Field Aflatoxin Contamination of Corn in South Georgia

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ABSTRACT

The weather conditions in 1977 were generally not favorable for corn production in many of the southeastern states. A combination of stress factors, weather conditions, and insect damage was favorable for ear mold by species of the *Aspergillus flavus* group. *A. flavus* was the dominant fungus in preharvest corn, and this led to extensive aflatoxin contamination.

In 1953 Sippel, Burnside and Atwood demonstrated that a toxicosis of swine and cattle resulted from eating moldy corn, *Zea mays* L. (1). They observed that this Geogia-grown corn was in poor condition and had generally been left standing in the field long after it should have been harvested. Swine or cattle were poisoned when they were allowed to forage in these fields. Burnside et al. (2) later isolated a strain of *Aspergillus flavus* Link ex. Fr. among the toxic fungi from the standing corn. Wilson et al. (3) established the relationship between toxic hepatitis of swine and aflatoxin contamination and reviewed the relationship between hepatitis X and aflatoxin in dogs in the southeastern United States.

In 1971 the FDA recalled 87 tons of corn meal mix made from Missouri-grown corn that allegedly contained excessive levels of aflatoxins (4). In this case, aflatoxin contamination was assumed to be primarily associated with poor harvesting and storage practices.

Aflatoxin contamination of United States corn before harvest has since been documented by several investigators (5-10). State by state reports on the aflatoxin contamination patterns indicate that southern states are more likely to have field contamination than corn belt states (5,8,9,11,12). However, field aflatoxin contamination in the corn belt is possible and has been observed in Iowa (6).

Field aflatoxin contamination of corn is probably common in much of the corn growing area of the southern United States, not just the southeastern states. Corn grown under stress conditions may be much more susceptible to invasion by *A. flavus* than that grown under favorable conditions; however, the stress conditions are poorly defined. Anderson et al. (5) noted that aflatoxin could be found in corn from late milk stage until harvest and that insect injury as well as reduced fertilization and very high plant populations appeared to have positive influences on the incidence of aflatoxin contamination. Widstrom et al. (13,14) confirmed the insect damage observations, and also showed that an intensive insecticide regime eliminated neither insect damage nor aflatoxin contamination. Reductions in insect damage reduced but did not eliminate aflatoxin contamination of preharvest corn.

Field aflatoxin contamination of corn may be common, or it may be rare and occur only with uncommon weather patterns during the growing season. We do not have enough data at this time to predict how much aflatoxin will be present with typical agronomic practices and weather patterns. There is no doubt that moisture control after harvest is one of the most important factors for controlling aflatoxin in corn. Delayed drying of corn after harvest or improper drying can lead to aflatoxin contamination. Furthermore, condensation or leaks in corn bins can lead to mold problems and aflatoxin contamination (15).

Feeding problems in swine that are probably caused by aflatoxins have been observed in Georgia for many years (1). In 1974, 1975, and 1976 there were 54 cases of probable swine aflatoxicosis from 30 counties based on histopathological findings of tissue at the Veterinary Diagnostic Laboratory in Tifton, Georgia. Aflatoxin assay of the feed at the time of diagnosis supported the probable diagnosis in 12 of the 18 cases where feed was analyzed; these feed samples ranged from 490 to 3422 ppb total aflatoxins (Wilson, D.M., and L.T. Sangster, unpublished data). In the other six cases, the aflatoxin range was from a trace to 360 ppb total aflatoxins. Diets containing these levels would not produce aflatoxicosis. Interviews of the farmers involved indicated that in 1974, 1975, and 1976 harvesting during rainy weather and inadequate drying causing poor storage conditions were responsible for almost all of the moldy corn fed to these problem herds (Wilson, D.M., and L.T. Sangsler, unpublished data).

Aflatoxins were determined from selected field plots in 1976, and no levels of field aflatoxin contamination exceeding 200 µg/kg were found in these samples; analyses of corn samples that were suspected to be toxic revealed that 11% contained levels over 200 ppb in 1974-76, although most of the highly contaminated samples could be traced to storage practices. Before 1977, the major problem with aflatoxin as related to swine production was not field contamination, but was associated with harvesting or storage (Wilson, D.M., and L.T. Sangster, unpublished data).

In 1977 ear mold by *A. flavus* accompanied by high levels of aflatoxin was widespread in several southern states. This *A. flavus* ear mold tended to be most severe in heat- and drought-stressed corn. During the week of August 8, 1977, samples from a 31 county survey in Georgia showed that 78% of the preharvest corn samples contained over 100 ppb total aflatoxins. Ten percent of the fields contained 0-20 ppb, 12% contained 21-100 ppb, 42% contained 101-400 ppb, 20% contained 401-1000 ppb, and 16% contained over 1000 ppb total aflatoxins. This 31 county survey sampled only one field per county and may not be truly representative of the total crop in the Costal Plain of Georgia since many fields had already been harvested. Data were taken on visible green ear mold, insect damage, and aflatoxin contamination. There were highly significant correlations between insect damage and visible ear mold, insect damage and aflatoxin, and visible ear mold and aflatoxin in this survey, $r = 0.73$, 0.52, and 0.66 respectively (16).

Lillehoj and Zuber (17) and Shotwell (9) have recent excellent reviews on field occurrence and surveys in corn, and these references should be consulted for summaries of the South Carolina surveys and multi-state studies that have been carried out.

By October 7, 1977, the Georgia Department of Agriculture had determined aflatoxins in 10841 corn samples using the Holaday Minicolumn Methods (18). Aflatoxin ranged from 0-20 ppb in 3368 samples, 20-100 ppb in 2751 samples, 100-400 ppb in 2076 samples and over 400 ppb in 2624 samples (Georgia, Agriculture, personal communication). These values are not representative of the total 1977 corn crop for several reasons: (a) representative samples from the whole crop were not tested; (b) there was no sampling plan; (c) the sample size was too small to give a reliable estimate; (d) there may have been many duplicate samples; (e) there may have been non-southern corn samples; and (f) there may have been samples from other crop years.

Thus, we have two observations on the extent of the aflatoxin problem in Georgia in 1977 that are generally in agreement, but they both have large potential error terms, making a good estimate difficult. However, there is little doubt that there was a substantial portion of the total crop affected by preharvest ear mold and aflatoxin contamination. It is also difficult to know how much of the total problem in 1977 was related to poor harvesting and storage techniques. For example, on one farm corn was sampled in the field, in the truck behind the combine, and in the bin prior to drying. The field and truck samples contained ca. 200 ppb total aflatoxins, and the bin sample contained ca. 2000 ppb total aflatoxins. The owner had a continuous flow dryer but did not have it in operation and could have prevented the postharvest buildup with drying (Wilson, D.M., and D.M. Bedell, unpublished data). Thus, improper drying and storage may still have been responsible for much of the high level contamination in 1977 as well as in previous years. The physical appearance of the corn may help to distinguish between preharvest and postharvest molding. If field contamination and ear mold occurred, the visible conidial heads of *A. flavus* generally will be associated with the insect-damaged corn; if post harvest molding occurred, the visible green mold will be associated with the germ and with physical damage as pictured by Christensen (15).

In addition to the 31 county survey and the analyses done by the Georgia Department of Agriculture, several observations were taken in Georgia in 1977 field plot studies. In general these observations concern only the 1977 crop year. Until more data is collected, only preliminary trends can be reported. In a 1977 planting date study, observations (Musick, G., and D.M. Wilson, unpublished data), indicated that corn had greater insect damage, mold growth, and aflatoxin contamination as planting date was delayed; the planting date apparently overcame any consistent varietal differences in aflatoxin production that may have been present in the corn. Inadequate nitrogen fertility resulted in greater aflatoxin contamination in 1977; whereas, in 1976 nitrogen fertility had no effect on aflatoxin contamination (Keisling, T., and D.M. Wilson, unpublished data). Other tests including irrigation, land preparation practices, preplant nematicide applications, and insecticide applications did not seem to have large effects on aflatoxin contamination. Many factors need extensive evaluation before the effects of production practices on aflatoxin contamination can be predicted.

The conditions in Georgia in 1977 favored ear mold by *A. flavus* and aflatoxin contamination. The temperature and moisture relationships that favored *A. flavus* appeared optimal, but these relationships under field conditions are not well understood. Insect damage in 1977 (16) was severe, and this was a factor contributing to ear mold and aflatoxins; however, insect damage was also severe in 1976 and ear mold by *A. flavus* was not severe. Other variables such as hybrids, planting date, weed control, fertility levels, tillage practices, wet harvest weather, lodging due to stalk rot, physical damage during harvest, and improper drying and storage also may influence aflatoxin contamination in more typical years.

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