Mycotoxin Contamination in Grain Sorghum from Fields in Georgia and Mississippi[1]

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ABSTRACT

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Contamination of grain sorghum, *Sorghum bicolor* (L.), with aflatoxin or zearalenone, was previously considered strictly a postharvest problem in grain improperly dried and stored. Samples of preharvest grain from 64 grain sorghum fields in the Georgia coastal plain in 1980 and 1981, however, demonstrated a 56% incidence of aflatoxin contamination ranging in levels from 1 to 90 ppb. In addition, 31% of the grain samples were contaminated with levels of zearalenone ranging from 2 to 1,468 ppb. These findings confirm the presence of mycotoxins in grain sorghum maturing in the fields. A 1981 survey of 15 fields in the Mississippi Delta found no detectable levels of aflatoxin or zearalenone. The data suggest that, although mycotoxins are present in samples of preharvest grain sorghum, the problem may not be as severe as in preharvest corn, *Zea mays* L., produced in the Southeast. The relatively high incidence of field contamination, however, may result in elevated levels of mycotoxins during storage of this grain. Growers and animal producers, therefore, should monitor closely the grain sorghum to be used for feed.

Grain sorghum, *Sorghum bicolor* (L.), is popular as a feed grain crop in Georgia and other southeastern states. Insect damage and fungal infection to developing heads, however, can significantly affect the quantity and quality of grain yield. Analyses of samples of grain sorghum, produced mostly in climates other than found in the hot and humid Southeast, have shown relatively low incidences and levels of contamination with aflatoxin (Shotwell et al 1969, 1980), a toxic metabolite of certain species of the *Aspergillus flavus* group. Zearalenone, an estrogenic metabolite of *Fusarium graminearum* or *F. roseum*, was found, however, exceeding 1,000 ppb in 18% of the grain samples (Shotwell et al 1980).

In Australia, Connole and Hill (1970) associated *A. flavus*-contaminated sorghum with a field outbreak of aflatoxicosis in swine. Mirocha and Christensen (1974) reported that swine are the most sensitive of domestic animals to the presence of zearalenone in diets, and the level considered physiologically significant is estimated to be about 1,000 ppb. Other studies (Anonymous 1979) have shown that approximately 100 ppb of aflatoxin in diets may result in adverse biological effects in swine.

Surveys of preharvest corn, *Zea mays* (L.), on the coastal plain of Georgia revealed high levels of aflatoxin in some samples (McMillian et al 1978, 1980). Therefore, a survey of preharvest grain sorghum fields in the same general area was conducted to determine whether a potentially serious field problem of mycotoxin contamination existed in this grain crop.

MATERIALS AND METHODS

Sorghum fields are sparse in the corn-growing area of the Georgia coastal plain. Mature grain was collected during late September and early October from fields chosen at random in each of 37 counties in 1980 and in each of 27 counties in 1981. A 10-lb (4.5 kg) sample was obtained by harvesting representative sorghum heads at each of five locations (center and four sides) within a field. Harvested grain samples were then taken to the laboratory, shelled, and dried for five days in an oven set at 60° C. The grain was then ground in a Wiley mill to pass a no. 20 sieve. The ground grain was divided using a Riffle sampler. Aflatoxin analyses were run on a representative 50-g subsample by using the high-pressure liquid chromatography (HPLC) method developed by Thean et al (1980). Aflatoxin-positive samples were then confirmed by using thin-layer chromatography (TLC) after making the trifluoroacetic acid (TFA) derivative of the sample extract (AOAC 1980).

A 50-g subsample was analyzed for zearalenone by using the base partition procedure (Mirocha et al 1974), followed by selected ion monitoring with a Hewlett-Packard 5985-B computerized gas chromatograph-mass spectrometer (GC-MS) or with a Hewlett-Packard 5711 gas chromatograph equipped with a flame-ionization detector (GC-FID).

In 1981, samples of mature grain were also collected from 15 preharvest sorghum fields located in the Mississippi Delta. Collection and analytical procedures were similar to those employed for the Georgia samples. Toxin values (x) obtained from all analyses were transformed to ln (x + 1) for statistical analysis.

RESULTS AND DISCUSSION

As shown in Table I, 81 and 22% of the sorghum samples collected in Georgia in 1980 and 1981, respectively, were positive for aflatoxin. For comparison, 100% of the preharvest corn sampled in this same general area in 1980 and 85% of the corn sampled in 1981 were positive for aflatoxin.[5] The average aflatoxin levels in sorghum sampled in 1980 (12 ppb) and 1981 (2 ppb) are considerably lower than levels found in nearby corn in 1980 (206 ppb) and 1981 (91 ppb). Zearalenone was present in 41 and 19% of the Georgia sorghum samples collected in 1980 and 1981, respectively. Coexistence of aflatoxin and zearalenone was detected in 35% of the samples. A correlation between the levels of

[5]W. W. McMillian. 1981. Unpublished data.

TABLE I
Levels of Aflatoxin and Zearalenone in Preharvest Grain Sorghum Field Samples Collected in Georgia in 1980 and 1981

	Percentage of Fields			
	1980		1981	
Toxin Level/(ppb)[a]	Aflatoxin	Zearalenone	Aflatoxin	Zearalenone
Not detected	19	59	78	81
1–20	59	···	18	···
21–100	22	···	4	···
101–250	0	···	0	···
251–500	0	27	0	15
501–1,000	0	6	0	4
1,001–1,500	0	8	0	0

[a]The detection limit for aflatoxin is about 1 ppb. The detection limit for zearalenone is about 10 ppb with a Hewlett-Packard 5985-B computerized gas chromatograph-mass spectrometer or about 250 ppb with a Hewlitt-Packard 5711 gas chromatograph equipped with a flame-ionization detector.

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aflatoxin and zearalenone in the sorghum grain, however, was not significant. Aflatoxin levels in the positive Georgia samples ranged from 1 to 90 ppb, whereas the zearalenone levels in the positive Georgia samples ranged from 2 to 1,468 ppb. Of the aflatoxin-positive samples, only B_1 was detected in 48%, whereas $B_1 + B_2$ was detected in 6%, and $B_1 + G_1$ was detected in 1%. Analytical results showed that all of the 15 samples of grain sorghum collected in Mississippi were negative for the presence of aflatoxin and zearalenone.

CONCLUSIONS

These analyses confirm the presence of aflatoxin or zearalenone or both in some preharvest grain sorghum in Georgia, but the levels found in these samples are considered relatively low. Previously, contamination with aflatoxin and zearalenone was considered to be strictly a postharvest problem in grain improperly dried and stored. The presence of zearalenone in the grain suggests that other *Fusarium* mycotoxins such as the trichothecenes may also be present. Deoxynivalenol (vomitoxin) is often associated with zearalenone-contaminated grain because the same species of *Fusarium* can produce both mycotoxins. The data suggest that, although aflatoxin contamination is a serious problem in preharvest corn in some areas of the Southeast, it may be less of a problem in preharvest grain sorghum being produced in the same area. Growers and animal producers should, however, closely monitor grain sorghum intended for animal feed. In addition to the problem of field contamination, mycotoxins could become elevated to more hazardous levels under poor storage conditions.

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