Chapter 11
Mycotoxin Situation with the 2011 U.S. Corn Crop and 2012 DDGS Production

Introduction

Mycotoxin prevalence and concentrations in feed ingredients are an ongoing concern in many countries. Historically, mycotoxin prevalence and concentrations in the U.S. corn crop are infrequent and low, respectively, compared the annual occurrence and relatively high concentrations in corn produced in many other countries around the world. Mycotoxins are produced by specific molds (e.g. *Aspergillus* and *Fusarium*), when optimal environmental conditions (e.g. drought stress, wet weather and high moisture, etc.) are present during the corn growing season or during storage. Typically, the incidence of mycotoxin production in U.S. corn is relatively low because of unfavorable mold growth climatic and storage conditions. Recent surveys of mycotoxin contamination and levels from numerous U.S. DDGS sources have been published (Zhang et al., 2009; Caupert et al., 2011; Zhang and Caupert, 2012). In the most recent study, Zhang and Caupert (2012) measured aflatoxins, deoxynivalenol (DON; vomitoxin), fumonisins, T-2 toxin, and zearalenone in 67 DDGS samples from 8 ethanol plants in the Midwestern U.S. from 2009 to early 2011. Among the 5 mycotoxins measured, vomitoxin was of particular interest because the 2009 corn growing season was favorable for vomitoxin production. Results from this survey showed that no more than 12% of the DDGS samples tested contained vomitoxin levels greater than the U.S. FDA minimum advisory concentrations for use in animal feed, and the vomitoxin concentrations were less than 2 ppm for all samples collected in 2011. Almost none of the DDGS samples produced in 2010 contained detectable concentrations of aflatoxins, and the highest concentration detected was 5.7 ppb. Less than 6% of the samples contained fumonisin concentrations higher than the U.S. FDA guidance level for feeding equids and rabbits, while most samples contained zearalenone concentrations between 100 and 300 ppb. No samples contained T-2 toxin above the detection limit.

Challenges of obtaining mycotoxin data

Obtaining current mycotoxin data for the 2011 U.S. corn crop and 2011-2012 DDGS production is difficult for several reasons. First, there is no annual feed industry or governmental monitoring system to report the presence and concentrations of mycotoxins in corn or DDGS. Most of the sampling and testing of mycotoxins is done by various grain, feed, and marketing companies and it is used for proprietary purposes and not published. Secondly, unless initial samples obtained at harvest contain frequent and high levels of one or more mycotoxins of concern, continued monitoring of corn and DDGS samples generally ceases due to low risk of contamination in supply channels of the market and the high cost of analysis. Thirdly, some commercial laboratories (e.g. Dairyland Laboratories) provide mycotoxin data summaries of corn and DDGS samples analyzed, but these results are highly biased and do not reflect the entire corn crop or all of the DDGS being produced because samples submitted were identified as being potentially contaminated and as a result, were submitted for analysis. Therefore, we must remember that the type of sampling procedures used, and the potential for bias must be considered when evaluating mycotoxin prevalence and concentations in corn and DDGS.

2011 U.S. Corn and DDGS

Wet weather as well as drought conditions in the Eastern Corn Belt (Michigan, Indiana, and Ohio) during 2011 resulted in some production of mycotoxins, particularly vomitoxin, but the concentrations were lower than those from the 2010 corn crop. In contrast, mycotoxin levels were very low in other major corn producing states of Illinois, Iowa, Minnesota, North Dakota, and South Dakota. Limited data are available (**Table 1**), but initial sampling of DDGS produced from corn harvested in 2011 indicate that the highest levels of vomitoxin (2.8 to 3.8 ppm) was in Indiana and Michigan, but levels at or below 1 ppm in ethanol plants in Illinois, Iowa, Minnesota, North Dakota, and South Dakota. Some areas of Nebraska also had higher than average levels of vomitoxin in corn resulting in 1.5 to 2.0 ppm in DDGS.

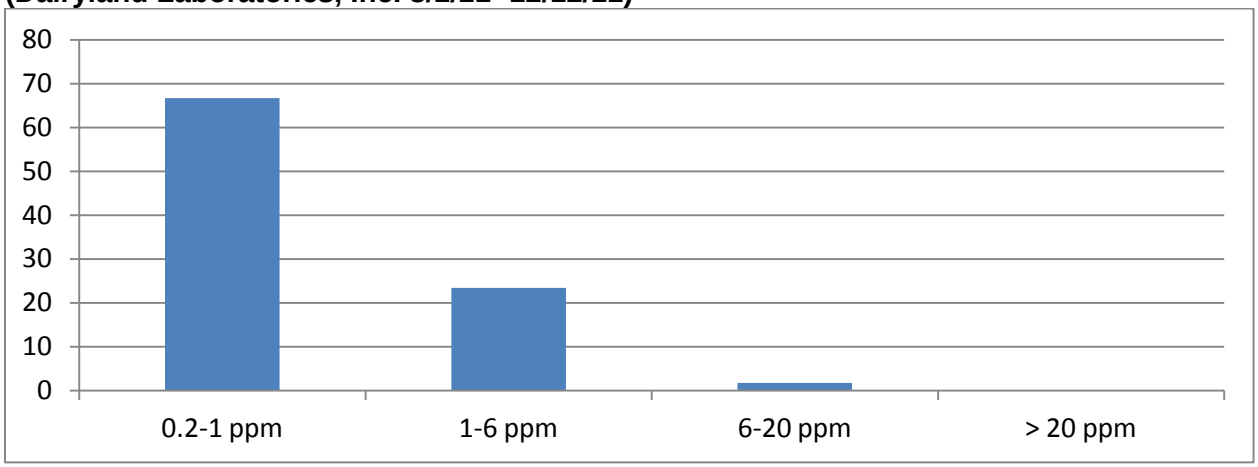
Table 1. Average vomitoxin concentrations in DDGS samples (November , 2011 to January, 2012) produced by state.

State	Average DDGS Vomitoxin Concentration, ppm
Michigan	2.8
Indiana	3.8
Illinois	1.0
Iowa	0.9
Minnesota	0.9
North Dakota	1.2
South Dakota	0.7
Nebraska	1.8

Source: Cenex Harvest States

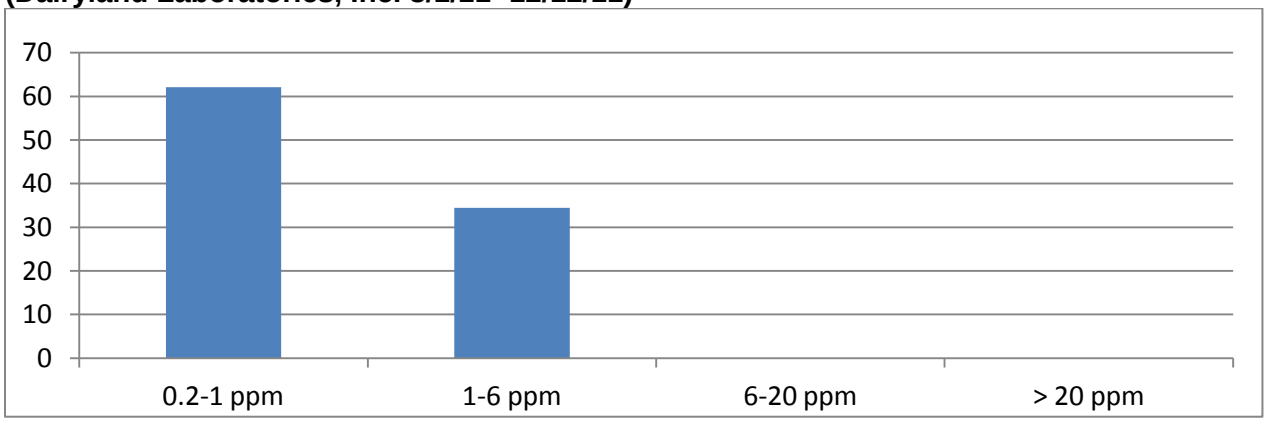
The majority of corn samples submitted to Dairyland Laboratories from August to December, 2011 (www.dairylandlabs.com/documents/moldtoxin10.10.1.pdf), contained relatively low levels of all mycotoxins. As shown in **Figure 1**, approximately 67% of corn samples analyzed contained less than 1 ppm vomitoxin, with about 23% of the samples containing between 1 to 6 ppm vomitoxin. Similar distribution of vomitoxin concentrations were also observed for DDGS samples (**Figure 2**). For zearalenone, about 32% of the corn samples contained concentrations between 10 to 250 ppb, with less than 5% of the samples containing concentrations between 250 to 1,000 ppm (**Figure 3**), but all DDGS samples submitted contained between 10 to 250 ppb zearalenone (**Figure 4**). The majority of corn samples (less than 20%), and about a third of the DDGS samples submitted for analysis had aflatoxins in the range of 2 to 5 ppb, with very few samples exceeding 5 ppb (**Figure 5 and 6**). Finally, T-2 toxin was detected in both corn (**Figure 7**) and DDGS (**Figure 8**) samples submitted to Dairyland Laboratories, but the majority of samples containing T-2 toxin had concentrations less than 100 ppb. These results indicate that corn harvested in 2011 contained primarily vomitoxin, and the majority of samples contained less than 1 ppm. Prevalence and concentrations of zearalenone, aflatoxins, and T-2 toxin were relatively low in corn, with a higher proportion of DDGS samples containing detectable concentrations of these mycotoxins.

Figure 1. Percentage of Corn Samples Containing Various Levels of Vomitoxin (Dairyland Laboratories, Inc. 8/1/11 -12/12/11)



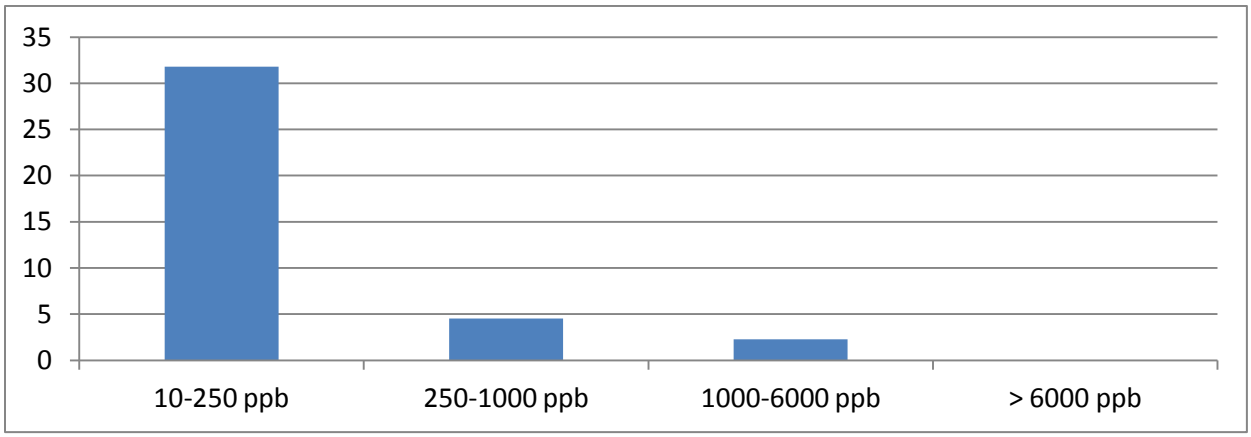
N = 111 samples

Figure 2. Percentage of DDGS Samples Containing Various Levels of Vomitoxin (Dairyland Laboratories, Inc. 8/1/11 -12/12/11)



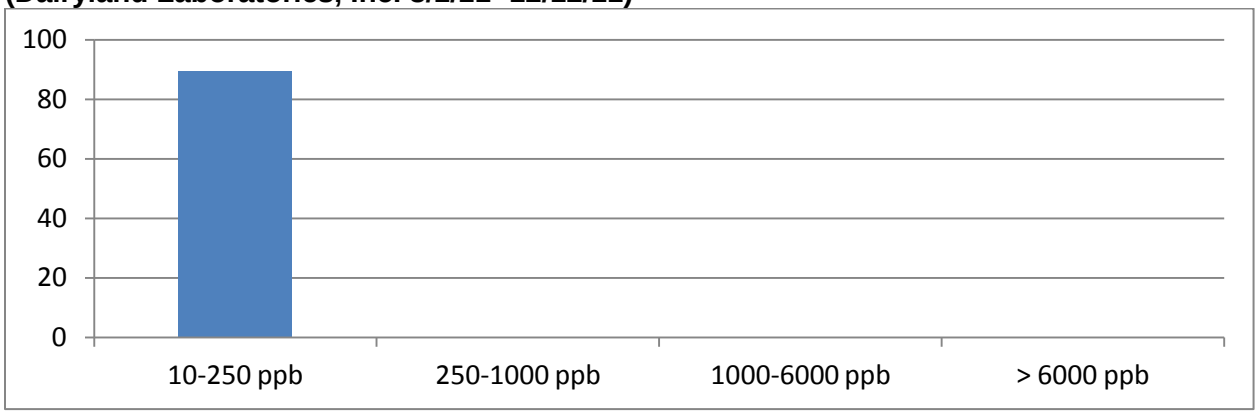
N = 58 samples

Figure 3. Percentage of Corn Samples Containing Various Levels of Zearalenone (Dairyland Laboratories, Inc. (8/1/11-12/12/11)



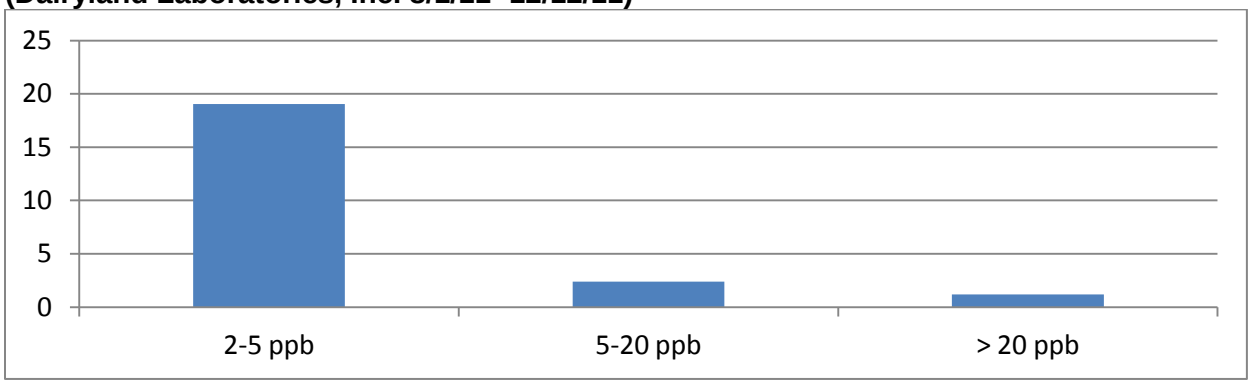
N = 88 samples

Figure 4. Percentage of DDGS Samples Containing Various Levels of Zearalenone (Dairyland Laboratories, Inc. 8/1/11 -12/12/11)



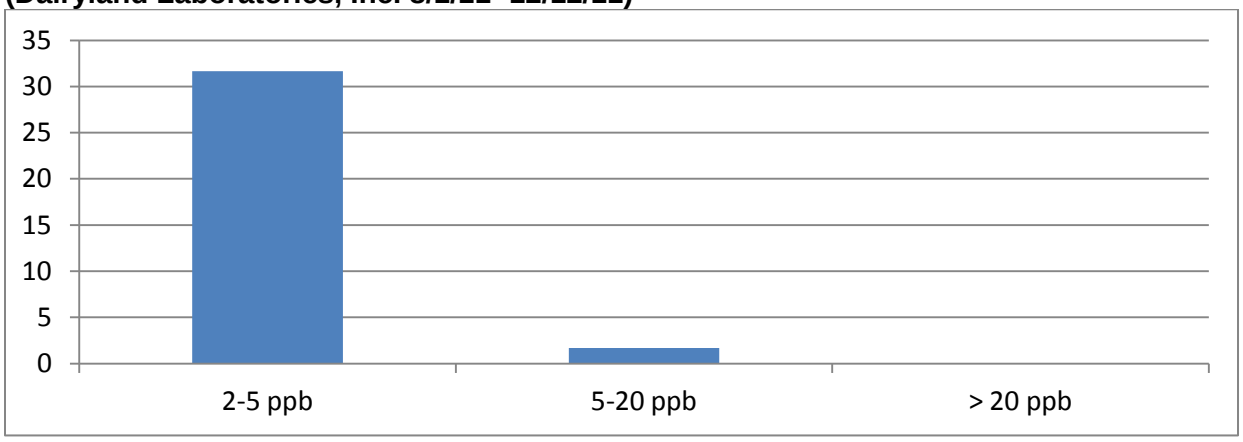
N = 29 samples

Figure 5. Percentage of Corn Samples Containing Various Levels of Aflatoxin (Dairyland Laboratories, Inc. 8/1/11 -12/12/11)



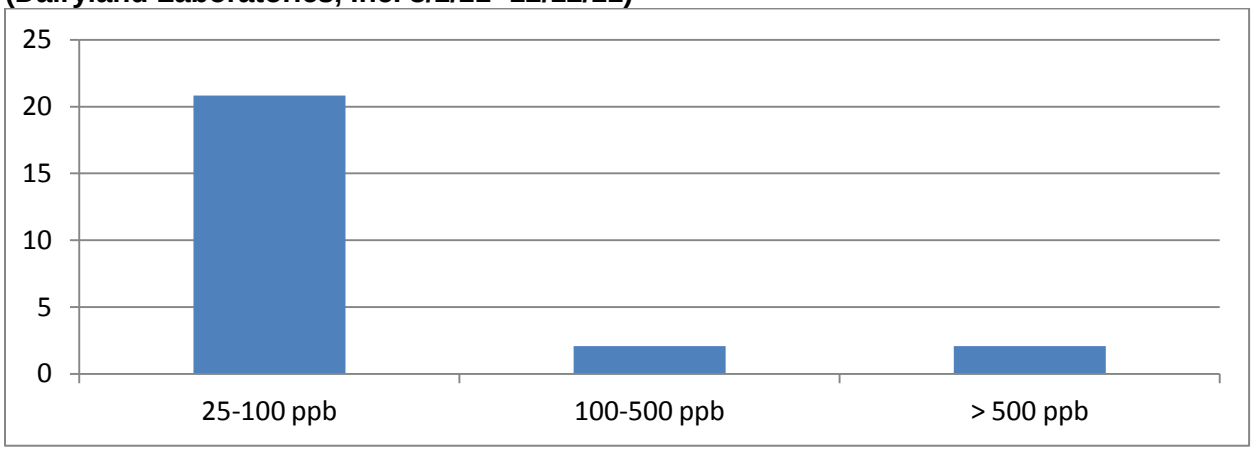
N = 84 samples

Figure 6. Percentage of DDGS Samples Containing Various Levels of Aflatoxin (Dairyland Laboratories, Inc. 8/1/11 -12/12/11)



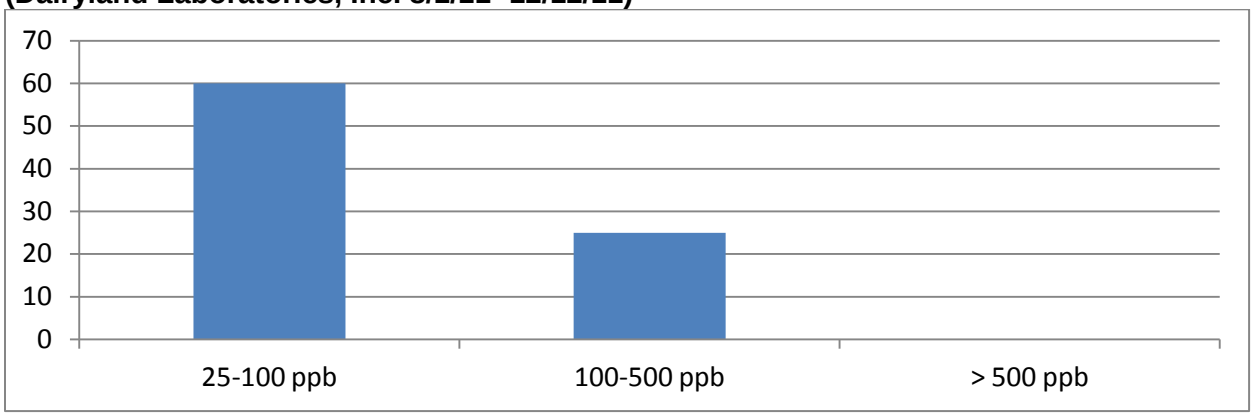
N = 60 samples

Figure 7. Percentage of Corn Samples Containing Various Levels of T-2 Toxin (Dairyland Laboratories, Inc. 8/1/11 -12/12/11)



N = 48 samples

Figure 8. Percentage of DDGS Samples Containing Various Levels of T-2 Toxin (Dairyland Laboratories, Inc. 8/1/11 -12/12/11)



N = 20 sample

In another survey, Nutriquest (Mason City, IA) collected and analyzed 141 DDGS samples from 83 ethanol plants in 12 states from December 2011 and January 2012 (**Figure 9**). No more than two samples from a single ethanol plant were included in the survey. Samples were analyzed for deoxynivalenol (DON) and zearalenone. Their results are consistent with those reported by CHS (**Table 1**) where the concentration of DON was highest in states in the Eastern U.S. Corn Belt (i.e. Ohio, New York, Michigan, and Indiana), except for Nebraska, compared to those in the Western Corn Belt (**Figure 10**). The average, standard deviation, and range of DON concentrations found in DDGS samples in Ohio, New York, Michigan, Indiana, and Nebraska compared to the overall average of 141 samples are shown in **Table 2**. The highest concentration of DON was nearly 17 ppm in Ohio, which exceeds the U.S. FDA advisory level for swine of 5 ppm. Therefore, DDGS coming from ethanol plants in Ohio should be monitored carefully and avoided if possible, if DDGS will be used in swine feeds. Overall, the average concentration of DON was 1.34 ppm which indicates that most U.S. sources have manageable amounts of DON in DDGS to cause minimal effects on animal performance. Concentrations of zearalenone followed a similar pattern to DON, where concentrations were highest in states in the Eastern U.S. Corn Belt (i.e. Ohio, New York, Michigan, and Indiana), except for Nebraska, compared to those in the Western Corn Belt (**Figure 11**).

Figure 9. Number of DDGS samples collected by state December, 2011 to January 2012.

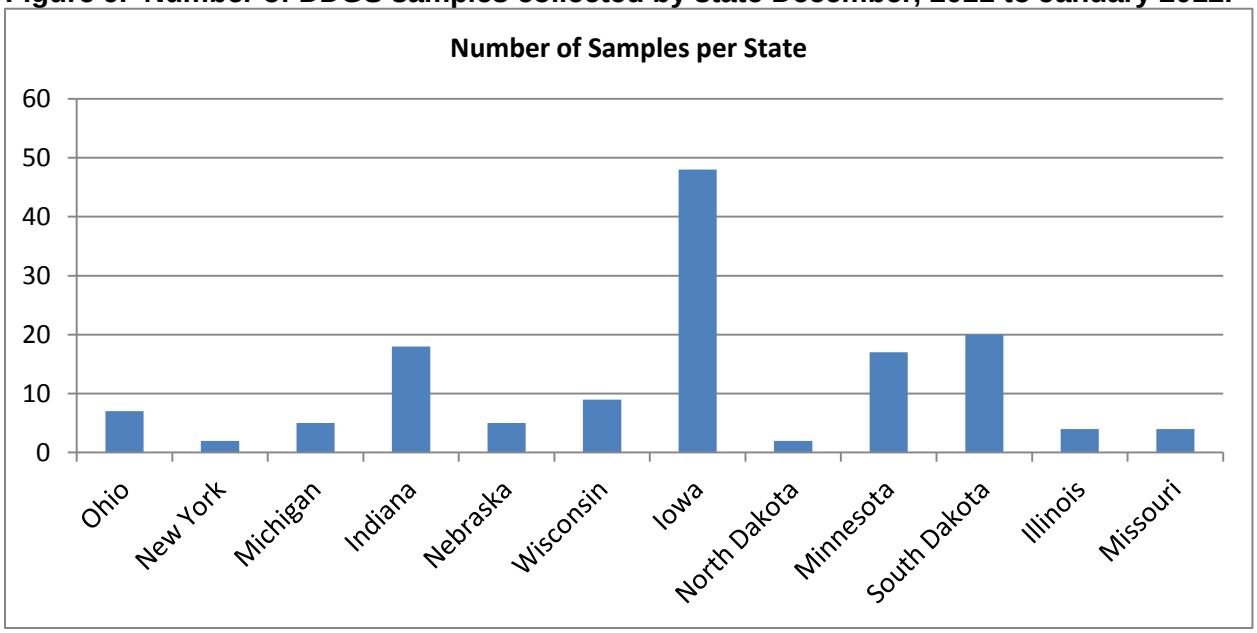


Figure 10. Average concentration of (DON) in DDGS samples collected in 12 states (number in parentheses is the number of samples collected and analyzed per state).

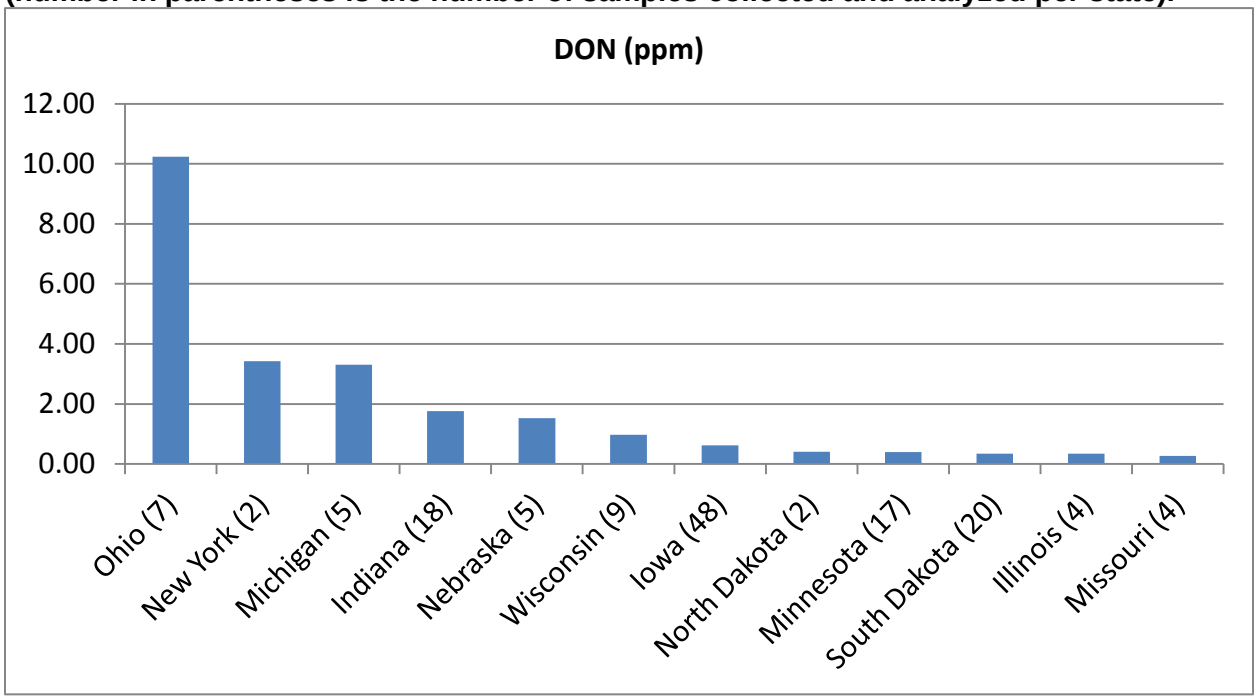
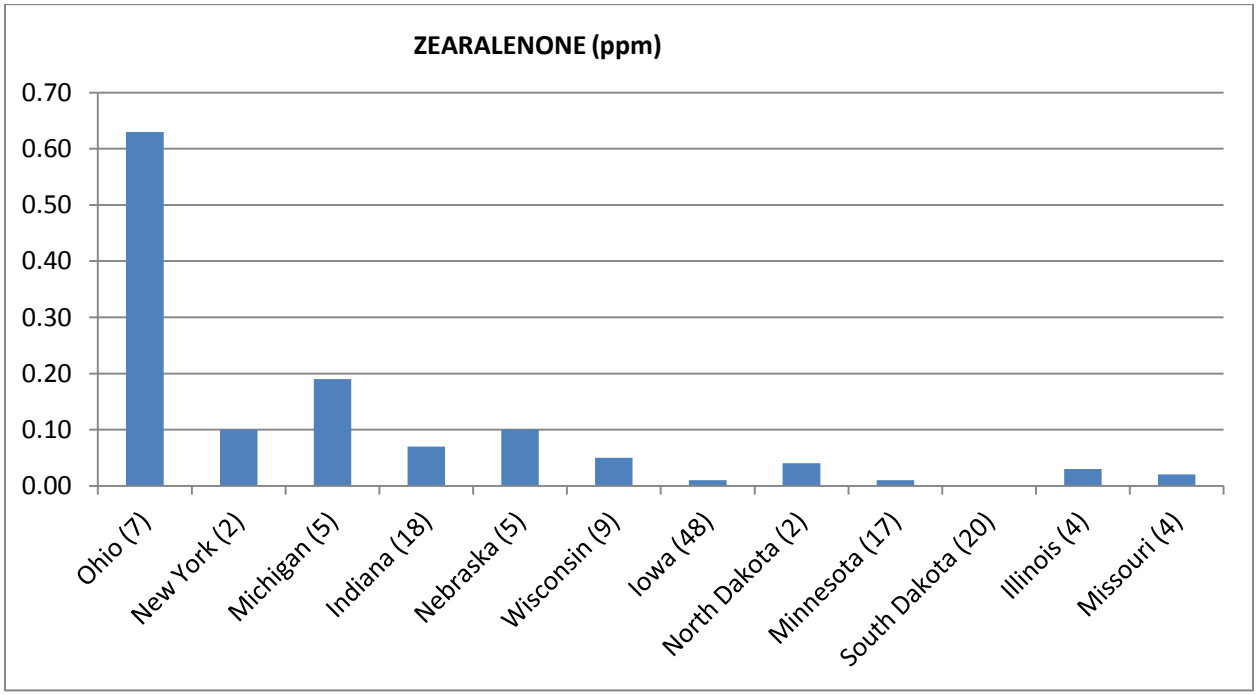


Table 2. Average, standard deviation, and range of DON concentrations found in DDGS samples in Ohio, New York, Michigan, Indiana, and Nebraska compared to the overall average of 141 samples.

Item	All	OH	NY	MI	IN	NE
Number of samples	141	7	2	5	18	5
Mean	1.34	10.24	3.43	3.31	1.76	1.53
Std. Dev.	2.44	4.74	0.19	1.46	1.22	0.90
High	16.99	16.99	3.56	4.96	3.24	2.48
Low	0.04	3.50	3.29	1.81	0.47	0.49

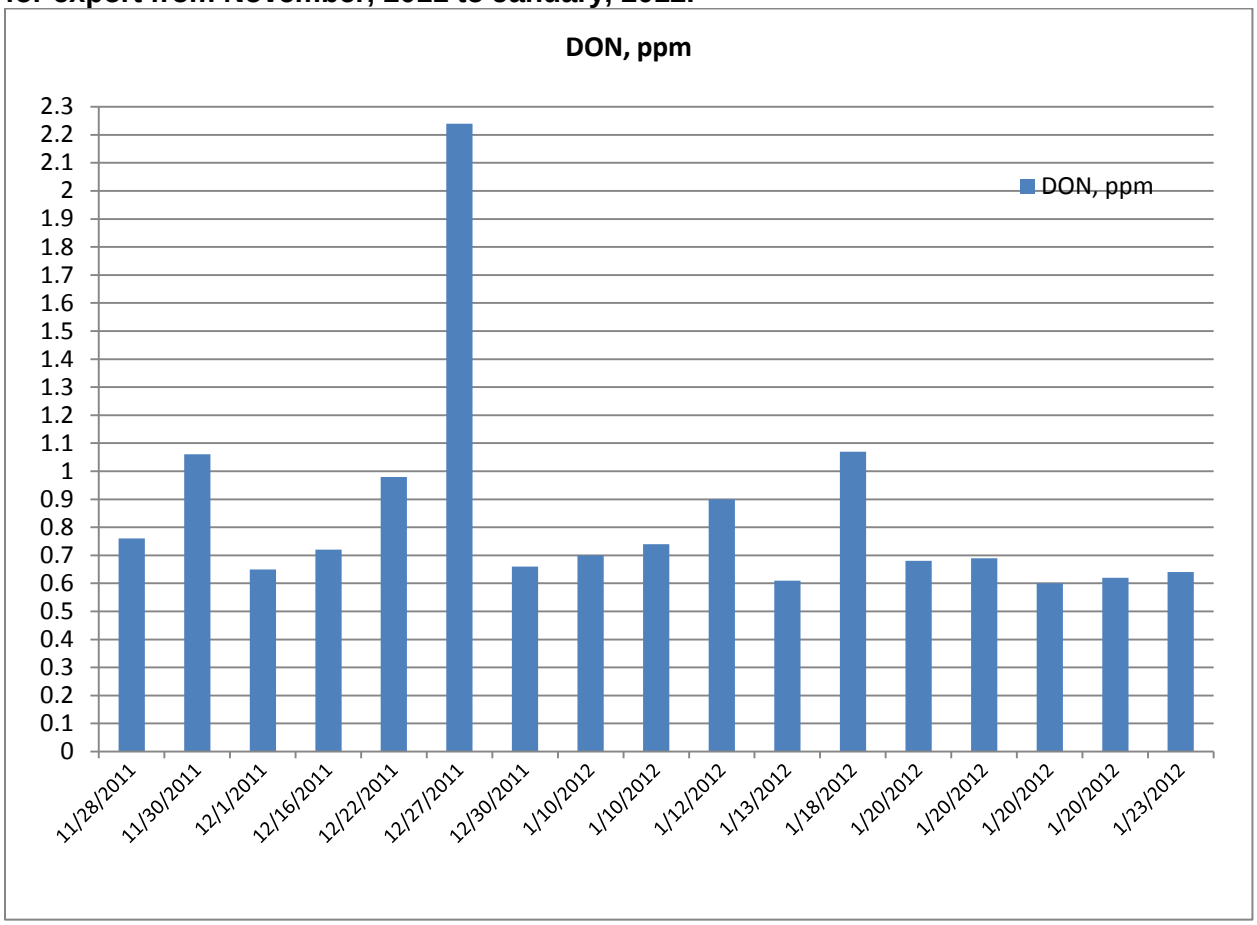
Figure 11. Average concentration of zearalenone in DDGS samples collected in 12 states (number in parentheses is the number of samples collected and analyzed per state).



Vomitoxin Concentrations in DDGS Exports

Limited data are available on mycotoxin presence and concentrations in DDGS being exported. However, data provided by Cenex Harvest States for DDGS samples in containers and barges (**Figure 12**) shows that vomitoxin content was generally less than 1 ppm for the period of November 28, 2011 to January 23, 2012. Only one sample contained slightly more than 2 ppm vomitoxin. No samples had aflatoxin greater than 5 ppb.

Figure 12. Vomitoxin (DON) concentrations of DDGS in barges and containers destined for export from November, 2011 to January, 2012.



Source: Cenex Harvest States

Conclusions

A few states in the U.S. Corn belt had growing and harvesting conditions conducive to vomitoxin production in 2011. However, although DDGS produced in these regions may have higher concentrations of vomitoxin than most regions of the Midwestern U.S., it appears that the majority of DDGS being produced in 2012 will have less than 1 ppm of vomitoxin. Some 2012 DDGS samples may also contain zearalenone, aflatoxins, and T-2 toxin, but the frequency and concentration of these mycotoxins are low.

References

Caupert, J., Y. Zhang, P. Imerman, J.L. Richard, and G.C. Shurson. 2011. Mycotoxin Occurrence in DDGS. In: Distillers Grains: Production, Properties, and Utilization, CRC Press, New York, NY. p. 219-234.

Zhang, Y., J. Caupert, J. Richard, P. Imerman and J. Shurson, 2009. Scientific overview of mycotoxins in DDGS. J. Agric. Food Chemistry 57:9828-9837.

Zhang, Y., and J. Caupert. 2012. Survey of mycotoxins in U.S. distiller's dried grains with solubles from 2009 to 2011. J. Agric. Food Chem. (in press).