SDSU Extension

iGrow Corn

BEST MANAGEMENT PRACTICES

Chapter: 52
Stored Grain Pests of Corn

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Several species of insects, as well as rodents and other animals, are economically important pests of stored grains. Unfortunately, this means that integrated pest management (IPM) for your corn crop is not finished until the grain has been delivered and accepted by the commercial buyer. The final stages of an IPM plan for your corn actually start before harvest and continue while the corn is being stored in bin facilities. During this storage period, the kernels are susceptible to direct damage from feeding unless necessary precautions are taken. The purpose of this chapter is to discuss storage sanitation considerations, stored grain insect pest management, bin aeration, and common stored grain insect pests of corn.

Corn Storage Damage

Direct insect feeding reduces germination, nutrition, weight, and ultimately market value. Insects and other animals also cause indirect damage, which results in the contamination and deterioration of the grain. This in turn, leads to reduced quality and lower market value, which can be attributed to the presence of heat damage, intact dead insects, insect parts, odors, or molds. The current Federal Grain Inspection Service (FGIS) regulation used to determine whether corn is infested, and also grading based on the maximum limits for broken corn and foreign material (e.g., dead insects or insect parts) are presented in Table 52.1.

Table 52.1 FGIS infested designation and grade standards for corn.

Crop	Insects per 2.2 pounds of grain to receive FGIS "infested" designation	Maximum limits of broken corn and foreign material[1] (percent) by grade
Corn	2 live weevils 1 live weevil + 5 other live stored grain pests 10 other live stored grain pests	U.S. No. 1: 2.0 U.S. No. 2: 3.0 U.S. No. 3: 4.0 U.S. No. 4: 5.0 U.S. No. 5: 7.0 U.S. Sample Grade: > 7.0

[1]Foreign material includes all matter that will pass through a 12/64 round-hole sieve.

It is important to remember that the insect pests attacking corn in the field are not the same species as the ones attacking the stored crop. Because damaged grain results in docked or reduced market prices, it is important to use an IPM plan with preventative tactics and routinely monitor grain bins for pest activity. These approaches rely heavily on preventative actions including sanitation, pre-binning insecticide

applications, and early detection of problems post-binning. This type of IPM plan should be employed until the grain leaves the farm.

Storage Sanitation Considerations

To ensure that the quality of stored grain is preserved, it is important to establish and follow an IPM plan (Table 52.2). A leading cause of decreased grain quality is improper storage conditions, especially poor sanitation. Proper sanitation accounts for approximately 80% of an effective IPM plan for stored grain. "Good" sanitation includes:

1. Determining whether the bin is weatherproof and does not have any leaks. Any holes or gaps should be caulked/sealed. After the bin is filled, the door should be caulked/sealed to remove potential entry points for insects and rodents.
2. Removing any established pests and their food sources prior to filling the grain bin. Bins should be swept and/or vacuumed, with special attention given to cracks and crevices of the floor.
3. Cleaning up any grain spills around the outside of the bin. All grain and dust should be disposed of away from the bin.
4. Establishing a 10-ft perimeter outside the bin that is devoid of vegetation and garbage.
5. Cleaning equipment used seasonally for handling or transporting grain.

Following these steps will reduce the chances of stored grain pests accidentally being introduced to the new crop during binning, and also reduce the overall chances of infestation.

Stored Grain Insect Pest Management

It is recommended that new grain should never be stored on top of old grain. However, if this situation arises, the old grain must be fumigated prior to the addition of new grain (Table 52.3). Fumigants are extremely hazardous, restricted-use insecticides and require a commercial applicators license with class 14 certification, or a private applicator certification in South Dakota. Because of the hazards associated with these insecticides, it is recommended to leave the application of fumigants to professionals. Additionally, fumigants have no residual period and are effective only against insects present in the grain at the time of application. Grain is susceptible to reinfestation within 72 hours post-application.

For an empty bin, a pre-binning application of a residual insecticide should be applied to all of the interior surfaces and also to the exterior walls and base once the debris has been removed (Table 52.4). Follow the label instructions regarding application rate, personal protective equipment, and re-entry times. Once the re-entry interval has expired, remove any insects that were killed by the insecticide.

For corn that will be removed from storage in May or June or used as a livestock feed within a year of harvest, protectant insecticides most likely will not be required (Table 52.4). A protectant insecticide should be applied to corn that is expected to be stored for greater than one year, and it should be applied only after high-temperature drying when the corn moisture is approximately 14% to 15%. These insecticides can be applied at the auger while the bin is being filled, or as a surface treatment that is referred to as either topdressing or capping-off.

Stored corn with a temperature above 55-60°F should be inspected each week, and every two weeks when the temperature is below 55°F. When inspecting stored grain, it is important to remember the associated hazards (Table 52.5). If an insect infestation is detected in stored grain, the grain can be: 1) moved to have a protectant insecticide applied; 2) fed to livestock as-is; 3) sold at a reduced market value; or 4) fumigated.

Bin Aeration

Stored grain insect pest development slows down when grain temperatures decrease to 60°F, and essentially stops when the temperature decreases below 55°F. Because of this, it is important to reduce grain temperatures to limit the risks of developing stored grain pest issues. Stored grain can be cooled once the outdoor temperatures begin to drop in the fall. For bins that are equipped with fans, run the fan during cooler temperatures. In addition to reducing potential insect issues, proper grain aeration will help

Table 52.2 The seven steps to a stored grain integrated pest management (IPM) plan:

Step 1. Structural maintenance: keep bins clean and repaired.

All season:

- Keep a 10-ft perimeter around the bin free of vegetation and trash.
- Clean up grain spills outside of the bin.

Pre-binning:

- Confirm that bin facilities are weathertight and rodent-proof; seal any holes.
- Screen ventilation openings to prevent entry of rodents and birds.
- *Do not mix new and old grain; remove all old grain from bin or fumigate old grain.
- *Use a broom, shop vacuum, or compressed air to clean the interior bin walls, ceiling, ledges, floors, and sills prior to filling with new grain.
- *Use a broom, shop vacuum, or compressed air to clean combines, wagons, grain carts, trailers, augers, and aeration equipment prior to handling new grain.
- Dispose of any debris removed from bins or machinery as insects may be present.
- Examine the outer bin perimeter to determine whether rodent bait stations are necessary.

Post-binning:

- Caulk around any doors.
- Do not seal roof aeration exhaust of inlet vents except during fumigation.

Step 2. Residual insecticide sprays (Table 52.4).

Pre-binning:

- Spray the interior wall surfaces, ledges, floors, and sills with a residual insecticide.
- Spray exterior walls (10-15 ft vertically up from bin base depending on label) and exterior base.
- For long-term storage (> 1 year) consider fumigating the area beneath the slotted floor (Table 52.3 for information regarding fumigants).

Step 3. Condition grain: store clean, dry grain.

Pre-binning:

- For long-term storage, corn moisture should be 15% or less.
- Use a grain cleaner to remove cracked kernels and other debris.

Step 4. Use insecticide protectants (Table 52.4).

- Treat grain at the auger as it is moved into storage or apply a topdressing.

Step 5. Proper aeration of grain.

Post-binning:

- Run bin fan and stirator to ensure uniform temperatures and prevent moisture buildup. This will reduce mold growth.
- Cool bin to a temperature below 55°F to reduce insect activity and inhibit mold growth.

Step 6. Regularly inspect the grain.

Post-binning: (if problems are detected, see Step 7)

- Monitor the grain regularly for the presence of insects, or insect parts. For grain above 55-60°F inspect weekly. For grain below 55°F inspect every two weeks. Inspection should continue from binning until the grain is marketed.
- Use a grain probe to take samples in a pattern from the surface and from the base of the grain mass.
- Take samples from the center to the areas near the wall, with samples being no farther than 20 feet apart.
- "Hot spots" felt on the grain surface or unusual odors are indicators of insect activity and should be examined.
- During the winter, insects will move to the center of the bin, so sampling at that location is important.

Step 7. Treating detected infestations.

Post-binning:

- If an insect infestation is detected:
    1. Move the grain and re-treat as in Step 4. It is possible to kill some of the insects if the grain is moved during cold weather (below 32°F).
    2. Feed the grain to livestock.
    3. Sell at a reduced price.
    4. Fumigate (Table 52.3).

*These precautionary maintenance steps should be taken 2-3 weeks prior to binning.

Table 52.3 Fumigant insecticides that can be used on stored corn grain.[1]

Active Ingredient	Insecticide*	Restricted Entry Interval (REI)	Comments
Aluminum phosphide	Detia Fumex Fumitoxin Gastoxin Phostoxin Weevil-cide	Corn must be aerated after fumigation. Do not enter bin if phosphine or hydrogen phosphide gas levels are above 0.3 ppm[2] unless protected by approved respirator.	Do not fumigate if temperature is below 40°F. Follow the minimum exposure period guide on the label. Fumigated areas must be placarded according to each product's label. Some products require grain to be aerated for 48 hours prior to offering to end consumer.
Carbon dioxide (CO_2)	Carbon dioxide	When CO_2 levels are below 5%.	Works best with grain bins designed for "closed-loop fumigation." Requires specialized application equipment. Fumigation with CO_2 takes 10 or more days. Self-contained breathing apparatus must be worn; respirators are not effective against CO_2.
Magnesium phosphide	Magtoxin	Corn must be aerated after fumigation. Do not enter bin if phosphine gas level is above 0.3 ppm unless protected by approved respirator.	Do not fumigate if temperature is below 40°F. Follow the minimum exposure period guide on the label. Fumigated areas must be placarded according to each product's label.
Methyl bromide	Meth-O-Gas 100	Corn must be aerated after fumigation. Do not enter the bin if methyl bromide levels are above 5 ppm unless protected by a full-face supplied-air respirator or self-contained breathing apparatus.	Do not fumigate if temperature is below 40°F. Fumigated areas must be placarded according to each product's label.

[1]All fumigant insecticides are restricted-use products and cannot be purchased or applied without proper certification and permit or licensing. Follow all label instructions.
[2]Parts per million (ppm)
**This list is not meant to be comprehensive. Mention of a trade name neither constitutes endorsement of the products mentioned nor criticism of similar ones not used or mentioned.*

Table 52.4 Pre-binning corn grain residual and protectant insecticides.[1]

Active Ingredient	Insecticide*	Restricted Entry Interval (REI)	Comments
Bacillus thuringiensis kurstaki	DiPel® DF Biobit® HP	4 hours	Protectant insecticide to be applied as a topdressing to the top 4 inches of stored corn. Will not control weevils or other beetles. Effective against Indian meal moth larvae. Labeled for organic production.
Beta-cyfluthrin	Tempo® SC Ultra	When spray has dried.	Do not allow runoff to occur. Pre-binning residual spray only.
Deltamethrin	Suspend SC Centynal	When spray has dried.	Suspend: Do not allow runoff to occur. Pre-binning residual spray only. Centynal: Do not reapply within 21 days. May be applied as a protectant while grain is being loaded into the bin. Can be used as a pre-binning residual spray.
Dichlorvos resin strips (DDVP)	Nuvan Prostrips®	N/A	Treatment normally lasts 4 months. One 16 gram strip treats 100-200 cubic feet. Place strips in the headspace of the bin. Wear gloves when applying strips.
Pirimiphos-methyl	Actellic 5E	When spray has dried.	May be applied while grain is being loaded into bin or as a topdressing, cannot be used for both. Do not make more than one application per year.
Pyrethrin	Pyronyl	12 hours	Do not reapply within 30 days. May be applied as a protectant while grain is being loaded into the bin. Can be used as a pre-binning residual spray.
Malathion	6% Malathion Grain Dust Malathion 5EC	12 hours	Malathion dust: Apply to grain prior to loading bin. Do not apply to grain within 7 days of selling. Malathion 5EC: Pre-binning residual spray only, do not spray directly onto grain.
(S)-methoprene	Diacon IGR Diacon D IGR	30 minutes	Apply to grain as it is being loaded into bin, or apply as a topdressing, but do not flood area. May be used with aeration.
Silicon dioxide (diatomaceous earth)	Dryacide Insecto	Once dust settle	Can be applied to grain when being loaded into the bin. Can also be applied as a pre-binning residual insecticide. Labeled for organic production. Overapplication of products may reduce grade of grain.

[1]Follow the label instructions for all pesticides. Always wear proper personal protective equipment.
**This list is not meant to be comprehensive. Mention of a trade name neither constitutes endorsement of the products mentioned nor criticism of similar ones not used or mentioned.*

Table 52.5 Bin-sampling safety protocol.
There are many potential hazards associated with sampling inside of a grain bin. For instance, suffocation can occur in grain bins due to bridged grain. Bridged grain occurs when grain mats together and forms a false floor. When the false floor is broken during sampling procedures, cave-ins can occur. Where possible:

1. Always have another person with a cellphone outside the bin in case there is a problem.
2. Wear a harness that is attached to a properly secured rope when entering a grain bin.
3. Use a pole to break up crusted grain from a distance.
4. If the grain begins to flow stay near the outer wall of the bin and continue walking and get to the bin ladder as quickly as possible.

maintain uniform temperatures throughout the bin. This will eliminate "hot pockets" that are favored by insects and mold. To ensure optimal airflow, level off the grain once the bin has been filled. When the grain is not level, areas with peaks can provide optimal conditions for stored grain insect outbreaks and mold growth.

Common Stored Grain Insect Pests of Corn

There are several species of insects that feed on stored grain in South Dakota. Both immature (larval) and adult stages of stored grain beetles are capable of causing damage to grain, while only the larval stage of the stored grain moths cause damage. These insect pests can be grouped based on whether they are internal feeders or external feeders. Internal feeders feed within the kernels, whereas external feeders consume grain dusts, cracked kernels, and other grain debris. Below are the common internal and external stored grain pests. In addition to these, other species including the foreign grain beetle and hairy fungus beetle may be observed in a bin feeding on molds or fungi growing on the grain.

Internal Feeders

Of the internal feeders, the weevils (Fig. 52.1A, B, and C) are generally given the most attention because they are among the most destructive pests of stored grain. The larvae of grain weevils develop within the kernels, and this pest can cause nearly complete destruction when infested grain is left undisturbed for long periods of time. Adult weevils are easily distinguished from other beetles by their elongated snouts.

The lesser grain borer (Fig. 52.1D) is a pest of a wide variety of grains including corn. The larvae and adult bore holes into whole undamaged kernels. Evidence of feeding may include a sweet musty odor and dust and thin brown shells on grain kernels.

The larvae of the angoumois grain moth (Fig. 52.1E, adult moth) are typically not a pest of shelled corn. However, the larvae are a pest of ear corn and can infest the corn before it is harvested. The larvae feed inside kernels, and cause an unpleasant smell. During a warm fall, several generations of the moth can complete their life cycle, resulting in significant damage.

External Feeders

External feeders consume grain dusts, cracked kernels, or other grain debris when present. The best management for these insects is prevention that includes proper aeration and corn grain cleaning.

The cadelle beetle (Fig. 52.2A), confused flour beetle (Fig. 52.2B), flat grain beetle (Fig. 52.2C), red flour beetle (Fig. 52.2D), and sawtoothed grain beetle (Fig. 52.2E) are present in the grain due to the availability of cracked kernels, dust, and other grain debris. In some instances, these beetles will feed on kernels that were damaged by internal feeders.

The larvae of the Indian meal moth (Fig. 52.2F, adult moth) cause direct damage to the grain by feeding on the seed germ. The larvae of this pest also reduce the quality of grain by producing waste and constructing silken webs in the grain.

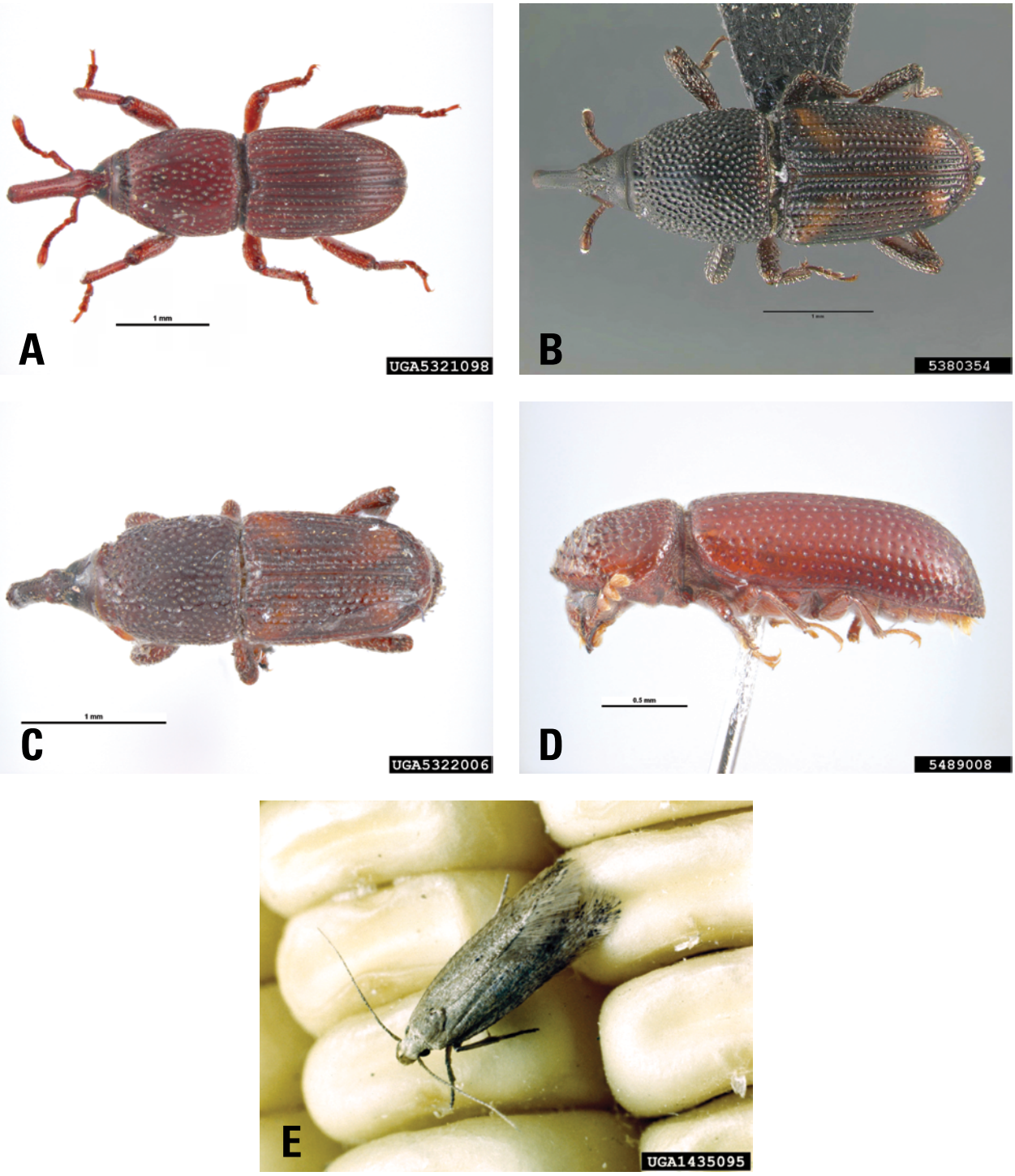

Figure 52.1 Internal feeding stored corn grain pests. (A) Granary weevil (aka wheat weevil) adult. (Photo courtesy of Pest and Diseases Image Library, Bugwood.org); (B) Maize weevil adult. (Photo courtesy of Gary Alpert, Harvard University, Bugwood.org); (C) Rice weevil adult. (Photo courtesy of Pest and Diseases Image Library, Bugwood.org); (D) Lesser grain borer adult. (Photo courtesy of Pest and Diseases Image Library, Bugwood.org); (E) Angoumois grain moth adult. (Photo courtesy of Clemson University-USDA Cooperative Extension Slide Series, Bugwood.org)

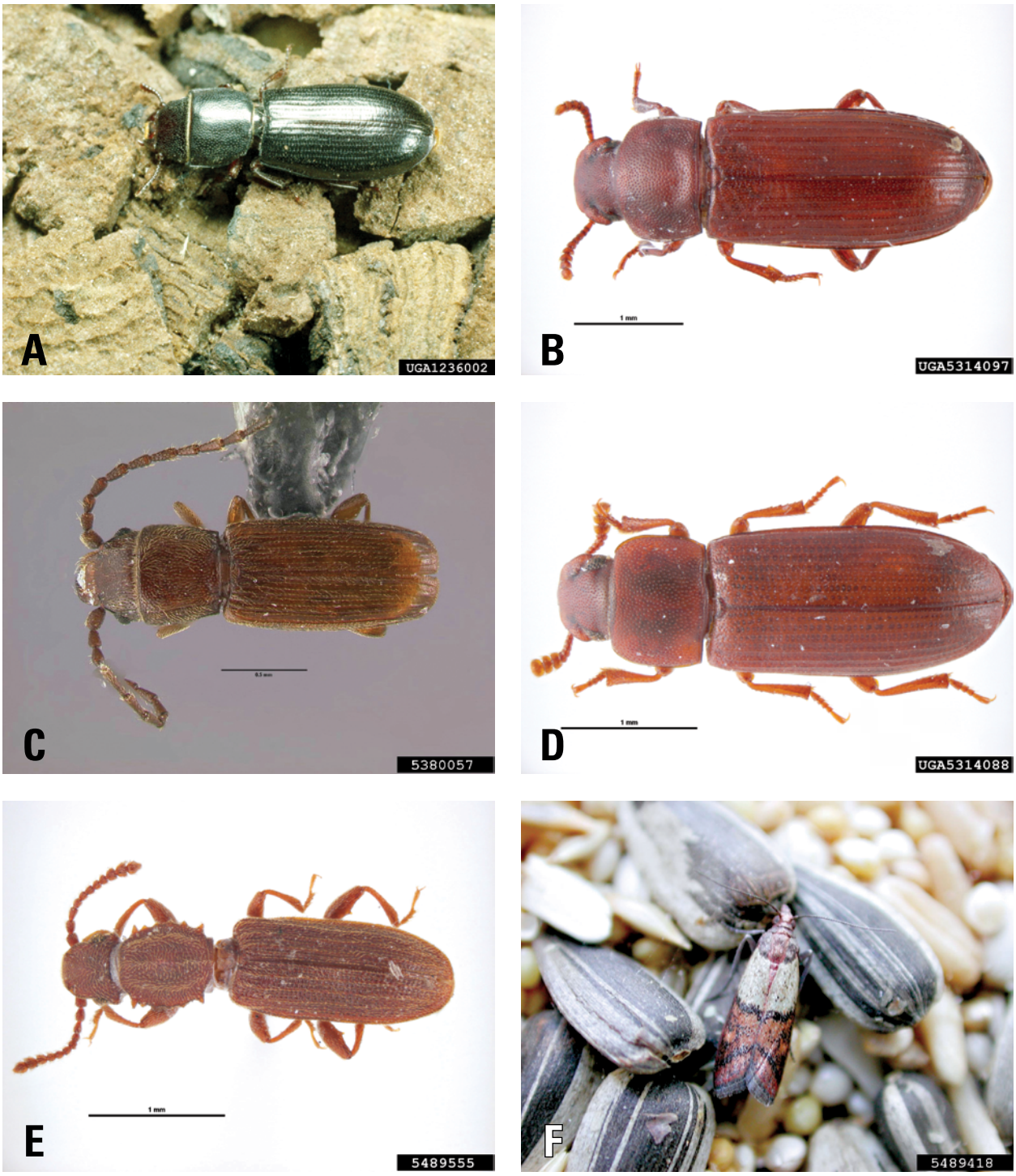

Figure 52.2 External feeding stored grain pests. (A) Cadelle beetle adult. (Photo courtesy of Clemson University-USDA Cooperative Extension Slide Series, Bugwood.org); (B) Confused flour beetle adult. (Photo courtesy of Pest and Diseases Image Library, Bugwood.org); (C) Flat grain beetle. (Photo courtesy of Gary Alpert, Harvard University, Bugwood.org); (D) Red flour beetle adult. (Photo courtesy of Pest and Diseases Image Library, Bugwood.org); (E) Sawtoothed grain beetle. (Photo courtesy of Pest and Diseases Image Library, Bugwood.org); (F) Indian meal moth adult. (Photo courtesy of Pest and Disease Image Library, Bugwood.org)

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Acknowledgements

Support for this document was provided by South Dakota State University, SDSU Extension, and the South Dakota Corn Utilization Council. The authors would like to thank Dr. Kenneth Holscher for his help with editing and reviewing this chapter.

Varenhorst, A.J. and B. Fuller. 2016. Chapter 52: Stored Grain Pests of Corn. In Clay, D.E., C.G. Carlson, S.A. Clay, and E. Byamukama (eds). iGrow Corn: Best Management Practices. South Dakota State University.

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