Corn Silage Mycotoxin Management

Matt Akins, Damon Smith, University of Wisconsin-Madison

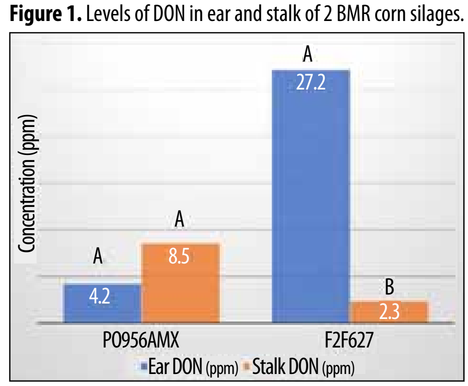
With the wet Midwest growing and harvesting season, there is a good likelihood of corn silage having mold contamination. Mold manifests from fungal infections that may have occurred in leaves, stalks, or ears. Multiple infections can occur on a plant and may or may not be related to one another. Depending on the type of organism involved in a particular infective event, there could be mycotoxins produced. However, visible mold doesn't mean there is going to be mycotoxin present and vice versa. Visual and laboratory identification of moldy growth can give an indication if mycotoxins may be present. However, testing is needed to determine if mycotoxins are present, which specific toxin you are dealing with, and the concentration of mycotoxin in feed.

Gibberella ear rot on corn.

Mycotoxins are secondary metabolites (not part of normal metabolism) produced by fungi that can be toxic to plants and/or animals. The cause of their production is not well-understood but it is thought stressors on the pathogen (possibly plant- or weather-related) trigger secondary metabolism resulting in mycotoxin development. Thus, there can be cases when moldy growth is visible and little mycotoxin is quantified, and other times when there are high levels with little or no visible moldy growth. The specific mycotoxins produced in silage feed are dictated by the fungal organism growing on corn plants. For example, aflatoxin is produced by *Aspergillus flavus* while deoxynivalenol (DON), fumonisin, and T-2 toxin are produced by *Fusarium* species. *Aspergillus sp.* generally proliferate during drought conditions and are usually not a significant concern in most years in the Upper Midwest. However, aflatoxin was identified in corn grain and feed in 2012, which was the last hot, dry Midwest summer. In 2018, *Fusarium sp.* were the fungi of primary concern, especially *Fusarium graminearum*. Use of fungicides may help manage fungal infections and lower corn silage mycotoxin levels. However, when weather conditions are highly favorable for fungal organisms, use of fungicides may not be successful.

In 2018, Damon Smith's Field Crops Plant Pathology Lab established corn silage plots to evaluate the use of different fungicides at different growth stages (V6, V12, R1, and R2) on 2 BMR corn silage hybrids (PO956AMX; F2F627). Yield, forage quality, disease, and DON (or vomitoxin) were assessed in response to fungicide applications. Vomitoxin is produced by the fungus *Fusarium graminearum*, which causes Gibberella ear rot (photo) and also Gibberella crown and stalk rot. There was little fungicide effect on corn silage yield or forage quality. Environmental conditions were favorable for fungal disease, with foliar and ear diseases relatively high compared to 2017. DON levels were high for all treatments (>7 ppm). For the PO956AMX hybrid, fungicide did not significantly affect DON levels. For F2F627, a few fungicide treatments/timing combinations had small effects on DON levels. Some products were consistent across the trial in giving some reduction relative to the non-treated control. These included Proline applied at R1, Delaro applied at R2, and Miravis Neo applied at V6. The R1 stage seems to be most effective for reducing subsequent mycotoxin levels. An interesting finding for the F2F627 hybrid was the ear had greater DON levels than the stalk, while PO956AMX had stalk DON levels twice as high as the ear, although not statistically significant (Figure 1). We then conducted some correlation analysis with several parameters. Ear DON levels were not significantly correlated with stalk DON. In fact, the relationship (not statistically significant) was actually negatively correlated, suggesting stalk DON levels and ear DON levels might be originating from independent events. Remember, *F. graminearum* can cause a stalk and crown rot and/or an ear rot. These different diseases can occur independent of each other. Thus, it is plausible that the stalk DON levels might be due to stalk infection and subsequent rot, not necessarily related to ear rot in corn. This study shows that fungicide application may help reduce mycotoxin levels, however, the levels may still be high due to environmental conditions favoring the fungus. A blog post with more detailed findings is at badgercropdoc.com/2018/10/12/2018-corn-silage-fungicide-trial-results-story-vomitoxin/.

Figure 1. Levels of DON in ear and stalk of 2 BMR corn silages.



Testing of corn silage suspected to have mycotoxin contamination is necessary for making feeding decisions. Proper sampling is important as there is high variation of mycotoxins within the silo and across the silage face. Use of a silage facer to remove silage then mixing the silage using the loader or a TMR mixer will result in a more representative sample. Do not send a sample taken by spot-sampling the silage surface as it is not representative, nor it is a safe sampling technique. Refrigerate the sample prior to shipment or use cold-packs for shipment. It is suggested to work with a nutritionist to determine which toxins to test for and also to contact the analytical lab to determine which lab methods to use for specific toxins. Potentially harmful mycotoxin levels for livestock have been summarized by John Goeser of Rock River Laboratories (Mycotoxin Guidelines and Dietary Limits) with the dairy and feedlot limits shown in Table 1. To calculate total diet mycotoxin levels, use this equation: feed mycotoxin concentration x (lbs feed DM in diet/lbs total diet DM). It is important to note the differences in toxin concentration units (ppm or ppb) when interpreting lab results. If reported values are in different units, convert to the correct units. To convert ppb to ppm, move the decimal three places to the left (1000 ppb DON = 1.0 ppm DON). To convert ppm to ppb, move the decimal three places to the right (0.5 ppm aflatoxin = 500 ppb aflatoxin). With results in hand you can decide if actions are needed. Actions can include dilution with clean silage/feeds to reduce diet toxin levels or using a feed additive flow agent (clays; activated carbons; yeast cell wall extracts) that adsorbs toxins and allows passage of the toxin through the digestive tract with reduced animal effects. The primary action should be minimizing the level of toxin in the diet using available forages and feeds. Feed additives are not completely understood and have not been proven to work in all cases, as they may only bind certain toxins. Most work has focused on aflatoxins with hydrated sodium calcium aluminosilicate clays working well, however, these may not work for other toxins including DON. It appears activated carbons may be most effective against DON (Whitlow and Hagler, 2017). A feed additive with a combination of ingredients (clays, yeast cell wall, or activated carbons) may be most beneficial if aflatoxin is not present and one or more *Fusarium*-related toxins are present (Hoffman, et al., 2009), which is often the case when DON is present. Request research-based information on product efficacy. Each toxin can cause different toxicity symptoms (Table 1). Symptoms are often reduced feed intake and milk production, poor condition, or poor reproduction. These symptoms are general and also may be associated with other nutrition or management issues; thus, testing helps determine if mycotoxins are an issue.

Table 1. Potentially harmful mycotoxin levels of the total diet dry matter (Summarized by John Goeser), favorable conditions for mycotoxins, and related toxicity symptoms (Adams, et al., 2016).

Toxin	Dairy	Feedlot	Favorable Conditions	Toxicity symptoms
Aflatoxin	20 ppb	20 ppb	Hot, dry conditions	Liver damage & reduced immune response; reduced intake & performance
DON or vomitoxin	0.5-1 ppm	10 ppm	Wet during pollination, then cool/wet at harvest	Low feed intake & production; possibly diarrhea
Fumonisin	2 ppm	7 ppm	Drought conditions followed by wet, cool conditions	Low feed intake & weight loss; liver damage
T-2 toxin	100 ppb	500 ppb	Wet & cool	Damage to digestive system; hemorrhaging; death
Zearalenone	400 ppb	5 ppm	Wet & cool	Similar structure to estrogen; causes udder & vulva swelling; possibly abortion
Ochratoxin	5 ppm	5 ppm	Improper storage conditions	Likely minimal effects as highly degraded in rumen

Overall, use of fungicides and hybrids resistant to fungal infections may reduce fungal growth, visible mold, and mycotoxin production. Testing and silage management can further reduce effects on cattle if toxins are present.

Sources:

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