STORED SEED INSECTS AND THEIR CONTROL

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Primary Grain Insects

There are only a few primary grain insects, that is, insects capable of destroying sound grain. The most important of the basic grain destroyers include the rice weevil, granary weevil, pea and bean weevils, lesser grain borer and angoumois grain moth. Of these grain pests, the rice weevil, lesser grain borer and pea and bean weevils are the most widespread and also do the most damage to seed and commercial grain.

The rice and granary weevils are similar in appearance and life histories and do the same kind of damage. However, the rice weevil is more important for it is capable of laying eggs on the grain in the field. It also is capable of flight, whereas the granary weevil is not. Both of these pests lay eggs, they then hatch and the young larvae tunnel into the grain and devour its contents.

Pea and bean weevils attack almost all seeds of the pea and bean family. Peas and beans may either be attacked in the field or in the granary. These insects are often insidious in that beans and peas may be infested in the field and not show that an infestation is present. Therefore, during the storage period heavy damage can be done to the seed.

The lesser grain borer is perhaps the most widespread of our primary grain insects. In many states it is considerably more prevalent in stored grain and seeds than are the other weevils. This insect does not fly, but deposits its eggs on the surface of the grain in storage. The larvae then enter the seed and tunnel out its contents.

The angoumois grain moth, at one time, was a very serious pest of corn and wheat. The adult is a moth and is capable of infesting grain in the field. In the old days when corn was picked and brought into the granary and stored as ear corn, this insect often did serious damage. Likewise, before invention of the combine, this pest infested wheat in the field, often doing heavy damage before the crop was threshed and stored.

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Secondary Grain Insects

The grain trade generally refers to a complex of secondary grain beetles as "bran bugs". These so called bran bugs are all members of the beetle family and feed on bits and fragments of grain, cereals, and mill products. These insects include the various flour beetles, the sawtoothed grain beetle, flat grain beetle and others.

The flour beetles are common in grain and milled products. They are especially important to the milling industry because of the fact that they may impart an odor to the flour or other finished products.

The sawtoothed grain beetle is so-called because of the saw-like projections on the middle body segment. This insect is very universal and is found not only in stored grain but in cereals, dog food, nuts and other products around the home, as well as on the farm and in industry.

The Indian meal moth is one of the most serious pests attacking stored grain and cereal products. It will attack almost any kind of grain that has been stored for a period of time. It is not a pest of grains that are either in transit or are moved quite regularly. The adult moth may be easily distinguished from other moth-like grain insects because it has a copper color on the outer two-thirds of its front wings. The female lays about 200 eggs, placing them on the surface of the grain. The caterpillars that hatch from these eggs are whitish in color and about half an inch long when mature. The larvae may completely web over the surface of grain, thus preventing proper aeration and/or fumigation, etc.

At one time, premium grade malathion applied to the surface of the grain adequately controlled this pest. However, in recent years the pest has developed a tolerance to malathion. Recently, workers at the USDA Grain Marketing Research Laboratory, Manhattan, Kansas, have discovered that a biological insecticide, Bacillus thuringiensis, sold as Dipel, when applied to the surface of stored grain, gives adequate protection against the Indian meal moth. This material is now available either as a wettable powder or a dust.

The cadelle beetle is an elongate black beetle about 1/3 of an inch long. The large white larvae grow to be about 3/4 of an inch long and has the habit of burrowing into the woodwork of bins where they are hard to control. This insect, like the other secondary grain pests, does not destroy sound grain but feeds upon grain fragments and mill products. Since most of the granaries now in use are made of metal, this insect has lost much of its importance as a grain pest.

Meal worms resemble wireworms in appearance and when fully grown are from 1 to 1¼ inches in length. Meal worms are scavengers by nature and prefer to feed on grain or mill products that are damp and in poor condition. They are commonly found under bags of feed, in warehouses
and other storage areas and in grain bins where some of the grain has become damp.

Factors Determining Insect Damage

It should be remembered that most stored grain insects are tropical in origin; therefore, in the United States they are active at rather high temperatures. Most grain insects are active at 60 to 70°F and higher, and activity for most of them ceases at 50°F or below. This is the main reason why stored grain pests are not the problem in the northern part of the United States that they are in the southern. Remember that we are talking about grain temperatures and not air temperatures. It should be remembered that seasonally, the temperature of stored grain in a bin or granary lags behind the outside air temperature.

Grain moisture is more important than grain temperature as a determining factor for insect growth and development. However, it should be remembered that both are interrelated because moisture plus insect activity will create an elevation in temperature. We are all aware of the so-called "hot spots" in grain and the fact that there is increased likelihood of finding insects in those areas.

Relative humidity definitely has an effect on the moisture content of the seed. In fact, the moisture content of the seed and the relative humidity of the air will come into equilibrium eventually. For instance, at a relative humidity of 80%, corn seed will contain about 14% moisture, whereas if the relative humidity is 45%, the corn will have an approximate moisture content of 9%.

To maintain high quality seed, it is important to reduce the moisture content of the grain as soon as possible after harvest. This, of course, can be done by aeration and/or drying of the grain. Also, it is important that one reduce the temperature of the grain mass as soon as possible. For summer-stored grains, this presents a problem; however, some producers run the fans on their aeration equipment at night when the temperature is cooler and shut them off during the day.

The estimated safe seed moisture content for storage for one year on sweet corn is 14% at 40-50°F. At 80°F the same corn should be dried to a moisture content of 8% to insure it being good seed for a one year storage period.

As stated above, grain in the southern states, which is harvested in the spring and summer, needs to have the temperature and moisture content reduced by aeration and/or drying. In more northern states, with fall harvested grain, it is generally not as important to reduce the temperature of the grain, since the nights at that time of year are cooling down. However, some grain in the northern areas is harvested with considerable moisture content. This moisture content needs to be
reduced so that the grain can be safely stored.

Control of Stored Seed Insects

One should constantly keep in mind that insect pests of stored seed generally originate in the immediate area of the storage site. In other words, they are not brought in from the field, nor do they fly in from that area. A few of the pests, such as the grain moths, have wings and can fly. However, they generally move from one bin site to another in a localized area. Therefore, the importance of a good clean-up program and the use of a residual insecticide in the storage site are very important. In cleaning up, it is extremely important to remove insects from cracks, crevices, below slated floors, at the bottom of elevators and dumps, etc. Also, spilled grain, even on the outside of the bin, should be removed. A vacuum cleaner is a splendid instrument for clean up of a bin.

After clean up, a residual insecticide should be applied to the inside and outside of the bin. Premium grade malathion is the best insecticide to use as a residual spray. Methoxychlor may be used; however, it does not have the residual effect of malathion. The residual spray should be applied to the point of runoff and for optimum results should be applied at least two weeks before grain goes into the granary.

Many seed producers apply premium grade malathion to the seed as it goes in storage. Some prefer to apply the malathion as a liquid. The liquid may be applied to the grain as a fine mist or allowed to trickle into the grain as it moves through the auger or conveyor. Malathion is also available as a dust which may simply be applied to the seed in the same manner. The dust form has an added advantage in that it can be merely sprinkled on top of the grain in the truck before it is augered into the bin. By the time the grain reaches its final resting place, the malathion is mixed uniformly with it to the point of giving good protection.

Some producers also like to top dress their bins with the malathion. The malathion may simply be sprayed or dusted over the surface of the grain. This treatment will give added protection to the grain from most insects entering the grain mass from the surface. However, you should keep in mind that the top dressing with malathion is only partially effective against infestations of the Indian meal moth.

It goes without saying that bins should be checked regularly for signs of insect activity. Inspections will also reveal any "hot spots" in the grain. During warm weather many producers inspect their bins every two to four weeks and check them once a month during the winter period. Sampling of the grain mass is easily done with a standard grain probe. Thermometers are available to give temperature readings in the
bin. However, if you do not have a thermometer, you can merely insert a steel rod into the grain, let it stand for a few minutes, remove it, and by running your hand over the rod you can tell at which level "hot spots" may be present.

To determine which insects are present, one can depositi the grain from the grain probe into a section of rain guttering. This will indicate to you at which level there may be insects present. Sifting the grain through standard grain sieves will allow the producer to determine which insects are present and their amount.

For spring-harvested grain, some seedsmen automatically fumigate the grain six to eight weeks after putting it in storage. This will kill insects brought in from the field and also those that may have been present in the bin. Fall harvested grain, such as corn, may or may not need a fumigation after binning.

Since many varieties of peas, beans, and vetch are infested by weevils in the field, it is especially important to fumigate these grains before they are stored for any period of time. In fact, some seed processors automatically fumigate all harvested peas and beans either with phostoxin or liquid fumigants immediately before cleaning and shipping. Most of this is done in the fall soon after the beans come in from the field. Others may clean and bag the peas and beans and then fumigate the bags with phostoxin during storage in the warehouse.

A few seedsmen fumigate bins each time that they are empty; however, most do not. Most processors will, at some time or other, fumigate warehouses of bagged grain. Since liquid fumigants do not work well under these conditions, most use phostoxin for this purpose. A few dealers still continue to use hydrogen cyanide fumigation. However, fumigation with this material should be done by an experienced pest control company. Some still use pyrethrum as a space spray, but since it is becoming very expensive and in short supply, most have converted to other materials. The insecticide Vapona in a fogging machine is used by some dealers as a space spray in their warehouses; however, it should be remembered that this material applied as a space spray will not control the primary grain insects.

Phostoxin gives good results when used to fumigate bagged grain in the warehouse. Some dealers use phostoxin as a space fumigant in their warehouses, especially so if they are having a problem of insects in the building itself. However, most simply use the phostoxin to treat only the bagged grain, placing a tarp over the bags to contain the vapors.

One large company with several wholesale and retail outlets automatically shuts down their activities in the fall around Thanksgiving. They call in a professional pest control company which applies hydrogen cyanide. The cyanide is allowed to work for about three days, then the warehouses are opened again. The manager states that treatment in such
a manner in expensive but does a job of keeping the plant insect free. An added bonus is the fact that excellent mouse, rat and bird control is obtained by this type of application.

The Effect of Fumigation on Seed Germination

Seedsmen should keep in mind that fumigation under some conditions will decrease germination of seed. High temperatures while fumigating, such as temperatures above 85° are liable to be damaging to the seed. Likewise, fumigation under high moisture conditions can be dangerous to the viability of seeds. A moisture content of less than 12% on seed is generally required; below 10% moisture is preferred. The application of very high dosages of a fumigant is also a factor in decreased germination. Therefore, one should carefully follow the dosage rates listed on the label. Also, long exposure to the fumigant may be a factor in decreased germination. As a rule of thumb, exposures of less than 24 hours to the fumigant should be the rule; less than 12 hours is preferred.

Most standard liquid grain fumigants are mixtures and used as such will not decrease germination of seed provided they are used according to label rates and directions. However, one should keep in mind that several available fumigants, both liquid and gas, may present a hazard to germination. These include chloropicrin, ethylene dibromide, methyl bromide, and sulphur dioxide. On the other hand, hydrogen cyanide and phostoxin have not presented problems in decreased viability of seed.

Indian Meal Moth and Its Control

The Indian meal moth is one of the most serious pests of stored seeds and grains. This pest does not chew holes in sound grain, but feeds on grain fragments and webs up the surface area of the grain. In doing so, it promotes mold and grain deterioration. The larvae of this insect is dirty-white in color and about ¼ inch long when mature. In the larval stage it moves about over the grain spinning a web as it goes. The adult moths do no damage except to lay eggs for the next generation. There are several generations during the summer months, each one being approximately one month in length. Of course, during the winter, activity ceases, but the insect is able to overwinter both as a larva and pupa.

With the advent of warmer weather in the spring, the larvae become active and adults will be found flying about. It must be remembered that this insect in the adult stage is able to fly from bin to bin or even from the neighbor's bin to start a new infestation.
Once this pest heavily infests a granary, the heavy webbing produced will often prevent a fumigant from penetrating the grain. If this is the case, it is necessary to remove the webbed-over layer of grain so that adequate control may be obtained.

Previously, the method used to prevent Indian meal moth infestations was to top dress the grain after it was placed in the granary. But with the advent of a developed resistance to malathion, this method does not always give adequate protection.

The insecticide Dipel can be used to treat the last grain going into the bin or may be used as a top dressing and mixed into the top four inches of grain in the bin. Either method gives excellent protection. Dipel is available either as a dust or wettable powder. The wettable powder, when mixed with water, is applied as a spray.

If one has "webbed-over" grain from an existing infestation of meal moth, it is advisable to skim off the webbed material, then one can institute several measures. One can either spray or dust malathion or use the Dipel spray or dust on the surface and rake it into the top four inches. Or, one can apply a standard grain fumigant. To complete the job, one should then hang insect pest strips containing Vapona (DDV) in the headspace above the grain.

In heavy existing infestations of Indian meal moth, one should probably use one of the liquid grain fumigants or phostoxin pellets to clean up the infestation. Any of the liquid grain fumigants will do a pretty good job except 80-20 (80% carbon tetrachloride - 20% carbon bisulfide). Phostoxin is okay and it is necessary to introduce it only in the upper part of the bin, since this insect rarely occurs in more than the top four to six inches of the grain. After treating with a fumigant, then apply the malathion or Dipel.

The insect pest strips serve to kill the adult moths, but are not effective on the larval stage. However, if strips are in place and kill the adults as they emerge, one can successfully break the life cycle of this pest.

For best control, the insect strips should be hung during spring or early summer soon after the larvae begin their activity and before large numbers of moths emerge. Each of these strips is adequate for 1,000 cubic feet of headspace. Therefore, in most bins one strip would be adequate. These strips should be replaced every 1 to 1½ months because you will want to keep a heavy concentration of insecticide in the atmosphere at all times.

Unfortunately, the insect pest strips will not work in large, flat storage areas where there are open doors and windows, etc. The air must be without appreciable movement for these strips to do an adequate job.
Even if a person has not had an infestation of Indian meal moth in his storage, it is perhaps a good idea to hang the insect strips, thus preventing this pest from becoming established.

Note: Most of the research involving the Indian meal moth was conducted at the U.S. Grain Marketing Research Laboratory, Manhattan, Kansas 66502. Specific questions concerning this subject may either be directed to that laboratory or to the author.