

STORED PRODUCT INSECT MANAGEMENT

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The key to storing grains and other commodities on the farm is to make storage conditions unfavorable for the survival of stored grain insects and molds. The following steps are designed to reduce the initial number of insects in the bin, slow the development of any remaining insects, and apply corrective measures to reduce insect populations if necessary. Following these steps will also greatly reduce stored grain molds and associated mycotoxins.

- Clean storage facilities thoroughly inside and out to eliminate starter colonies of insects. Remove any weeds, crop debris, or clutter around the facility to reduce insect and rodent activity. All grain residues from the previous year should be removed from inside the facility as soon as the old crop is shipped.

INSECTICIDES FOR USE FOR EMPTY BIN TREATMENTS			
INSECTICIDE	RATE	MOA	REMARKS
<i>beta-cyfluthrin</i> Tempo SC Ultra	0.25-0.5 fl oz/gal/1000 sq ft	3A	Apply to all interior surfaces of storage bin and allow to dry before filling bins.
<i>deltamethrin</i> Centynal	0.25-1.5 fl oz/gal/1000 sq ft	3A	Apply to wall and floor surfaces of grain bins and warehouses prior to storing or handling grain.
D-Fense SC	0.25-1.5 fl oz/gal/1000 sq ft	3A	Apply to wall and floor surfaces.
Suspend SC	0.25-1.5 fl oz/gal/1000 sq ft	3A	Apply finished spray to equipment, wall and floor surfaces of grain bins and warehouses prior to storing or handling grain.
<i>diatomaceous earth</i> Insecto	Dust: 1 lb/1000 sqft		Apply at least 2-3 days before filling bin. Use aeration fan or other air supply to apply dust.
Dryacide 100	Dust: 1-3 lb/1000 sq ft Slurry: 1.5 lb/1.5 gal/100 sq ft		Apply as a dust with a hand or power duster or as a slurry spray.
Protect-It	Dust: 0.6 lb./1000 sq ft Slurry: 1.5 lb/1.5 gal/100 sq ft		Apply 2 weeks before filling bins. Use a dust blower or bin fan to reach all cracks, crevices, and on surfaces. Apply slurry as a fine mist.
<i>diatomaceous earth</i> Storcide II <i>deltamethrin + chlorpyrifos methyl</i>	1.8 fl oz/gal/1000 sq ft	1B + 3A	Application can only be made from outside the bin using automated spray equipment.
<i>pyriproxyfen</i> Nyguard IGR Concentrate	0.8-2.4 tsp/gal/1500 sq ft 4-12 ml/gal/1500 sq ft	7C	This product will not kill adults but will control immatures, may be mixed with an adulticide.
<i>s-methoprene</i> Diacon-D IGR	1.5 oz/1000 sq ft	7A	This product will not kill adults, but will control immatures; applicators must wear a dust mask and protective gloves.
Diacon IGR	Fogging Treatment: 1 ml/1000 sq ft (0.2 tsp/1000 sq ft) Pressure Spray: 2 ml/1000 sq ft (0.4 tsp/1000 sq ft)	7A	Apply fogging treatment in water or oil in a cold aerosol generator. Diacon IGR is an insect-growth regulator that interferes with the development of insects. It will not kill adult insects. Apply as a pressure spray in low-pressure sprayer to all areas which may harbor insect pests.

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- Seal any gaps or holes in the sides and roof of the bin using caulk or polyurethane foam. Check to make sure the bottom seal with the concrete is intact. Prevent water from flowing underneath the bin by applying plastic roof cement.
- Apply an EPA-approved insecticide on the floors and sides of empty storage facilities to eliminate insects hiding in cracks and crevices and to create a first line of defense against any insects that do find their way into the bin. Spray the outside of the bin to a height of 3 ft, and the surrounding concrete, gravel, or sod to a distance of 6-10 ft surrounding the bin. The following insecticides can be used for this empty bin treatment:

The use of residual insecticides by itself does not constitute an insect management program. Appropriate programs should also include incoming product inspection, product rotation, sanitation, monitoring with traps, properly sealed doors and windows, and sealing up cracks and wall voids. Exterior premises should be maintained by draining water away from the facility, directing light away from the building, removing vegetation near the structure, and promptly cleaning up spilled grain.

- Eventually, insects will build up on fines and broken kernels that accumulate under the perforated bin floor. Bins with false floors should be fumigated if the grain debris cannot be removed. Cover with plastic tarp (6 ml or thicker) to contain and hold the gas. Place the fumigant over the empty floor under the tarp. Note that all fumigants are **RESTRICTED USE** pesticides. Fumigation should only be conducted by trained and licensed applicators. Read the label and the applicator's manual. You will need to prepare a fumigation management plan before you fumigate.

FUMIGANTS FOR CONTROLLING INSECTS BENEATH THE FALSE FLOOR		
INSECTICIDE	MOA	REMARKS
<i>aluminum or magnesium phosphide</i>	24A	See fumigant section below for individual product names. Use rates as indicated on label.

- Clean out harvesting and loading equipment such as combines, trucks and augers at the end of each harvest season. If not clean, insects will reproduce in the small amounts of grain left in the equipment and then be conveyed into the new crop grain.
- Store the grain at the appropriate moisture content. Insects and molds require moisture to survive

RECOMMENDED MAXIMUM MOISTURE CONTENT FOR GRAIN IN AERATED* STORAGE CONDITIONS			
CROP	PLANNED STORAGE TIME BEFORE MARKETING		
	6 MONTHS	6-12 MONTHS	MORE THAN 1 YEAR
Corn and grain sorghum	14%	13%	12%
Soybeans	13%	12%	11%
Small grains	12%	11%	10%
Edible beans	14%	12%	10%

*Decrease each moisture content percentage by 2 percent if storing grain without aeration.

- Store the grain at the appropriate moisture content. Insects and molds require moisture to survive
- Store clean grain. Removing or equally dispersing fine particles and other foreign material will increase aeration efficiency and the effectiveness of grain protectants and fumigants. The following steps each contribute to clean grain: Effective in-season weed control; properly adjusted combines; use of a grain pre-cleaner; coring the bin after it has been loaded; and use of a mechanical spreader at the top of the bin.
- Apply an approved grain protectant directly to clean grain as it is loaded into the bin. Apply to a moving grain stream at the bottom of the bucket elevator or auger so the material has an opportunity to contact as many kernels as possible as the grain is moved. It is important to run the grain through a cooling cycle or similar procedure before applying the protectant as high heat rapidly breaks down insecticides.

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INSECTICIDES FOR APPLYING DIRECTLY ON THE COMMODITY AS A PROTECTANT TREATMENT^{1,2}			
INSECTICIDE	MOA	RATE PER 1000 BUSHELS (Dilute in 5 gal of water)	REMARKS
<i>pirimiphos-methyl</i> Actellic 5E	1B	8.6-11.5 fl oz. (corn) 8.6-11.5 fl oz (grain sorghum)	Labeled for use on shelled corn, popcorn and grain sorghum only. DO NOT use if grain has been previously treated with Actellic or if Actellic will be used as a topdress treatment.
<i>deltamethrin</i> Centynal	3A	8.5 fl oz (corn) 9.1 fl oz (wheat) 4.9 fl oz (oats) 8.5 fl oz (grain sorghum) 8.5 fl oz (rye)	Labeled for use on barley, corn, oats, popcorn, rice rye, grain sorghum, and wheat.
D-Fense SC	3A	8.5 fl oz (corn) 9.1 fl oz (wheat) 8.5 fl oz (oats) 8.5 fl oz (grain sorghum) 8.5 fl oz (rye)	Labeled for use on barley, corn, oats, popcorn, rice, rye, grain sorghum, and wheat.
<i>s-methoprene</i> Diacon IGR	7A	1.8-7 fl oz (corn) 1.8-7 fl oz (wheat) 1-4 fl oz (peanuts) 1-4 fl oz (oats) 1.8-7 fl oz (grain sorghum)	Labeled for use on wheat, corn, grain sorghum, barley, rice, oats, peanuts, and sunflower; will not control weevils. Diacon IGR is an insect-growth regulator that interferes with the development of insects; it will not kill adult insects. Treat existing insect populations with an adulticide before or at the same time as applying Diacon IGR. Apply only once to grain of known treatment history. Use highest rates for maximum residual. Lowest rate provides shorter residual.
Diacon-D IGR	7A	8-10 lb	Labeled for use on cereal grains, corn, sunflower, canola, legumes, popcorn, wheat, spices, grain sorghum, rice, cocoa, peanuts, oats and millet. Will not control weevils. Diacon-D IGR is an insect-growth regulator that interferes with the development of insects. It will not kill adult insects. Treat existing insect populations with adulticide before or at the same time as applying Diacon-D IGR. Apply only once to grain of known treatment history.
<i>diatomaceous earth</i> Dryacide 100		1-2 lb/ton	Thoroughly mix with grain. For use on grains, soybeans, peanuts, popcorn, and others (see label). Diatomaceous earth products are less effective when used on grain with increased moisture content and under humid conditions; diatomaceous earth is known to decrease test weight and grain flowability
Insecto		1 lb/ton 1-2 lb/ton (if infested)	Apply uniformly as a dust on grains, soybeans, peanuts, popcorn, and others (see label). See note above.
Protect-It		18 lb (wheat, beans, peas) 9.6 lb (oats) 16.8 lb (rye)	Uniformly treat grain as it is loaded into bin. For use on grains, soybeans, peanuts, popcorn, and others (see label). See note above.
<i>deltamethrin + chlorpyrifos-methyl</i> Storcide II	1B + 3A	12.4 fl oz (wheat) 11.6 fl oz (grain sorghum) 6.6 fl oz (oats)	Dilute with water or an FDA-approved food grade mineral oil or soybean oil. Wheat, barley, oats, rice, and grain sorghum.

¹Do not apply before sending the grain through a grain drier or immediately after coming out of the drier as the heat will quickly degrade the insecticide. Grain protectants should only be applied to cool grain that is of proper storage moisture with minimal dockage and fines. It is best to apply protectants at the bottom of the auger so the insecticide can thoroughly coat the kernels as they are conveyed.

²Surveys consistently show that stored grain insect populations are resistant to malathion.

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- Once the grain is in the bin, make sure that the surface is level and that the bin is not over filled. Leave a few feet of the straight side of the bin as air space to facilitate aeration and monitoring. If your bin does not have a spreader, unloading some grain will help level the central peak, as well as uniformly distribute fine particles that otherwise accumulate in the center of the bin.
- If grain will be stored for more than a few months and was not treated with a protectant, apply a top dress treatment. The following can be used as a top dress treatment:

INSECTICIDES LABELLED FOR TOP DRESS TREATMENTS			
INSECTICIDE	MOA	RATE/1,000 SQ FT OF GRAIN SURFACE	REMARKS
<i>pirimiphos methyl</i> Actellic 5E	1B	3 fl oz	Shelled corn and grain sorghum only. DO NOT use if grain has been previously treated with Actellic spray.
<i>s-methoprene</i> Diacon-D IGR	7A	8 lb	Use sufficient water or oil to provide adequate coverage as a spray or a fogging treatment. Note: Labeled for use on cereal grains, corn, sunflower, canola, legumes, popcorn, wheat, spices, grain sorghum, rice, cocoa, peanuts, oats, and millet. Will not control weevils. Apply only once to grain of known treatment history. Methoprene is an insect-growth regulator that interferes with the development of insects. It will not kill adult insects.
Diacon IGR	7A	0.2 tsp (1 ml)	Apply uniformly and rake into the grain to a depth of 1 foot. See note above.
<i>diatomaceous earth</i> Insecto		4 lb	Apply Insecto as a dust to surface of binned grain (see instructions on the label). For grains, soybeans, peanuts, popcorn, and others (see label).
Protect-It		3 lb or 40 lb (see remarks)	Apply the 3-pound rate on surface that has already been treated with Protect-It. Apply the 40-pound rate on surface that has not been previously treated with Protect-It. Uniformly treat grain as it is loaded into bin. For use on grains, soybeans, peanuts, popcorn, and others (see label).
<i>Bacillus thuringiensis</i> (various products including Biobit HP, Dipel DF, Javelin WG, and Xentari DF)		See label	Controls lepidopteran pests only. Apply evenly over the surface immediately after loading and mix into a depth of 4" with a scoop or rake.

- If you have had problems with Indian meal moths in the past, you may want to consider head space treatment:

HEADSPACE TREATMENTS			
<i>dichlorvos</i> pest strips including Prozap Insect Guard and Hot Shot No Pest Strip.	1B	80 g per 900-1200 cu ft	Polyvinyl strips impregnated with dichlorvos can be hung in the bin headspace to help control Indian meal moth adults.

- Stored grain insects thrive in warm grain. The hotter it is, the faster insects feed, grow and reproduce. Conversely, stored grain insects quit feeding and developing when temperatures are below 60°F. Grain temperatures are optimally managed using thermostatically controlled aeration that enables the fans to operate only when the outside air temperature is cooler than the set point. Once the grain reaches the set point temperature, set the thermostat to the next cooler set point. Growers in the Deep South should use temperature set points of 75°F, 65°F and 45 °F, whereas growers farther from the coast should use 70°F, 60°F and 40°F. It is important not to let the grain freeze as this will result in “sweating” when the grain warms in the spring; similarly, grain can sweat if the differential between the grain and air temperatures is greater than 20°F. Temperature cables, moisture sensor cables, and automated aeration controllers make aeration more efficient, but you can do this manually. [See Grain Storage Aeration Guidelines for the Southeast.](#)
- Initiate a systematic and thorough insect-monitoring system. Check the grain every 21 days from spring to fall and monthly in winter for the presence of insects. Five trier samples or probe traps should be sufficient on each sampling date.
- If you begin to find insects such as weevils or lesser grain borers, sell the grain; move the grain to another bin and apply a grain protectant as you move it; or fumigate the grain. Read the fumigant label and applicator guide carefully. Follow the instructions provided because the label is the law. Aluminum phosphide is the most frequently used on-farm fumigant. It requires the preparation of a fumigation management plan before any fumigant is applied. If there are leaks in the bin, the fumigant cannot be held long enough to kill the insects. Seal all openings before loading the bin, including the aeration fan, top vents, eaves, roof entry door and side entry door. Many fumigation attempts end in failure. Be sure to leave the fumigant in the bin long enough to be effective. Read the fumigant label to determine how long it will take the fumigant to reach a lethal level. It may take a day or two to reach the desired concentration; therefore, leave the bin sealed for the recommended length of time. A closed-loop fumigation can make fumigation more efficient and safe. In this method, fumigant is circulated in a pipe outside the bin from the top to the bottom and then drawn up through the grain to the surface. See <https://store.aces.edu/ItemDetail.aspx?ProductID=16989>.

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GRAIN FUMIGANTS		
PRODUCT	RATE	REMARKS
<i>aluminum phosphide</i> (phosphine gas)		All formulations of aluminum phosphide now require you to prepare a written fumigation management plan. READ THE LABEL AND THE APPLICATORS MANUAL CAREFULLY BEFORE USING ALUMINUM PHOSPHIDE. Many on-farm fumigations fail because the bin is not sealed adequately. Seal bin as tightly as possible. Use higher doses for older, less well-sealed grain bins. Dosage must be based on the capacity of the grain bin, not on the amount of grain in storage, unless the surface of the grain is tarped after aluminum phosphide application. If grain is tarped, dose can be based on the volume of the grain in storage. All formulations of aluminum phosphide are RESTRICTED USE pesticides. Dosage rate varies with the site. See the Applicators Manual that is part of the label. See ANR-1154, "Fumigating Agricultural Commodities With Phosphine" (www.aces.edu/pubs/docs/A/ANR-1154/) for more information.
aluminum phosphide pellets Weevil-Cide 60% pellets, Phosfume2 60% pellets, or Phostoxin 60% pellets	Farm bins: 350-725 pellets/1000 cuft	
aluminum phosphide tablets* Weevil-Cide 60% tablets, Phosfume2 60% tablets, or Phostoxin 60% tablets	Farm bins: 70-145 tablets/1000 cu ft	
Phostoxin Tablet Prepac (33 tablets)**	See label	
<i>cylinderized phosphine + carbon dioxide gas</i> Eco2fume Fumigant Gas	See label	
<i>pure phosphine gas</i> Vaporph ₃ os	See label	Vaporph ₃ os is a RESTRICTED USE pesticide and requires specialized training and equipment for application. It is pure phosphine gas that is blended with carbon dioxide on site.
<i>cylinderized sulfuryl fluoride</i> Profume	See Label	To be blended with carbon dioxide or forced air on site. Contact Cytec Industries for more details (905-374-5899). Profume is a RESTRICTED USE insecticide. See label and applicators manual.

- For more information on storing commodities on the farm, see this website: Maintaining Quality of Stored Grain, from the Alabama Cooperative Extension System

HELPFUL CONVERSIONS FOR APPLYING INSECTICIDES TO STORED GRAINS*			
BIN DIAMETER (FT)	GRAIN SURFACE AREA (SQ FT)	BUSHEL PER FOOT OF HEIGHT	APPROXIMATE SURFACE AREA OF EMPTY BIN (SQ FT)
8	50	40	100 + (height x 25)
16	201	161	400 + (height x 50)
24	452	362	900 + (height x 75)
32	804	643	1600 + (height x 100)

* 1 bushel = 1.25 cubic feet; 1 cubic foot = 0.8 bushels.

Number of tons = (Number of bushels x test weight in pounds per bushel)/2000

PROTECTING SMALL QUANTITIES OF COMMODITIES

Here are several tips to keep unwanted visitors from getting into your dried commodities, such as beans, flour, spaghetti, dog biscuits, and peanuts.

1. Avoid buying material that is already infested. Start with high quality material that has been purchased from a reputable source.
2. Purchase only as much food or pet food as you normally consume in a month. Keeping foodstuffs in the home for several months makes them much more likely to become infested with stored product insects.
3. If there is good reason for thinking the food may be infested, freeze the package in a household freezer or use a heat treatment before it is stored. (See Step 6.)
4. Make sure food is dry. (See Table 1.) Whole grains and beans that are stored before they have been completely dried are prone to insect and disease problems.
5. Store food in tightly sealed containers that are safe for food products.
6. Monitor the food periodically for pest infestations. Discard any heavily infested food to keep problems from spreading; likely infestation sources include pet foods and treats, breakfast cereal, wheat flour, cornmeal, spices, dry noodles, popcorn and dried beans.
7. A light insect infestation can be dealt with by sifting out as many insects as possible and freezing the affected materials at 0°F for 4 days (small package) or for a week (large box). Alternatively, spread the material out into a thin layer on cookie sheets and bake the material at about 130° F for 30 minutes.
8. If storing in bulk (more than 1 gallon), it may be beneficial to use a grain protectant. An example is diatomaceous earth such as Insecto. When working with this product, wear a mask or work outdoors to avoid over-exposure to dust, particularly if you have pre-existing respiratory ailments. Mixing a bit of diatomaceous earth into the bottom and top layers of stored products can help keep bulk stored commodities insect free. Use it at a rate of 0.5-1 cup/5 gallons of stored product. You may also find food-grade diatomaceous earth at your farmers co-op or feed store as an anti-caking agent. Do not use pool-grade or beverage grade diatomaceous earth.

GRAIN BAG STORAGE

Storing grain in large plastic grain bags has become popular in recent years. Research studies have shown varying results in terms of how well the system prevents insect and mold infestations. The most important consideration is that bags must be placed on hard, level, well-drained land. If bags are placed on a slope, they must be arranged to run along the direction of the slope, not across it. Every precaution must be taken to prevent the bags from being punctured, which is why bags should not be placed on top of crop stubble or other sharp surfaces. More information on the economics of crop storage can be found in the online publication "Economics of Grain Storage Bags in the Coastal Bend and Upper Gulf Coast of Texas" (<http://farmassistance.tamu.edu/publications/focus/2009-5pages.pdf>).

TEMPORARY GRAIN STORAGE

Stored grain in the Southeast is at high risk for damage from insects and molds. That risk is dramatically increased if the grain is stored in unaerated conditions or if the grain is not stored in a sealed structure. Use caution in storing grain in piles and in structures not intended for grain storage. For more information see: www.extension.purdue.edu/extmedia/gq/gqtf38/gqtf-38.html