

FARM-STORED GRAIN INSECT MANAGEMENT

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The quality of farm-stored grain is at its peak when the grain is loaded into the bin for storage. After loading the best you can do is to try to maintain this level of quality. Thus, it is important to maximize the quality of your grain *prior* to storage. At harvest, for instance, make sure that your harvesting equipment is adjusted to minimize breaking or cracking the grain or beans.

Sanitation is critical in on-farm grain storage. Only load your grain into a thoroughly cleaned, empty bin! Thoroughly clean bins using brooms, brushes, compressed air, vacuuming to remove grain dust and debris and webbing (wear a dust mask!). Be sure to clean out seams and joints, inside hollow ladder rungs, and especially the ledge over the door. Clean out under perforated flooring (if possible), and be sure the fan and air duct are clean. Do this after the bin is emptied. Cover the fan when it is not in use. You may even want to use silicone caulk to seal seams. Also clean combines, grain truck beds, augers and other equipment that can be contaminated with grain and grain debris and dust. Not thoroughly cleaning out storage is not an option.

Don't load grains on top of older grains! This past year *all* of the calls I received on stored grain insect and mite problems involved situations where storage had *not* been cleaned, and where new grain was loaded into storage on top of *old grain*. When loading grain into the storage bin make sure your loading auger and mechanical spreaders in the bin are in good condition and will not damage the grain when loading. Run the auger at full capacity (run at a slow speed) to minimize breaking the grain kernels or beans. And the cleaner and drier the grain is going into the bin the better.

Do not overfill the bin. Carefully level the grain in the bin as soon as it is filled and immediately begin aeration to cool the grain. Poorly controlled temperatures are the most important cause of stored grains going out of condition. Get the grain cooled down to the outside air temperature as soon as possible. Keep the bin temperature no more than 10 – 15°F of the outside temperature during storage. Ideally the temperature should be maintained at 35 - 40°F.

As soon as bins are loaded, clean up *all* spilled grain. Keep ground around bins clear of weeds and debris.

Proper storage management provides the best control for the cost. Proper harvest, loading and storage of grain is critical for managing potential insect infestations. It is important in any insect management system to not rely solely on insecticides. This is particularly true for stored grains, as there are few insecticides registered in this use area, and fewer still for the individual stored commodities. Also, insecticide resistance has already made at least malathion essentially useless in many stored grain environments; malathion is not recommended (*and see notes below*.)

Insects will stop feeding and reproduction at temperatures below about 50°F. Because some grains, wheat and corn for example, are harvested when temperatures can still be fairly warm in South Carolina, immediate aeration to get harvested corn to ambient temperature is critical to help prevent insect infestations. Even grain, especially corn, held at the moisture levels that will not allow mold growth, can still be infested by at least Indian meal moth. This moth infests the grain from the top of the bin. Indian meal moth can be controlled using DDVP resin strips in the head space of the bin, using 1 strip per 1,000 cubic feet (controls adults only). Change strips every one to two months in hot weather, every three to four months after that. You may alternatively, or also, use a *Bacillus thuringiensis* (*Bt*) product (for example, Dipel) as a top dressing (grain surface treatment) applied immediately after bin loading (controls larvae only.) Diatomaceous earth products may also be used here but monthly treatments will be needed.

Properly loaded grain should be stored in thoroughly cleaned and surface-treated bins (bin surface treatment). A grain protectant can also be used when loading the grain. However, even if both of these procedures are followed, do not fail to regularly check your grain – check storage temperature and moisture levels, and for flying moths and for surface crusting. Remember that grain protectants have low volatility and don't penetrate grain kernels and so won't control insects feeding inside the kernels, and also usually don't kill eggs. Soybeans stored for short time periods may not need to be treated with a grain protectant; they are less prone to insect attack by other than surface feeders than other grains. Before you use grain protectants, check with your buyer(s) to see what materials may or may not be acceptable to them for their markets. Grain with below U.S. pesticide residue tolerances may still not be acceptable to some buyers, and may not be acceptable for sale or use outside of the U.S.

Remember that grain protectants cannot replace good initial storage preparation and thoroughly cleaned equipment and bins, and that top-dressing cannot replace grain protectants.

These recommendations are based on active ingredients. These recommendations are not a substitute for carefully reading and following the pesticide label. Other registered products not mentioned may be as effective.

Pest or Application Type	Active Ingredient(s) (Products)	Rates <i>READ and FOLLOW the LABEL INSTRUCTIONS</i>	Site(s)	Re-entry Interval (REI)	Comments <i>(And see Notes after this table)</i>
Bin Repair & Sanitation			Interior and exterior of grain storage bins prior to loading.		Sanitation is critical. Repair (fix and fill holes, cracks) and <i>thoroughly</i> clean bins before loading with grain. Most pesticide product labels note sanitation as a pre-treatment procedure!
Empty Bin Residual Sprays (Bin interior and/or exterior surface treatment)	<p><i>beta</i>-Cyfluthrin (Tempo 20WP, Tempo 2.0, Tempo SC Ultra)</p> <p>Chlorpyrifos-methyl + deltamethrin (Storcide II)</p> <p>Diatomaceous earth (DE) (Insecto)</p> <p>Deltamethrin (Centynal)</p>	<p>Spray empty, cleaned bin to run-off with low pressure sprayer (“garden sprayer”) (less than 50 psi) with flat fan nozzle tip. One gal. spray covers 750–1,000 sq. ft.</p> <p>Outside bin surfaces – 1.8 fl. ozs. for 1.0 gal. of spray solution applied</p> <p>1 lb./1,000 sq. ft. of surface</p> <p>0.25 – 1.5 fl. ozs. for 1 gal. solution /1,000 sq. ft. of bin surfaces. Perimeter spray 2-3 ft. up outside foundation</p>	<p>Empty bin only</p> <p>Empty bins – <i>Exteriors only!</i></p>	<p>When sprays have dried</p>	<p><i>Do not treat grain with Tempo</i></p> <p><i>Outsides of bins only!</i></p> <p><i>Must be applied from the outside only with downward spray with high-pressure hand or automated equipment.</i></p> <p>Applied through aeration fan. May meet organic requirements.</p> <p>Fumigate empty bins. Apply Centynal for residual control. Do not allow runoff to occur or product to enter any drain</p>

	Pyriprooxyfen/ (Nylar) - (NyGuard)	and 6-10 ft. band out on ground Surface spray - 4 ml-12 ml/gal. for 1,500 sq. ft.	Empty bins	When sprays have dried	during or after application. Can tank mix with Diacon IGR. See labels. Insect growth regulator - Can tank mix with registered adulticide (not with malathion or vapona)
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<i>Empty Bin Treatment</i>	(s)- methoprene (Diacon-D IGR)	1.5 oz./1,000 sq. ft. surface area	Empty grain bins. Crack and crevice		<i>Controls larvae only.</i>
<i>Empty Bin Fumigation</i>	Aluminum phosphide - phostoxin gas (Phostoxin; Phosfume; Weevil-cide; pellets /tablets)	<i>Follow label, applicator manual instructions exactly</i>	Insects which infest stored crops	<i>Follow label, applicator manual procedures exactly</i>	Fumigate empty bin after <i>thorough</i> bin clean-out and interior residual treatment. Extremely toxic RUP with strict application procedures. No residual control.
<i>Grain Protectants</i> (Direct grain / Admixture treatment)	Pirimiphos- methyl (Actellic 5E) Chlorpyrifos- methyl + deltamethrin (Storcide II)	9.2 – 12.3 fl.ozs. (6 – 8 ppm) in 5 gal. water /1,071 bu. (30 tons) 6.6 fl oz./1,000 bu Oats 9.9 oz. /1000 bu Barley 12.4 oz./1000 bu Wheat 12.4 fl. ozs./ 1,000 bu. (For five (5) gals. of solution (3.0 ppm chlorpyrifos methyl and 0.5 ppm deltamethrin) /1,000 bu. grain)	Corn, grain sorghum only Wheat, barley, oats, grain sorghum (milo), rice, seeds with in- storage tolerances	When sprays have dried When sprays have dried	One (1) treatment per load of grain only. Use calibrated applicator. One (1) treatment per load of grain only. Use calibrated applicator. <i>U.S. marketed grain only. Not labeled for corn or soybeans.</i>

	Deltamethrin (Centynal)	7.3 – 9.1 fl. ozs./5 gal. water/1,000 bu.	Barley, corn, oats, rye, sorghum (milo) Wheat, others		May tank mix with Diacon-IGR. See label for treating stored grain seed.
	(s)-methoprene (Diacon IGR)	1 to 7 fl. oz product/5 gal. water/1,000 bu. grain <i>or</i> 0.0625 – 0.25 oz a.i./ton of commodity– rate varies with length of protection needed and kind of grain, seed – <i>see label.</i>	Any food or feed commodity		(s)methoprene <i>Is an insect growth regulator - controls larvae only.</i> Pre-treat storage facilities before filling with DIACON IGR treated commodities.
	(Diacon-D IGR)	8-10 lbs product/ 1,000 bu. of commodity	Any food or feed commodity		
	Diatomaceous earth (DE, Insecto)	1- 2 lbs./ton of grain to top 2-3 ft. of grain.			May meet organic requirements. Treatment varies with time of harvest, anticipated storage time.
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Grain Top-Dressing (Stored grain surface treatment, especially for Indian-meal moth larvae- <i>Applications are to leveled grain</i>)	Pirimiphos-methyl (Actellic 5E)	3 fl. oz/2 gal. water/1,000 sq. ft. (3.0 ppm)	Corn, grain sorghum only	When sprays have dried	Clear webbing, break-up crusting. Apply 1 gal. and rake into top 4 inches of grain; apply second gal. to raked surface.

	(s)methoprene (Diacon IGR)	0.2 teaspoon or 1.0 ml./1,000 sq. ft. <i>or</i> .6 tsp. or 3.0 ml./10,000 cu. ft. in sufficient diluent	Any commodity		Use only enough water for coverage – <i>Do not flood top-dress area.</i> Controls larvae only.
	(Diacon-D IGR)	8 lbs. product /1,000 sq.ft.			Rake to depth of 1 foot.
	<i>Bacillus thuringiensis (Bt)</i> (Biobit HP, Dipel DF, Javelin WG)	1 lb./10-20 gal. water/1,000 sq. ft.; see label			Apply to surface and rake into top 4 inches of grain; see label instructions. Controls only larvae. May meet organic requirements.
	Diatomaceous earth (DE) (Insecto)	4 lbs./1,000 sq. ft.			Especially for Indian-meal moth. May require second application for heavy infestation. Apply at monthly intervals. May meet organic requirements.
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<i>Filled Bin Fumigation</i> <i>These materials are extremely dangerous to use. You must follow all label and applicator manual instructions and procedures.</i>	Aluminum phosphide - phostoxin gas (Phostoxin; Phosfume; Weevil-cide; pellets or tablets)	<i>Follow label, product applicator manual exactly</i>	Insects which infest stored crops	<i>Fumigant detection, post-treat ventilation</i>	<i>Extremely toxic RUP.</i> Strict application procedures including placarding, fumigant detection, other required measures.
	Sulfuryl fluoride gas (Profume)		Insects which infest stored crops	<i>Follow label, product applicator manual all products.</i>	<i>Extremely toxic RUP.</i> Strict application procedures fumigant detection, other measures.

Note: Product use sites - *Read the label carefully!* Use sites vary widely from product to product. Some products may only be used to treat grain storage bin surfaces and not grain; few products may be used for both applications. Grains that may be treated, including stored grain seed, also vary widely across products. See the product labels.

Note: Product rates - *Read product labels carefully!* Rates vary with formulation of product used, use site/crop being stored, anticipated storage time, and pest species, and pest development stage. Some grain protectants may only have one (1) application made to a load. Period of control can vary with pest insect species and is shortest at the lowest rates.

Note: Pests controlled – Read the label. Not all products control all pests, especially at the lowest rates. Insect growth regulators (IGRs), such as Diacon IGR, Diacon-D IGR, NyGuard, and *Bacillus thuringiensis (Bt)* products control only immature stages (larvae, caterpillars, grubs). Control will be slow. *Bacillus thuringiensis* controls only caterpillars (moth larvae), and not beetle grubs. Some IGRs may be tank mixed with some registered insecticides controlling adults (adulticides). See the labels. When tank mixing products most stringent label applies.

Note: Formulations – Read the label. Choose the correct formulation. Be sure you have the necessary application and safety equipment and PPE to make an application with the product formulation you consider. Some formulations may not be applied directly to grain. Some products may be applied with water or food-grade oil or soybean oil, usually except for peanuts and rice.

Note: Actellic 5E – only one (1) application method is allowed per load. Only one (1) application allowed per load.

Note: Diacon IGR (s-methoprene) – Insect growth regulator controlling larvae only. Lowest rates give control for less than 6 months. May be applied with water or food-grade oil or soybean oil, except for peanuts and rice. Product may be applied with an insecticide controlling adults, such as Centynal (deltamethrin). Read the label(s). **NyGuard** (pyriproxyfen/Nylar) also may be applied with an adulticide. When tank mixing products most stringent label applies.

Note: Insecto (a diatomaceous earth product) – “Insecto Control Plan” calls for dusting the empty bin, treating the bottom 2 feet of grain, treating the top 2 feet of grain, top-dressing leveled grain with this product at labeled rates. Inspect grain bi-weekly. Organic Materials Review Institute (OMRI) Listed.

Note: Fumigants are the most effective way of controlling insect infestations in stored grain; however, fumigants provide *no* residual control. Fumigants are Restricted Use Pesticides (RUPs) and may be purchased and used only by licensed applicators. These pesticides are Danger, Danger/Poison labeled because of acute toxicity. Fumigants have strict application requirements via the label and applicator manual. Product-specific training and/or product company supervision may be required, especially for liquid and gas formulations.

Note: Malathion is registered for empty bin treatments (labeled EC formulations only) and for grain protectant treatments (labeled *dust formulations* only). However, malathion is not being recommended here as it is not seen as effective by many because of wide-spread insect resistance to it, especially in the Indian-meal moth. Further, international tolerances for malathion on grain are now much lower than U.S. tolerances, effectively making malathion treated grain unmarketable outside of the U.S. Grain buyers are telling growers that they will not accept grain treated with malathion.

Grain Bin Surface Areas and Capacities *R.G. Bellinger 12/11*

Bin Diameter (Feet)	Grain Head Surface Area or Bin Floor Area (Square feet)	Approximate Surface Area of Empty Bin (Square feet)	Bushels per Foot of Bin Height	Approximate Bin Head-space (Volume of a cone - cubic feet)
15	177	(Bin Height x 47) + 354	141	59 x cone height
18	254	(Bin Height x 57) + 508	204	85 x cone height
21	346	(Bin Height x 66) + 692	277	115 x cone height
24	452	(Bin Height x 75) + 900	362	151 x cone height
27	573	(Bin Height x 85) + 1146	458	191 x cone height
30	707	(Bin Height x 92) + 1400	566	236 x cone height
33	855	(Bin Height x 104) + 1710	685	285 x cone height
36	1,018	(Bin Height x 113) + 2000	815	339 x cone height
42	1,385	(Bin Height x 132) + 2770	1109	462 x cone height
48	1,810	(Bin Height x 151) + 3,620	1448	603 x cone height
54	2,290	(Bin Height x 170) + 4580	1833	763 x cone height
60	2,827	(Bin Height x 188) + 5654	2263	942 x cone height