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Leading the Way for Agriculture in the Central Texas Blacklands

AgriLIFE RESEARCH & EXTENSION
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2012 Stiles Farm Field Day

June 19, 2012

The Department of Soil and Crop Sciences · Texas AgriLife Research & Extension

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Central Texas Blacklands Tillage Trails
Stiles Farm Foundation
2003-2010

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Background:

The Stiles Farm Foundation has as one of its objectives to evaluate tillage practices and tillage methods and to provide educational information to growers in the region.

The summary that follows is a compilation of 8 years of data from 2003-2010 comparing no till, conventional tillage and strip tillage in five rotations: corn 09/corn10 etc., cotton 09/corn10 etc., sorghum 09/cotton 10 etc., corn 09/cotton 10 etc., and cotton 09/sorghum10 etc.

Discussion:

The tillage plots are designed as large scale plots that are machine harvested by custom harvesters. The plots are 16 rows each on 38 inch row spacing with each tillage treatment replicated three times in each rotation. Depending on the field row length, each 16 row tillage treatment encompasses from 2 to 4 acres. All of the plots are dryland and receive no supplemental irrigation. The plots are grown on a Burleson Clay vertisol soil. Over the range of these years, growing conditions have ranged from very dry years to very optimal moisture years.

Conventional tillage consists of either chiseling with sweeps or heavy discing followed by multiple passes with a field cultivator. Strip tillage in 2003 was achieved using a DMI 5310 strip till unit. The 2004-2006 strip till plots were done with a Yetter Maverick 8 row strip till unit. The 2007-2010 plots were treated with the Orthman 1-tRIPr strip till tool.
The 2003-2010 tillage trials results listed show the rotation, yield and net income. Net income includes the value of the individual crop at harvest time with expense deductions that includes tillage trips, spraying, planting and harvesting as well as any other treatments at custom rates for the region. Other expenditures were actual costs as incurred during the season.

Summary:

There are benefits to some tillage in high clay content soils in the thermic regions prevalent in the Central Texas Blacklands. It may not be necessary to do whole acre tillage each year however. An annual check of compaction will be a good guide to determine if tillage is necessary as many factors are involved in compacted soils. Growers may not need to till the entire field depending on the crop to be planted and the previous crop but may want to consider some type of zone tillage such as strip tillage. Strip tillage allows for a narrow band of “ clean soil” in the row with residue in the middles for moisture conservation.

The soil band left after strip tillage will generally warm sooner in cool springs. In addition, strip till enables application of fall or winter fertilizer placed strategically where the crop can use it more efficiently. Soil quality makes marked improvements by increasing the water holding capacity of the soil.

Including RTK guidance systems as a part of the strip till program further increases efficiency and results in cost savings with better fertilizer placement and a uniform crop stand.

2003-2010 Tillage Trials: Stiles Farm Foundation

ROTATION	YIELD	NET PROFIT
CORN/CORN		
No Till	84.4 bu/ac	$72.73
Strip Till	88.0 bu/ac	$72.19
Conventional Till	90.5 bu/ac	$57.40
COTTON/CORN		
No Till	76.4 bu/ac	$37.17
Strip Till	82.3 bu/ac	$45.32
Conventional Till	78.0 bu/ac	$01.55
COTTON/SORGHUM*		
No Till	4414 lb/ac	$85.85
Strip Till	4683 lb/ac	$93.76
Conventional Till	4806 lb/ac	$87.26
CORN/COTTON		
No Till	536 lb/ac	$04.92
Strip Till	593 lb/ac	$30.99
Conventional Till	620 lb/ac	$07.73
SORGHUM/COTTON		
No Till	590 lb/ac	$51.69
Strip Till	651 lb/ac	$69.87
Conventional Till	686 lb/ac	$66.23

*Represents 7 years data due to sorghum wind damage in 2005.

Reduced Potential Leaching and Runoff Losses and Improved Production Economics Through Management of Residual Nitrogen in Corn

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Introduction

Increasing concerns regarding nutrient contamination of surface and groundwater resources have refocused attention on nitrogen management in several major row crops. At the same time, dramatically higher prices for nitrogen (N) fertilizer have sharply increased input costs for production of these important commodities. In Texas, corn has commonly been grown as a rotational crop with cotton with just over two million acres planted annually. Previous research has shown that residual nitrogen levels in several major crop production areas could be substantial with cotton showing a yield response to supplemental N fertilizer at only 23% of study sites.

Materials and Methods

Field studies were conducted at 26 sites throughout the Upper Coastal Bend and Central Texas Blacklands in 2008, 2009, 2010 and 2011 to determine the plant availability and effects on grain yield of residual soil nitrate to a 24-inch depth. Treatments included standard N fertilizer rates and reduced rates where residual soil N measured to depths of 6, 12, and 24 inches was credited.

Results and Discussion

Residual soil N to 24 inches ranged from 16 to 54 lb/A in 2008, 50 to 108 lb/A in 2009, 25 to 85 lb/A in 2010 and 21 to 76 lb/A in 2011 across study locations (Tables 1 - 4, respectively). Grain yields and bushel weights were not affected for 25 of the 26 site-years when residual N was credited, indicating efficient recovery of carryover soil N (Tables 5 - 8, respectively). The only exception was the 0 to 24-inch residual N treatment in Hill County in 2009.

Based on an average retail costs of \$0.50, \$0.50, \$0.44, \$0.63/lb of N in spring 2009-11, respectively, input cost savings across these study sites through crediting of residual soil N could have exceeded \$18.00, \$35.00, \$21.00 and \$25.00 per acre, respectively. These results support previous work from a 7-year study in cotton across a wide range of soils and site conditions which showed that residual N to a depth of 24 inches could be credited at 100%. Potential reductions in fertilizer N application rates through deeper profile sampling not only improve production economics, but also provide added protection to both surface and groundwater resources in these regions of Texas.

Table 1. Pre-plant, residual NO_3-N with soil depth to 24 inches and retail value of the N. Upper Gulf Coast and Central Texas Blacklands Regions. 2008.

	Cumulative Amount and Value of Residual NO_3-N				
Study Site	0 to 6 inches	6 to 12 inches	12 to 24 inches	0 to 24 inches	Value
	-------------------------------lb/A----------------------------				\$/A[†]
Burleson I	6	10	20	36	18.00
Burleson II[‡]	14	12	16	42	21.00
Collin	8	4	6	18	9.00
Colorado	6	16	16	16	19.00
Hill	25	9	20	54	27.00
Williamson I	32	8	4	44	22.00
Williamson II	6	6	10	22	11.00

[†]Based on Spring retail survey, average \$0.50/lb of N.
[‡]Applied 1.5-inch irrigation using drop nozzles on 10 and 23 June.

Table 2. Pre-plant, residual NO_3-N with soil depth to 24 inches and retail value of the N. Upper Gulf Coast and Central Texas Blacklands Regions. 2009.

	Cumulative Amount and Value of Residual NO_3-N				
Study Site	0 to 6 inches	6 to 12 inches	12 to 24 inches	0 to 24 inches	Value
	-------------------------------lb/A----------------------------				\$/A[†]
Burleson I	52	32	24	108	54.00
Burleson II[‡]	33	8	18	59	29.50
Calhoun	26	18	24	68	34.00
Colorado	24	15	20	59	29.50
Hill	22	21	34	77	38.50
Wharton	25	20	28	73	36.50
Williamson	26	8	16	50	25.00

[†]Based on Spring retail survey, average \$0.50/lb of N.
[‡]Applied 3-inch furrow irrigation on 11 and 17 June.

Table 3. Pre-plant, residual NO_3-N with soil depth to 24 inches and retail value of the N. Upper Gulf Coast and Central Texas Blacklands Regions. 2010.

	Cumulative Amount and Value of Residual NO_3-N				
Study Site	0 to 6 inches	6 to 12 inches	12 to 24 inches	0 to 24 inches	Value
	-----------lb/A-----------				\$/A†
Calhoun	3	18	64	85	37.14
Colorado	25	19	26	70	30.59
Hill	9	8	8	25	10.92
Victoria	3	7	22	34	14.85
Wharton	11	5	26	42	18.35
Williamson	7	11	24	42	18.35

†Based on Spring retail survey, average \$0.437/lb of N.

‡Applied 3-inch furrow irrigation on 11 and 17 June.

Table 4. Pre-plant, residual NO_3-N with soil depth to 24 inches and retail value of the N. Upper Gulf Coast and Central Texas Blacklands Regions. 2011.

	Cumulative Amount and Value of Residual NO_3-N				
Study Site	0 to 6 inches	6 to 12 inches	12 to 24 inches	0 to 24 inches	Value
	-----------lb/A-----------				\$/A†
Burleson	31	27	18	76	47.50
Calhoun	9	12	20	41	25.62
Colorado	7	26	22	55	34.37
Ellis	8	10	10	28	17.50
Victoria	6	7	8	21	13.12
Wharton	6	10	12	28	17.50

†Based on spring retail survey, average \$0.625/lb of N.

Table 5. Effect of crediting the nitrogen fertilizer rate for pre-plant, residual NO_3-N on grain yield of corn. Upper Gulf Coast and Central Texas Blacklands Regions. 2008.

	Grain Yield†				
Study Site	Control	NO_3-N to 24 inches	NO_3-N to 12 inches	NO_3-N to 6 inches	Based on crop yield goal
	---bushel/A---				
Burleson I	36.0 b‡	122.2 a	122.9 a	123.0 a	126.2 a
Burleson II§	82.4 b	154.1 a	148.2 a	153.2 a	145.4 a
Collin	44.1 a	49.5 a	--	50.5 a	51.0 a
Colorado	83.2 b	126.3 a	122.4 a	130.0 a	128.8 a
Hill	47.1 a	53.1 a	48.6 a	50.8 a	51.3 a
Stiles I	71.2 c	77.5 bc	78.2 abc	83.8 ab	85.5 ab
Stiles II	50.1 b	64.2 a	64.9 a	--	66.8 a

†Yields corrected to 15.5% moisture.
‡Means followed by the same letter within a row do not differ significantly (P=0.05, LSD).

Table 6. Effect of crediting the nitrogen fertilizer rate for pre-plant, residual NO_3-N on grain yield of corn. Upper Gulf Coast and Central Texas Blacklands Regions. 2009.

	Grain Yield†				
Study Site	Control	NO_3-N to 24 inches	NO_3-N to 12 inches	NO_3-N to 6 inches	Based on crop yield goal
	---bushel/A---				
Burleson I	81.8 c‡	114 b	123.7 ab	126 a	122.6 ab
Burleson II§	90.2 b	138.6 a	139.9 a	136.9 a	137.8 a
Calhoun	67.5 a	75.9 a	70.6 a	64.3 a	64.4 a
Colorado	70.1 a	66.3 a	67.7 a	78.4 a	71.5 a
Hill	50.6 c	53.6 bc	57.8 a	57.1 ab	58 a
Wharton	44.2 a	49.4 a	52.1 a	50.6 a	58.3 a
Williamson	35.2 a	47.9 a	51 a	36.5 a	46.4 a

†Yields corrected to 15.5% moisture.
‡Means followed by the same letter within a row do not differ significantly (P=0.05, LSD).
§Applied 3-inch furrow irrigation on 11 and 17 June.

Table 7. Effect of crediting the nitrogen fertilizer rate for pre-plant, residual NO_3-N on grain yield of corn. Upper Gulf Coast and Central Texas Blacklands Regions. 2010.

Study Site	Grain Yield[†]				
	Control	NO_3-N to 24 inches	NO_3-N to 12 inches	NO_3-N to 6 inches	Based on crop yield goal
	bushel/A				
Calhoun	114.5 a[‡]	120.7 a	123.3 a	---[§]	126.1 a
Colorado	128 b	162.7 a	147.8 a	162.6 a	148.1 a
Hill	114.6 a	135.8 a	126.7 a	---	127 a
Victoria	61.2 b	135.4 a	144.1 a	---	142.3 a
Wharton	75.8 b	143.4 a	---	138 a	142.9 a
Williamson	99.7 a	102.9 a	104.6 a	104.8 a	105.7 a

[†]Yields corrected to 15.5% moisture.
[‡]Means followed by the same letter within a row do not differ significantly (P=0.05, LSD).
[§]Amount of residual N at interval soil depth was not sufficient to establish a treatment.

Table 8. Effect of crediting the nitrogen fertilizer rate for pre-plant, residual NO_3-N on grain yield of corn. Upper Gulf Coast and Central Texas Blacklands Regions. 2011.

Study Site	Grain Yield[†]				
	Control	NO_3-N to 24 inches	NO_3-N to 12 inches	NO_3-N to 6 inches	Based on crop yield goal
	bushel/A				
Burleson	83.1 a[‡]	71.7 a	65.4 a	73.7 a	59.1 a
Calhoun	94.6 b	121.8 a	118.2 a	120 a	115.8 a
Colorado	108.2 a	101.8 a	108.6 a	---[§]	98.5 a
Ellis	52.7 a	64.3 a	61.8 a	---	61.7 a
Victoria	98.3 a	92.6 a	101.1 a	---	96.4 a
Wharton	66.3 a	76.8 a	75.9 a	---	76.4 a

[†]Yields corrected to 15.5% moisture.
[‡]Means followed by the same letter within a row do not differ significantly (P=0.05, LSD).
[§]Amount of residual N at interval soil depth was not sufficient to establish a treatment.

Deep Soil Sampling Equipment

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Deep soil sampling is a practice that can be valuable to many cotton producers. Nitrogen fertilizer expense has become a significant input cost issue, and excessive nitrogen can be a factor in higher aphid numbers, more verticillium wilt pressure, and when coupled with late irrigation or excessive rainfall can adversely impact crop maturity. Sampling is generally done with a soil sampling probe, although other tools may work. Hand probes can be purchased from a number of sources and cost from $25 to $150, depending on the type of probe. For deeper sampling, hand probes may not suffice, especially in dry, hard soil situations. It may be necessary to purchase a hydraulic probe sampling system. We are unaware of exactly how many companies manufacture these and it is likely that there are more than the ones we mention below.

A sampling system could also be constructed using existing long hydraulic cylinders found around the farm. Dr. J.C. Banks, Extension Cotton specialist with Oklahoma State University at Altus, built a deep sampling system that bolted to the tractor frame and used a hydraulic ram from the basket of an obsolete John Deere 482 stripper (Figure 1). Dr. Banks also adapted a coring tube purchased from Giddings Machine Company, Inc. to the hydraulic cylinder (Figure 2). A probe such as this can be used to take deep samples that otherwise would be difficult to obtain in hard soils. Several bits can also be purchased from Giddings which can be selected based on the site-specific soil texture and moisture status. This company sells a complete line of soil sampling equipment. The contact information for Giddings is:

www.soilsample.com
631 Technology Circle
Windsor, CO 80550
Phone: (970) 674-0259
Toll Free: 1-800-611-0404

Figure 1. View of hydraulic cylinder mounted on tractor frame.

Figure 2. View of Giddings probe adapted to hydraulic cylinder.

AGVISE Laboratories, Inc. also sells deep soil sampling equipment. The product line includes soil probes of varying lengths, different screw-on tips for varying soil conditions, and electric and gas powered hydraulic sampling machines. There contact information is:

www.agvise.com
AGVISE Laboratories
604 Highway 15W
Northwood, ND 58267
Phone: (701) 587-6010

Sampling can be performed to the desired depth, but most often is at least 18 or 24 inches. Once a core is taken, it can be separated into 0-6 inch and either 6-18 or 6-24 inch depths. Take the 0-6 inch portion of the sample and place it into a properly labeled clean plastic bucket. Place the 6-18 or 6-24 inch portion in a second properly labeled bucket. Make sure that the two increments get placed properly into their respective buckets. Once 15-20 cores per field are obtained, thoroughly mix the soil samples in each bucket, then fill soil sample bags marked appropriately as 0-6 inch and 6-18 or 6-24 inch depths. The 0-6 inch sample can be submitted for routine analysis, plus micronutrients or other surface soil tests that are needed. The 6-18 or 6-24 inch sample will only need to be tested for nitrate (NO_3-N).

It will be important to know if the laboratory allows the sender to submit samples based on varying sampling depths. Some laboratories will assume that each sample sent in is from the 0-6 inch depth. If this occurs with the 6-18 or 6-24 inch sample, then the amount of residual NO3-N will be underestimated. For proper calculations refer to the Interpreting Soil Analysis and Table 3 in the publication: Nitrogen Management in Cotton SCS-2009-1 (www.soilcrop.tamu.edu).

A modification of a soil auger system coupled with a cordless electric drill has been suggested by Oklahoma State University personnel (see OSU PT 2003-6 Sweatless Soil Sampler). This system uses and 18-inch ship auger with a 12-inch extension attached and incorporates a bucket with a PVC fitting in the center through which the soil auger is inserted. Our experiences with this system indicate that it can work especially well in hard, dry soils, but is less useful in wet soils. Sticky clay soil or subsoil can clog the flutes in the auger and make removal a challenge. If an auger type system is used, it will then become necessary to take an additional 0-6 inch soil sample to base recommendations for nutrients other than nitrogen. The 0-18 inch sample which is obtained using the auger should only be used for residual nitrate nitrogen analysis.

Corn Yield Response to Slow-Release Nitrogen Sources and Additives

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Summary

A field study was established on the Stiles Foundation Farm, near Thrall, TX to evaluate the response of corn to several nitrogen fertilizer management products including Nutrisphere, Agrotain Ultra, N-Sure, CoRoN, and NDemand compared to standard fertilizer materials. Soil moisture conditions at planting were adequate; however, limited rainfall during April, May and June limited corn grain yields. Grain yield and test weight were not affected by rate of standard fertilizer nitrogen or by application of any of the N management products.

Objective

To determine yield response of corn to liquid urea ammonium nitrate (UAN), slow-release nitrogen sources and combined urease-nitrification inhibitors under rain-fed conditions.

Materials and Methods

Corn hybrid DKC 69-43 was planted into conventionally-tilled Burleson clay soil on April 1, 2010, a delayed planting date due to heavy rainfall in early March. Planting density was 22,737 seed per acre with 38-inch spacing between rows. Soil samples were collected on March 6, 2010. According to soil test results, amount of residual N to 24 inches was 28 pounds. Rates of N fertilizer applied were based on soil test results and a crop yield goal of 120-bushels per acre. Liquid N and phosphate fertilizers were sidedress banded using knife shanks to a five-inch depth after planting. Experimental plots were four rows wide, 46 feet in length, and arranged in four randomized complete blocks:

1. No additional N; 65 lb P_2O_5 /A (according to 6-inch soil test)
2. 50 lb N/A; 65 lb P_2O_5
3. 75 lb N/A; 65 lb P_2O_5 /A
4. 100 lb N/A; 65 lb P_2O_5 /A
5. 100 lb N/A with Nutrisphere-N; 65 lb P_2O_5 /A
6. 100 lb N/A with Agrotain Ultra; 65 lb P_2O_5 /A
7. 100 lb N/A with N-Sure; 65 lb P_2O_5 /A
8. 100 lb N/A with CoRoN; 65 lb P_2O_5 /A

9. 100 lb N/A with NDemand; 65 lb P_2O_5 /A
10. 130 lb N/A; 65 lb P_2O_5 /A
11. 130 lb N/A with Nutrisphere-N; 65 lb P_2O_5 /A
12. 130 lb N/A with Agrotain Ultra; 65 lb P_2O_5 /A
13. 130 lb N/A with N-Sure; 65 lb P_2O_5 /A
14. 130 lb N/A with CoRoN; 65 lb P_2O_5 /A
15. 130 lb N/A with NDemand; 65 lb P_2O_5 /A

Except where indicated, urea ammonium nitrate (UAN, 32-0-0) was the sole source of N fertilizer applied. Addition of urease-nitrification inhibitors to UAN and blending of slow-release N products with UAN was done according to company recommendations indicated below.

SFP's Nutrisphere-N – 0.5 gallon/100 gallons 32-0-0 or 20 ml/5 gal 32-0-0
Agrotain's Agrotain Ultra – 1.5 quarts/180 gallons 32-0-0 or 40 ml/5 gal 32-0-0
Tessenderlo Kerley's N-Sure (28-0-0) – 50/50 blend with 32-0-0 for 30% N
Wilbur Ellis' NDemand (30-0-0) – 50/50 blend with 32-0-0 for 31% N
Helena's CoRoN (25-0-0) – 50/50 blend with 32-0-0 for 28% N

Monthly rainfall accumulation during February and March was similar to long-term averages. However, from planting through pollination and kernel filling stages, rainfall amounts were considerably below normal totaling 7.33 inches and occurred as follows; February = 3.57 inches, March = 2.78 inches, April = 1.52 inches, May = 0.91 inches, June = 2.74 inches, and July = 2.16 inches.

Two center yield rows from each plot were harvested on 26 August 2010 with a JD 3300 combine equipped with a Harvestmaster Grain Gauge that measured plot weight, test weight, and grain moisture. Statistical differences were determined by analysis of variance and means separated using Fisher's Protected LSD, where appropriate.

Results

No differences in grain yield and test weight were observed between the control and other treatments, including rates of N fertilizer with UAN, UAN with urease-nitrification inhibitors or UAN blended with any one of three slow-release N products (Tables 1 and 2, respectively). Plant stress due to lack of moisture was observed during the tassel-silk stage in early June, a critical period during the transition from vegetative to reproductive stages of plant growth. Even though these dry conditions persisted, bushel weights fell within an expected range. Corn grain yield and bushel weights in this study were numerically similar to observations made in Corn Performance Test plots (http://varietytesting.tamu.edu/corn), also located on the Stiles Foundation Farm.

Table 1. Yield response of corn to subsurface-band applied urease-nitrification inhibitors or slow-release nitrogen sources blended with liquid urea ammonium nitrate (UAN, 32-0-0). Thrall, Texas. 2010.

Rate of Nitrogen Fertilizer	Grain Yield†					
	UAN	UAN with Nutrisphere-N (0.5 % v/v)	UAN with Agrotain Ultra (0.2% v/v)	UAN with N-Sure (50/50 blend)	UAN with CoRoN (50/50 blend)	UAN with NDemand (50/50 blend)
lb/A	--------------------bu/A--------------------					
0	73.7‡	--§	--	--	--	--
50	76.2	--	--	--	--	--
75	85.5	--	--	--	--	--
100	77.4	73.1	74.2	78.5	80.5	88.2
130	85.1	74.3	81.8	83.4	77.8	78.7

†Yields corrected to 15.5% moisture.
‡Means within a row or column were not significantly different (Fishers LSD P=0.05).
§Treatment not established.

Table 2. Test weight response of corn to subsurface-band applied urease-nitrification inhibitors or slow-release nitrogen sources blended with liquid urea ammonium nitrate (UAN, 32-0-0). Thrall, Texas. 2010.

Rate of Nitrogen Fertilizer	Grain Test Weight†					
	UAN	UAN with Nutrisphere-N (0.5 % v/v)	UAN with Agrotain Ultra (0.2% v/v)	UAN with N-Sure (50/50 blend)	UAN with CoRoN (50/50 blend)	UAN with NDemand (50/50 blend)
lb/A	--------------------bu/A--------------------					
0	57.1‡	--§	--	--	--	--
50	57.8	--	--	--	--	--
75	57.3	--	--	--	--	--
100	56.7	56.4	56.6	57.7	56.5	57.5
130	57.5	57.2	57.2	57.2	56.7	56.6

†Yields corrected to 15.5% moisture.
‡Means within a row or column were not significantly different (Fishers Protected LSD P=0.05).
§Treatment not established.

Replicated Agronomic Cotton Evaluation (RACE)
South, East and Central Regions of Texas, 2011

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Cotton variety selection is one of the most important decisions a producers will make each season. The cotton variety and associated technology will dictate the management decisions for the entire season and can significantly impact the profitability of a farm. To gather unbiased information on cotton varieties, Texas AgriLife Extension Service initiates 3 large-plot, replicated, cotton variety trials in the Blacklands each year. The objective of these variety trials are to compare yield and lint quality of stacked-gene Bollgard II and WideStrike Roundup Ready Flex cultivars grown in large plot replicated trials on producer-cooperator fields across this region. Because of the various environmental conditions and site locations that these trials are conducted annually, these trials produce a wealth of data on variety performance. These variety results are made available to local producers throughout these regions of the state as handouts. Additionally, these results are presented at most educational meetings within the Blacklands. County cotton variety trials conducted in 2011 is summarized below in the annual results titled "Replicated Agronomic Cotton Evaluation (RACE) for South, East, and Central Regions of Texas, 2011" The 40 page summary booklet is distributed to county agents, IPM agents, distributors, and seed companies electronically.

Additionally the results can be viewed at http://varietytesting.tamu.edu/cotton/index.htm or http://cotton.tamu.edu. Last, these results were presented in the poster session of the 2012 Beltwide Cotton Conference.

Comparison of Effects of Glufosinate to Multiple Windstrike® Roundup Flex®and Liberty Link® Bollgard II® Transgenic Cotton Varieties on Plant Development and Yield

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Introduction

Herbicide-resistant cottons have revolutionized cotton production since Roundup Ready cotton was first introduced by Monsanto and DeltaPine in 1996. Because of the effectiveness and ease of use of Roundup Ready and subsequently Roundup Flex herbicide-resistant technology, growers rapidly adopted the technology in cotton and other crops in the late 1990's, including corn and soybeans. This led to widespread, repeated use of glyphosate applications annually and has subsequently resulted in numerous Amaranthus species (pigweed) becoming tolerant/resistant to glyphosate throughout the Cotton Belt. As a result, growers began looking at other options to help manage the glyphosate resistant Amaranthus species.

One option was to use the herbicide Ignite (glufosinate), with relatively wide spectrum of activity, and had been reported to be an option for over-the-top application in Phytogen Widestrike cotton varieties. In 2011, PhytoGen had at least seven varieties with WideStrike technology, a unique Lepidopteran two-gene Bt technology. Glufosinate is the active ingredient in the cotton herbicide Ignite that is manufactured by Bayer CropSciences as well as other brands of herbicide. Bayer CropSciences has developed glufosinate herbicide resistant technology in cotton, called Liberty Link Cotton. With Liberty Link technology, producers are able to apply Ignite over-the-top of cotton throughout the growing season with good crop tolerance; however, varieties containing the LL technology have not consistently performed well in the Upper Gulf Coast region of Texas which was the first region in Texas to experience glyphosate resistant common waterhemp.

Both the Roundup and Ignite herbicide systems provide acceptable weed control on both many grass and broadleaf weeds species, if applications are applied according to the label. The Roundup system has been shown to be slightly more effective on broadleaf weeds than the Ignite system (Mott et al., 2011). In addition, previous studies suggest that Phytogen 375 WRF cotton showed less phytotoxicity injury from the application of Ignite herbicide @ 22 oz/A and 29 oz/A over-the-top when applied to younger cotton.

However, the phytotoxicity increased as the plants progressed in their physiological development (Figure 1). Furthermore, the untreated check out-yielded both sequential Ignite treatments by 12% or more.It should be noted that neither Bayer CropScience nor Dow AgroSciences stands behind the application of Ignite herbicide over-the-top of Widestrike, Round-up Flex cotton.

Objective

The purpose of this trial was to evaluate the tolerance of over-the-top applications of Ignite to several Bayer Liberty Link and Phytogen WideStrike cotton varies, to multiple max-label rate applications of Ignite herbicide. Because of the tolerance to the Roundup Flex (RF) varieties to Roundup, there was no need to evaluate any varieties tolerance levels to Roundup herbicide.

Materials and Methods

A field study was conducted at the Texas AgriLife Research and Extension Center near Snook, Texas (Burleson County). The study was planted on April 14, 2011. Plot sizes were 4 (40") rows by 40' long, with 3 replications arranged in a randomized complete block design. The previous crop was corn and fertility consisted of 80 lbs/A of N applied side-dressed on May 19. Herbicide applications were made at 15 gal/A with a self-propelled Lee Spider sprayer using 8002DG tips on a 20 inch spacing. See Table 1 for additional treatment information.

The main treatments were over-the-top Ignite herbicide treated twice at 29 oz/a and hand-weeded. The secondary treatments consisted of 5 different varieties. See Table 2. Application A was applied on April 28 to cotton that was at 1-2 true leaves and application B was applied on May 31 to cotton that was at 6-7 true leaves.

Data collection included stand counts on May 11, a visual vigor rating on May 11 and May 25 (1-9 scale, where 1 is the least vigorous and 9 being the most vigorous), plant height, total nodes and phytotoxicity ratings (1-9 scale, where 1 is no phytotoxicity injury to the plants and 9 being the most phytotoxicity damage to the plants) on June 13, and nodes above white flower were taken on July 7. Weed control for all plots was excellent throughout the length of the study. The center two rows of each plot were mechanically harvested on September 23 with a 2-row John Deere 9910 picker to determine lint yield. Cotton fiber quality was analyzed using HVI. Data were analyzed with ARM 8 using LSD at 5% level.

For HVI analysis, fiber samples were sent to the Fiber and Biopolymer Research Institute at Texas Tech University in Lubbock, Texas. Statistical analysis for comparison among cultivars was conducted using Agricultural Research Manager 8, using LSD (P=0.05).

Table 1. Summary of application information, Snook, Texas, 2011.

	Application	
	A	B
Date	April 28	May 25
Placement	Foliar	Foliar
Crop Stage	1-2 TL	6-7 TL
Air Temp (ºF)	78	84
Relative Humidity (%)	71	53
Wind (MPH) Direction	6 NW	7 S
Nozzle Size/Type	8002 DG	8002 DG
Nozzle Spacing	20“	20”
Carrier	Water	Water
Spray Volume (GPA)	15	15

Table 2. Summary of treatments, Snook, Texas, 2011.

Ignite 280 Treatment (2x @ 29 oz/a)	Hand-weeded Check
PHY 375 WRF	PHY 375 WRF
PHY 499 WRF	PHY 499 WRF
FM 1773 LLB2	FM 1773 LLB2
FM 4145 LLB2	FM 4145 LLB2
FM 1244 GLB2	FM 1244 GLB2

Results and Discussion

The 2011 growing season was characterized by record setting heat and drought which greatly affected cotton development and performance in this study, even though 6.15 “ of water were added through sprinkler irrigation and receiving 6.05” of rain during the growing season.

There were no differences in stand counts or visual vigor ratings among treatments on May 11. However, on May 25, differences in visual vigor ratings were observed. The hand weeded PHY 375 WRF and FM 1244 GLB2 treatments had a better vigor rating, than the Ignite treated.

On June 13, PHY 375 WRF and PHY 499 WRF varieties were shorter when treated with Ignite. No differences among treatments were observed based on total nodes at the same date (Figure 1). There were some slight differences in mean phytotoxicity ratings on June 13.

The 2011 growing season was characterized by extremely hot and dry conditions. In addition, during the spring and early summer, relatively windy conditions persisted which dried the soil out quicker than normal. A record was set in 2011 for the number of days where the high temperature reached or exceeded 90° and 100 for a single year. Although this study was under a sprinkler irrigation system that received 6.05” of rain and 6.15 inches of irrigation, it still needed more water to truly produce good yields due to poor moisture profile at planting and exceptionally extreme weather experienced during the season.

There were no differences in stand counts or visual vigor ratings among treatments on May 11. However, on May 25, differences in visual vigor ratings were observed. The untreated PHY 375 WRF and FM 1244 GLB2 treatments had a better vigor rating, 7.3 and 7.7, respectively, than the Ignite treated PHY 375 WRF and FM 1244 GLB2 treatments, 6.0 and 6.7, respectively.

On June 13, PHY 375 WRF and PHY 499 WRF varieties were shorter when Ignite was applied over-the-top and some slight numerical differences in mean phytotoxicity ratings where observed. No differences among treatments were observed based on total nodes on that date. There were some slight differences in mean phytotoxicity ratings on June 13.

On July 7, the Ignite treated PHY 375 WRF had a higher average nodes above white flower (NAWF), 5.4, value than all other treatments. This was likely due to Ignite applications detrimentally affecting PHY 375WRF, causing a delay in fruiting (Figure 2).

Both hand-weeded Phytogen varieties, 375 WRF and 499 WRF, had higher mean yields than any other treatments, 535 and 615 lbs of lint/ac, respectively, including Ignite treated PHY 375 WRF and 499 WRF (Figure 3). There were no other differences in yield among any LL varieties and weed management system. There were no significant differences between like varieties among the two different weed management systems for mean lint length, strength or loan values (Table 3). There were slight differences in mean percent lint turnout between treatments, but no general trends. There were no differences among treatments in regards to mean micronaire and uniformity values among treatments.

The hand-weeded PHY 499 WRF treatment had the highest overall mean per acre lint value, $327, of all treatments (Figure 4). In addition, Phytogen 375 WRF had the next highest mean per acre lint value, $277, of all treatments. There were no differences in per acre lint value amongst the any of the other treatments.

It is interesting to note that the only yield differences that were observed where from the 2 Phytogen varieties. The two hand-weeded Phytogen varieties both out-yielded all other treatments, including their Ignite treated counterparts. These two hand-weeded varieties also had a greater mean plant height than their Ignite treated counterparts.

Conclusions

The LLB2 varieties demonstrated good crop tolerance to the over-the-top applications of Ignite herbicide. However, the yield potential of LLB2 varieties was not as high as the Phytogen varieties at this location.

The Phytogen WRF varieties that were not specifically designed for over-the-top applications of Ignite herbicide did exhibit detrimental physiological affects and yield response.

As previously mentioned, neither does Bayer Crop-Science nor Dow AgroSciences stand behind applications of Ignite herbicide over-the-top of WRF cotton.

Figure 1. Total plant nodes between Ignite treated and hand-weeded plots. June 13, 2011. Snook, TX.

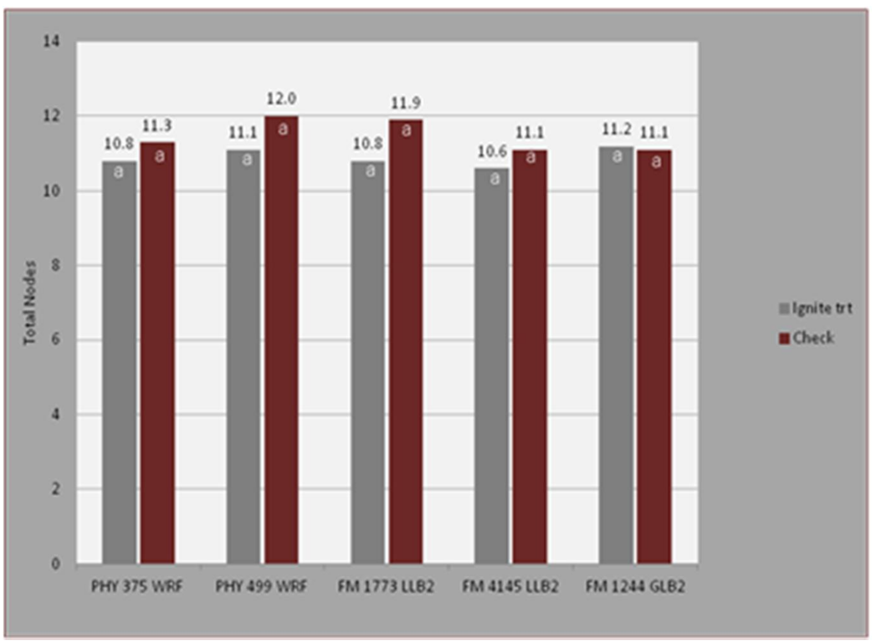

Figure 2. Nodes Above White Flower between the Ignite treated and hand-weeded plots. July 13, 2011. Snook, TX.

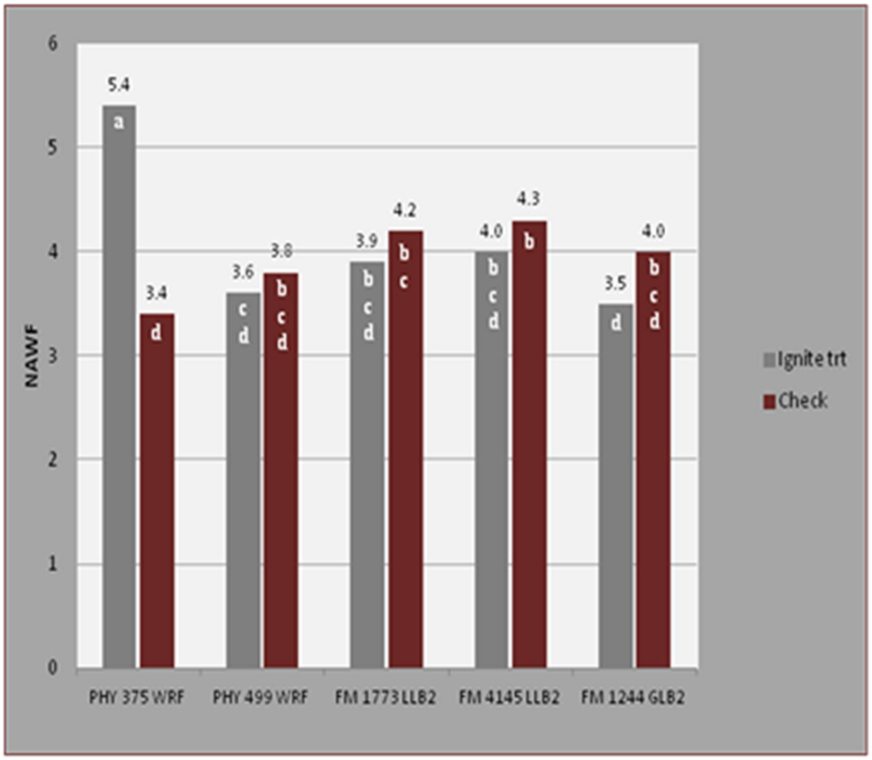

Figure 3. Lint Yield between the Ignite treated and hand-weeded plots. July 7, 2011. Snook, TX.

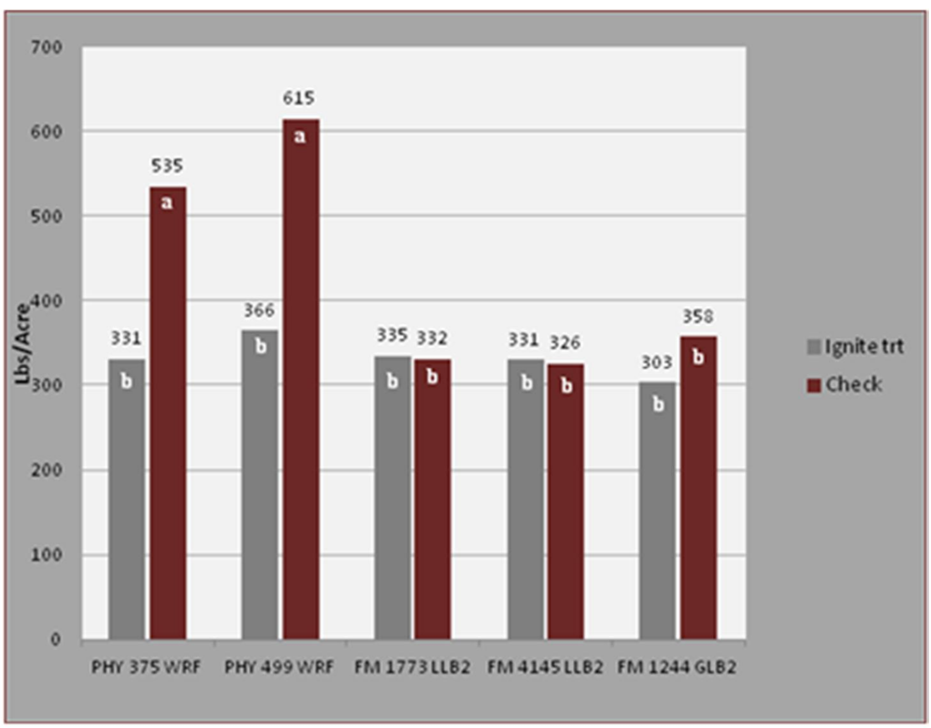

Figure 4. Mean Lint Value between the Ignite treated and hand-weeded plots. July 13, 2011. Snook, TX.

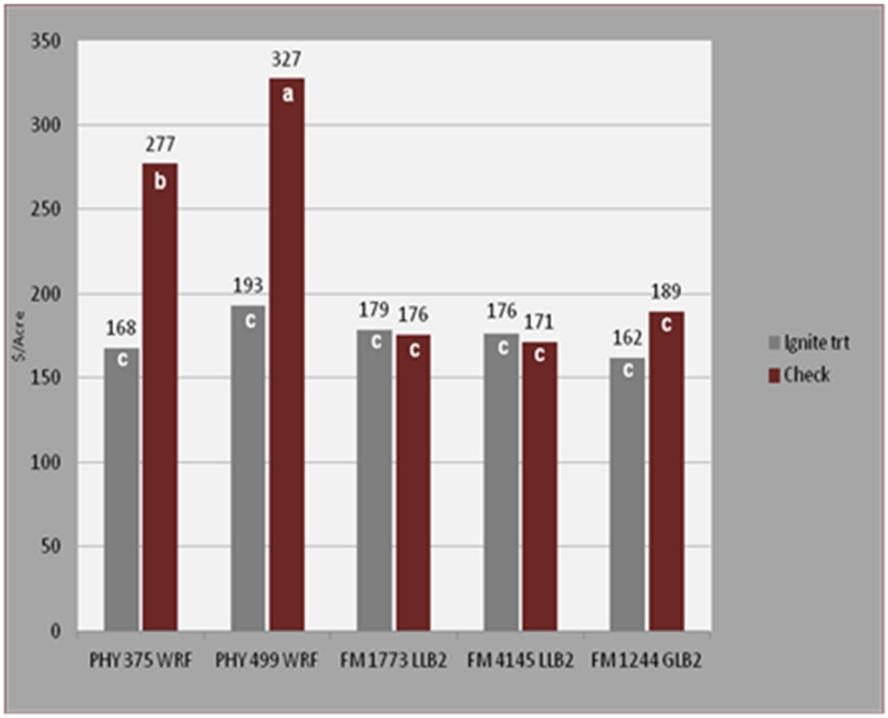

Table 3. Lint quality and value between the Ignite treated and hand-weeded plots. Snook, TX.

Treatment		Length	Strength	Mic	Unif	Loan Value $/Ac
Ignite Trt	PHY 375 WRF	1.08 cd	27.5 c	3.43	81.27	50.63 c
Ignite Trt	PHY 499 WRF	1.07 d	30.7 ab	3.83	82.03	52.82 ab
Ignite Trt	FM 1773 LLB2	1.10 abc	29.8 ab	3.97	81.07	53.37 a
Ignite Trt	FM 4145 LLB2	1.11 ab	28.9 bc	3.80	81.63	53.28 a
Ignite Trt	FM 1244 GLB2	1.13 a	28.9 bc	3.87	81.87	53.42 a
Hand Weed	PHY 375 WRF	1.06 d	27.0 c	3.73	80.83	51.80 bc
Hand Weed	PHY 499 WRF	1.08 bcd	31.7 a	3.83	82.57	53.23 a
Hand Weed	FM 1773 LLB2	1.12 a	29.8 ab	3.87	81.57	52.98 ab
Hand Weed	FM 4145 LLB2	1.08 bcd	27.4 c	3.67	81.37	52.62 ab
Hand Weed	FM 1244 GLB2	1.13 a	28.7 bc	3.67	81.13	52.77 ab
	Mean	1.10	29.0	3.77	81.53	52.69
	P>F	0.0002	0.0027	0.393	0.460	0.014
	LSD (P=0.10)	0.0276	2.048	NS	NS	1.413
	Std Dev	0.0161	1.194	0.244	0.882	0.824
	CV%	1.47	4.11	6.49	1.08	1.56

Cotton Leaf Grade as Influenced by Cotton Defoliation and Varieties

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Introduction

Cotton leaf grade is a visual estimation of the amount of plant material in a lint sample on a scale of 1 to 7, with one being the ideal score (Larson and English, 2001). Plant material in harvested lint is waste, and can result in price dockage for the producer because additional processing is required to remove the plant material. Currently, several factors are believed to negatively influence the leaf grade values. First is the level of defoliation and desiccation prior to harvest. Second are the varietal characteristics, such as leaf hairiness, bract hairiness, and leaf and bract size. The efficacy of chemical defoliation can be an unpredictable process but is vital for the harvest efficiency and to minimize dockage from plant materials (Valco and Snipes, 2001). Factors impacting defoliation vary from harvest-aid selection, plant condition, weather prior to and during application, spray coverage, canopy density, translocation, and varietal traits (Cathey, 1986, Oosterhuis et al. 1991). Additionally, hairier varieties are suspected of contribute to higher leaf grades through a "velcro effect". The hairiness of commercial cotton varieties are assigned by a subjective rating system (smooth to very-hairy), and inconsistencies exist between varietal ratings available to producers.

Objectives

This study will identify the impact of traditional harvest-aid products on defoliation, desiccation and leaf grade. Additionally, data will shed light on the impact of variety characteristics, defoliation and desiccation on cotton leaf grade.

Materials and Methods

All trials were four rows wide and 40 feet long and were treated with a Lee Spider sprayer with 11 GPA carrier volume using XR 8002 flat fan tips. Percent defoliation, desiccation and green leaf were rated at 7 and 14 days after treatment. Untreated check was rated as zero and complete absence of leaves was 100%. Plots were mechanically harvested with a picker. Samples were ginned in a miniature gin, and leaf grade and fiber quality parameters were processed at the Fiber and Biopolymer Research Institute using HVI analysis.

In the defoliation trials, treatments were superimposed over a field of Phytogen 375 WRF. Twenty defoliation treatments were applied to obtain a wide range of defoliation and desiccation levels in 2010 (Figure 1). In 2011, sixteen defoliation treatments were selected to provide the range of defoliation and desiccation (Figure 2).

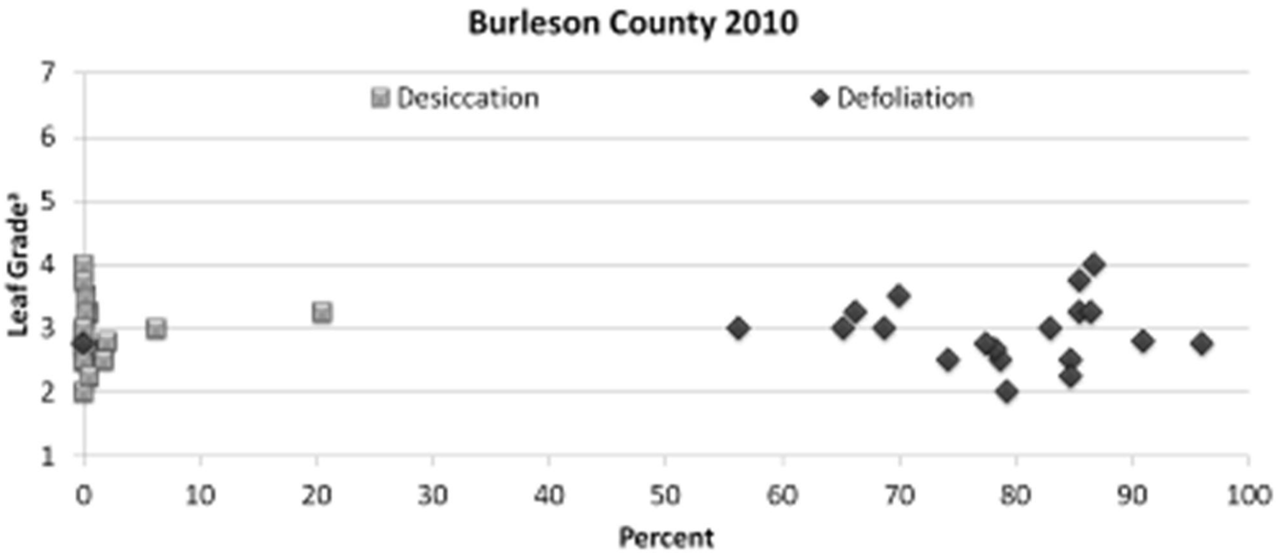
In the variety by defoliation trials, Stoneville 5458 B2RF, a hairy leaf variety, and DynaGro 2570 B2RF, a smooth leaf variety, received five defoliation treatments and had four replications in a split block design. Treatments were applied to achieve variable defoliation levels. In 2010 the trial was conducted in Colorado county (Figure 3), and in 2011 the trial was repeated in Matagorda county (Figure 4).

ANOVA was performed and means separation using LSD with P=0.05 (data not shown). Kruskal-Wallis was used to identify significance between leaf grades. Locations are shown separately due to significant location interaction.

Results and Discussion

Defoliation Trial

A wide range of defoliation and desiccation levels were obtained with the selected defoliation treatments (Figure 1 and 2). Despite the range of defoliation levels, no differences were observed in leaf grade values (Figure 1 and 2). The 2010 season had leaf grades of 3 and 4, while in 2011 leaf grade values did not exceed 2. Low leaf grades in 2011 were the result of more suitable harvest conditions, compared to 2010.



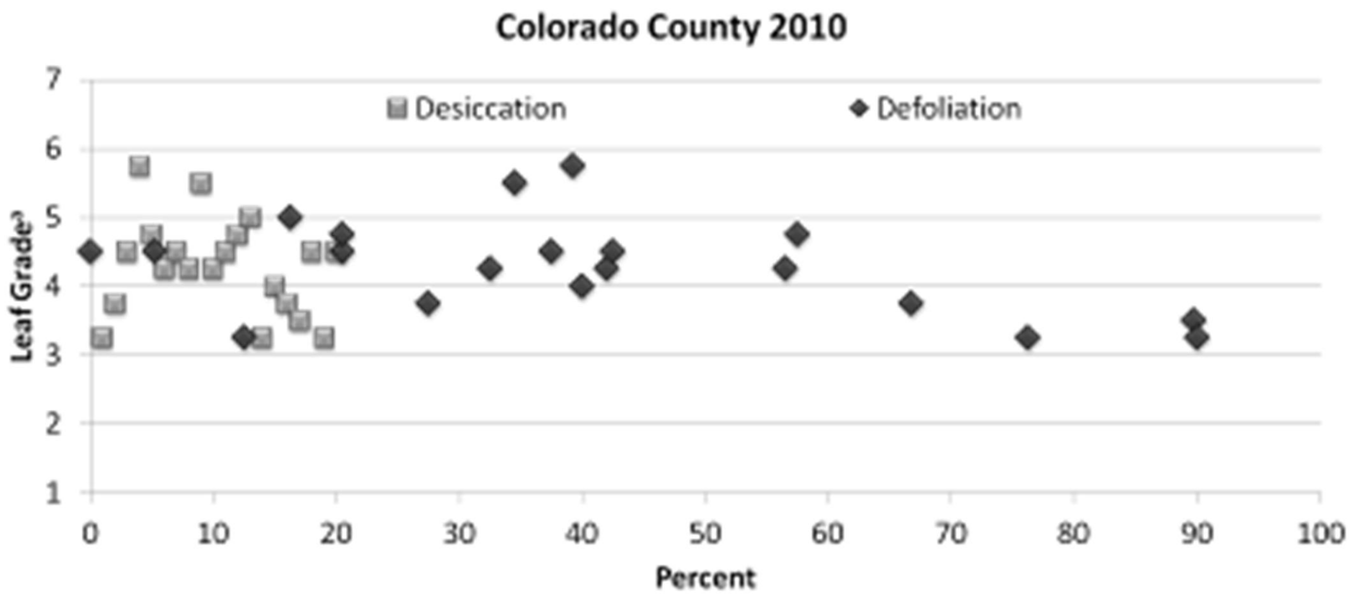


Figure 1. Leaf grade of cotton in defoliation trials from two locations in 2010 based on defoliation ratings at 14 days after application of treatments.
[a]Kruskal-Wallis test indicated the cotton leaf grade was not affected the defoliation treatment at any of the locations in 2010 or 2011 (P = 0. 05).

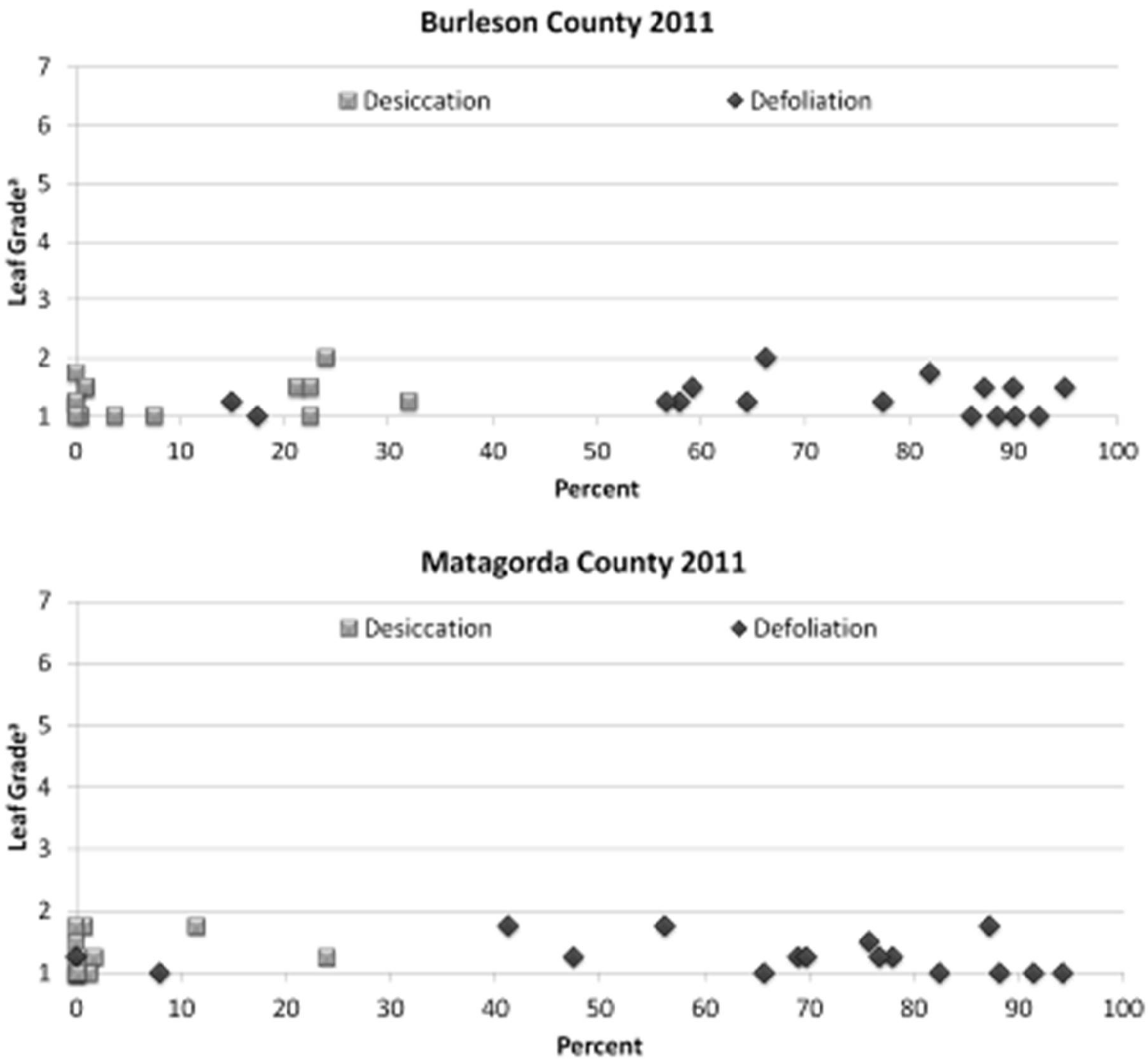


Figure 2. Leaf grade of cotton in defoliation trials from two locations in 2011 based on defoliation ratings at 14 days after application of treatments.
[a]Kruskal-Wallis test indicated the cotton leaf grade was not affected the defoliation treatment at any of the locations in 2010 or 2011 (P = 0.05).

Variety Hairiness by Defoliation

An extended range of defoliation levels were obtained with the 5 defoliation treatments and efficacy was comparable for the smooth leaf and hairy leaf varieties (Figure 3). Leaf grade values were consistently lower across all defoliation levels for the smooth leaf variety (Figure 3 and 4). Leaf grade ratings were less than 1.5 regardless of the defoliation level or variety hairiness (Figure 4). Though 2011 conditions were suitable for low leaf grade, there was a variety effect on the scores (Figure 4).

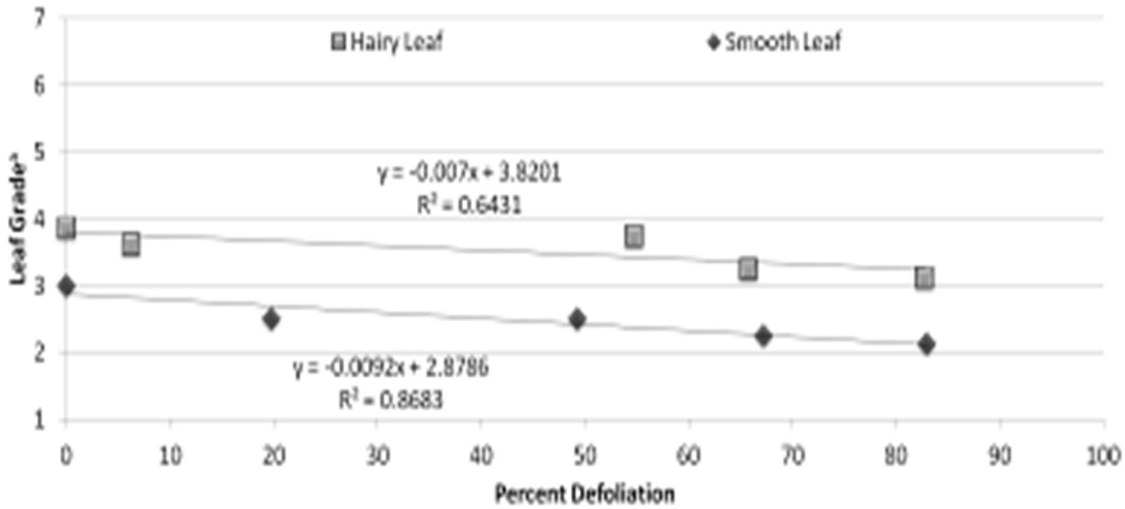


Figure 3. Impact of leaf hairiness on the leaf grade of cotton treated with five harvest-aid treatments during the 2010 growing season.
[a]Kruskal-Wallis test indicated the cotton leaf grade was affected by leaf hairiness ($P = 0.05$).

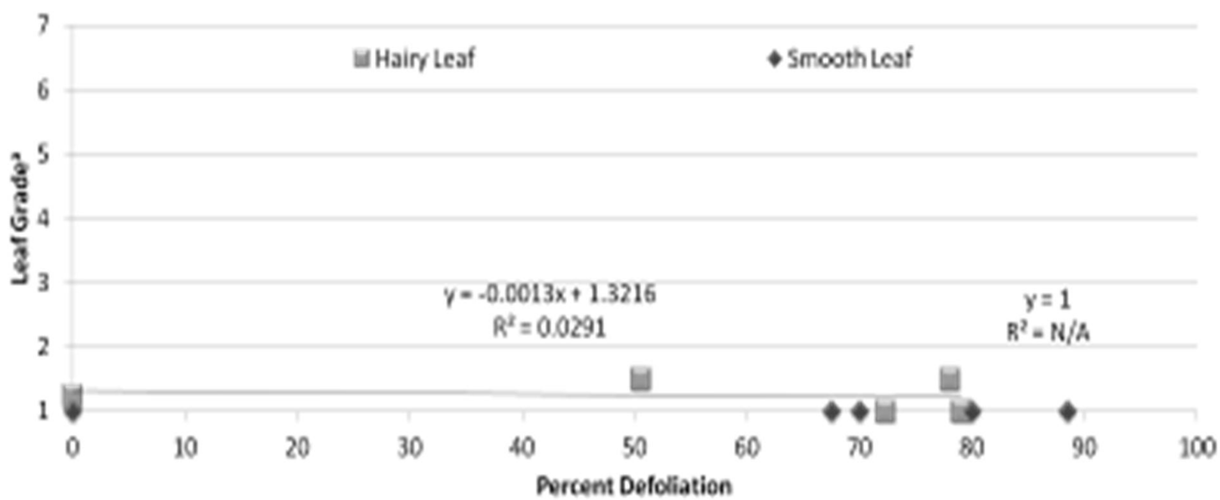


Figure 4. Impact of leaf hairiness on the leaf grade of cotton treated with five harvest-aid treatments during the 2011 growing season.
[a]Kruskal-Wallis test indicated the cotton leaf grade was affected by leaf hairiness ($P = 0.05$).

CONCLUSIONS

The leaf grade data showed no correlation with the percentage of defoliation or desiccation in any trial. Variety by harvest-aid trial data demonstrated leaf hairiness is positively correlated with leaf grade. Environmental differences between 2010 and 2011, rainfall after harvest-aid application, impacted leaf material in harvested lint, and conditions in 2011 were not negatively influenced by late season rain.

Based on these results, when concerned with leaf grade, defoliation treatments need to be examined on the basis of economical rates and product costs. Various physiological traits may influence cotton leaf grade and other fiber qualities, and need to be evaluated. Leaf hairiness was found to significantly affect leaf grade and was more influential than defoliation leaf grade.

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Foliar Applied Potassium on Cotton – 2011

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In 2011, much of the cotton across the South and Central Texas began showing potassium deficiency symptoms. Various levels of this K deficiency were found from leaves showing slight discoloration to more severe cases where the leaves turned darker purple in color. In many cases, fields had recommended levels or higher of K in the soil, but due to limited soil moisture roots were unable to uptake the K. To determine if these K deficiencies could be corrected with foliar applications of K, a field trial was initiated in the Hill county. The selected field was beginning to show symptoms of K deficiency when the trial was initiated with the folia applications of Re-N force K, which had a 5-0-20 analysis.

The study consisted was initiated on a field of DP 1044 B2F planted on April 15, 2011. The plots were 5 rows wide (30" spacing) x 40 feet in length setup in a RCB design and with 4 reps. The treatments consisted of ReN-force K applied at the rate of 1, 2 and 3 gallons/acre with split application on June 30 and July 8, 2011 and an untreated check. The plots were taken to harvest and 1/1000th of an acre from the center row of each plot was hand harvested, ginned and classed.

There were no differences in lint yield or lint quality among any of the treatments (Table 1).

Table 1. Lint yield and quality of foliar potassium evaluation. Hill County. 2011.

Treatment	Rate/Ac	Mic		Length		Strength		Unif		Yield lbs/A		% TO		Loan $/lb		Lint $/A	
Renforce 5-0-20	4 qt/a	3.9	a	0.95	a	25.5	a	77.9	a	540	a	48.3	a	47.00	a	254	a
Renforce 5-0-20	8 qt/a	4.1	a	0.94	a	25.1	a	77.8	a	530	a	48.8	a	46.15	a	245	a
Renforce 5-0-20	12 qt/a	4.0	a	0.94	a	24.8	a	78.7	a	470	a	48.8	a	45.71	a	214	a
Untreated Check	Check	3.9	a	0.95	a	25.7	a	78.3	a	508	a	47.8	a	46.79	a	238	a
Mean		4.0		0.95		25.3		78.1		512		48.4		46.41		238	
Trt Prob(F)		0.3251		0.3054		0.5363		0.2001		0.4249		0.8744		0.195		0.319	
LSD (P=.05)		0.272		0.0199		1.469		0.934		98.62		3.231		1.3576		46.78	
CV		4.28		1.32		3.64		0.75		12.05		4.17		1.83		12.3	

Evaluation of Atoxigenic Strains of *Aspergillus Flavus* for Aflatoxin Control in Corn on Commercial Farms in Texas - 2011

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Summary

Two products, Afla-Guard and AF 36, are labeled for aflatoxin control on corn in Texas. Both consist of strains of *Aspergillus flavus* that do not produce aflatoxin (i.e. they are atoxigenic) and they prevent aflatoxin production by out-competing native, toxin-producing strains for space during the colonization of developing corn seed during the growing season. These products were evaluated for their effectiveness to reduce aflatoxin contamination in corn in four replicated, randomized experiments on non-irrigated farms in different corn production areas of Texas. The experimental replicates (8 rows by 100 feet long) were small enough to allow precise application of the atoxigenic strains by hand, but large enough to harvest with the grower's combine, and were separated by a distance of 100 feet. Rainfall was substantially below normal during the growing season, providing sub-optimal conditions for activation of these products. At the Ellis county farm, Afla-Guard treatment significantly (P=0.05) reduced the average aflatoxin levels to 37% of the control, which was 340 parts per billion (ppb). At the Hill county farm, aflatoxin levels with the AF 36 and Afla-Guard treatments (including an Afla-Guard treatment at V5-V6) were 35-42% of the control, which was 161 ppb. However, this reduction was not uniform among replicates, nor was it statistically significant (P=0.05). On farms in Colorado and Nueces counties, the levels of aflatoxin in the untreated portions were probably not high enough (4 and 31 ppb, respectively) to economically justify treatment, particularly in the Nueces county field that yielded 40 bu/A. At the Nueces county farm, aflatoxin was significantly (P=0.05) reduced with Afla-Guard, but not AF 36. The proportions of harvested seed colonized by *A. flavus* following atoxigenic strain treatments in the experiments ranged from 1-13%, which were 2.5× to 4× higher than that of the controls. Our experimental approach can be used to evaluate timing of application of atoxigenic strains or other factors that can affect aflatoxin management.

Objective

The objective of these experiments was to evaluate two products, AF 36 and Afla-Guard, to control aflatoxin in corn in replicated, randomized experiments in commercial fields in different corn production areas of Texas (Fig. 2). The specific objectives were: (1) to compare an application earlier than V7 with the recommended application timing, V7 to R1; (2) to compare the effectiveness of AF 36 and Afla-Guard in the same field.

Materials and Methods

Experimental Design: Each treatment was replicated four times in a randomized complete block design and each replicate consisted of 8, 100-ft rows. Replicates were separated from each other by a distance of 100 ft. The specific treatments are listed in the sections for each county. In all experiments, the atoxigenic strains were applied at 10 lb/A by hand to the tops of rows.

The replicates were harvested with the grower's combine. Samples were obtained by holding a bucket over the auger that moves the corn from the concave to the combine's grain bin (Fig. 1). To reduce the possibility of cross-contamination, incoming grain was not collected for the first 30 seconds. Thereafter, only a portion of the harvest was continuously collected, allowing for sampling of the whole replicate (i.e. stream sampling). The amount of corn collected per plot ranged from 11-18 lb. Prior to grinding with a Romer mill, the samples were split in half with a Boerner divider. Total aflatoxin was quantified from 50-g subsamples using the Vicam Aflatest USDA FGIS procedure.

After harvest, the proportion of intact corn kernels colonized by *A. flavus* was determined as follows. Kernels were surface-disinfested in 10% bleach for two min, rinsed twice with sterile water and incubated 4 days on moist, sterile paper towels in 8 in.× 8 in. aluminum trays sealed in Zip-loc plastic bags. Two hundred kernels were evaluated for each replicate.

Fig. 1. Sampling corn for aflatoxin analysis in the experiments. The bucket is held under the auger as the combine moves through the plot so that only 11-18 lb. of a plot is sampled.

Nueces county: The experiment consisted of the following treatments: AF 36 applied on Mar. 30, when corn was "knee high" (V4-V5); AF 36 applied on Apr. 20, when corn was at V10; Afla-Guard applied on Apr. 20; and a control.

The hybrid ‘Pioneer 33F85’ was planted Feb. 22 on a Victoria clay (fine, montmorillonitic, hyperthermic, Udic Pellusterts) at a population of 18,046 plants per acre, using a 38 in. row spacing. The fertilizer applied was 300 lb/A 25-5-0 and 1 qt/A Roundup was used for weed control. Corn was at VT on Apr. 25. Rain occurred in Feb. (0.02 in.), Mar. (0.59 in.), May (2.97 in.), and Jun. (0.56 in.). Details of weather conditions, from the second atoxigenic application to harvest, are shown in Fig. 3. On Jul. 8, the treatments were harvested, but only 6 of the 8 rows were harvested using the grower’s 6-row combine. The grower’s yield for this field was 45 bu/A with a level of 15 ppb aflatoxin.

Hill county: The experiment consisted of the following treatments: Afla-Guard applied on Apr. 26, when corn was “knee high” (V5-V6); Afla-Guard applied on May 10, when the corn was at V9-V10; AF 36 applied on May 10; and a control.

The hybrids (‘DK 69-43’ and ‘DK 69-40’) were planted Mar. 19 in Houston black clay (fine, montmorillonitic, thermic Udic Pellusterts) at a seeding rate of 22,900/A and a 30 in. row spacing. The fertilizers applied were 120 lb/A NH_3 and 7 gal/A 11-37-0. The herbicide used was Roundup. Rain occurred May 2 (0.8 in.), May 11 (1.4 in.), May 20 (0.06 in.), May 21 (trace), and Jun. 21 (0.5 in.). Details of weather conditions, from the second atoxigenic application to harvest, are shown in Fig. 4. On Jul. 20, the treatments were harvested. The grower’s yield in this field was 30 bu/A.

Colorado county: The experiment consisted of the following treatments: AF 36 applied May 5, when corn was 50% was either at VT or R1; Afla-Guard applied May 5; and a control.

The hybrid ‘DK66-05’ was planted March 26 in Mohat loam (coarse-silty, mixed, superactive, calcareous, hyperthermic Typic Udifluvents), using a 36 in. row spacing. Details of weather conditions, from the application of the atoxigenics to harvest, are shown in Fig. 5. The field was harvested Jul. 22. The grower’s yield in this field was 89 bu/A.

Ellis county: The experiment consisted of Afla-Guard applied on May 10, when corn was at V6-V9, and a control.

The hybrids (‘DK69-40’ and ‘P1498 HR’) were planted Mar. 10 in Burleson clay (Fine, montmorillonitic, thermic Udic Pellusterts), using a 36” row spacing. The treatments were harvested Jul. 29. The grower’s yield was 40 bu/A.

Results

Nueces county: The average level of aflatoxin in the control plots was 31 ppb (range: 22-50 ppb) (Table 1). The average level of aflatoxin with the Afla-Guard treatment at V10 growth stage was 2 ppb (range: 0-4.5 ppb), which was significantly less (P=0.05) than that of the control. This is a reduction to 6% of the control. In contrast, neither of the AF 36 treatments significantly reduced aflatoxin levels in comparison with the control (Table 1).

The levels of harvested kernels colonized by *A. flavus* ranged from 7-10% with the atoxigenic strain treatments, which was significantly (P=0.05) greater than that of the control, 2% (Table 1).

Table 1. Comparison of aflatoxin among treatments, Mayo Farm, Nueces county, Robstown, TX.

Treatment	Aflatoxin (PPB)*	Range of Aflatoxin (PPB)	% Colonization of kernels by *A. flavus**
AF 36 on 3/30/11 (V4-V5)	27 a	5 - 67	7 a
AF 36 on 4/20/11 (V10)	30 a	1 - 65	10 a
Afla-Guard on 4/20/11 (V10)	2 b	0 - 4	7 a
Control	31 a	22 - 50	2 b

*Mean of four replicates. Log-transformed aflatoxin data was analyzed. Numbers within a column followed by different letters are significantly (P=0.05) different using Fisher's protected LSD.

Hill county: The mean aflatoxin levels were 35-42% of the control with AF 36 and Afla-Guard treatments (Table 2). However, because of the variability among replicates within treatments, these differences were not statistically significant (P=0.05) using an analysis of variance. Friedman's test, a nonparametric ranking test, also did not show any statistical difference (χ_r^2=3.3, 3 df).

The proportion of harvested kernels colonized by A. flavus ranged from 9-13% with the Afla-Guard strain treatments, which was significantly (P=0.05) greater than that of the control, 3% (Table 2). Kernels from the AF 36 treatment had a higher proportion of colonization (6%) than that of the control, but this difference was not statistically significant (P=0.05).

Table 2. Comparison of aflatoxin among treatments, Hejl Farm, Hill county, Hillsboro, TX.

Treatment	Aflatoxin (PPB)*	Range of Aflatoxin (PPB)	% Colonization of kernels by *A. flavus**
Afla-Guard on 4/26/11 (V5-V6)	60 a	7 - 140	13 a
Afla-Guard on 5/10/11 (V9-V10)	67 a	6 - 120	9 ab
AF 36 on 5/10/11 (V9-V10)	56 a	34 - 96	6 bc
Control	161 a	64 - 270	3 c

*Mean of four replicates. Log-transformed aflatoxin data was analyzed. Numbers within a column followed by different letters are significantly (P=0.05) different using Fisher's protected LSD.

Colorado county: The levels of aflatoxin in the treatments and the control were all very low; the highest level was 12 ppb in one replicate (Table 3). The proportion of harvested kernels colonized by A. flavus was low at this site compared with the other three sites in the study, but there was a significantly (*P*=0.05) higher level of *A. flavus* colonization with the Afla-Guard treatment than the AF 36 or control (Table 3).

Table 3. Comparison of aflatoxin among treatments, Mahalitc Farm, Colorado county, Eldridge, TX.

Treatment	Aflatoxin (PPB)*	Range of Aflatoxin (PPB)	% Colonization of kernels by *A. flavus**
Afla-Guard on 5/5/11 (VT-R1)	0 a	0	3 a
AF 36 on 5/5/11 (VT-R1)	0 a	0	1 b
Control	4 a	0 - 12	1 b

*Mean of four replicates. Numbers within a column followed by different letters are significantly (*P*=0.05) different using Fisher's protected LSD.

Ellis county: The Afla-Guard treatment applied at V6-V9 significantly (*P*=0.05) reduced aflatoxin to 126 ppb, which was 37% of the control, 340 ppb (Table 4). The proportion of harvested kernels colonized by *A. flavus* was significantly (*P*=0.05) higher with the Afla-Guard treatment, as compared with the control.

Table 4. Comparison of aflatoxin between treatments, Wilson Farm, Ellis county, Avalon, TX.

Treatment	Aflatoxin (PPB)*	Range of Aflatoxin (PPB)	% Colonization of kernels by *A. flavus**
Afla-Guard on 5/10/11 (V6-V9)	126 a	86 - 150	10 a
Control	340 b	180 - 630	4 a

*Mean of four replicates. Log-transformed aflatoxin data was analyzed. Numbers within a column followed by different letters are significantly (*P*=0.05) different using an analysis of variance.

Discussion

The replicated experiments conducted on non-irrigated farms showed that the benefits of applying atoxigenic strains under the conditions of the extreme drought of 2011 were not consistent. On two of the farms, in Nueces and Ellis counties, the application of Afla-Guard significantly (*P*=0.05) reduced aflatoxin contamination, in comparison with the controls. At the Nueces county farm, the level of aflatoxin in the control was relatively low and unless the corn was intended for food or dairy feed, it is questionable whether there would have been an economic benefit from application of an atoxigenic strain. At the Hill county location, there were reductions in aflatoxin with Afla-Guard and AF 36 treatments that were not statistically different from the control. At the Colorado county location, the level of aflatoxin the control was too low to warrant application of atoxigenic strains. So, out of the four experiments, just the one in Ellis county showed a clear benefit in applying an atoxigenic strain.

One of our hypotheses was that the two atoxigenic strains have similar activity. In the Nueces county experiment, there was a significant reduction in aflatoxin with Afla-Guard, but not AF 36. In contrast, in Hill county, the trend of reduction with AF 36 was similar to that of the Afla-Guard treatment. The reason for this discrepancy is not known. Based on preliminary experiments showing differences in sporulation of the two strains over different relative humidities (B. Hassett, unpublished), our hypothesis to explain this discrepancy is that the atoxigenic formulations may differ in their ability to sporulate under extremely dry conditions. The experiments done to date are insufficient to know whether the strains will have similar activity; more experiments are needed.

We also hypothesized that an early application (i.e. earlier than V9) would be advantageous in a drought year, as the material may have more opportunity to sporulate, especially following an early-season rain. For example, with the Hill county experiment, the Afla-Guard applied V5-V6 was exposed to one more rain shower than Afla-guard applied at V9-V10. In lab tests, both atoxigenic strains sporulate, but not profusely, between 84% and 100% relative humidity (B. Hassett, unpublished). Such conditions occurred for 5-10 hr on almost a daily basis at the Nueces county location (Fig. 3). A longer exposure to conditions favoring sporulation will allow for more spore production. Additional experiments are needed to determine optimal timing.

There were significantly higher levels of colonization by *A. flavus* in harvested, non-symptomatic corn kernels from atoxigenic-treated plots, as compared with the control. However, no further testing was done to determine toxigenicity of the *A. flavus* colonies. A 2009 study found a higher incidence of visible *A. flavus* on ears of drought-stressed corn treated with an atoxigenic strain and most of these isolates were atoxigenic (T. Isakeit *et al*., Can. J. Plant Pathol., 32:407-408, 2010, Abstract). Monitoring *A. flavus* colonization of harvested kernels can provide additional information on the effectiveness of atoxigenic strain treatment.

This research shows that it is possible to measure the effects of atoxigenic strains using plot sizes that are large enough to harvest with the grower's combine, but small enough to treat by hand. Treating by hand allows for precise placement of the atoxigenic formulations. The 100-ft separation of replicates is large enough to minimize cross-contamination. Previous studies have shown a gradient of movement which is negligible at 30-42 ft. from a point source (Olanya *et al*., Plant Disease 81:576, 1997; B. Hassett, unpublished). Yet, the separation is small enough to have replicates close enough to minimize variability in aflatoxin indirectly affected by variations in soil type, fertility, or drainage. With our experimental approach, it is possible to evaluate timing and dosage of atoxigenic strains in experimental designs that will take into account the variation of aflatoxin levels that occur naturally within fields. With experiments done over several years, we anticipate generating information that will allow growers in different areas of Texas to have an understanding of when they will benefit from an atoxigenic treatment.

Acknowledgements
We appreciate the cooperation and support of the growers, Joe Wilson, Stephen Mahalitc, Edwin Hejl, and David Mayo, and the technical assistance of J.R. Cantu, Robert Kwiatkowski, and Brandon Hassett.

Fig. 2. Locations of the experiments. Counties indicated by first initial.

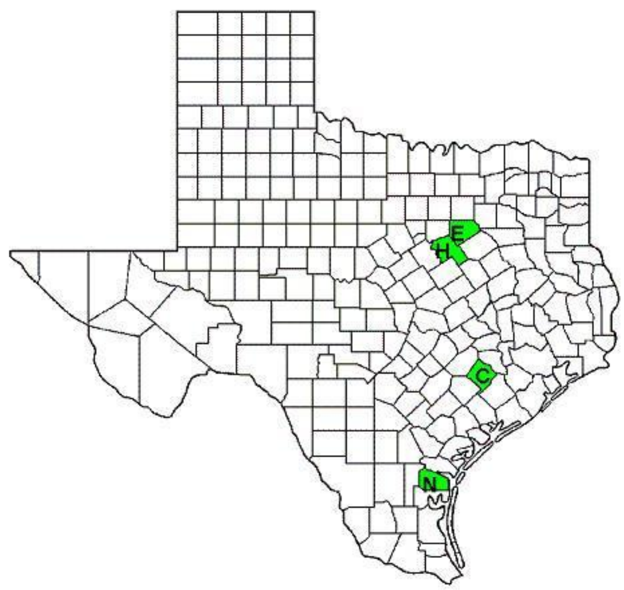


Fig. 3. Daily weather conditions during the experiment in Nueces county. Green bars indicate the number of hours per day that the relative humidity exceeds 84%.

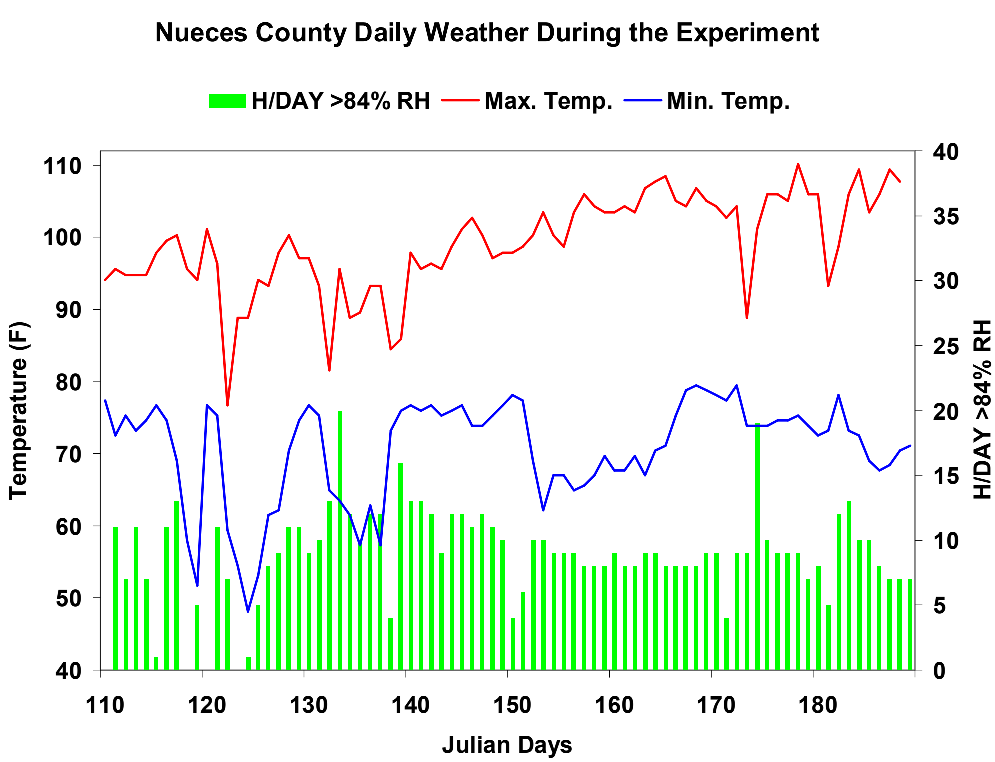


Fig. 4. Daily weather conditions during the experiment in Hill county. Green bars indicate the number of hours per day that leaf wetness exceeds 10, on a scale of 0-14.

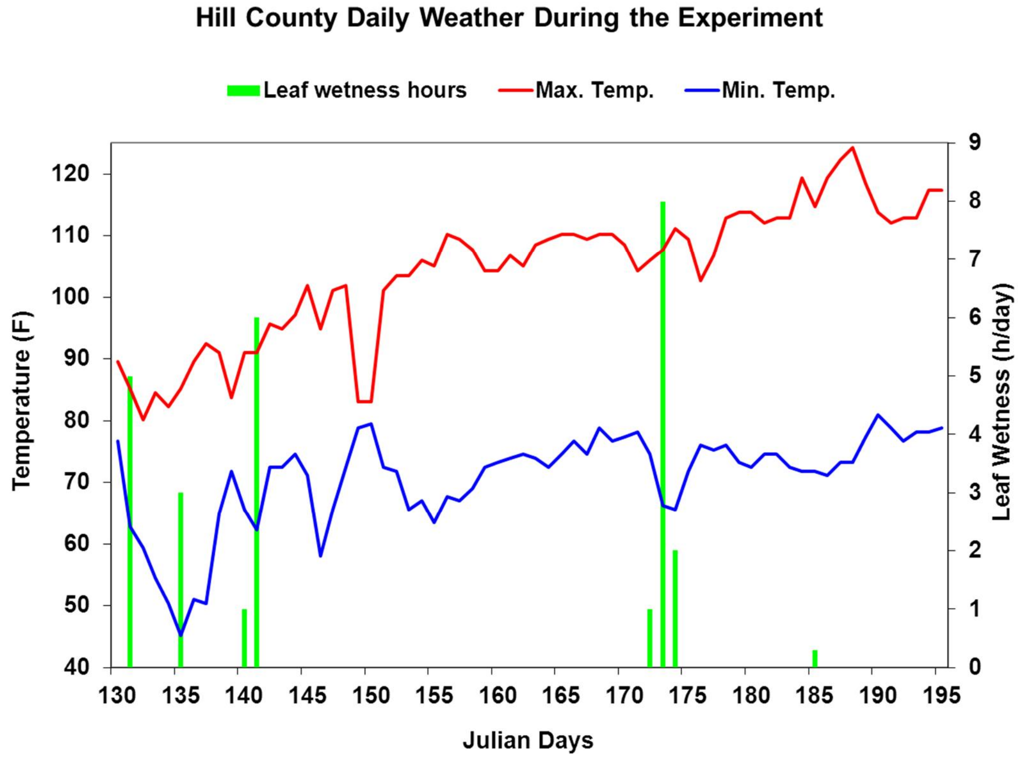
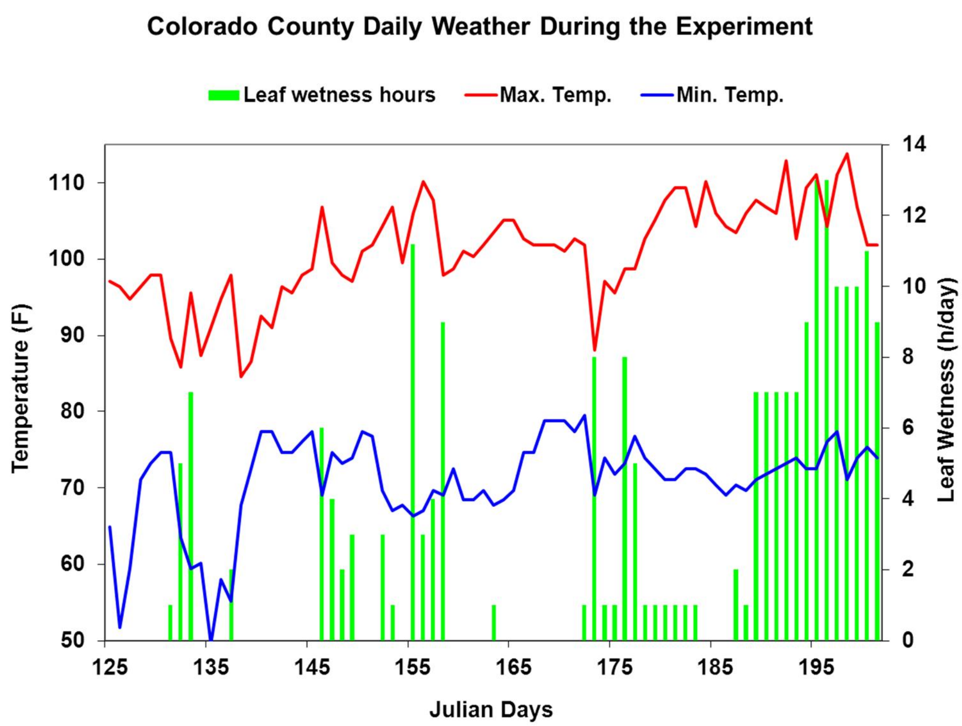


Fig. 5. Daily weather conditions during the experiment in Colorado county. Green bars indicate the number of hours per day that leaf wetness exceeds 10, on a scale of 0-14.



Is There a Future for Bioenergy Feedstock Production in the Blacklands of Texas?

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Introduction

A number of bioenergy crops are well adapted for production in the Texas Blacklands. It is estimated that the Blacklands can sustain over a 2.3 billion tons of biomass production annually. This document provides background information of biofuel conversion systems and dedicated bioenergy crops. We outline current and developing energy conversion technologies, the types of crops that could be considered dedicated energy crops, and specific crops and their conversion requirements that could be or are readily adaptable to a bioenergy cropping system for the Blacklands of Texas.

Conversion of crops to biofuel

There are three general pathways to produce energy from biomass: 1) physicochemical; 2) thermochemical; and 3) biochemical:

1) **Physicochemical conversion.** This is the simplest process of producing liquid transportation fuel from biomass. It is made by mixing refined, bleached, and deodorized vegetable oil or animal fats with an alcohol (most commonly methanol) in the presence of base or acid catalysts such as lye to yield biodiesel. The theoretical conversion rate is 100 pounds of biodiesel (B100) and 10 pounds of unpurified glycerin produced from every 100 pounds of oil and 10 pounds of methanol.

2) **Thermochemical conversion.** Heat coverts biomass to syngas or in the presence of oxygen, directly to energy:

   - **Pyrolysis.** Pyrolysis is achieved in the complete absence of oxygen and is the endothermic step of the thermochemical conversion of biomass. Pyrolysis converts biomass to volatile hydrocarbons and char. Temperatures of the pyrolysis process can vary, where low temperatures and slow heating typically result in high yields of bio-char, and rapid heating and high temperatures (750 to 930°F) produce high yields of gaseous compounds.

   - **Gasification**. Gasification is achieved in the presence of limited oxygen and is the second step in the thermochemical conversion of biomass. Gasification converts volatile hydrocarbons and char to Syngas.

   - **Combustion**. Systems of direct biomass combustion in the presence of oxygen are now technically and economically viable for wood. There are numerous biomass-fueled power plants currently installed in the U.S. for this purpose. Most biomass power plants are wood-based due to the low ash content of most wood residues.

Unlike most row crop residues, sugarcane bagasse has low ash content and has been proven viable for combustion systems and in boiler applications.

3) **Biochemical conversion.** This process utilizes microbes in anaerobic digestion to produce methane biogas and fermentation to produce ethanol

- **Anaerobic Digestion.** The anaerobic digestion process begins with the breaking down of cellulosic biomass compounds into organic acids by enzymes from acid producing microbes. This is followed by conversion into methane by the methane producing microbial population. The reactor must be free of oxygen to ensure that anaerobic microbes will be kept alive. In addition, methane producing microbes are very sensitive to low pH and thus, conversion efficiency will diminish when the microbe population is decreased due to low pH. Two types of anaerobic digesters are used commercially: the low rate (conventional) and the high rate digesters. Conventional anaerobic digesters have retention times of several days or weeks, making the digester volume large; while high rate digesters offer a smaller reactor footprint and shorter retention times of a few days or hours.
- **Ethanol Fermentation.** Conversion of ethanol from biomass resources differs based on the form of substrate used. Water-soluble sugar compounds, such as sweet sorghum or sugarcane juices, only need ethanol-producing yeasts for conversion. However, starchy materials need amylase-producing microbes to convert the starch into sugar, followed by the use of yeast to convert the resulting sugar into ethanol. Cellulosic biomass needs an additional step to convert the cellulosic materials into organic acids, to sugars, and then to ethanol. There are numerous ways to replicate the process. Some methods use steam explosion to break cellulose down into simpler organics, while others use high strength acid for the same purpose. More recently, thermal conversion systems have been designed to convert cellulosic biomass into liquid fuel via a thermal catalytic process, a combination of the thermal and biochemical conversion processes.

Overview of Bioenergy Crops

Dedicated energy crops can be divided into four conversion systems by type of plant material: 1) water-soluble sugars; 2) grain starch; 3) cellulosic biomass; and 4) vegetable oils.

Sugar Crops. Sugarcane, sweet sorghum and sugar beets store energy in the form of water-soluble sugars. Their juice is extracted and fermented anaerobically by yeast into alcohol. Pure alcohol (ethanol) is obtained by distillation. The juiced plant tissue or bagasse can be further processed by enzymatic conversion plus fermentation to yield even more biofuel from each plant.

Grain Crops. Grain crops (corn, sorghum, wheat, rice, etc.) store energy in the form of starch in the seed. Starch is a framework of sugars arranged in chain-like fashion with relatively little branching. Enzymes can break up this framework into single sugars. These sugars can be fermented anaerobically by yeast into alcohol. Pure alcohol (ethanol) is obtained by distillation. Distiller grain is a valuable byproduct, typically high in minerals and digestible proteins.

Cel1lulosic Crops. Cellulosic crops include perennial and annual grasses (high biomass sorghum, energy cane, miscanthus, switchgrass, etc.) and small trees such as poplar. These crops accumulate large quantities of carbohydrate in their stalks and stems.

The carbohydrates are converted to biofuels by enzymatic conversion plus fermentation, or by thermo-chemical conversion.

Crop Residues. Crop residue is cellulosic material comprised of stalk/stem and leaf of grain and cereal crops, and considered as a source of bioenergy feedstock. Estimates are that the Blacklands of Texas produce over 2.3 billion tons of crop residue annually. It is also well understood that the conversion of this source of biomass to biofuel would not be sustainable. The loss of crop residue as soil cover would result in severe losses of soil and nutrients through erosion, and increased losses of water through unobstructed evaporation.

Oilseed Crops. Almost 100 years ago, Rudolph Diesel developed an engine that was able to run on vegetable oil (the diesel engine). In the past fifteen years this fuel, biodiesel, has experienced a revival. Vegetable oils derived from any oilseed crop such as cottonseed, soybeans, sunflowers, or canola can be converted to biodiesel. Biodiesel is synthesized through a physicochemical conversion process, by adding alcohol to the oil in the presence of lye. Biodiesel (methylated seed oil) and glycerin are the resulting products.

Table 1. Total energy potential of all crop residue in Texas

	Tons of Biomass	BTU/Year (Millions)
Northern High Plains	3,404,400,000	25,533,000
Southern High Plains	388,600,000	2,914,500
Northern Low Plains	363,200,000	2,724,000
Southern Low Plains	430,200,000	3,226,500
Cross Timbers	180,600,000	1,354,500
Blacklands	2,254,500,000	16,908,750
East Texas North	80,600,000	604,500
East Texas South	78,600,000	589,500
Trans-Pecos	9,800,000	73,500
Edwards Plateau	229,200,000	1,719,000
South Central	412,600,000	3,094,500
Coastal Bend	424,200,000	3,181,500
Upper Coast	850,800,000	6,381,000
South Texas	79,000,000	592,500
Lower Valley	560,400,000	4,203,000
Combined Districts	5,100,000	38,250
State	9,751,800,000	73,138,500

Source: Cornwell, Bret, David Sandhop, Lauralee Shanks, Lauralee Phillips, and Deborah Webb

Dedicated bioenergy crops with potential for production in the Texas Blacklands

The variation in available land, rainfall, competing crops, producer interest, economic incentives, and infrastructure will determine actual production. The most important "potential" sources of bioenergy feedstock for the Texas Blacklands are sweet and high biomass sorghums, energy cane, and switchgrass.

High biomass sorghums—have high yield potential and growth habit which allows more flexible management. These sorghums can produce biomass yields in excess of 36 tons per acre (fresh weight) and 9 tons per acre (dry weight). Refer to Tables 2 and 3 for examples of biomass and energy yields in South and Central Texas.

Energy cane—is a vegetatively propagated perennial grass. Unlike sugarcane, energy cane is selected for high biomass production, or cellulose, not for its high water-soluble sugar content. Genetic improvements in energy cane cold tolerance are necessary before it might be considered a viable dedicated bioenergy crop for the Blacklands of Texas.

Sweet Sorghum and Sugarcane—The two most important potential sources of dedicated energy crops for non-structural carbohydrates from Texas are sweet sorghum and sugarcane. Among the sugar-producing group, sweet sorghum is well adapted to the Blacklands. Currently, 40,500 acres of sugarcane are grown in the lower Rio Grande Valley of Texas. Although all sugar derived from cane is currently converted to refined sugar for human consumption, fermentation of sugarcane and molasses to ethanol is feasible.

Sweet sorghums produce high levels of sugar in the stalk. These cultivars can be milled and fermented to ethanol using the same methods employed by sugarcane processors. Sweet sorghum is currently used for ethanol conversion in India and Brazil and its efficacy is also being tested in other countries such as China, Uruguay, and Colombia.

Sweet sorghums have advantages over energy and sugarcane because sorghum can be easily incorporated into multiple crop rotation schemes and are adapted over a much wider area of Texas. Expected improvements in high biomass sorghums and energy cane will extend the potential of these types of hybrids to a very wide range of environments.

Table 2. Biomass yields of three sorghum types. Data presented represents average annual yields from varietal adaptability studies performed in Weslaco and College Station, 2010 and 2011. 2011 yields were exceptionally low, 20% lower than 2010 yields, due to prolonged heat stress through much of the growing season.

	BIOMASS YIELDS (ton/A)		
SORGHUM TYPES	**FRESH**	**DRIED**	**LIQUID**
cellulosic	24.6	7.3	17.6
forage	17.0	4.5	12.6
sweet	18.6	5.0	13.6
average	20.1	5.6	14.6

Table 3. Theoretical ethanol yields of three sorghum types. Data presented are estimated EtOH yields based on US DOE biomass-to-energy conversion models, and average annual biomass yields and brix measures from varietal adaptability studies performed in Weslaco and College Station, 2010 and 2011. 2011 yields were exceptionally low due to prolonged heat stress through much of the growing season.

	THEORETICAL ETHANOL YIELDS (gal/A)		
SORGHUM TYPES	**FERMENT -ATION**	**ENZYMATIC CONVERSION**	**COMBINED YIELD**
cellulosic		620	620
forage		395	395
sweet	228	400	628
average	228	471	547

Table 4. Nutrient removal rates of three sorghum types. Data presented are average annual biomass yields and plant tissue nutrient analyses from varietal adaptability studies performed in Weslaco and College Station, 2010 and 2011. 2011 yields were exceptionally low, 20% lower than 2010 yields, due to prolonged heat stress through much of the growing season.

	NUTRIENT REMOVAL (Lb/ton dm)			**NUTRIENT REMOVAL** (Lb/A)		
SORGHUM TYPES	**NITROGEN**	**PHOSPHORUS**	**POTASSIUM**	**NITROGEN**	**PHOSPHORUS**	**POTASSIUM**
cellulosic	17	3	31	127	22	228
forage	19	4	33	86	16	148
sweet	19	4	29	97	18	144
average	18	3	31	103	19	173

Switchgrass—A native warm-season perennial grass that can be grown throughout Texas. Yield potential will be determined by the amount and timing of precipitation. Average yield in Texas was estimated by scientists at the Texas Agrilife's Blacklands Research Center to be 6.25 tons per acre.

Miscanthus—A tall perennial grass was developed for biofuel usage in Europe over the past decade. Some of the beneficial characteristics noted in European trials include: relatively high yields (three to six dry tons/acre), tolerance to cold weather, low moisture content (as low as 15 to 20 percent depending on time frame), low mineral content, and an annual harvest pattern providing yearly income to growers. However, there is very little experience with commercial production of Miscanthus in the U.S.

Giant Reed—*Arundo donax* grows in many parts of Texas, but it is classified a noxious invasive plant. Along the Rio Grande, it has demonstrated growth rates of as much as four inches per day and reaches 20 to 25 feet in height. The implications of cultivating *Arundo* as a dedicated energy crop have not been well studied, because of significant hurdles associated with the Texas Department of Agriculture permit process, specifically assuring that it can be controlled within the cropped area.

A summary for Texas Blacklands energy crop production

As energy prices continue to rise and the desirability of our dependence on foreign petroleum sources declines, the feasibility of establishing a biofuel infrastructure may become a reality. If or when this occurs, the Blacklands could serve as one of the nation's leading producers of bioenergy feedstocks and biofuel.

The best adapted crops for the Blacklands of Texas are the sweet sorghums, switchgrass and miscane, a cross between sugarcane and Miscanthus. Oil seed crops best adapted to Blackland cropping systems are flax and sunflower.

Soil and water conservation remain a priority. Adoption of a conversion process that relies solely upon crop residue, primarily corn stover, could severely damage Blackland agriculture. The conversion of corn stover as a sole or major source of biofuel feedstock is not sustainable. The removal of corn stover as soil cover would result in severe soil erosion. If bioenergy feedstock becomes one of our major cropping systems, it is crucial that we carefully weigh the effects of residue management and nutrient removal on soil quality.

We present this document as a primer, to focus on production factors that would be managed as integrated components of a different kind of cropping system. Clearly, the existing agricultural infrastructure and commodity prices of energy will have to be greatly altered before we choose to step into this challenging arena. Until we see changes in the pricing and availability of petroleum-based fuels, bioenergy cropping systems will not be a viable alternative for the Texas Blacklands.

Ryegrass Research in Central Texas
Texas AgriLife Extension Service

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Volunteer ryegrass (*Lolium multiflorum*) has been a problematic weed in wheat fields for many years in central Texas and up through the northern Texas Blacklands. In the past good control of this weed has come from the application of ALS herbicides (Osprey, Glean, Amber, etc.) to early seedling ryegrass. However, in recent years herbicides with this mode of action is becoming less effective on controlling this weed. There are numerous situations in North Texas of tolerant ryegrass to the ALS herbicides. Recognizing the potential devastating effects of herbicide tolerant weeds in wheat fields is key to managing this situation. Numerous ryegrass control studies have been conducted at the Stiles Farm Foundation observing different ryegrass herbicides and evaluating for the most effective ryegrass control method.

Data presented in this summary and in Table 1, on the following page, are from a study that evaluated Osprey, Axial, and Axiom as volunteer ryegrass management herbicides. This research was conducted in both 2011 and 2012 at the Stiles Farm Foundation.

This herbicide study was designed with seven treatments consisting of Axiom at two rates both applied when the wheat was at spike stage, a single application of Osprey applied at the 2-leaf wheat stage, a split application of Axiom followed by Osprey, a single application of Axial applied at the 2-leaf wheat stage, and a split application of Axiom followed by Axial. In addition to these, an untreated control was also included in this experiment to determine the impact the ryegrass would have on the wheat crop. Numerous ryegrass control ratings occurred throughout the growing season, but only one rating taken near the end of February for each year is presented in Table 1 below. These data indicate that the best ryegrass control for both years came from both split applications and the single application of Axial.

Grain yields responded favorably to the addition of the herbicides. Due to the excessive drought in 2011, grain yields were much lower than normal, and distinct differences were much more difficult to determine. The single applications of Axiom and Axial along with the split application of Axiom followed by Osprey had significantly higher yields above the untreated control. In 2012 when yields were closer to average, all treatments were significantly higher yielding than the untreated control. Both split applications and the single applications of Axial and Axiom at 10 oz/a were all in the top-yielding group.

Conclusions drawn from this research were that Osprey (ALS inhibitor) when applied alone did not give acceptable control of volunteer ryegrass. Better ryegrass control was found with the single applications of either Axial (ALS inhibitor) or Axiom (Photosynthesis AND Shoot Growth Inhibitor). Split applications of Axiom followed by either Osprey or Axial gave the most effective control and maintained the yield potential of the crop. In addition, the use of these split applications aid in the minimization of creating herbicide resistant weeds by rotating the modes of action used in volunteer ryegrass weed control.

The authors of this summary would like to sincerely thank Archie Abrameit and everyone at the Stiles Farm Foundation for the use of the land and its preparation, and their technical assistance, which was vital to the success of this research. In addition, we would like to thank Bayer Crop Science for their technical assistance and funding this and numerous research projects like this one.

Table 1. Ryegrass management using Axiom, Osprey, and Axial XL at Stiles Farm in 2011 and 2012.

Treatment[1]	**Rate**	**Application Timing**	**% Control 2/22/2011**	**% Control 3/5/2012**	**2011 Yield (bu/a)[2]**	**2012 Yield (bu/a)[2]**
1) Untreated			0.0 c	0.0 c	16.4 b	14.9 d
2) Axiom DF	6 oz/a	Spike	93.5 a	40.0 b	20.5 a	47.7 b
3) Axiom DF	10 oz/a	Spike	-	92.5 a	-	54.0 ab
4) Osprey NIS UAN	4.75 oz/a 0.5 %v/v 1.5 qt/a	2 leaf 2 leaf 2 leaf	60.0 b	32.5 b	19.9 ab	40.2 c
5) Axiom DF Osprey NIS UAN	6 oz/a 4.75 oz/a 0.5 %v/v 1.5 qt/a	Spike 2 leaf 2 leaf 2 leaf	97.0 a	87.5 a	20.1 a	54.4 ab
6) Axial XL	16.4 oz/a	2 leaf	92.3 a	95.0 a	20.9 a	50.6 ab
7) Axiom DF Axial XL	10 oz/a 16.4 oz/a	Spike 2 leaf	97.0 a[3]	97.5 a	19.7 ab	56.8 a
LSD (P=.05)			12.87	16.90	3.65	7.03
Standard Deviation			8.75	11.37	2.44	4.73
CV			11.65	17.89	12.38	10.39
Grand Mean			75.09	63.57	19.68	45.52

[1]Axiom has two modes of action (Photosynthesis inhibitor (group 5) and Shoot Growth Inhibitor (group 15), Osprey is an ALS herbicide (group 2) and Axial is an ACCase inhibitor (group 1)

[2] Letters denote significant differences between treatments.

[3]Axiom was applied at 6 and 10 oz/a for 2011 and 2012, respectively for this treatment.

Wheat and Oat Variety Performance in Central Texas

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A major consideration for producers preparing to plant small grains is variety selection. The variety selection decision impacts other management practices through the season from fungicide use to fertility and herbicide use. For the past several years, the Texas AgriLife Extension Service has conducted replicated variety trials in Williamson County that contain locally available hard red winter wheat (HRWW) varieties, soft red winter wheat (SRWW) varieties, and oat varieties. These trials were conducted over multiple years to give producers a long-term yield performance of the varieties tested.

The variety trials presented in this summary were grown over two growing seasons 2011 and 2012 at the Stiles Farm Foundation. The trial in 2012 consisted of ten HRWW varieties, six SRWW varieties, and seven oat varieties. Grain yield, test weights, and a two-year average of the trials are presented for hard wheat, soft wheat and oats on Tables 1, 2 and 3, respectively on the following page. As the reader reviews the data from these trials, it is important to understand the impact of the extreme drought of 2011. The two-year averages are much lower than normal due to crop injury from that drought.

The 2012 data from Table 1 shows the top statistical category for hard red winter wheat varieties included all but Duster and Jackpot. Likewise, the top category for soft red winter wheat varieties from Table 2 included all varieties but Crawford. Table 3 shows the combined data for the oat varieties. The top group of oat varieties in this study included: Horizon 270 and Horizon 201. TX 347-1 is an experimental line from the Texas A&M breeding program that is being considered for release. This line is showing great promise for yield potential in many areas throughout Central Texas.

When developing one's small grain management plan, multiple varieties should be selected and incorporated into the production rotation. This strategy not only adds variety diversity, but will also help to limit the uncontrollable risk that is encountered each season due to the environment. To make appropriate variety decisions, it is highly encouraged that producers consider multiple years of data in addition to many different locations within a region. These types of data will indicate a variety's yield stability over many different environments. Yield stability allows producers to make better management decisions through the growing season based on the expected yield. For more information on varieties and small grains management in all regions of Texas, please visit http://varietytesting.tamu.edu/wheat

The authors would like to sincerely thank Archie Abrameit and the staff at the Stiles Farm Foundation for providing the land, its preparation and the technical support that was vital to the success of this research.

Table 1. Hard Red Winter Wheat variety yields for 2012 and the 2-Year yield average at the Stiles Farm.

Variety[1]	2012 Yield (bu/a)[2]	2011 Yield (bu/a)[2]	2-Year Yield Average (bu/a)	2012 Test Weight (lbs/bu)
Billings	70.7 a	21.8 c-g	46.3	57.6
TAM 203	63.7 a	25.9 ab	44.8	56.8
Fuller	64.1 a	23.1 b-e	43.6	57.9
Greer	58.7 ab	24.8 abc	41.8	53.8
TAM 304	57.5 ab	24.7 bc	41.1	55.2
TAM 401	61.6 ab	19.8 e-h	40.7	55.9
Coronado	53.4 abc	24.5 bc	39.0	57.7
Fannin	55.5 abc	22.2 c-g	38.9	59.6
Duster	43.8 bcd	24.0 bcd	33.9	56.9
Jackpot	38.1 cd	20.4 e-h	29.3	53.5
LSD (P = .05)	18.35	3.45	-	1.35
Standard Deviation	12.84	2.44	-	0.96
CV	23.49	11.15	-	1.93
Grand Mean	54.68	21.9	-	49.6

[1]Ranked according to 2-year average.
[2]Letters denote significant differences in yield.

Table 2. Soft Red Winter Wheat variety yields for 2012 and the 2-Year yield average at the Stiles Farm.

Variety[1]	2012 Yield (bu/a)[2]	2011 Yield (bu/a)[2]	2-Year Yield Average (bu/a)	2012 Test Weight (lbs/bu)
TAMsoft 700	58.8 ab	22.3 c-f	40.6	55.1
USG 3555	60.8 ab	19.5 fgh	40.2	55.9
Coker 9553	54.3 abc	22.1 c-g	38.2	57.9
Crawford	26.5 d	20.5 d-h	23.5	53.4
USG 3251	54.2 abc	-	-	56.4
USG 3120	53.1 abc	-	-	57.6
LSD (P = .05)	18.35	3.45	-	1.35
Standard Deviation	12.84	2.44	-	0.96
CV	23.49	11.15	-	1.93
Grand Mean	54.68	21.9	-	49.6

[1]Ranked according to 2-year average.
[2]Letters denote significant differences in yield.

Table 3. Oat variety yields for 2012 and the 2-Year yield average at the Stiles Farm.

Variety[1]	2012 Yield (bu/a)[2]	2011 Yield (bu/a)[2]	2-Year Yield Average (bu/a)	2012 Test Weight (lbs/bu)
Horizon 270	85.6 a	44.7 a	65.2	35.0
Horizon 201	84.7 a	37.1 ab	60.9	33.1
TAMO 406	58.9 bc	28.6 c	43.8	35.8
TAMO 606	43.3 d	35.6 bc	39.5	31.5
Bob	46.1 cd	28.7 c	37.4	32.9
TX 347-1	85.5 a	-	-	36.6
RAM 99016	71.8 ab	31.5 bc	51.7	36.0
LSD (P = .05)	15.57	8.32	-	1.35
Standard Deviation	11.01	5.52	-	0.96
CV	22.43	16.06	-	1.93
Grand Mean	49.1	34.38	-	49.6

[1]Ranked according to 2-year average.

[2]Letters denote significant differences in yield.

Well Owner Drought Response

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During periods of severe drought, groundwater resources are relied upon to provide water. The combination of increased pumping and the loss of recharge often results in lowered water table elevations. It should be noted that some aquifers are less reliant on recent recharge and/or may be responding to climate conditions that occurred during decades prior to the current drought. Regardless of the cause of lowered water tables, there are several best management practices recommended to protect your water supply.

- Monitor your pump. Rapid cycling of the pump on and off over short periods of time is the result of lowered water tables and slow static water level recovery. Rapid pump cycling will burn out the motor. Heat generated by a submersible pump in lowered water tables can damage the drop-pipe if it is constructed of PVC. Allow your pump to rest or, if possible, throttle-down your pumping rate.

- If pumping causes the sound of 'sucking air,' shut down the pump and allow it to rest. When the water table is drawn down below the pump intake, the well may begin to produce sand. If you notice sand in the toilet tank, the well is in danger of going dry and the pump will likely be damaged. A milky appearance of the water that clears upon standing also can occur when the pump draws air and may be an indication that the water level has dropped.

- Depending on the overall depth of the well, lowering the pump may be an option. Check with a licensed pump installer. The Texas Dept. of Licensing and Regulation maintains an online database of licensed well drillers and pump installers; the list is available through http://www.license.state.tx.us/LicenseSearch/.

- As the water table drops and pulls air (oxygen) into the aquifer, the chemistry of the water will change. Sometimes exposing the aquifer to oxygen dissolves naturally occurring arsenic and may cause arsenic concentrations to increase. For example, if well water normally contains low concentrations of arsenic, expect concentrations to increase during drought and plan to sample the well water on a regular basis during and after the drought. Concentrations of other water quality parameters, such as TDS (salinity) may also change.

- Lowered pumping rates and storage may protect well equipment and your groundwater resource.

- Working with neighbors to schedule common or heavy water use may help. For example, if everyone in a neighborhood typically does laundry on Saturday, wells may begin to go dry Sunday. Distributing the schedule of heavy water use over the week may allow individual wells to recover and sustain water supply in your neighborhood.

- Practice water conservation to protect your groundwater resource during times of drought.

Facts about Fracking…….and Your Drinking Water Well

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Revisions to the Safe Drinking Water Act by the Energy Policy Act of 2005 exempted key aspects of hydraulic fracturing from rules that had previously regulated the injection of fluids underground. Texas is the first state in the United States to require public disclosure of the chemicals used in the process, but private domestic well owners will remain responsible for the monitoring of their own wells to ensure safe drinking water.

Hydraulic fracturing:

The mechanical fracturing of water supply aquifers, oil/gas reservoirs, and for salt solution mining has existed for decades: new technology has made 'fracking' more prevalent. Hydraulic fracturing uses large quantities of water under pressure within a borehole to fracture the rock to increase production. In the water well industry, fracking can double the volume of yield in a well; in the oil/gas industry, fracking a well may be the difference between economic profit and loss.

Geology:

Liquids and gases move through the subsurface in either consolidated or unconsolidated rock material. Within unconsolidated material, like sands and gravels, the porous space between the rocks and grains are all interconnected. You cannot hydraulically fracture porous material

Another important technological development has been the design of packers or bladders that expand within the borehole to seal short sections in preparation for fracking. In the past, a well would be fracked over the vertical production length – today, the horizontal borehole can be fracked at higher pressures over multiple, shorter sections. New packer designs also allow for rapid entry/exit from the borehole and increased pressures that can be sustained for longer periods of time. Production rates have soared, making smaller oil and gas reservoirs more accessible for development.

Chemicals injected:

In addition to the sand or ceramic beads used to prop open fractures (known as 'proppants'), other chemicals are used during the fracking procedure. Chemicals include those to manage the density and viscosity of the fracking solution, dissolve scale, and flush clays that may clog fractures. Public disclosure of chemicals used and their associated health risks, if any, is the basis of current controversy. The Governor of Texas recently signed a bill requiring the Railroad Commission of Texas (RRC) to write disclosure rules for hazardous chemicals by July 1, 2012. The bill requires the RRC to complete rulemaking for all other chemicals used in the process by July 1, 2013. Potential water quality impacts are the focus of on-going EPA environmental studies.

Water use and disposal of waste:

Several million gallons of water are needed for each fracking process, and a well can be fracked multiple times over the entire length of the borehole. Some concern has been expressed that pumping groundwater from a water supply aquifer or from a surface water source will reduce the amount available for other uses, and could impact private wells. Proper wastewater management and disposal also are important because wastewater will contain some of the hydrocarbon constituents released from the oil or gas reservoir, in addition to the original fracking solution. The RRC regulates wastewater management from oil and gas development, and the Texas Commission on Environmental Quality (TCEQ) regulates the wastewater treatment facilities.

Recommendations for private well owners:

Under current regulations and with proper management of the drilling process, it is unlikely that hydraulic fracturing will have any adverse impacts on your water well. However, individuals who use private water wells as a source of drinking water are responsible for ensuring that the water is safe for consumption. Because the potential exists for the quality of well water to change, it is recommended that private well owners obtain a background water sample and then test periodically thereafter (typically once per year) to monitor the quality of water in their well.

Routine testing is important, since some water contaminants cannot readily be detected during routine household use. Further, if a change in taste, color, or odor is detected, it can be difficult to establish the cause of the change without having first measured the original, background or baseline chemistry of the well water.

Keep in mind that if a private drinking water well is in an area undergoing oil or gas exploration and development, it is possible that the aquifer may already contain naturally occurring contaminants from normal geologic processes. Small concentrations of petroleum constituents and natural gas have been known to seep towards the surface from reservoirs deep underground. Trace concentrations of these contaminants may be naturally occurring prior to any fracking operation. It is important to measure the <u>baseline</u> chemistry of your well water so that you know the quality of the water you are currently using, and so that you can detect and verify any changes that may occur.

In addition to annual well testing for coliform bacteria, total dissolved solids, and nitrate, a screening for non-refined hydrocarbons is recommended to establish the presence /absence of constituents related to oil/gas development.

Sampling and Analysis of Well Water:

Part of the decision on what to test for and how often depends on how much you are willing to pay. If you were to sample and analyze for all of the EPA recommended drinking water contaminant constituents, the laboratory fee would exceed several thousand dollars, and for that reason you should prioritize which constituents to test. Testing prior to any oil/gas drilling is imperative, as it is difficult to prove water quality impact without a baseline to compare against.

The well owner can collect the sample, but the analyses should be conducted by a Texas-certified drinking water laboratory (see contact information below). The laboratory will provide sample collection bottles and instructions on how to collect, manage, and ship the samples back to the lab for analysis, and these instructions should be followed exactly. For example, the sample collection for dissolved methane requires the collection bottle be filled to the top with no air bubble. During shipment, the dissolved methane could degas out of the water and collect in the air bubble, and the sample analysis would not be valid.

It is recommended that drinking water wells in proximity to natural gas or oil development wells be tested for the following list of constituents. By providing the name of the recommended testing method to the laboratory, you will be assured of the use of the appropriate standard method.

Constituent	***Laboratory Method***	***Estimated Cost***
Total Dissolved Solids (TDS)	SM 2540C	\$20.00
Dissolved Methane	RSK-175 or 176	\$75.00
Total Petroleum Hydrocarbons (TPH)	TX-1005 or 1006	\$60.00

Total Dissolved Solids (TDS) is the sum of all dissolved constituents in the water. Because water is an excellent solvent, it dissolves various minerals as it moves downward through the soil and into an aquifer. Thus, all groundwater typically contains some level of naturally occurring TDS. TDS is most often correlated with the dissolved salts of sodium, potassium, calcium and magnesium (such as NaCl – sodium chloride). Natural groundwater will exhibit a range of TDS from around 150 to 400 mg/l, but is considerably higher in water from some Texas aquifers. If the baseline value for TDS exceeds the EPA secondary drinking water standard of 500 mg/L, you should test to determine what the individual dissolved minerals may be. For example, bromide is common to brackish water and brines that may be associated with oil exploration or ocean water. Any change in TDS from baseline is of concern because it suggests groundwater contamination that may – or may not – be due to oil/gas development.

Dissolved methane and hydrocarbons are not expected to be found in groundwater, but may be present under natural conditions if the aquifer is in proximity to an oil and gas producing zone.

Methane may also be associated with coal beds. If you find these constituents in your baseline water quality testing, you should speak to a professional and do further testing.

After fracking, or any oil/gas development activity, retesting your water quality to compare against baseline is recommended. If significant change from baseline is detected, then further investigation by a professional is recommended. Any change in water taste, smell or color also calls for expanded water quality testing. The EPA also maintains a Drinking Water Hotline that is available Monday-Friday from 8:30 AM-4:30 PM Eastern time at 1-800-426-4791 to assist with your drinking water quality questions.

For more information:

To locate a Texas National Environmental Laboratory Accreditation program (NELAC) certified drinking water laboratory in your area:
http://www.tceq.state.tx.us/assets/public/compliance/compliance_support/qa/txnelap_lab_list.pdf

For additional information, contact your local County Extension Office, Kristine Uhlman (kuhlman@tamu.edu, 979-845-1641), Diane Boellstorff (dboellstorff@tamu.edu, 979-458-3562) or Mark McFarland (ml-mcfarland@tamu.edu, 979-845-2425).

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