CHARACTERIZATION OF *ASPERGILLUS FLAVUS*, AFLATOXIN, FUMONISIN IN CORN: EFFECTS OF COVER CROP, ROTATION, AND GLYPHOSATE

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INTRODUCTION

Corn and cotton seed are frequently contaminated with aflatoxins and fumonisins produced by *Aspergillus* and *Fusarium* fungi, making them unfit for human and animal consumption. Mycotoxin contamination is influenced by the level of infestation by toxigenic fungi and environmental factors that stress crop plants. In 1998, drought and high temperatures in Mississippi contributed to significant levels of both aflatoxin and fumonisin in corn. Because of food safety concerns, it is critical to investigate cultural practices and crop management techniques that maximize crop yields and minimize inoculum potential of the causal fungi and mycotoxin production. Glyphosate inhibits the enzyme 5-enolpyruvylshikimate-3-phophate synthase (EPSPS) in the shikimate pathway. Roundup Ready corn and cotton created by stable integration of a transgene that code for insensitive EPSPS are resistant to glyphosate. Fungi possess a sensitive EPSPS and are susceptible to glyphosate. These field studies examined the effects of simple agronomic practices on *Apergillus flavus* in soil and levels of aflatoxin and fumonisin in corn and cotton seed.

OBJECTIVE

To study the effects of crop rotation, cover crop, and selection of conventional and Roundup Ready cultivars on *Apergillus flavus* in soil and levels of aflatoxin and fumonisin in corn and cotton seed.

MATERIALS AND METHODS

GENRAL CONDITIONS:
Location: USDA-ARS Southern Weed Science Research farm, Stoneville, MS.
Soil:Dundee silt loam.
Years: 2000, 2001, 2002, 2003, 2004.
Tillage:
- •1st year: previous fall – subsoil, disking, and bedding.
- • Subsequent years: just re-bedding after harvest.

Row spacing: 102 cm, 8 rows/plot.
Crops irrigated as needed.
Data:
1. *A. flavus* populations in soil determined using modified dichloronitroaniline rose bengal agar.
2. Aflatoxin and fumonisin in seed determined using ELISA.

1. CORN-COTTON ROTATION STUDY:
Production practices: Table 1; Treatments: Table 4.
Plot size: 45.7 m long and 8.1 m wide.
Design: Randomized Complete Block Design with 4 replications.

2. COVER CROP STUDY IN ROUNDUP READY CORN
Cover crop: Hairy vetch and none. Killed at planting corn.
Variety: AG RX 738RR in 2002; DKC69-72RR in 2003.
Planting date: April 5, 2002 & April 1, 2003.
Plot size: 15.2 m long and 8.1 m wide.
Herbicides:
PRE: None.
POST: Glyphosate at 0.84 kg ae/ha at 3 and 5 WAP in a 38-cm wide band, broadcast, and no herbicide.
Design: Split-plot arrangement in RCBD with 4 replications.
Harvest date: August 22, 2002 & August 18, 2003.

3. COVER CROP STUDY IN NON-ROUNDUP READY CORN
Similar to Roundup Ready corn in Study 2.
Variety: Pioneer 3223 in both years.
Herbicides:
PRE: Atrazine 1.8 kg/ha + Metolachlor 1.4 kg/ha.
POST: Atrazine 1.0 kg/ha + Metolachlor 0.7 kg/ha + Carfentrazone 9 g/ha at 5 WAP in a 38-cm wide band, broadcast, and no herbicide.

Table 1. Production practices for cotton and corn rotation in 2000-2004.

Practices	Cotton					Corn				
	2000	2001	2002	2003	2004	2000	2001	2002	2003	2004
Variety: Conventional	Stoneville 474	Stoneville 474	Stoneville 474	Stoneville 474	Sure-Grow 747	Pioneer 3223	Pioneer 3223	Pioneer 3223	Pioneer 3223	Pioneer 3223
Roundup Ready	DP 436 RR	DP 436 RR	DP 436 RR	DP 436 RR	DP 444 BG/RR	AG RX 738 RR	AG RX 740 RR	AG RX 738 RR	DKC69-72 RR	DKC69-71 RR2
Planting date	11 May	18 April	1 May	22 April	22 April	7 April	22 March	5 April	31 March	24 March
Herbicides: PRE: Conventional Var	Fluometuron 1.1 to 1.7 kg/ha + Pendimethalin 1.1 kg/ha					Atrazine 1.8 kg/ha + Metolachlor 1.4 kg/ha				
Roundup Ready Var	Fluometuron 1.1 to 1.7 kg/ha + Pendimethalin 1.1 kg/ha					None				
EPOST (3-4 WAP) Conventional Var	Pyrithiobac 105 g/ha	Pyrithiobac 105 g/ha	Pyrithiobac 105 g/ha	Fluazifop 210 g/ha + Pyrithiobac 105 g/ha	Pyrithiobac 105 g/ha	None	None	None	None	None
Roundup Ready Var	Glyphosate 1.1 kg/ha	Glyphosate 1.1 kg/ha	Glyphosate 1.1 kg/ha	Glyphosate 1.1 kg/ha	Glyphosate 1.1 kg/ha	Glyphosate 1.1 kg/ha	Glyphosate 1.1 kg/ha	Glyphosate 1.1 kg/ha	Glyphosate 1.1 kg/ha	Glyphosate 1.1 kg/ha
LPOST (5-9 WAP) Conventional Var	Sethoxydim 0.28 kg/ha	None	Fluometuron 0.9 kg/ha + MSMA 2.24 kg/ha	Fluometuron 0.9 kg/ha + MSMA 2.24 kg/ha	Fluometuron 0.9 kg/ha + MSMA 2.24 kg/ha	None	Atrazine 1.0 kg/ha + Metolachlor 0.7 kg/ha	None	Atrazine 1.0 kg/ha + Metolachlor 0.7 kg/ha + Carfentrazone 9 g/ha	Atrazine 1.0 kg/ha + Metolachlor 0.7 kg/ha + Basagran 0.8k g/ha
Roundup Ready Var	Sethoxydim 0.28 kg/ha	None	Glyphosate 1.1 kg/ha	Glyphosate 1.1 kg/ha	Glyphosate 1.18 kg/ha	None	Glyphosate 1.1 kg/ha	Glyphosate 1.1 kg/ha	Glyphosate 1.1 kg/ha	Glyphosate 1.1 kg/ha
Cultivation (Conv. & RR)	None	Once	Once	None	None	None	None	None	None	None
Harvest date	22 September	20 September	23 September	19 September	23 September	14 August	16 August	28 August	18 August	10 August

RESULTS

Table 2. Aflatoxin and fumonisin in CORN grain as affected by Roundup Ready and Non-Roundup Ready cotton-corn rotation in 2002-2004.

Cultivar	Rotation	Aflatoxin			Fumonisin		
		2002	2003	2004	2002	2003	2004
		ppb			ppm		
Non Roundup Ready	Continuous	0 a	1 a	0 b	2 a	16 a	4 a
	Rotation	1 a	1 a	0 b	2 a	15 a	4 a
Roundup Ready	Continuous	0 a	1 a	34 a	2 a	17a	1 b
	Rotation	1 a	1 a	20 ab	4 a	13 a	1 b

Note: Means within a column followed by the same letter are not significantly different at the 5% level using Fisher's protected LSD test.

Table 3. Aflatoxin and fumonisin in COTTON seed as affected by Roundup Ready and Non-Roundup Ready cotton-corn rotation in 2002-2004.

Cultivar	Rotation	Aflatoxin			Fumonisin		
		2002	2003	2004	2002	2003	2004
		ppb			ppm		
Non Roundup Ready	Continuous	1 a	1 a	0 a	0 a	0 a	0 a
	Rotation	1 a	2 a	1 a	0 a	0 a	0 a
Roundup Ready	Continuous	0 a	1 a	2 a	0 a	0 a	0 a
	Rotation	1 a	2 a	3 a	0 a	0 a	0 a

Note: Means within a column followed by the same letter are not significantly different at the 5% level using Fisher's protected LSD test.

Table 4. *Aspergillus flavus* populations in surface 5-cm soil at planting and harvest as affected by Roundup Ready and Non-Roundup Ready cotton-corn rotation in 2002-2004.

Crop rotation	2002			2003		2004	
	April	June	Sept	March	Sept	March	Sept
	Log (10) colony forming units/g soil						
Non-Roundup Ready							
Cot-Cot-Cot-Cot	2.5 a	2.8 a	2.6 d	2.6 a	2.6 a	2.0 b	2.3 a
Corn-Corn-Corn-Corn	2.4 a	2.7 ab	2.6 d	2.6 a	2.5 a	2.3 b	2.5 a
Cot-Corn-Cot-Corn	2.3 a	2.6 abc	2.6 d	2.5 a	2.5 a	2.2 b	2.6 a
Corn-Cot-Corn-Cot	2.5 a	2.7 ab	2.8 c	2.7 a	2.6 a	2.2 b	2.6 a
Roundup Ready							
Cot-Cot-Cot-Cot	na	2.8 a	3.2 a	2.6 a	2.5 a	2.0 b	2.4 a
Corn-Corn-Corn-Corn	na	2.7 ab	3.0 b	2.5 a	2.4 a	2.8 a	2.8 a
Cot-Corn-Cot-Corn	na	2.4 c	3.2 a	2.5 a	2.5 a	2.3 b	2.5 a
Corn-Cot-Corn-Cot	na	2.5 bc	3.1 ab	2.6 a	2.5 a	2.3 b	2.5 a

Note: Means within a column followed by the same letter are not significantly different at the 5% level using Fisher's protected LSD test.

CONCLUSIONS

1. *A. flavus* populations in surface 5-cm soil before planting and harvest ranged from 2.0 to 3.2 log (10) cfu/g soil with no clear trend among eight rotation systems in 2002-2004, although *Aspergillus* populations were significantly greater in plots with Roundup Ready cultivars compared to conventional cultivars on several sampling dates.
2. In cotton seed, aflatoxin and fumonisin levels were (≤3 ppb) similar regardless of rotation and glyphosate.
3. In corn grain, aflatoxin was above the regulatory level (≥20 ppb) only in Roundup Ready cultivar in 2004. Fumonisin was higher in conventional cultivar (4 ppm) regardless of rotation in 2004. However, in 2002 and 2003, the mycotoxins levels were similar regardless of rotation and glyphosate.
4. In corn grain from cover crop study, aflatoxin and fumonisin levels were very low and unaffected by either hairy vetch cover crop or glyphosate (data not shown).
5. These results indicate the potential for increased aflatoxin levels (1 of 3 years) in corn and a stimulation of *A. flavus* populations in a Roundup Ready cropping system under climatic conditions encountered in Mississippi.

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