

Stored Product Pests

Department of Entomology

STORED GRAIN INSECT PEST MANAGEMENT

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Direct-feeding damage by insects reduces grain weight, nutritional value, and germination of stored grain. Infestations also cause contamination, odor, mold, and heat-damage problems that reduce the quality of the grain and may make it unfit for processing into food for humans or animals. Commercial grain buyers may refuse to accept delivery of insect contaminated grain, or may pay a reduced price.

Kinds of Stored Grain Insects

Several species of insects may infest grain in storage. The principal pests that cause damage are the adult and larval stages of beetles, and the larval stage of moths (For aid in identifying stored grain insects, see page 6 of this publication). All may be a problem by their presence, either alive or dead, in grain that is to be processed for food.

Stored-grain insects are known as “internal feeders” if they feed within the kernels, otherwise they are referred to as “external feeders.” The granary weevil, rice weevil, lesser grain borer, and larvae of the Angoumois grain moth are internal feeders. External feeders (or “bran bugs”) that feed on grain dusts, cracked kernels, and grain debris without entering the kernel, include Indianmeal moth, sawtoothed grain beetle, red and confused flour beetles, flat grain beetle, and cadelle. Other species, such as the foreign grain beetle and hairy fungus beetle, feed on molds or fungi growing on grain stored at excessive moisture levels.

Preventative Measures Before Binning

Grain Bin Clean-up: Newly harvested grain may become infested when it comes in contact with previously infested grain in combines, truck beds, wagons, other grain-handling equipment, augers, bucket lifts, grain dumps, or grain already in the bin. Insects may also crawl or fly into grain bins from nearby accumulations of old contaminated grain, livestock feeds, bags, litter, or any other cereal products. Insect infestations can be prevented with good management practices. Where appropriate, the following guidelines should be used two or more weeks before grain is placed in bins:

- 1) Brush, sweep out and/or vacuum the combine, truck beds, transport wagons, grain dumps, augers, and elevator buckets to remove insect-infested grain and debris.
- 2) In empty bins, thoroughly sweep or brush down walls, ceilings, ledges, rafters, braces, and handling equipment, and remove debris from bins.
- 3) Remove all debris from fans, exhausts, and aeration ducts (also from beneath slotted floors, when possible).
- 4) Remove all debris from the storage site and dispose of it properly according to area, state, and/or federal guidelines (this debris usually contains insect eggs, larvae, pupae, and/or adults, all ready to infest the new grain).
- 5) Remove all debris and vegetation growing within ten feet of the bins (preferably the whole storage area).
- 6) Examine area to determine if rodent bait stations are required, and use if needed. Be sure to follow all label directions.
- 7) Spray cleaned area around bins with a residual herbicide to remove all undesirable weedy plants.
- 8) Inside bins, spray wall surfaces, ledges, braces, rafters, and floors with one of the following residual insecticides to the point of runoff: Tempo®, malathion, Storcide II, chlorpyrifos-methyl. Outside, spray the bases and walls up to 15 feet above the bases, plus the soil around the bins.
- 9) If the grain is expected to remain in the bins for at least a year, fumigate the area beneath the slotted (drying) floors with a formulation of chloropicrin according to label directions (only certified applicators may purchase and apply). Chloropicrin, available in several sizes of containers as CHLOR-O-PIC and QUASAR, is a liquid formulation which, when applied to the bin floor, forms a gas that is 5 times heavier than air. Chloropicrin is a restricted-use product that is extremely toxic to all living organisms; follow label directions for application and personal protection information.

10) If newly harvested grain and/or insect-free grain must be added to grain already in storage, the latter must be fumigated with either aluminum phosphide or methyl bromide (only certified applicators may purchase and apply). (If doing this, omit step 9.)

ing because extreme heat will result in rapid volatilization and reduced residual qualities of the pesticide. Grain protectants applied to 13% moisture grain will have a greater residual life than grain at 15% or greater moisture. Grain protectants, when applied according to label directions, can be sold or fed immediately after application.

Preventative Measures During Binning

Grain Protectants (Table 1). It is recommended that a grain protectant be applied to grain that will be in storage for one or more years. Grain protectants are insecticides registered for application to whole grain to protect against insect infestations while the grain is in storage. Grain protectants kill insects as they crawl about or feed on treated grain and/or grain fragments. These formulations are generally applied to grain as it is being augured, loaded, or turned into storage facilities. Do not apply grain protectants before high temperature dry-

Preventative Measures After Binning

Top-Dress: Some grain protectants may be applied as a surface treatment (“top-dress” or “cap off”) to the grain mass already in storage to control “surface feeders” such as the Indianmeal moth larva (Refer to Table 1). Remove any webbing that may already exist (produced by the larvae) before applying the top-dress treatment. Raking the product into the top few inches of leveled off grain will increase the likelihood that the larvae will be controlled. **Caution:** legal tolerances

Insecticide*	Commodity	Comments
<i>Bacillus thuringiensis</i> (B.t.)	Corn (field and popcorn), wheat (small grains), sorghum, soybeans, peanuts, birdseed, crop seed, tobacco	May be used on empty grain bins, but best if used as a top-dress treatment to prevent or control lepidopterous pests such as Indianmeal moth and almond moth larvae.
pirimiphos-methyl (Actellic)	Corn (field and popcorn), sorghum	Can be used as either a grain protectant or top-dress treatment, not both. Is effective on all stored grain insect pests.
malathion	Corn, wheat (small grains), barley, sorghum, rye	Can be used for bin wall treatments, top-dress, or a grain protectant, Read and follow label directions so that legal tolerances are not exceeded. Do not use for Indianmeal moth control.
chlorpyrifos-methyl	Wheat (small grains), sorghum	Can be used for bin wall treatments, top-dress, or a grain protectant for only the crops listed. Removed from market. Existing stocks only.
pyrethrins and piperonyl butoxide	Corn, wheat (small grains), sorghum	These products are registered primarily to control exposed Indianmeal moth adults and larvae. There is no residual activity.
diatomaceous earth/silicon dioxide	Corn, buckwheat, wheat (small grains), sorghum, soybeans, rice, rye, seed grain	These products kill insects by scratching the body surface and causing dehydration. Grain buyers may be reluctant to purchase grain treated with DE because of a possible lower grade, reduced flowability, reduced test weight and increased wear on grain moving equipment. Its use as an empty bin treatment, especially beneath the slotted floor, shows promise.
deltamethrin combined with chlorpyrifos-methyl (Storcide II)	Wheat, barley, oats, sorghum, rice	This product can be used for empty bin application as well as grain. May not be used on corn.
DDVP	Area above stored corn, grain, peanuts, soybeans	This product is a non-residual space treatment that can be used in empty grain bins and in the headspace of full bins. Primary targets: adult moths.
methoprene	Empty storage bins, barley, birdseed, cereal grains, corn, popcorn, oats, peanuts, rice, sorghum, wheat sunflower, grain products	This is an insect growth regulator and will not kill adult stages. It will only prevent immature life stages from becoming adults. May be applied as top-dressing.
*Always read and follow label instructions.		

can be exceeded for a specific insecticide if applied as both a grain protectant and a top-dress treatment; check the label.

No-Pest Strips: Dichlorovous impregnated strips (DDVP) may be hung in the open space of the grain bin during the spring, summer, and fall months to control flying insects such as the adult Indianmeal moth. Suspend one strip per 1,000 cubic feet of air space. The strips may or may not have to be replaced during the summer depending on the amount of air transfer in the open space.

Control Measures After Binning

Any time the grain is at or above 55°F, it should be inspected every two weeks for insect activity. Stored grain pests are generally inactive at temperatures below 55°F. Even if insects appear active only on the surface of the grain, use a grain probe or other sampling device and determine the extent of infestation within the grain mass. Insects collected should be identified before chemical treatment is considered. Knowing what insect species is infesting stored grain can provide important information on the grain condition and what should be done about it. Grain that is infested with insects does not automatically make it “weevily!” Grain should only be graded weevily if it contains an internal feeding insect. The Federal Grain Inspection Service (FGIS) has set the following standards for grain that is graded “infested.” Notice the emphasis that is placed on weevil (internal feeders).

Federal Grain Inspection Service Standards for Grain that is Graded "Infested"	
Grain 1000 g Sample	Number and Type of Insects
Wheat, triticale, rye	<ul style="list-style-type: none"> • 2 or more live weevils • 1 live weevil and 1 other live insect injurious to stored grain, or • 2 other live insects injurious to stored grain
All other grains	<ul style="list-style-type: none"> • 2 or more live weevils • 1 live weevil and five other live insects injurious to stored grain, or • 10 other live insects injurious to stored grain

The most common stored grain insect pests may be grouped by their feeding habits. Listed below are appropriate management strategies for these groups. Remember, correct identification is imperative. Samples may be sent to the Plant and Pest Diagnostic Laboratory, LSPS – Room 101, 915 W. State Street, W. Lafayette, Indiana 47907-2054, for insect identification.

Internal Feeders

Weevils and Lesser Grain Borer

The only options with weevily infested grain is to feed it as is, sell it at a discounted rate, or fumigate it. All fumigants are classified as restricted use products. Farmers desiring to

fumigate their own grain must attain two levels of certification: Private applicator and Category 7d. Otherwise, a certified and licensed commercial applicator must be hired. Fumigants are **extremely hazardous** for the user and must be applied in strict accordance with instructions listed on the product label and any accompanying instruction manuals, etc. Fumigants for use in farm storage bins are registered as either “liquid under pressure” or “solid formulations.” Regardless of the formulation, fumigants become effective when they change to a gas form, and settle down through the grain mass. Refer to Table 2 (page 4) for list of registered fumigants for use in Indiana.

The grain bin should be air-tight and all openings sealed before fumigation. Best conditions for treatment are a calm day with grain temperatures at or above 65°F. Success depends on the concentration of the fumigant, grain temperature, and length of time the fumigant is in the bin. The minimum exposure period is generally 72 hours. After fumigation, the grain must be aerated for at least 48 hours, or until the gas concentration level is below that listed on the fumigant label. All labeling information regarding safety in handling and proper application techniques must be followed when making application. Specific safety equipment such as the use or availability of self contained breathing apparatus and specialized instruments to measure gas concentrations are now required.

Remember that although a successful fumigation does drastically reduce the insect pest population, it offers no residual effect. The grain becomes immediately susceptible to reinfestation once the gas is evacuated (approx. 72 hrs).

External Feeders

There are several management options available for control of “bran bugs” other than fumigating. Management decisions will vary depending on the insect species and numbers present, your storage facilities, and how quickly you want to move the grain.

Indianmeal Moth

The caterpillar (larva) is a surface feeder and stays in the top 3-6 inches of the grain mass feeding on fines while creating a webbing. For control refer to PREVENTIVE MEASURES AFTER BINNING.

Foreign Grain Beetle and Hairy Fungus Beetle

These beetles are fungus feeders and are present in the grain mass because of moldy grain. Correcting aeration and/or moisture problems on the surface or within the grain mass and removing the out-of-condition grain will control this problem. Pulling grain out the center of the bin (collection of fines), cleaning the remainder of the grain mass as it is being moved, and conditioning (drying and cooling) the grain will provide a bin unsuitable for these mold feeders.

Sawtoothed Grain Beetle, Red and Confused Flour Beetles, Flat Grain Beetle, and Cadelle

These secondary feeders infest bins because of the availability of grain dusts, cracked kernels, and grain debris. These pests can be distributed and feeding throughout the grain mass or localized because of a collection of fines, such as in the core of the bin where fines collect at binning. They

Table 2. Fumigants* Approved for Stored Grain in Indiana		
Insecticide*	Commodity	Comments
aluminum phosphide Sold as: Detia, Fumitoxin, Gastion, Gastoxin, Phostek, Phostoxin, Quick Phos	Corn (field and popcorn), wheat (small grains), sorghum, soybeans	This is the most common fumigant used in grain bins. The solid tablets or pellets break down to gas when exposed to the atmosphere (moisture) and releases phosphide gas.
carbon dioxide Sold as: Carbon dioxide	Corn, wheat (small grains), sorghum, soybeans	This requires the use of specialized equipment (CO ₂ generator) and air tight bins. Fumigation may take 10 or more days.
magnesium phosphide Sold as: Fumi-cel, Magtoxin	Corn (field and popcorn), wheat (small grains), sorghum, soybeans	This fumigant is normally not used for stored grain fumigation. It releases phosphide gas much faster than aluminum phosphide which may endanger the applicator or hinder even gas penetration throughout the grain mass.
methyl bromide Sold as: Brom-O-Gas, Meth-O-Gas	Corn (field and popcorn), wheat, sorghum	Recirculation is necessary when using this fumigant. MB is colorless and odorless.
*All fumigants are Restricted Use Products and cannot be purchased or applied unless the applicator is certified and has either a Private Applicator Permit or a Commercial Applicator License.		

will also feed on the dusts and damaged kernels created by internal feeders; if this is the case then the only control option is fumigation.

A grain bin of whole undamaged kernels is the key to preventing the secondary feeders. This may require running the grain through a cleaner or aspirator while moving the grain from one bin to another. This will not only remove the fines, but dead and live insects as well. Applying a grain protectant (see Table 1) while moving this grain would be a sound management practice. Refer to PREVENTIVE MEASURES BEFORE BINNING for proper preparation of the grain bin.

Continued Stored Grain Pest Management

All grain producers having grain in on-farm storage need to maintain a good management program that includes proper grain-handling, regular grain inspections, and pest control. An excellent reference publication on grain management is Purdue Extension Publication AE-90, Managing Grain for Year-Round Storage, G.H. Foster and B.A. McKenzie <<http://www.ces.purdue.edu/extmedia/AE/AE-90.html>>. Other materials are available at <<http://extension.entm.purdue.edu/grainlab/>>.

READ AND FOLLOW ALL LABEL INSTRUCTIONS. THIS INCLUDES DIRECTIONS FOR USE, PRECAUTIONARY STATEMENTS (HAZARDS TO HUMANS, DOMESTIC ANIMALS, AND ENDANGERED SPECIES), ENVIRONMENTAL HAZARDS, RATES OF APPLICATION, NUMBER OF APPLICATIONS, REENTRY INTERVALS, HARVEST RESTRICTIONS, STORAGE AND DISPOSAL, AND ANY SPECIFIC WARNINGS AND/OR PRECAUTIONS FOR SAFE HANDLING OF THE PESTICIDE.

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