SDSU Extension

iGrow Corn

BEST MANAGEMENT PRACTICES

Chapter: 46
Mycotoxins in Corn

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Figure 46.1 Aspergillus ear rot. (Photo courtesy of Gary Munkvold, Iowa State University)

Mycotoxins are secondary metabolites produced by some fungi that are highly toxic to humans and animals. Consequently, the presence of mycotoxins can raise serious concerns if allowed to enter the food chain. Some fungal pathogens infect corn ears and cause ear rots/molds and in addition to reducing corn yield, produce the mycotoxins. Mycotoxin consumption in livestock can lead to reduced intake or feed refusal, altered endocrine system, suppressed immune function, and other effects. Corn showing symptoms of fungal infections that produce mycotoxins should be sampled and sent for laboratory analysis. Production of mycotoxins starts in the field, and may continue during the storage period, depending on storage conditions. Mycotoxin levels never decrease during storage, but concentrations may increase if grain is not stored correctly.

To minimize mycotoxins in the food supply, the Food and Drug Administration has established action and advisory levels for these compounds. Mycotoxins and their level of toxicity vary by fungal pathogens producing them. Therefore, each mycotoxin has a different acceptable maximum level, depending on the end-use product or the animal consuming the product. The purpose of this chapter is to discuss mycotoxins in corn production.

Introduction

There are several mycotoxins that can contaminate corn. These include: aflatoxins produced by *Aspergillus spp* (Fig. 46.1); fumonisins, deoxynivalenol (also known as vomitoxin) and zearalenone produced by *Fusarium spp*.; and ochratoxins produced by *Penicillium verrucosum*. The level of mycotoxin(s) contaminating grain is dependent on many factors, including: the incidence and severity of ear rot in the field; the amount of damage on corn kernels during combining; the prevailing weather conditions (Robertson et al, 2011); and the adoption of cultural practices that minimize yield-limiting factors.

Aflatoxins

The fungus Aspergillus flavus produces aflatoxins in corn. This fungus is abundant in nature, but

Table 46.1 FDA action levels for aflatoxins in human food, animal feed, and animal feed ingredients.

Intended Use	Grain, Grain Byproduct, Feed or Other Products	Aflatoxin Level (ppb)
Human consumption	Milk	0.5 ppb
Human consumption	Foods, peanuts and peanut products, brazil and pistachio nuts	20 ppb
Immature animals	Corn, peanut products, and other animal feeds and ingredients, excluding cottonseed meal	20 ppb
Dairy animals, animals not listed above, or unknown use	Corn, peanut products, cottonseed, and other animal feeds and ingredients	20 ppb
Breeding cattle, breeding swine and mature poultry	Corn and peanut products	100 ppb
Finishing swine 100 pounds or greater in weight	Corn and peanut products	200 ppb
Finishing (i.e., feedlot) beef cattle	Corn and peanut products	300 ppb

(Source: National Grain and Feed Association)

infection in corn is favored by dry and hot weather during grain fill, and at or after physiological maturity. Aflatoxins are highly toxic and carcinogenic. Consumption of aflatoxins by livestock can cause feed refusal, reduced growth rate, and rough hair coat among other symptoms. The FDA-established action level for aflatoxin in grain is 20 ppb in lactating dairy cows. The level of aflatoxin for beef cattle, swine, or poultry is 100 ppb (Table 46.1). In combination with drought, other stress factors such as insect injury, nematode infestation, and fertility stress can increase chances for this mold to develop.

Fumonisins

Fumonisins are a family of mycotoxins produced by many species of Fusarium including the corn pathogens *Fusarium verticillioides* and *F. proliferatum*. Corn ears with Fusarium ear rot typically have scattered infected kernels on ears. Kernels with moisture levels > 18% have increased chances for Fusarium infection. Fumonisin consumption in animals affects the liver of cattle and immune system in pigs and poultry. Allowable amount of fumonisins varies by animal type and the age of the animal (Table 46.2).

Table 46.2 FDA guidance levels for fumonisin in animal feed.

Class of Animal	Grain or Grain Byproducts	Total Fumonisins (FB1, FB2 and FB3) Levels in Grain or Grain Byproducts and (Complete Diet) [parts per million (ppm)]
Horses and Rabbits	Corn and corn byproducts not to exceed 20% of diet**	5 ppm (1ppm)
Swine and Catfish	Corn and corn byproducts not to exceed 50% of diet	20 ppm (10 ppm)
Breeding Ruminants, Breeding Poultry and Breeding Mink*	Corn and corn byproducts not to exceed 50% of diet	30 ppm (15 ppm)
Ruminant > 3 months old being raised for slaughter and mink being raise for pelt production	Corn and corn byproducts not to exceed 50% of diet**	60 ppm (30 ppm)
Poultry being raised for slaughter	Corn and corn byproducts not to exceed 50% of diet**	100 ppm (50 ppm)
All Other Species or Classes of livestock and pet animals	50% of diet**	10 ppm (5 ppm)
Livestock and Pet Animals		10 ppm (5 ppm)

*Includes lactating dairy cattle and hens laying eggs for human consumption
**Dry weight basis
(Source: National Grain and Feed Association)

Table 46.3 FDA advisory levels for vomitoxin.

Intended Use	Grain or Byproducts	Vomitoxin levels in grains or grain byproducts and complete diet
Human Consumption	Finished products	1 ppm
Swine	Grain and grain byproducts not to exceed 20% of diet	5 ppm (1 ppm)**
Chickens	Grain and grain byproducts not to exceed 50% of diet	10 ppm (5 ppm)**
Ruminating beef and feedlot cattle older than 4 months	Grain and grain byproducts *	10 ppm (10 ppm)**
Ruminating dairy cattle older than 4 months		10 ppm (5ppm)**
Distillers grains, brewers grains, gluten feeds, and gluten meals *	Ruminating beef and feedlot cattle older than 4 months, and ruminating dairy cattle older than 4 months	30 ppm
(10ppm beef/feedlot)**		
(5ppm dairy)**		
All other animals	Grain and grain byproducts not to exceed 40% of diet	5 ppm (2 ppm)**

* 88 percent dry matter basis ** Complete diet figures shown within parentheses
(Source: National Grain and Feed Association)

Deoxynivalenol (DON) or Vomitoxin

Deoxynivalenol is produced by *Gibberella zeae* (also known as *Fusarium graminearum*). This compound is sometimes called vomitoxin because it can cause vomiting in swine, especially young pigs. The main negative effect of this mycotoxin is feed refusal and reduced feed intake. Gibberella-infected ears when peeled back have pinkish-red kernels covered with the fungal mycelium. Levels of DON acceptable in animal feeds vary by animal type, but generally beef cattle and poultry can tolerate higher levels than swine (Table 46.3). Infection by this fungus is favored by temperatures between 70-80°F after silking. This disease is more prevalent in fields of continuous corn. Grain moisture content of greater than 20% is also conducive for this ear rot and mycotoxin problem to develop.

Zearalenone

Zearalenone is a second mycotoxin produced by *Gibberella zeae (Fusarium graminearum)*. Zearalenone interferes with reproduction hormones in animals. Often found with DON. The FDA does not have recommended action or advisory levels for zearalenone, but levels over 560 ppb is of concern.

Ochratoxins

Ochratoxins are produced by *Penicillium verrucosum*. This fungus usually colonizes corn in storage if grain has > 18% moisture. However, Penicillium ear rots also can develop in the field, especially on ears with mechanical or insect damage. Unlike other ear rot pathogens, Penicillium attacks only mature kernels (after black layer). The fungus may invade and discolor the embryo resulting in "blue eye." Ochratoxin A is the most common ochratoxin, and swine are the most sensitive. No FDA guidelines for this toxin are available at this time.

Sampling for Ear Rots and Mycotoxins

Scouting fields before harvest is important to determine the amount of ear rot in a field and consequently if there is a risk of mycotoxin contamination of grain. Scout fields by peeling back the husks and inspecting at least 10 ears and at least 5 random stops throughout the field. If > 10% of ears in a field have > 10-20% moldy kernels, the field should be scheduled for harvest as early as possible. Care should be taken not to damage kernels during harvest. The grain should be cooled and dried to < 15% moisture content immediately after harvest. Grain from fields where ear rot was a problem should be stored in a separate bin to grain from fields where the ears were healthy.

To sample grain for mycotoxin testing from a moving grain stream, take a composite sample of 10 lbs using a diverter-type mechanical sampler. If a mechanical sampler is not available, take a fistful of seeds carefully from the grain stream (avoid personal injury) and collect 10 lbs. For stationary corn, use a grain probe, and sample the load at several locations until a composite sample of 10 lbs is collected. With any sampling method, care should be taken to obtain a representative sample of the entire load. Representative samples can be sent to diagnostic labs for mycotoxin analysis. The South Dakota State University Plant Disease Clinic performs these tests and seed can be mailed to:

SDSU Plant Disease Clinic
SPSB 153 Jackrabbit Drive, Box 2108
Brookings, SD 57007.

Reducing Mycotoxin Development in Grain

All ear rot pathogens are abundant in the environment and therefore development of ear rots is driven by favorable conditions (dry and hot for Aspergillus ear rot; hot for Fusarium ear rot; and cool and wet for Gibberella ear rot). Many ear rot pathogens also survive on infested residue. The following practices can reduce chances of mycotoxin development on corn.

- Use crop rotation to reduce ear rot fungal pathogens inocula.
- Minimize yield-limiting factors by selecting an appropriate hybrid for the field, timely seeding, planting at suitable population, using adequate fertility, and controlling pests and diseases.
- Manage insect pests to minimize insect injury to ears and kernels.
- Scout fields before harvesting to determine the level and type of ear rots.
- Minimize kernel damage during harvest by adjusting combine settings to prevent damage.
- Harvest early to avoid continued development of ear rots, and consequently mycotoxin production, when risk of disease and contamination are high.
- If mycotoxin problems are suspected, screen the kernels to remove cracked kernels.
- Dry grain to < 15% moisture immediately after harvest (within 24h) and before storage.
- Clean combines, carts, augers, and bins with pressurized air to avoid cross-contamination.
- Regularly check bins during storage to ensure molds are not developing during storage.

References and Additional Information

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