Preharvest Development of Aflatoxin B_1 in Corn in the United States

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ABSTRACT

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A preharvest sampling of field corn at various locations in the United States showed B_1 aflatoxin content exceeding 20 ng/g (20 ppb) at three of 13 (23%) locations in 1972, four of 15 (27%) in 1973, and 11 of 21 (52%) in 1974. Some locations in Georgia and Texas had aflatoxin-contaminated corn in each of the three years. Also, there was a tendency for a much higher incidence of excessive aflatoxin B_1 in corn in the more southerly locations in the U. S. than in those farther north. Thus, there appear to be distinct regional differences in aflatoxin production in corn within the United States. It is evident that aflatoxin B_1 often is produced as a result of *A. flavus* infection of developing grain in the field.

Aflatoxin B_1 is a toxic, secondary metabolite produced by the fungus *Aspergillus flavus* Lk. ex Fr. growing on certain foodstuffs; e.g., cotton seed, wheat, rice, peanuts, sorghum, and corn (3). Corn (*Zea mays* L.) grown in southeastern Missouri in 1971 was found at preharvest to contain amounts of aflatoxin B_1 in excess of the 20 ng/g guideline set by the U. S. Food and Drug Administration (FDA) (1). This incident suggested that aflatoxin may be produced in the field as well as in storage.

Rambo, Tuite, and Caldwell (5) detected no *A. flavus* infection in 156 preharvest samples of corn from Indiana in 1971, and only 0.08% from 369 samples in 1972. The infected samples all originated from southern Indiana. They concluded that corn infected with *A. flavus* in Indiana, and possibly Kentucky, appeared to be of little consequence in regard to production of significant levels of aflatoxin. However, W. R. Wichser *(personal communication)* observed high levels of aflatoxin in individual kernels of corn taken directly from the field in Georgia in 1971. In 1953, Weiss and O'Brien (6) reported that *A. flavus* yellow ear mold occurred in Florida, Illinois, Iowa, and Texas. Lillehoj et al. (4) reported the natural preharvest occurrence of aflatoxin B_1 in corn from several locations in South Carolina and observed levels exceeding 20 ng/g in 94 of 297 samples (32%). This is conclusive evidence for the development of *A. flavus* and the production of aflatoxin in corn before harvest.

The purpose of our investigation was to establish the geographical preharvest occurrence of aflatoxin in field corn using samples from different regions in the United States.

MATERIALS AND METHODS

In 1972 and 1973, plantings of four male-sterile cytoplasms in the Ky21 inbred line background were made at 16 locations in the United States. Cooperators were asked to harvest 10 to 20 ears from each of the four different cytoplasms after the ears had reached physiological maturity (50 days after silking). The harvested ears immediately were dried to 14-15 percent grain moisture and sent to the Northern Regional Research Laboratory in Peoria, Illinois, for aflatoxin analyses. The aflatoxin assays were carried out by the procedure described by Dantzman and Stoloff (2).

The 1974, plantings of two yellow dent single crosses, H49 × CI44 with a relatively thin pericarp, and B37 × B14A with a relatively thicker pericarp, were made at 22 locations. Samples were harvested, dried, and assayed in the same manner as in 1972 and 1973.

RESULTS AND DISCUSSION

The occurrence and level of aflatoxin B_1 observed in 1972, 1973, and 1974 samples are shown in Table 1. Naturally occurring preharvest levels of aflatoxin B_1 exceeding 20 ng/g in corn in the field was found at three of 13 locations in 1972, at four of 15 locations in 1973, and at 11 of 21 locations in 1974.

TABLE 1. Natural preharvest occurrences of aflatoxin B_1 in corn in the United States, 1972-1974

	Aflatoxin B_1 (ng/g)			
	Ky21	Ky21	B37 × B14A[a]	H49 × CI44[b]
Location	1972	1973	1974	1974
Auburn, AL	. . .[c]	. . .	256	52
Tallahassee, FL	0	. . .	. . .	. . .
Fayetteville, AR	. . .	0	0	3
Riverside, CA	. . .	. . .	18	0
Gainesville, FL	0	0	594	61
Athens, GA	. . .	. . .	0	0
Experiment, GA	400[d]	100-400	233	75
Tifton, GA	20	20-200	29	8
Bloomington, IL	. . .	20	. . .	. . .
Dekalb, IL	. . .	100	. . .	. . .
Urbana, IL	0	0	20	0
Evansville, IN	0	0	. . .	. . .
Lafayette, IN	0	0	0	73
Lexington, KY	0	0	0	14
Alexandria, LA	. . .	. . .	16	129
Baton Rouge, LA	200	0	. . .	. . .
Laurinburg, NC	. . .	. . .	262	0
State College, MS	. . .	. . .	17	0
Raleigh, NC	. . .	. . .	2,760	381
Columbus, OH	. . .	. . .	0	0
Wooster, OH	0	0	37	0
Landsville, PA	. . .	. . .	0	0
Florence, SC	. . .	. . .	0	325
Knoxville, TN	0	0	14	0
College Station, TX	2,000	100-400	329	0
Blacksburg, VA	0	0	0	0

[a]Hybrid B37 × B14A has a thick pericarp.
[b]Hybrid H49 × CI44 has a thin pericarp.
[c]. . . = not grown.
[d]Inbred Ky21 in four different cytoplasms was tested and the data combined at each location.

In the 1974 comparison of thick- and thin-pericarp corn hybrids, it was found that aflatoxin levels exceeded 20 ng/g in the thick-pericarp hybrids at eight of the 21 locations, and in the thin-pericarp hybrids at seven of the 21 locations. The difference was not statistically significant.

There appeared to be higher aflatoxin incidence and levels in corn from the more southerly locations. Among the factors that might account for this are: (i) more infestation by insects, especially the corn earworm [*Heliothis zea* (Boddie)] which provide infection courts for *A. flavus;* (ii) higher spore load of *A. flavus;* and (iii) higher temperature and humidity which favor *A. flavus* development.

We concluded that preharvest aflatoxin production in corn is a real problem, particularly in the southern part of the U.S. It will be important to determine if there is resistance in some corn genotypes to invasion by *A. flavus* and/or to aflatoxin production before any breeding work can be initiated to control the problem.

LITERATURE CITED

1. ANONYMOUS. 1971. FDA recalls corn meal bread mix allegedly tainted by aflatoxin. Southwest Miller 50:26.
2. DANTZMAN, J., and L. STOLOFF. 1972. Screening method for aflatoxin in corn and various products. J. Assoc. Off. Anal. Chem. 55:139-141.
3. DETROY, R. W., E. B. LILLEHOJ, and A. CIEGLER. 1971. Aflatoxins and related compounds *in* A. Ciegler et al., eds. Microbial toxins. Vol. VI Fungal Toxins. Academic Press, New York. 536 p.
4. LILLEHOJ, E. B., W. F. KWOLEK, G. M. SHANNON, O. L. SHOTWELL, and C. W. HESSELTINE. 1975. Aflatoxin occurrence in 1973 corn at harvest: I. A limited survey in the southeastern U.S. Cereal Chem. 52:603-611.
5. RAMBO, G. W., J. TUITE, and R. W. CALDWELL. 1974. Aspergillus flavus and aflatoxin in preharvest corn from Indiana in 1971 and 1972. Cereal Chem. 51:848-853.
6. WEISS, F., and M. J. O'BRIEN. 1953. Index of plant diseases in the United States. Plant Dis. Rep. 37:449.