom-O-Gas)	soybeans, rice, wheat	3 lb
99% methyl bromide plus 1% chloropicrin*	milo (grain sorghum)	4 lb

Restrictions and Comments

Very highly toxic to humans. Only trained fumigators should use methyl bromide. Do not store fumigants on farm; buy only what is to be used. Do not get liquid methyl bromide on skin; it will burn. Will not corrode most metals but will react with aluminum or magnesium in the absence of oxygen to form explosive mixture. (Never connect aluminum or magnesium tubing to methyl bromide cylinder.) Odorless, non-flammable, rapid grain penetration, and rapid kill. Heavier than air; requires air circulation for even distribution. May adversely affect seed germination. Undesirable odors can result when certain materials are exposed to methyl bromide (see distributor). Wear protective clothing and special respirators when handling.

The information given here is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended of other products that may also be suitable.

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