Incidence and Level of Aflatoxin in Preharvest Corn in South Georgia in 1978[1]

W. W. McMILLIAN,[2] D. M. WILSON, [3] N. W. WIDSTROM,[2] and R. C. GUELDNER[2]

Cereal Chem. 57(2):83-84

ABSTRACT

In 1978, an early and a late season survey of preharvest dent corn in 45 counties on the coastal plain of Georgia revealed 94 and 76% incidences of aflatoxin contamination, respectively. Aflatoxin levels in field samples of corn averaged 62 μg/kg and 51 μg/kg during the weeks of July 25 and September 5, respectively, and ranged from 0 to 620 μg/kg. Thus, the contamination level was considerably lower in the 1978 than in the 1977 survey, in which aflatoxin averaged 622 μg/kg and ranged from 0 to 4,708 μg/kg. Insect damage in 1978 increased significantly between the early and late surveys, but the average level of aflatoxin decreased. A positive correlation was found between ears with insect damage and ears with visible *Aspergillus flavus* Link, and between ears with visible *A. flavus* and those with aflatoxin level. However, the correlation between ears with insect damage and those with aflatoxin level was nonsignificant. These data suggest that environmental factors, in addition to kernel damage, may strongly influence the ultimate level of aflatoxin contamination in preharvest corn.

Considerable attention has been focused on the economic and health problems that are related to aflatoxin contamination in grain and other feed and food crops. Midwest surveys of corn (*Zea mays* L.) in 1964 and 1965 (Shotwell et al 1969) and in 1967 (Shotwell et al 1970) revealed low incidence and low levels of aflatoxin, a carcinogenic metabolite of *Aspergillus flavus* Link. Members of the *A. flavus* group of fungi are common on corn in Georgia (Doupnik 1972). Subsequent surveys (Shotwell et al 1973) showed that grain infection and aflatoxin contamination are more serious problems in the southeastern than in the midwestern United States. In 1977, a survey (McMillian et al 1978) of preharvest corn in 31 counties on the coastal plain of Georgia suggested that ears infected by *Aspergillus* spp. of the *A. flavus* group of fungi and ears contaminated with high levels of aflatoxin were widespread in about 810,000 ha (2 million acres) of corn. One of the most severe droughts in 20 years occurred during the early and middle parts of the 1977 growing season in Georgia, but rainfall was about normal during the latter part of the season. Insect populations, mostly corn earworms, *Heliothis zea* (Boddie), and fall armyworms, *Spodoptera frugiperda* (J. E. Smith), were severe throughout the season, and overall damage to foliage and ears was at one of the highest levels in the state's history.

The 1978 survey of preharvest corn grown in southern Georgia is reported herein. Our main objectives were to monitor any differences between 1977 and 1978 in incidence and level of aflatoxin contamination in corn in south Georgia and to identify possible reasons for the differences.

MATERIALS AND METHODS

During the week of July 24, 1978 (early survey), and again during the week of September 4, 1978 (late survey), a dent corn field in each of 45 counties on the coastal plain of Georgia was surveyed (Fig. 1). Selection of fields and sampling within fields followed the procedures used in the 1977 survey (McMillian et al 1978). Generally, we selected the first field we encountered after crossing the county line and traveling for about 6.4 km down a main highway if it apparently was typical for the area and the ears were at about 20–30% moisture. The top 10 ears on 10 plants at each of five locations in the field were husked and observed for visible greenish yellow fungal growth characteristic of *Aspergillus* spp. We recorded the number of infected ears and of ears damaged by insects and the amount of insect damage to ears, measured in depth penetration from the tip toward the butt of the ear. Two ears judged to be representative at each of the five sampling sites in a field were picked, bulked in a paper bag, brought to the laboratory within the day, and immediately shelled. Moisture content was read with a Steinlite moisture meter. Then grain samples were dried to 7% moisture in an oven at 60°C. Aflatoxin was determined on each sample by the AOAC official rapid modification for cotton seed products method. Correlation coefficients were calculated to determine relationships among the characteristics measured.

RESULTS AND DISCUSSION

The 1977 growing season, in which aflatoxin contamination was high in preharvest corn in Georgia, differed from the 1978 season in total precipitation. According to records at the Tifton station, total precipitation for April through July was 32.0 cm in 1977 and 43.2

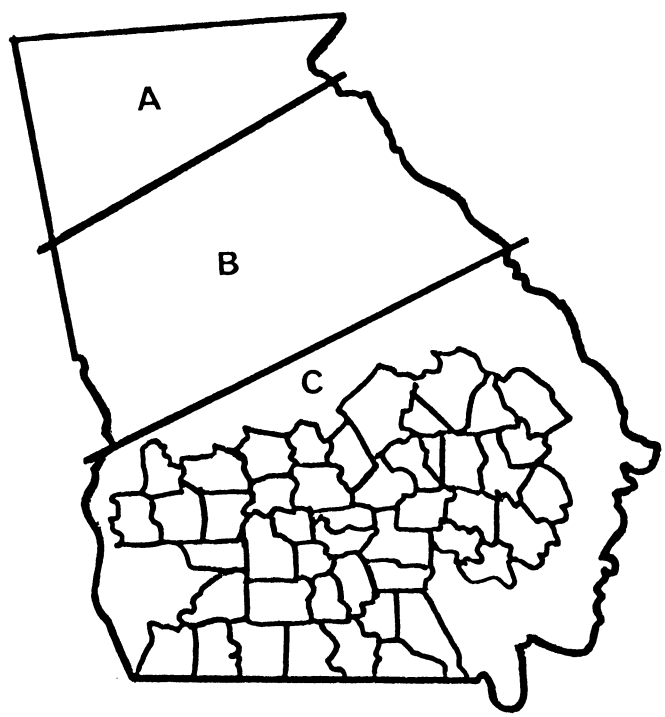

Fig. 1. Outline of the counties in the Coastal Plain Region (**C**) of Georgia surveyed for corn with *Aspergillus flavus*, aflatoxin, and insect damage in 1978. **A** and **B** are the Mountain and Piedmont Regions, respectively.

[1]Contribution of the Science and Education Administration, U.S. Department of Agriculture, in cooperation with the University of Georgia College of Agriculture Experiment Stations, Tifton, GA 31794.

Mention of a propriety product does not constitute endorsement by the USDA.

[2]Research entomologist, research geneticist, and research chemist, respectively, Southern Grain Insects Research Laboratory, USDA-SEA/AR, Tifton, GA 31794.

[3]Plant pathologist, University of Georgia College of Agriculture Experiment Stations, Coastal Plain Station, Tifton, GA.

This article is in the public domain and not copyrightable. It may be freely reprinted with customary crediting of the source. The American Association of Cereal Chemists, Inc., 1980.

TABLE I
Data from Surveys of Dent Corn Fields in the Georgia Coastal Plain Region in 1978

Characteristic	Field Data[a]	
	July 25	September 5
Average corn moisture (%)[b]	27	17
Range in corn moisture (%)	15–38	13–31
Average ear damage by insects (cm)[b]	1.2	2.1
Range in ear damage by insects (cm)	0.1–4.3	0.3–7.6
Average insect-damaged ears (%)[b]	33	60
Range in insect-damaged ears (%)	4–74	8–100
Average aflatoxin level (μg/kg)[b]	62	51
Range in aflatoxin level (μg/kg)	0–419	0–620
Incidence of aflatoxin (% of fields)	94	76

[a]Forty-five fields (one field per county) were surveyed on each date.
[b]Averages for dates within a characteristic are significantly different at the 5% level.

TABLE II
Aflatoxin Contamination in Preharvest Dent Corn Fields in the Georgia Coastal Plain Region in 1978

Aflatoxin Concentration (μg/kg)	Number of Fields[a]	
	July 25	September 5
0–19	23	33
20–99	15	7
100–399	5	2
400–799	2	3
Total	45	45

[a]One field surveyed per county on each date.

cm in 1978. In the latter part of the growing season, August through October, total rainfall was 32.5 cm in 1977 and 10.9 cm in 1978. Overall, insect population and resulting damage to foliage and ears were less severe in 1978 than in 1977.

In 1978, the incidence of aflatoxin in the July survey was 94%, compared with 76% in the September survey (Table I). Also, the average aflatoxin level was significantly lower in the late-season than in the early-season survey. Table II demonstrates the increase in the number of late-season survey samples falling into the low level aflatoxin category. Comparing years, the late-season survey in 1978 averaged 51μg/kg (range, 0–620 μg/kg) compared with 622 μg/kg (range 0–4,708 μg/kg) of total aflatoxin for the late-season survey in 1977 (31 fields in the same area). Correlations were not significant between counties surveyed in 1977 and 1978 for insect damage ($r = 0.14$) or for percent of ears with visible *A. flavus* ($r = 0.10$) or aflatoxin ($r = 0.03$). In 1978, the average percent of grain moisture was significantly lower in the late-season than in the early-season survey, and average insect damage was significantly higher in the late-season survey. Insect damage for the late-season survey was lower in 1978 (2.1 cm average ear penetration) than in 1977 (4.9 cm average ear penetration). No significant association was found in either the early-season or late-season survey between percent grain moisture at harvest and corn earworm penetration ($r = -0.02$ early or $r = 0.01$ late), percent damaged ears ($r = -0.06$ or $r = 0.11$), or percent ears with visible *A. flavus* fungal growth ($r = 0.01$ or $r = 0.11$) or aflatoxin ($r = -0.27$ or $r = 0.13$). In addition, no significant association was found between aflatoxin level and corn earworm penetration ($r = 0.21$ or $r = 0.21$) or percent damaged ears ($r = 0.18$ or $r = 0.24$). Data for percent ears with visible *A. flavus* fungal growth were not reported because so few ears (about 2% for both surveys) were affected. In both 1978 surveys, however, correlation ($r = 0.42$ or $r = 0.42$) was found between earworm penetration and percent ears with visible *A. flavus* mold. Correlation also was found between percent ears with visible *A. flavus* mold and aflatoxin level ($r = 0.43$ and $r = 0.67$) in both 1978 surveys. Indications are that ear damage by insects or by other means is conducive to, but does not guarantee, *A. flavus* or aflatoxin production. Environmental factors other than kernel damage may influence the ultimate level of aflatoxin contamination.

LITERATURE CITED

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS. 1975. Official Methods of Analysis, 12th ed. The Association: Washington, DC.

DOUPNIK, B. 1972. Maize seed predisposed to fungal invasion and aflatoxin contamination by Helminthosporium maydis ear rot. Phytopathology 62:1367.

McMILLIAN, W. W., WILSON, D. M., and WIDSTROM, N. W. 1978. Insect damage, Aspergillus flavus ear mold, and aflatoxin contamination in south Georgia corn fields in 1977. J. Environ. Qual. 7:564.

SHOTWELL, O. L., HESSELTINE, C. W., BURMEISTER, H. R., KWOLEK, W. F., SHANNON, G. M., and HALL, H. H. 1969. Survey of cereal grains and soybeans for the presence of aflatoxin. II. Corn and soybeans. Cereal Chem. 46:454.

SHOTWELL, O. L., HESSELTINE, C. W., and GOULDEN, M. L. 1973. Incidence of aflatoxin in southern corn, 1969-1970. Cereal Sci. Today 18:192.

SHOTWELL, O. L., HESSELTINE, C. W., GOULDEN, M. L., and VANDEGRAFT, E. E. 1970. Survey of corn for aflatoxin, zearalenone, and ochratoxin. Cereal Chem. 47:700.

[Received June 1, 1979. Accepted August 6, 1979]