

Use of GEM Germplasm for Evaluation and Development of Drought Tolerance, Corn Earworm (CEW) Resistance, and Low Aflatoxin Level Grain

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Objectives:

This report serves to document research conducted under a specific cooperative agreement between ARS and Texas A&M University. It covers progress from October 1, 2008 to September 30, 2009. Specific objectives of this project include: (1) conducting field trials for drought tolerance, CEW resistance, grain mold, grain yield, silage yield and quality of top crosses of GEM lines with public and Holden's lines; (2) developing inbred lines from GEM populations and characterizing inbred lines for stress tolerance and agronomic traits; (3) assaying aflatoxin of testcrosses of GEM lines; and (4) evaluating 18 new GEM breeding crosses for drought tolerance, CEW resistance and agronomic performance.

1. Testcrosses of GEM Lines: About 150 top crosses of GEM lines were tested for yield and stress tolerance at three locations on the Texas High Plains (Lubbock, Halfway and Dumas), and a subset of the top crosses at four south Texas sites (College Station, Ganado, Uvalde, and Wharton). The Lubbock and Halfway tests had both full-irrigation and drought treatments. Most of them were tested for the second year. These top crosses were made with the licensed Holden lines and and/or public lines.

At the time of preparing this report, I have only finished data analysis on some of the tests. This report presents part of the data obtained in 2009.

Table 1 and 2 show the yield and other agronomic traits of test crosses of five GEM inbred lines developed by our project. These lines produce competitive hybrids and will be released soon.

The advanced lines from ANTIG01:N16 have nice looking plant and excellent grain quality. But in general, these lines are very susceptible to Southwest corn borer and hence show severe stalk lodging at harvest time (Tables 3 and 4).

2. Inbred line development and characterization: Inbred lines developed from the breeding crosses ANTIGO01:N16AR03056:N0902, BR52051:N04, CH05012:N12, CUBA164:S20, CUBA117:S15, DK888:N11, FS8A(T):N11a, FS8A(T):N1801, SCROGP3:N2017, and SCROGP3:N1411a have been characterized as line per se and in the testcross combinations for agronomic traits and stress tolerance under well watered and drought conditions in Lubbock and Halfway for a second year.

3. Aflatoxin analysis: Fifteen top crosses of GEM-lines developed from CUBA117:S15, DK888:N11, BR52051:N04, SCROGP3:N1411a, and Tx205 were grown along with 11 hybrids in Texas at Lubbock, Halfway, Corpus Christi and Beeville and in Mississippi for aflatoxin assays where the test plots were inoculated with *A. flavus*. Table 5 shows the results of aflatoxin.

4. Breeding crosses of BR105 and BR106: Eighteen breeding crosses of BR105 and BR106 and two commercial checks (DKC 66-23 and P34F96) were planted in Lubbock under well

watered and drought stressed conditions. Hand-harvested ears are being analyzed at the time of this report.

5. Biomass and silage quality: Fifteen test crosses of GEM-lines were included in a 40 entry silage yield trial at Dumas and Halfway, Texas. The GEM-lines are the inbred lines developed by our project from AR01150:N04, BR52051:N04, CUBA117:S15, DK888:N11, GUAT209:N19, SCROGP3:N1411a, and SCROGP3:N2017. The testcrosses were chosen for their height and good grain yield in previous trials. The biomass is comparable to the best commercial silage hybrids (Table 6). These GEM-lines may be a good source for biofuel and silage corn production.

Germplasm distribution: We have distributed seeds of Tx204, Tx205, and four inbred lines (to be released) to 14 seed companies. Breeders, agronomists, and sales reps toured yield trial plots involving GEM top crosses with seed company lines during the growing season.

Communications on GEM project:

The GEM project and use of the GEM germplasm in our breeding program were specifically mentioned in the following publications and presentation.

Field Day:

Wenwei Xu. Texas A&M Lubbock Center Centennial Celebration Field Tour. September 17, 2009, Lubbock, TX. A section was dedicated to GEM germplasm. Participants included corn producers, seed company representatives, university and USDA scientists, Ag consultants, and policy makers.

Presentations:

Wenwei Xu, Gary Odvody, and Paul Williams. 2009. New stress-tolerant and low-aflatoxin corn inbred lines. Reducing aflatoxin contamination in corn workshop. October 27-28, 2009. Mississippi State University, Mississippi State, MS.

Wenwei Xu. Progress in breeding multiple stress tolerant corn. An invited presentation to the Texas Corn Producers Board. April 1, 2009. Austin, Texas.

Wenwei Xu. Silage corn hybrids for the Texas High Plains. Llano Estacado Corn Conference. February 10, 2009. Dimmit, Texas.

Wenwei Xu. Phenotyping corn for drought tolerance. Drought tolerance mini symposium. Dow Agroscience, Jan. 20-21, 2009. Indianapolis, IN.

Technical Report:

Wenwei Xu, Thomas Marek, Bruce Spinhirne, Bruce Carlson, Travis John, Brent Bean, and Dennis Pietsch. 2009. 2009 State Silage Corn Performance Test on the Texas High Plains. Texas AgriLife Research and Extension-Lubbock Center Technical Report No.09-4. pp.10.

Table 1. Grain yield (bu/a adjusted to 15.5% moisture) of testcrosses of five GEM inbred lines under well-watered (WW) and drought (DRT) conditions in Dumas (DU), Halfway, and College Station (CS), Texas in 2009. The test used 46 Texas A&M AgriLife experimental hybrids and 4 commercial hybrids.

Hybrids	Yield (bu/a)							Moisture				
	DU- WW	DU- DRT	HF- WW	HF- DRT	CS	Average	% CK M	DU- WW	DU- DRT	HF- WW	HF- DRT	CS
BR52051:N04-1 x SS3	276.6	262.5	171.2	68.7	131.2	182.0	97.0	17.0	17.5	14.0	12.1	14.3
CUBA117:S15-1 x NS1	277.6	239.2	191.4	95.2	176.6	196.0	104.5	19.0	16.1	15.3	14.3	14.1
DK888:N11-5 x SS3	256.5	209.5	165.2	80.9	163.2	175.1	93.3	16.0	16.1	14.5	12.0	13.6
DK888:N11-7 x SS3	290.0	257.7	160.7	75.3	166.0	189.9	101.2	18.0	17.1	16.1	12.7	13.6
SS2 x Tx204	223.4	163.0	158.1	60.0	143.7	149.6	79.8	16.0	17.0	12.7	10.7	12.6
BH8913RR/YGCB	240.2	234.7	173.8	70.8	148.6	173.6	92.6	17.0	16.6	13.2	14.0	13.5
DKC66-23	319.8	237.5	201.5	90.6	174.0	204.7	109.1	17.0	15.5	12.9	10.1	14.1
DKC67-87	312.3	236.0	210.6	94.1	183.9	207.4	110.5	18.0	16.6	15.1	14.2	13.7
P31G96	328.8	288.8	188.2	77.5	196.8	216.0	115.1	18.0	17.0	15.1	12.6	13.5
CK Mean	254.2	231.1	193.5	83.2	175.8	187.6	100.0	18.3	17.1	14.1	12.7	13.7
Test mean of 50 entries	250.0	224.3	170.2	74.5	152.5	174.3	92.9	17.5	16.5	14.0	12.2	13.6
CV%	9.5	12.8	10.6	17.7	9.2			3.7	3.4	6.7	6.6	2.2
LSD 0.05	47.6	57.5	36.1	26.5	28.2			1.3	1.1	1.9	1.6	0.6

Table 2. Days to pollen shed, plant height, ear height, and stalk lodging of testcrosses of five GEM inbred lines under well-watered (WW) and drought (DRT) conditions in Dumas (DU), Halfway (HF), and College Station (CS), Texas in 2009. The test used 46 Texas A&M AgriLife experimental hybrids and 4 commercial hybrids. Pedigrees of the GEM lines are abbreviated due to the space limitation.

Hybrids	Days to pollen shed				Plant ht., cm					Ear ht., cm				
	DU-	HF-	HF-	CS	DU-	DU-	HF-	HF-	CS	DU-	DU-	HF-	HF-	CS
	WW	WW	DRT		WW	DRT	WW	DRT		WW	DRT	WW	DRT	
BR52051:N04-1 x SS3	74	74	74	73	276	269	263	240	234	108	111	93	96	80
CUBA117:S15-1 x NS1	72	71	71	72	297	276	284	260	255	111	110	104	98	85
DK888:N11-5 x SS3	72	75	74	72	270	265	275	255	230	120	121	114	108	85
DK888:N11-7 x SS3	75	75	74	76	279	268	259	242	240	105	123	98	102	85
SS2 x Tx204	74	75	75	76	278	264	254	221	246	110	111	114	91	81
BH8913RR/YGCB	77	76	77	75	269	243	259	228	224	121	104	100	104	79
DKC66-23	70	70	69	73	277	250	265	237	237	93	88	74	88	74
DKC67-87	73	72	72	73	281	274	267	250	251	118	124	110	109	95
P31G96	75	76	75	77	284	272	285	252	260	117	121	120	108	94
CK Mean	75	74	73	75	294	274	269	242	243	120	112	101	102	86
Test mean	73	72	72	74	274	257	259	238	227	103	103	97	94	77
CV%	2	1		2	4	3	2	4.2	9	12	8	9	8.1	9
LSD 0.05	2	2		3	22	17	12	15.2	42	25	16	17	15.2	14

Table 3. Grain yield and moisture of testcrosses of advanced lines developed from ANTIG01:N16 under well-watered (WW) and drought conditions in Dumas and Halfway, Texas, 2009.

ENO	Hybrids	Yield (bu/a)				Moisture (%)			
		Dumas-	HF-	HF-	% CK	Dumas-	HF-	HF-	
		WW	WW	DRT		Mean	WW	WW	DRT
1	ANTIG01:N16-B1-5-1-1 x B110	176.7	165.5	37.7	126.7	67.5	19.9	15.6	15.3
2	ANTIG01:N16-B1-5-1-1-2 x SS1	180.3	179.0	24.7	128.0	68.2	17.6	15.5	23.1
3	ANTIG01:N16-B1-B-1-1 x B110	240.2	105.9	61.2	135.8	72.3	19.6	15.5	15.3
4	ANTIG01:N16-B1-B-1-2 x B110	202.2	170.7	61.6	144.8	77.2	18.7	15.2	13.1
5	ANTIG01:N16-B1-B-1-1-1 x SS1	235.8	185.4	94.2	171.8	91.5	17.9	15.2	13.8
6	ANTIG01:N16-B1-B-1-2-1-1 x SS1	236.4	211.2	77.8	175.1	93.3	18.6	14.1	12.8
7	ANTIG01:N16-B1-B-1-2-2-1 x SS1	197.3	158.7	51.2	135.7	72.3	21.1	14.4	13.3
8	ANTIG01:N16-B1-B-2-1 x B110	173.4	147.8	75.2	132.1	70.4	18.2	15.3	12.5
9	ANTIG01:N16-B1-B-2-1-1-1 x SS1	242.1	185.9	89.6	172.5	91.9	17.2	14.1	12.5
10	ANTIG01:N16-B1-B-2-2 x B110	199.8	166.3	55.6	140.6	74.9	18.1	13.9	15.7
11	ANTIG01:N16-B1-B-2-2-1-1 x SS1	248.1	159.3	84.6	164.0	87.4	17.4	14.0	11.9
12	ANTIG01:N16-B1-B-2-2-2-1 x SS1	266.5	144.4	92.5	167.8	89.4	17.0	15.1	12.4
13	ANTIG01:N16-B1-B-2-3 x B110	246.6	138.2	65.3	150.0	79.9	19.8	15.2	13.5
14	ANTIG01:N16-B1-B-2-3-1-1 x SS1	211.1	145.3	76.0	144.1	76.8	17.9	15.3	12.7
15	ANTIG01:N16-B1-B-2-3-2-1 x SS1	235.5	196.3	81.9	171.3	91.2	21.4	13.4	13.7
16	ANTIG01:N16-B1-B-2-4 x B110	208.8	133.0	72.8	138.2	73.6	21.3	15.0	17.1
17	ANTIG01:N16-B1-B-2-4-1-1 x SS1	245.2	191.1	86.4	174.3	92.8	17.6	15.3	12.6
18	ANTIG01:N16-B1-B-2-4-2 x SS1	236.2	142.6	81.8	153.5	81.8	17.0	15.3	12.0
19	ANTIG01:N16-B3-1-1-1 x B110	221.3	111.3	43.6	125.4	66.8	18.6	15.8	15.4
20	ANTIG01:N16-B3-1-1-1-3 x SS1	235.9	160.8	68.1	154.9	82.5	20.8	15.3	13.1
21	ANTIG01:N16-B3-1-1-2 x B110	190.8	182.9	52.1	141.9	75.6	19.5	15.8	13.8
22	ANTIG01:N16-B3-1-2-1 x B110	252.8	150.0	63.8	155.5	82.9	19.0	15.2	13.7
23	ANTIG01:N16-B3-1-2-1-1 x SS1	215.2	192.6	36.8	148.2	78.9	18.1	15.5	20.8
24	ANTIG01:N16-B3-1-2-1-2 x SS1	237.9	148.8	56.7	147.8	78.7	17.7	15.6	14.6
25	ANTIG01:N16-B1-5-1-1-1 x B5C2	235.9	116.6	43.0	131.8	70.2	20.7	15.3	16.2
26	ANTIG01:N16-B1-B-2-3-1 x B5C2	206.6	111.7	73.1	130.5	69.5	20.2	14.9	14.4
27	DKC66-23 (RM116)	274.9	221.4	85.8	194.0	103.4	16.9	15.3	12.0
28	DKC67-87 (RM117)	252.4	235.6	79.4	189.1	100.8	19.3	15.4	13.2
29	Pioneer 34F96 (RM110)	250.3	198.3	91.9	180.1	96.0	17.9	13.3	13.4
30	Garst 82H80GT/CB/LL	292.0	200.7	70.3	187.7	100.0	17.9	15.4	11.2
	CK mean	267.4	214.0	81.9	187.7	100.0	18.0	14.9	12.5
	Test mean	228.3	165.2	67.8	153.8	81.9	18.8	15.0	14.2
	CV%	12.6	16.9	20.9			7.1	6.0	15.0
	LSD 0.05	58.6	57.0	29.0			2.7	ns	4.3

Table 4. Days to pollen shed (DTP), plant height, ear height, and stalk lodging of testcrosses of advanced lines developed from ANTIG01:N16 under well-watered (WW) and drought conditions in Dumas (DU) and Halfway, Texas, 2009.

ENO	Hybrids	DTP		Plant ht., cm			Ear ht., cm			Stalk lodging, %		
		DU-	HF-	DU-	HF-	HF-	DU-	HF-	HF-	DU-	HF-	HFD-
		WW	WW	WW	WW	DRT	WW	WW	DRT	WW	WW	RT
1	ANTIG01:N16-B1-5-1-1 x B110	77	77	304	286	252	142	132	117	35	11	13
2	ANTIG01:N16-B1-5-1-1-2 x SS1	80	78	304	294	242	132	139	100	10	5	12
3	ANTIG01:N16-B1-B-1-1 x B110	74	75	291	288	260	143	128	134	59	22	12
4	ANTIG01:N16-B1-B-1-2 x B110	76	75	290	288	262	150	143	132	42	13	13
5	ANTIG01:N16-B1-B-1-1-1 x SS1	75	77	296	287	271	137	144	122	37	8	4
6	ANTIG01:N16-B1-B-1-2-1-1 x SS1	77	75	292	287	261	131	123	116	14	7	3
7	ANTIG01:N16-B1-B-1-2-2-1 x SS1	77	75	296	292	267	131	137	120	67	11	14
8	ANTIG01:N16-B1-B-2-1 x B110	76	75	272	283	255	143	145	126	34	11	5
9	ANTIG01:N16-B1-B-2-1-1-1 x SS1	77	74	299	280	258	139	132	143	8	13	1
10	ANTIG01:N16-B1-B-2-2 x B110	75	75	275	270	263	131	124	115	67	19	16
11	ANTIG01:N16-B1-B-2-2-1-1 x SS1	75	74	295	288	258	126	134	116	21	7	3
12	ANTIG01:N16-B1-B-2-2-2-1 x SS1	76	75	286	288	263	132	125	113	8	13	1
13	ANTIG01:N16-B1-B-2-3 x B110	75	75	267	283	241	137	132	113	12	20	7
14	ANTIG01:N16-B1-B-2-3-1-1 x SS1	75	75	280	295	255	121	137	109	28	7	5
15	ANTIG01:N16-B1-B-2-3-2-1 x SS1	76	76	293	285	259	148	121	113	17	4	4
16	ANTIG01:N16-B1-B-2-4 x B110	77	75	281	271	244	135	136	122	60	16	6
17	ANTIG01:N16-B1-B-2-4-1-1 x SS1	77	75	282	277	272	126	115	112	23	0	4
18	ANTIG01:N16-B1-B-2-4-2 x SS1	76	75	302	285	240	134	136	102	7	9	3
19	ANTIG01:N16-B3-1-1-1 x B110	76	78	297	276	258	142	138	128	24	5	15
20	ANTIG01:N16-B3-1-1-1-3 x SS1	79	76	304	277	259	133	123	108	13	6	17
21	ANTIG01:N16-B3-1-1-2 x B110	76	76	272	273	246	119	117	105	50	4	11
22	ANTIG01:N16-B3-1-2-1 x B110	76	75	283	264	254	124	133	115	42	6	13
23	ANTIG01:N16-B3-1-2-1-1 x SS1	76	77	292	286	252	126	118	112	17	5	9
24	ANTIG01:N16-B3-1-2-1-2 x SS1	75	78	291	265	250	126	123	105	22	4	11
25	ANTIG01:N16-B1-5-1-1-1 x B5C2	79	77	309	297	240	126	144	118	12	4	14
26	ANTIG01:N16-B1-B-2-3-1 x B5C2	79	77	285	279	261	150	134	140	26	21	10
27	DKC66-23 (RM116)	72	71	270	271	243	92	96	98	0	0	0
28	DKC67-87 (RM117)	75	72	277	279	248	114	109	104	0	0	0
29	Pioneer 34F96 (RM110)	73	71	265	248	221	105	86	83	0	0	1
30	Garst 82H80GT/CB/LL	70	73	288	289	268	110	102	102	0	0	1
	CK mean	73	72	275	272	245	105	98	97	0	0	1
	Test mean	76	75	288	281	254	130	127	115	25	8	8
	CV%	2	1	3	4	6	6	9	10	52	51	59
	LSD 0.05	3	1	18	ns	ns	17	24	31	27	9	23

Table 5. Aflatoxin levels in GEM-line testcrosses Mississippi State, MS and Corpus Christi, Texas in 2007 and 2008. This test used 26 Texas A&M AgriLife experimental and four commercial hybrids. The table shows only the testcrosses having GEM-lines as a parent. Pedigrees of inbred lines are abbreviated due to space limitation.

Hybrid	Aflatoxin (ppb)					Log (Aflatoxin)		
	MS-07	MS-08	CC-08	Mean	% of CK Mean	MS-07	MS-08	CC-08
B5C2 x DK888:N11-5	567.0	4006.7	181.0	1584.9	114.2	6.22	7.38	5.13
B7PR96AS-2 x Tx205	290.0	1833.3	152.0	758.4	54.7	5.67	7.41	4.80
CML25B6 x Tx205	263.0	1840.0	258.0	787.0	56.7	5.48	7.51	5.14
C273A6 x Tx205	617.0	506.7	265.0	462.9	33.4	6.19	6.21	5.47
C32B4 x TX025	236.0	706.7	245.0	395.9	28.5	5.19	6.50	5.46
B113 x CUBA117:S15-1	247.0	496.7	93.8	279.2	20.1	5.39	6.04	3.87
DK888:N11-5 x B110	307.0	476.7	111.0	298.2	21.5	5.69	6.03	4.66
DK888:N11-7 x SS2	253.0	656.7	152.0	353.9	25.5	5.34	6.42	4.91
C3S1B-3-3 x DK888:N11-7	390.0	7866.7	136.0	2797.6	201.6	5.97	8.92	4.74
SGP3:N1411a-1 x B110	404.0	2226.7	228.0	952.9	68.7	5.26	7.63	5.35
B5C2 x BR52051:N04-1	397.0	1636.7	40.5	691.4	49.8	5.66	7.02	3.50
BR52051:N04-1 x B7PR96AS-2	403.0	263.3	323.0	329.8	23.8	6.00	5.46	5.43
Tx205 x B110	236.0	843.3	335.0	471.4	34.0	4.80	6.71	5.73
Tx205 x S1W-1	260.0	286.7	285.0	277.2	20.0	5.56	5.52	5.54
BH8913RRYGCB	2400.0	5306.7	443.0	2716.6	195.8	7.78	8.42	5.97
DKC66-80	293.0	903.3	138.0	444.8	32.1	5.62	6.73	4.92
Garst 8288	390.0	453.3	433.0	425.4	30.7	5.92	5.96	5.51
P31B13	280.0	5453.3	155.0	1962.8	141.5	5.36	8.30	4.61
CK mean	840.8	3029.2	292.3	1387.4	100.0	6.17	7.4	5.3
Test mean	411.1	1547.8	186.6	715.2	51.5	5.37	6.6	4.8
CV%						18.60	13.03	18.90
LSD 0.05						1.39	1.22	1.27

Table 6. Total biomass of GEM-line testcrosses at Dumas and Halfway, Texas in 2009. The test had 40 entries. The table only shows the yield of the GEM-line-testcrosses and three commercial check hybrids. Yield was adjusted to 65% moisture. Pedigrees of the lines are abbreviated due to space limitation.

Hybrid	Biomass yield (tones/acre)			Percent of the check mean yield		
	Dumas	Halfway	Average	Dumas	Halfway	Average
AR01150:N04-D x SS1	27.94	30.80	29.4	80.1	102.0	90.4
AR01150:N04-F x SS1	31.31	28.75	30.0	89.8	95.3	92.4
AR01150:N04-G1 x SS1	32.44	33.63	33.0	93.0	111.4	101.6
AR01150:N04-G2 x SS1	34.71	31.71	33.2	99.5	105.1	102.2
BR52051:N04-1 x B110	31.59	31.92	31.8	90.6	105.8	97.7
BR52051:N04-1 x SS2	31.62	31.67	31.6	90.6	104.9	97.4
CUBA117:S15-1 x NS1	33.05	26.81	29.9	94.8	88.8	92.1
DK888:N11-5 x SS2	31.24	30.50	30.9	89.6	101.1	95.0
DK888:N11-7 x SS2	31.89	29.13	30.5	91.4	96.5	93.9
GUAT1/2 x B5C2BM1	27.13	26.59	26.9	77.8	88.1	82.7
GUAT-10/13 x SS1	33.00	30.92	32.0	94.6	102.5	98.3
GUAT209:N19-14/17A x SS1	34.74	30.32	32.5	99.6	100.5	100.1
GUAT209:N19-14/17B x SS1	32.91	28.71	30.8	94.4	95.1	94.8
SGP3 x SS2	35.04	31.96	33.5	100.4	105.9	103.1
SCRON2017 x SS2	35.48	24.86	30.2	101.7	82.4	92.8
Mycogen TMF2N804	31.43	29.45	30.4	90.1	97.6	93.7
DKC67-87	36.01	28.81	32.4	103.2	95.4	99.7
P31G96	36.61	32.28	34.4	105.0	106.9	106.0
Check mean	34.88	30.18	32.5	100.0	100.0	100.1
Test mean	31.15	29.49	30.3	89.3	97.7	93.3
CV%	5.78	8.52	7.2			22.0
LSD 0.05	3.64	5.08	4.4			13.4