Aflatoxin Contamination of Bt and Non-Bt Cottonseed

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Abstract

Transgenic Bt cotton varieties that are resistant to pink bollworm should sustain less feeding damage to bolls and cottonseed, compared to non-Bt varieties that are more susceptible to feeding damage by pink bollworm larvae. Prior to boll opening, the aflatoxin producing fungus Aspergillus flavus cannot penetrate undamaged cotton bolls. Thus resistance to pink bollworm could result in reduced aflatoxin contamination under high pink bollworm pressure. Cottonseed aflatoxin levels of Bt and non-Bt varieties were compared at various planting and harvest dates. Bt and non-Bt cotton varieties had similar cottonseed aflatoxin levels. Long season production systems favored high cottonseed aflatoxin levels, compared to short season production systems, regardles of the cotton variety grown.

Introduction

Aflatoxin contamination of cottonseed from the toxin producing fungus *Aspergillus flavus* occurs primarily at elevations below 1800 feet, or in counties along the Colorado River and in south central Arizona. Infection results in damage to cotton lint by staining and weakening the fibers, and when the fungus penetrates the seed, viability is lost since seed germination is inhibited. Furthermore, the feeding of cottonseed exceeding 20 ppb aflatoxin to dairy cows is prohibited since aflatoxins can be transmitted from the feed to the milk of dairy cows.

Only open bolls and bolls or seeds damaged by insects such as the pink bollworm are subject to invasion by the aflatoxin producing fungus. The critical period for boll invasion and contamination from aflatoxin is from early August to mid-September when bolls start to open. Approximately 95% of the seed infection and aflatoxin formation can take place during this time. These susceptible bolls are normally located on the lower 1/3 to ½ of the plant where dense leaf canopies maintain high humidity and prevent air movement around the bolls. Rank cotton is usually more susceptible to aflatoxin problems.

Late season irrigation management and cotton harvesting methods can affect aflatoxin levels in cotton seed. During high risk growing seasons, when above normal August and September nighttime air temperatures occur, reduction of the growing season and limiting the number of irrigations in August shows promise for reducing aflatoxin levels. Careful management of irrigation and nitrogen to avoid rank cotton growth can lessen fungus development. Rood cotton should not be mixed with picked cotton since rood cotton can have aflatoxin levels up to 50 times higher than picked cotton.

Transgenic Bt cotton may have reduced susceptibility to aflatoxin contamination due to its pink bollworm resistance. However, under heavy pink bollworm pressure, first and second instar pink bollworm larvae can damage Bt cotton bolls and seed. Furthermore, even Bt cotton varieties are not resistant to *Aspergillus flavus* infection following boll opening, and large quantities of aflatoxin can form during this period. When Bt cotton growers extend the growing season due to low cost pink bollworm control, most advantages of Bt cotton in aflatoxin

management may be lost (Cotty et. al., 1997).

Materials and Methods

Field experiments were conducted during 1995 and 1996 in Parker Valley (located in southwestern La Paz County) and Mohave Valley (located in southwestern Mohave County) to determine aflatoxin levels in cottonseed produced there. In 1995, approximately 50 pounds of seed cotton was hand picked on November 7 from the bottom, middle, and top 1/3 of the cotton plants from an early (March 15) and late (April 20) planted fields. The experiment was conducted at V&K Wakimoto farms in Mohave Valley. In 1996, approximately 5 pounds of cottonseed was saved from 4 replicates each of Deltapine 5415 and 33B cotton grown in a variety test at Avi Kwa 'Ame Farms in Mohave Valley. Also in 1996, approximately 25 pounds of cottonseed was saved from full field (40 acre) evaluations of Deltapine 33B and 35B harvested at several different dates at the King Ranch in Parker Valley. Cottonseed samples were tested for aflatoxin levels by Chandler Analytical Laboratories through Anderson Clayton Gins.

Results and Discussion

In the 1995 study, highest aflatoxin levels were observed in cottonseed from seed cotton hand harvested from the upper one third of the cotton plant compared to the middle one third and bottom one third portions (Table 1). Most likely, this was caused by pink bollworm damage to bolls growing at the tops of plants. It is pretty common to see the top crop of non-Bt cotton varieties infested with pink bollworm larvae late in the growing season. Additionally, aflatoxin levels in cottonseed from the early planted (March 15) cotton field were higher than those observed in the late planted (April 20) field. Since both fields were harvested on November 7, the early planted field was subjected to a relatively long growing season and probably had more susceptible (open) bolls during the critical period for infection from August through mid-September.

In 1996, a non-transgenic variety Deltapine 5415 was grown side by side with its transgenic Bt daughter line Deltapine 33B in a replicated upland cotton variety test located in Mohave Valley (Table 2). At the November 15 harvest, aflatoxin levels of Deltapine 5415 cottonseed ranged from 10 to 31 ppb, and Deltapine 33B cottonseed had aflatoxin levels ranging from 35 to 83 ppb. Statistically, the aflatoxin levels of cottonseed from the two varieties were not significantly different. This indicates that although Bt cotton is somewhat resistant to pink bollworm, it may not be resistant to infection by *Aspergillus flavis*. First or second instar pink bollworm larvae can survive in Bt cotton and impart some damage to bolls and cottonseed which can be penetrated by the *A. flavus* fungus. Boll damage from insects other than pink bollworm and heat stress induced suture cracking may also predispose bolls to infection. Furthermore, Bt cotton varieties are not resistant to aflatoxin increases occurring after boll opening.

Also in 1996, full field (40 acre) evaluations of transgenic Bt cotton varieties harvested at various dates were examined in Parker Valley (Table 3). Deltapine 35B harvested from October 21 through November 13 had cottonseed aflatoxin levels ranging from 2 to 16 ppb. However, Deltapine 33B and 35B harvested on December 4 had cottonseed aflatoxin levels ranging from 58 to 411 ppb. Therefore, Bt cotton varieties harvested during October and November had cottonseed aflatoxin levels acceptable for dairy cow feed, while the same Bt cotton varieties harvested in December did not. Therefore, long or full season cotton production systems seem to favor high cottonseed aflatoxin levels, compared to short season production systems, regardless of what cotton variety is grown.

References

Cotty, P.J., D.R. Howell, C. Block, and A. Tellez. 1997. Aflatoxin contamination of Bt cottonseed. 1997 Cotton Report. University of AZ College of Agriculture Series P-108. P. 435-439.

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Table 1. Effects of planting date and plant portion picked on November 7, 1995 on aflatoxin levels in Mohave Valley cottonseed.

Cotton Plant Portion Picked	Planted March 15 (ppb Aflatoxin)	Planted April 20 (ppb Aflatoxin)
Top Third	70	10
Middle Third	29	4
Bottom Third	15	5

Table 2. Varietal comparison between a Bt and its non-Bt counterpart of aflatoxin levels in cottonseed from a November 15, 1996 harvest in Mohave Valley.

Variety	ppb Aflatoxin
Deltapine 5415 (non-Bt, 4 reps)	10 to 31
Deltapine 33B (Bt daughter line, 4 reps)	35 to 83

Table 3. Comparison of harvest dates of Bt cotton and their effect on observed cottonseed aflatoxin levels during 1996 in Parker Valley.

Harvest Date	Variety	ppb Aflatoxin
December 4	Deltapine 33B (4 fields)	58 to 411
October 21	Deltapine 35B	2
November 12	Deltapine 35B	16
November 13	Deltapine 35B	7
December 4	Deltapine 35B	315