INSECT DAMAGE AND AFLATOXIN CONTAMINATION IN PREHARVEST CORN: INFLUENCE OF GENOTYPE AND EAR WETTING[1,2]

W. W. McMillian, N. W. Widstrom, and D. M. Wilson[3]

(Accepted for publication Nov. 30, 1984)

ABSTRACT

A corn, *Zea mays* L., hybrid with loose-husk characteristics developed for the Corn Belt and a hybrid with tight-husk characteristics developed for the South were evaluated in field plots for relative levels of corn earworm [*Heliothis zea* (Boddie)] feeding damage, visible *Aspergillus flavus* sporulation, and aflatoxin contamination in 1980 and 1981. Supplemental corn earworm eggs and *A. flavus* spores were applied to silks of all ears. Water treatments consisted of an untreated check and a water spray (simulated heavy morning dew) applied to developing ears either once or 3 times per week for 4 weeks. Water was applied to ears with a hand-held garden sprayer until runoff occurred. The southern-adapted hybrid with good husk cover sustained significantly less insect damage and aflatoxin contamination than the Corn Belt-adapted hybrid during both years. Significant differences between hybrids (5% level) in visible *A. flavus* sporulation were obtained only in 1981. Corn plots treated with 3 water sprays per week for 4 weeks tended to sustain more insect damage, visible *A. flavus,* and aflatoxin than plots sprayed with water once a week for 4 weeks, although significant differences at the 5% level were obtained for aflatoxin concentrations only in 1981. These data demonstrate significant levels of insect resistance and resistance to aflatoxin development between two corn genotypes. Also, heavy morning dews that frequently occur in the Southeast may be involved in the elevation of aflatoxin contamination in this area.

Key Words: Corn earworm, *Aspergillus flavus, Heliothis zea* (Boddie), *Zea mays* L., mycotoxins.

J. Entomol. Sci. 20(1): 66-68 (January 1985)

INTRODUCTION

In 1961, Sargeant et al. reported that *Aspergillus flavus* Link, a fungus often found in cornfields, was the progenitor of toxic and carcinogenic metabolites that were later labeled "aflatoxins." Subsequently, studies have associated fungal infection and/or aflatoxin development in preharvest corn, *Zea mays* L., with insect damage, irrigation, fertilization, temperature, and planting and harvest dates (Anderson et al. 1975; Fennell et al. 1975; Lillehoj and Hesseltine 1977; Jones and Duncan 1981; Jones et al. 1981; McMillian et al., in press). Research has suggested that grain of some corn genotypes is infected by *A. flavus* and/or contaminated with aflatoxin to a lesser extent than grain of other genotypes and that these differences are genetically controlled (Zuber 1977).

Overall, ears of hybrids developed for southern growing conditions have a tighter, more complete husk cover than ears of hybrids developed for Corn Belt growing conditions. In addition, aflatoxin formation in preharvest corn appears to

[1] *Zea mays* L.

[2] In cooperation with the University of Ga. Coll. of Agric. Exp. Stns., Coastal Plain Station, Tifton, GA.

[3] Research Entomologist and Research Geneticist, Insect Biology and Population Management Research Laboratory, USDA-ARS, Tifton, GA; and Plant Pathologist, University of Georgia, Coastal Plain Experiment Station, respectively.

be more prevalent during a hot, humid growing season, characteristic of the southeastern United States. This study, therefore, was designed to compare insect damage, visible *A. flavus* sporulation, and aflatoxin development in preharvest ears of a Southern and a Corn Belt hybrid evaluated under southeastern growing conditions and subjected to insect infestations, fungal spore contamination, and varying degrees of ear wetting that simulated heavy morning dews common to this area.

MATERIALS AND METHODS

The experimental field plots were planted on 23 April in 1980 and 22 April in 1981 in a split-plot design with seven replications. A southern-adapted hybrid with a relatively tight, complete husk cover and a Corn Belt-adapted hybrid with a relatively loose, open husk cover were whole plots. Water treatments of: no water spray on ears (check), ears sprayed about 9:00 a.m. with water once a week (Wednesday), or three times a week (Monday, Wednesday, and Friday) were subplots. Beginning 2 weeks after full silking, the water spray was applied for 4 weeks using a hand-held garden pressure sprayer. Each ear was sprayed until runoff occurred. To insure maximum potential for differentiating between treatments, ears in all plots were infested at 5 days postfull silking with 30 corn earworm *[Heliothis zea* (Boddie)] eggs/ear suspended in 0.5 ml of a 0.2% agar solution applied with a hand-lotion dispenser. Ears were also inoculated with a water suspension of *A. flavus* (NRRL 3357) spores (1×10^6 conidia per ml) applied to silks with a plastic squeeze bottle (ca. 0.5 ml/ear).

Ten ears were harvested from each plot 56 days after silking and each ear was observed for visible *A. flavus* sporulation. Each ear was rated for insect (mostly corn earworm) damage by measuring (in cm) the amount of feeding penetration from the ear tip toward the base. Harvested ears were placed in a 60°C dryer and shelled after 7 days' drying. Total aflatoxin concentrations (B_1, B_2, G_1 and G_2) were determined on grain samples by the procedure of Thean et al. (1980).

Aflatoxin concentrations were transformed to $\ln (ng \cdot g^{-1} + 1)$ and percentages were converted to angle = $\arcsin \sqrt{\text{percentage}}$ for statistical analysis. Means were separated by Duncan's multiple range test.

RESULTS AND DISCUSSION

Insect damage and visible sporulating *A. flavus* on preharvest ears were higher in 1981 than in 1980 (Table 1). The highest aflatoxin concentration (992 $ng \cdot g^{-1}$) was also detected in 1981. The hybrid developed with a tight husk for use in the South, sustained significantly less (5% level) insect damage and total aflatoxin contamination ($B_1 + B_2 + G_1 + G_2$) during both years than the more open-husked hybrid developed for the Corn Belt. Also, in 1981, the southern-adapted hybrid had significantly less (5% level) visible *A. flavus* sporulation than the Corn Belt-adapted hybrid. These data suggest that a significant degree of plant resistance to corn earworm feeding damage and aflatoxin formation is present in some corn germplasm.

Ears treated with 3 water sprays per week for 4 weeks tended to sustain more insect damage, visible *A. flavus,* and aflatoxin contamination than the ears sprayed with water once a week for 4 weeks. However, significant differences at the 5%

Table 1. Insect damage, *Aspergillus flavus* sporulation, and aflatoxin contamination sustained by two corn hybrids at Tifton, GA, 1980 - 81.

Treatment*	Insect damage (cm)		Ears with visible *A. flavus* (%)		Geom. mean† of aflatoxin concentration ($ng \cdot g^{-1}$)	
	1980	1981	1980	1981	1980	1981
Hybrid						
Southern-adapted	3.1 a	3.8 a	14.0 a	34.7 a	60 a	16 a
Corn Belt-adapted	4.6 b	11.4 b	29.8 a	55.6 b	148 b	992 b
Water spray						
Check	3.7 a	7.0 a	28.1 a	37.5 a	81 a	74 a
1 per week	3.7 a	7.8 a	16.8 a	41.6 a	99 a	81 a
3 per week	4.1 a	8.0 a	20.1 a	56.3 a	110 a	299 b

* Means within a column followed by different letters are significantly different at the 5% level.
† The antilogarithm of the logarithmic mean.

level were obtained for aflatoxin concentrations only in 1981. No significant interaction between hybrid and water treatment was detected in the analyses. Data from the water-spray treatments suggest that the heavy morning dews frequently occurring in the Southeast may be favorable for aflatoxin contamination of preharvest corn in this area.

LITERATURE CITED

Anderson, H. W., E. W. Nehring, and W. R. Wichser. 1975. Aflatoxin contamination of corn in the field. J. Agric. Food Chem. 23: 775-82.

Fennell, D. I., E. B. Lillehoj, and W. F. Kwolek. 1975. *Aspergillus flavus* and other fungi associated with insect-damaged field corn. Cereal Chem. 52: 314-21.

Jones, R. K., and H. E. Duncan. 1981. Effect of nitrogen fertilizer, planting date, and harvest date on aflatoxin production in corn inoculated with *Aspergillus flavus*. Plant Dis. 65: 741-4.

Jones, R. K., H. E. Duncan, and P. B. Hamilton. 1981. Planting date, harvest date, and irrigation effects on infection and aflatoxin production by *Aspergillus flavus* in field corn. Phytopathology 71: 810-6.

Lillehoj, E. B., and C. W. Hesseltine. 1977. Aflatoxin control during plant growth and harvest of corn. pp. 107-19. *In:* J. V. Rodricks, C. W. Hesseltine, and M. A. Mehlman [eds.]. Mycotoxins in Human and Animal Health. Pathotox Pub. Inc., Park Forest South, IL.

McMillian, W. W., D. M. Wilson, and N. W. Widstrom. A six-year study of insect damage, visible *A. flavus*, and aflatoxin contamination in ears of preharvest Georgia corn. J. Environ. Qual. (In press).

Sargeant, K., A. Sheridan, J. O'Kelly, and R. B. A. Carnaghan. 1961. Toxicity associated with certain samples of groundnuts. Nature 192: 1096-7.

Thean, J. E., D. R. Lorenz, D. M. Wilson, K. Rodgers, and R. C. Gueldner. 1980. Extraction, cleanup, and quantitative determination of aflatoxin in corn. J. Assoc. Off. Anal. Chem. 63: 631-3.

Zuber, M. S. 1977. Influence of plant genetics on toxin production in corn. pp. 173-9. *In:* J. V. Rodricks, C. W. Hesseltine, and M. A. Mehlman [eds.]. Mycotoxins in Human and Animal Health. Pathotox Pub. Inc., Park Forest South, IL.