# Breeding Stress Tolerant Corn For Food, Feed And Silage - Report of 2011 Corn Breeding Program Results

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**Collaborators**: Dr. Seth Murray, Assistant Professor, TAMU, College Station; Dr. Christian Nansen, Entomologist, Texas AgriLife Research, Lubbock; Dr. Paul Williams, USDA-ARS, Mississippi; and seed companies.


**March, 2012**

## Technical Report LB-AREC 2012-04

## Texas A&M AgriLife Research, Lubbock

**Final Report for TCPB Research**

**(January 1– December 6, 2011)**

**A. Project Tile**: Breeding stress tolerant corn for food, feed and silage

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**Cooperators:** Dr. Seth Murray, Assistant Professor, TAMU, College Station; Dr. Christian Nansen, Entomologist, Texas AgriLife Research, Lubbock; Dr. Paul Williams, USDA-ARS, Mississippie; and seed companies

**C. Objectives:**

Specific objectives are: (1) to develop inbred lines tolerant to drought/heat and resistant to earworm and mites through introgression of tropical corn germplasm; (2) to develop drought/heat tolerant and insect resistant and high yielding corn hybrids, (3) to identify low-aflatoxin and high-yielding hybrids from our multiple stress tolerant corn, and (4) to determine the optimum irrigation and plant population for new corn hybrids. We will also conduct state silage corn performance trials in the Texas High Plains.

**D. Research Activities and Major Accomplishments:**

**Adverse environments and poor seed production:** The year 2011 was a very challenging year for both corn research and production. The record drought stress, low temperature one week after planting (last two weeks of April and first few days of May), and prolonged high temperatures throughout the season posed various stresses for the corn plants. Three tests at Helms Farm in halfway were abandoned due to the problems in our drip irrigation system. In addition to the high temperatures and drought stress, corn earworm and fall armyworm pressure were very high in the breeding nursery. As a result, seed set in hand-pollinated nursery plots and isolation plots for hybrid seed production was very poor. Even with these challenges, we were able to advance hundreds of lines. Hybrid seeds were re-produced in the winter nursery.

**Yield trials:** A total of 20,000 small research plots were planted at Etter, Halfway, New Deal, Lubbock, Corpus Christi, College Station, and Weslaco. Inbred lines have been developed from the breeding. crosses ANTIGO01:N16, AR03056:N0902, BR52051:N04, CH05012:N12, CUBA164:S20, CUBA117:S15, DK888:N11, DK888:Na08f, DKXL380:S08a, FS8A(T):N11a, FS8A(T):N1801, GUAT209:N1925 SCROGP3:N2017, and SCROPG3:N1411a. About 100 testcrosses between GEM lines (developed in Lubbock) with public and licensed proprietary lines were evalauted for grain yield, CEW resistance, and drought tolerance in the Texas High Plains (Lubbock, Halfway, and Dumas) under well-watered and drought conditions and in the south-central Texas (College Station, Corpus Christi, Ganado, Uvalde, and Wharton).

The hybrids of the GEM lines developed from BR52051:N04, CUBA117:S15, DK888:N11 produced grain yield comprable to commercial hybrids (Table 1 and 2). These hybrids yield showed. The hybrids of the lines derived from BR52051:N04 and CUBA117:S15 also had excellent grain quality. Aflatoxin resistance of the GEM-line hybids were tested in the SERAT tests for aflatoxin and yield performance in 2011. The SERAT is a muti-state afaltoxin testing network. Exprimental hybrids from the public breeders in the Georgia, Mississippi and Texas are tested along with commercial check hybrids in multiple states. Each location usually use three reploication, and plants are inoculated with high aflatoxin producing strains of *A. flavus*. Two of our experimental hybrids Tx-WX11-4 and Tx-WX-11-9 had consistently low aflatoxin at College Station, TX and Starkville, MS in 2011 (Table 2). Tx-WX-11-4 is the testcross of a line developed from BR52051:N04 while Tx-WX-11-9 is the testcross of a line derived from and CUBA117:S15.

Inbred lines from ANTIG01:N16 have nice looking plants and excellent grain quality with low grain molds, however, these lines have a high ear placement. Their testcrosses shed pollens close to the hybrids with a relative muarity of 117 day and yield slightly lower than commercial checks. The hybrids of ANTIGO:N16 performed well under severe drought stress and hot enviroment (Table 3).

The brown midrib lines with the background of GUAT209:N1925 (*bm1*) and DK888:N11 (*bm3*) are being advanced to a higher generation and will be test for silage yield and quality in 2012.

Four testcrosses of GEM lines were included in the 2011 Texas State Silage Corn Performance Test in the High Plains. WXY10F is the testcross of a brwon midrib line that was developed from a breeding cross made with the GEM GUAT209:N19. WXY11C is the testcross of a line derived from BR52051:N04. WXY11D and and WXY11E are the testcrosses of a line from CUBA117:S15. WXY11C produced a forage yield of 35.7 tons/a, ranked second among 43 entries. Yield, agronomic data, and silage quality of these testcrosses and other commercial hybrids are shown in Tables 4. The hybrids of the GEM lines usually produce tall and robust plants. When grain yield is high, these hybrids are suitable for high tonnage and high quality silage corn production.

**Aflatoxin tests at Corpus Christi, Halfway, and Weslaco**: A tests of 50 hybrids were inoculated with A. *flavus*. Teosinte is an important genetic source to improve maize for abiotic and biotic stress tolerance. Testcrosses from teosinte-derived lines (teo-lines) have been observed in the field with ears having less mold growth than commercial hybrids. Forty-five testcrosses of the teo-lines and five commercial hybrids were tested in multiple locations. A randomized complete block design with two replications was used. Each plot consisted of two-rows, and size varied among locations. The plants were inoculated by spreading A. flavus colonized kernels between rows at Weslaco, or by injecting conidia solution into the silk channel. Ten inoculated ears per plot were harvested for aflatoxin analysis and ear traits. The remaining plants were combined for yield. The grain samples were used in the Vicam fluorometer assay for aflatoxin. Statistical analyses were performed in SAS. Testcrosses of the teo-lines yielded as high, or higher, than commercial hybrids across multiple locations and years. Some are also more resistant to aflatoxin accumulation than other hybrids. The majority of the testcrosses that are aflatoxin resistant also have yields that are not statistically different than the commercial checks. This finding was presented at the 2011 International Meeting of ASA-CAAS-SSSA Annual Meetings in San Antonio, TX on October 16-20, 2011 (Appendix 1).

**Breeding and testing silage corn:** I managed and conducted a state corn silage performance test with 35 entries at Halfway (29 commercial and 8 AgriLife experimental) and 43 entries (35 commercial and 8 AgriLife experimental hybrids) at the North Plains Research Field at Etter. The Etter test looked good while Halfway test was not uniform due to sloppy field and limited irrigation. The final report was published as technical report (Appendix 2) and is available online at Texas Crop Performance Test website (http://varietytesting.tamu.edu/corn/).

**E. Publications:**


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3. Wenwei Xu, Gary Odvody, and Paul Williams. Use of GEM Germplasm for Evaluation and Development of Drought Tolerance, Corn. ttp://www.public.iastate.edu/~usda-gem/Public_Reports/Yr_2011/Xu%20GEM%20Report.pdf. pp.7
4. Teresa A. Gaus, Wenwei Xu, andThomas Thompson. 2011. The role of corn silage in Texas' growing daiary industry. Progessive Dairyman. November 15, 2011. http://www.progressivedairymanmagazine.com.
5. Chen, J., J. Burke, W. Xu, and G. Burrow. 2011. Dissection of high temperature tolerance traits of maize. Maize Genetics Conference Abstracts. 53:P214.
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8. Ledbetter, K., T. Marek, and W. Xu. 2011. New AgriLife Research germplasm, irrigation management make a difference in corn production. AgriLife Today. Sep. 27, 2011. One page.
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10. Marek, T. H., W. Xu, Q. Xue, B. Bean, G. J. Michels, S. H. Amosson, J. Moorehead, N. P. Kenny, J. M. Sweeten, T. A. Howell, P. D. Colaizzi, and P. Gowda. 2011. 2010 North Plains Research Field 12-200 limited irrigation corn production study. Texas AgriLife Research-Amarillo. AREC 2011-12. 57 pages.
11. Marek, T. H., W. Xu, Q. Xue, G. J. Michels, and B. Bean. 2011. Potential to produce 200 bushels of corn on 12 inches of irrigation water. North Plains Water News. Dumas, TX. Spring 2011. 1 page.
12. Marek, T. H., W. Xu, Q. Xue, G. J. Michels, and B. W. Bean. 2011. Potential to produce 200 bushels of corn on 12 inches of irrigation water. Amarillo AREC Fact sheet.
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2011 International Annual Meeting Abstract. October 16-19, 2011. San Antonio, TX. CD-ROM 221-9.

14. Warburton, M. L., W. P. Williams, G. W. Windham, S. C. Murray, W. Xu, L. H. Hawkins, C. Daves, and B. Henry. 2011. Phenotypic characterization of a maize association mapping panel developed for the identification of *Aspergillus flavus* and aflatoxin accumulation resistance genes. ASA-CSSA-SSA 2011 International Annual Meetings. October 16-19, Santonio, TX. CD-ROM 91-8.
15. Xu, W., G. Odvody, P. Williams, and Y. Xue. 2011. New corn germplasm with improved stress tolerance and aflatoxin resistance. ASA-CSSA-SSA 2011 International Annual Meetings. October 16-19, San Antonio, TX. CD-ROM 91-7. 4.
16. Xu, W., G. Odvody, P. Williams, and Y. Xue. 2011. New corn germplasm with improved stress tolerance and aflatoxin reistsance. ASA-CSSA-SSA 2011 International Annual Meetings. October 16-19, Santonio, TX. CD-ROM 91-7.
17. Xu, W., T. H. Marek, Y. Yu, A. Cranmer, B. W. Bean, and D. Pietsch. 2011. 2011 State Silage Corn Performance Test on the Texas High Plains. Texas AgriLife Research and Extension-Lubbock Center Technical Report No.11-4. pp.8.
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20. Xue, Q., T. Marek, B. Bean, W. Xu, G. J. Michels, K. Jessup, and J. Becker. 2011. Physiological determination of yield in corn hybrids under limited irrigation in the Texas High Plains. Proceedings of ASA-CSSA-SSSA 2011 Annual Meetings. San Antonio, TX. 10/16-19/11. 1 page.
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22. Xue, Y., W. Xu, G. Odvody, and P. Williams. 2011. Breeding low-aflatoxin corn inbred lines. In Genetics of Maize Disease Workshop, February 20-23, 2011. Raleigh, NC.

Table 1. Grain yield (bu/a, adjusted to 15.5% moisture) of testcrosses of the lines develpped from CUBA117:S15 and DK888:N11 (entries 11, 12, and 13) under well-watered conditions at Etter and severe drought (DRT) conditions in Halfway (HF) and Lubbock (LB), Texas in 2011. This test had 50 entries.

| ENO | Hybrid | Etter | LBB-DRT1 | HF-DRT | LBB-DRT2 | Mean |
|---|---|---|---|---|---|---|
| 1 | C2B5BM1 x NS | 192 | 127 | 66 | 48 | 108 |
| 4 | C2A554-4 x SS | 159 | 92 | 133 | 43 | 107 |
| 6 | C25B76-2 x NS | 248 | 131 | 132 | 24 | 134 |
| 8 | C2A632-2 x NS | 205 | 125 | 111 | 43 | 121 |
| 11 | CUBA117:S15-1 x NS | 197 | 131 | 62 | 50 | 110 |
| 12 | DK888:N11-5 x SS | 282 | 104 | 67 | na | 151 |
| 13 | DK888:N11-7 x SS | 185 | 124 | 112 | 31 | 113 |
| 20 | B3C2B5-1 x NS | 220 | 97 | 139 | 49 | 126 |
| 22 | B3C2B5-4 x NS | 231 | 124 | 93 | 36 | 121 |
| 23 | B3C2B5-5 x NS | 223 | 107 | 96 | 33 | 115 |
| 25 | B3C2B5-7 x NS | 229 | 123 | 105 | 33 | 123 |
| 29 | B3C2B5-14 x NS | 207 | 132 | 110 | 38 | 122 |
| 30 | B3C2B5-15 x NS | 252 | 134 | 60 | 35 | 121 |
| 33 | B3C2B5-20 x NS | 232 | 148 | 109 | 21 | 128 |
| 34 | B3C2B5-23 x NS | 229 | 158 | 70 | 46 | 126 |
| 41 | S3C2B6 x NS | 260 | 127 | 101 | 33 | 130 |
| 43 | S3C2B8 x NS | 214 | 132 | 104 | 40 | 123 |
| 44 | S3C2B9 x NS | 209 | 156 | 86 | 33 | 121 |
| 45 | S3C2B10 x NS | 225 | 149 | 104 | 19 | 124 |
| 46 | BH8928VTTP (CK1) | 224 | 95 | 143 | 63 | 131 |
| 47 | DKC66-23 (CK2) | 241 | 122 | 61 | 25 | 112 |
| 48 | DKC67-87 (CK3) | 274 | 129 | 121 | 32 | 139 |
| 49 | P31G96 (CK4) | 251 | 136 | 104 | 52 | 136 |
| 50 | P33D49 (CK5) | 250 | 146 | 125 | 42 | 141 |
| | Test mean | 209 | 124 | 87 | 33 | 113 |
| | CV% | 13 | 14 | 25 | 33 | |
| | LSD 0.05 | 56 | 36 | 44 | 22 | |

Table 2. Aflatoxin (ppb) of the Southeastern Regional Aflatoxin Test (SERAT) at College Station, TX and Starkville, MS in 2011. Plants in both locations were inoculated with high aflatoxin producing strains of *A. flavus*. Experimental hybrid Tx-WX11-4 is the testcross of a line developed from BR52051:N04 while Tx-WX-11-9 is the testcross of a line derived from and CUBA117:S15.

| Hybrids | Aflatoxin (ppb) | | | | Grain yield (bu/a) | |
|---|---|---|---|---|---|---|
| | Starkville | | College Station | | College Station | |
| Tx-WX11-4 | 84 | a | 353 | ab | 138.6 | bcde |
| Tx-WX11-9 | 107 | a | 373 | a | 162.1 | a |
| P31G98 | 114 | a | 570 | ab | 160.8 | a |
| TAMU-7 | 120 | a | 463 | ab | 127.8 | def |
| TAMU-6 | 151 | a | 860 | ab | 131.3 | cde |
| TAMU-5 | 152 | a | 340 | a | 143.5 | abcde |
| TAMU-1 | 159 | a | 980 | ab | 130.1 | cdef |
| DK697 | 159 | a | 917 | ab | 161.7 | a |
| TAMU-2 | 226 | a | 513 | ab | 139.1 | bcde |
| Tx-WX11-1 | 243 | a | 737 | ab | 144.4 | abcd |
| GT-1 | 270 | a | 757 | ab | 113.2 | gf |
| GT-4 | 289 | a | 847 | ab | 114.8 | gf |
| Tx-WX11-8 | 303 | ab | 817 | ab | 125.1 | def |
| GT-3 | 310 | ab | 750 | ab | 140.1 | bcde |
| Tx-WX11-5 | 354 | ab | 830 | ab | 148.8 | abc |
| Tx-WX11-7 | 388 | ab | 853 | ab | 105.8 | g |
| GT-2 | 406 | ab | 860 | ab | 84.5 | h |
| TAMU-2 | 447 | ab | 1250 | b | 138.9 | bcde |
| GT-5 | 520 | b | 1267 | b | 129.4 | cdef |
| TAMU-3 | 565 | b | 943 | ab | 124.0 | efg |
| P31P41 | 826 | bc | 697 | ab | 158.1 | a |
| Tx-WX11-3 | 1117 | bc | 693 | ab | 153.5 | ab |
| Tx-WX11-2 | 1599 | bc | 1057 | ab | 141.2 | bcde |
| Tx-WX11-6 | 3443 | c | 1130 | ab | 142.6 | abcde |

Table 3. Days to pollen shed, plant and ear height, and grain yield (bu/a) of testcrosses of the lines develpped from ANTIG01:N16 at Etter and Halfway, Texas in 2010 and 2011. The 2011 test at Halfway experienced severe heat and drought stress.

| Pedigree | Days to pollen | | Grain yield-2010 | | Grain yield -2011 | |
|---|---|---|---|---|---|---|
| | Etter | Halfway | Etter | Halfway | Etter | Halfway |
| ANTIGO1 x SS3 | 72 | 71 | 163.8 | 205.9 | 170.4 | 135.6 |
| ANTIGO3 x SS3 | 72 | 69 | 186.2 | 219.3 | 166.7 | 123.2 |
| ANTIGO4 x SS3 | 73 | 69 | 192.4 | 214.5 | 181.0 | 132.3 |
| ANTIGO5 x SS3 | 73 | 70 | 226.1 | 207.2 | 195.0 | 121.5 |
| ANTIGO6 x SS3 | 73 | 70 | 198.1 | 206.6 | 179.8 | 118.5 |
| ANTIGO7 x SS3 | 71 | 69 | 157.7 | 215.9 | 129.5 | 109.1 |
| ANTIGO8 x SS3 | 71 | 71 | 185.6 | 237.9 | 133.4 | 102.5 |
| ANTIGO9 x SS3 | 72 | 67 | 179.0 | 228.6 | 139.8 | 145.4 |
| ANTIGO11 x SS3 | 71 | 68 | 182.0 | 234.6 | 141.7 | 114.2 |
| ANTIGO13 x SS3 | 71 | 70 | 155.3 | 227.4 | 165.1 | 152.5 |
| ANTIGO14 x SS3 | 71 | 70 | 171.2 | 227.4 | 154.0 | 110.9 |
| ANTIGO15 x SS3 | 71 | 70 | 187.2 | 222.6 | 122.7 | 137.1 |
| ANTIGO17 x SS3 | 73 | 70 | 179.3 | 225.1 | 151.3 | 133.6 |
| ANTIGO19 x SS3 | 73 | 71 | 186.6 | 212.6 | 161.2 | 148.2 |
| DKC66-23 (RM116) | 66 | 65 | 250.6 | 249.0 | 185.1 | 53.6 |
| DKC67-87 (RM117) | 70 | 67 | 245.8 | 249.6 | 241.0 | 127.4 |
| Pioneer 34F96 (RM110) | 69 | 64 | 229.4 | 215.3 | 230.2 | 141.4 |
| 82H80GT/CB/LL | 69 | 68 | 249.0 | 243.6 | 204.1 | 127.5 |
| Testcross mean | 72 | 69 | 182.2 | 220.4 | 150.1 | 126.7 |
| Test mean | 71 | 69 | 195.9 | 224.6 | 161.0 | 124.3 |
| CK mean | 69 | 66 | 243.7 | 239.4 | 215.1 | 112.4 |
| CV% | 1 | 2 | 11.1 | 5.1 | 16.4 | 13.1 |
| LSD 0.05 | 1 | 4 | 49.5 | 24.4 | 54.5 | 33.8 |

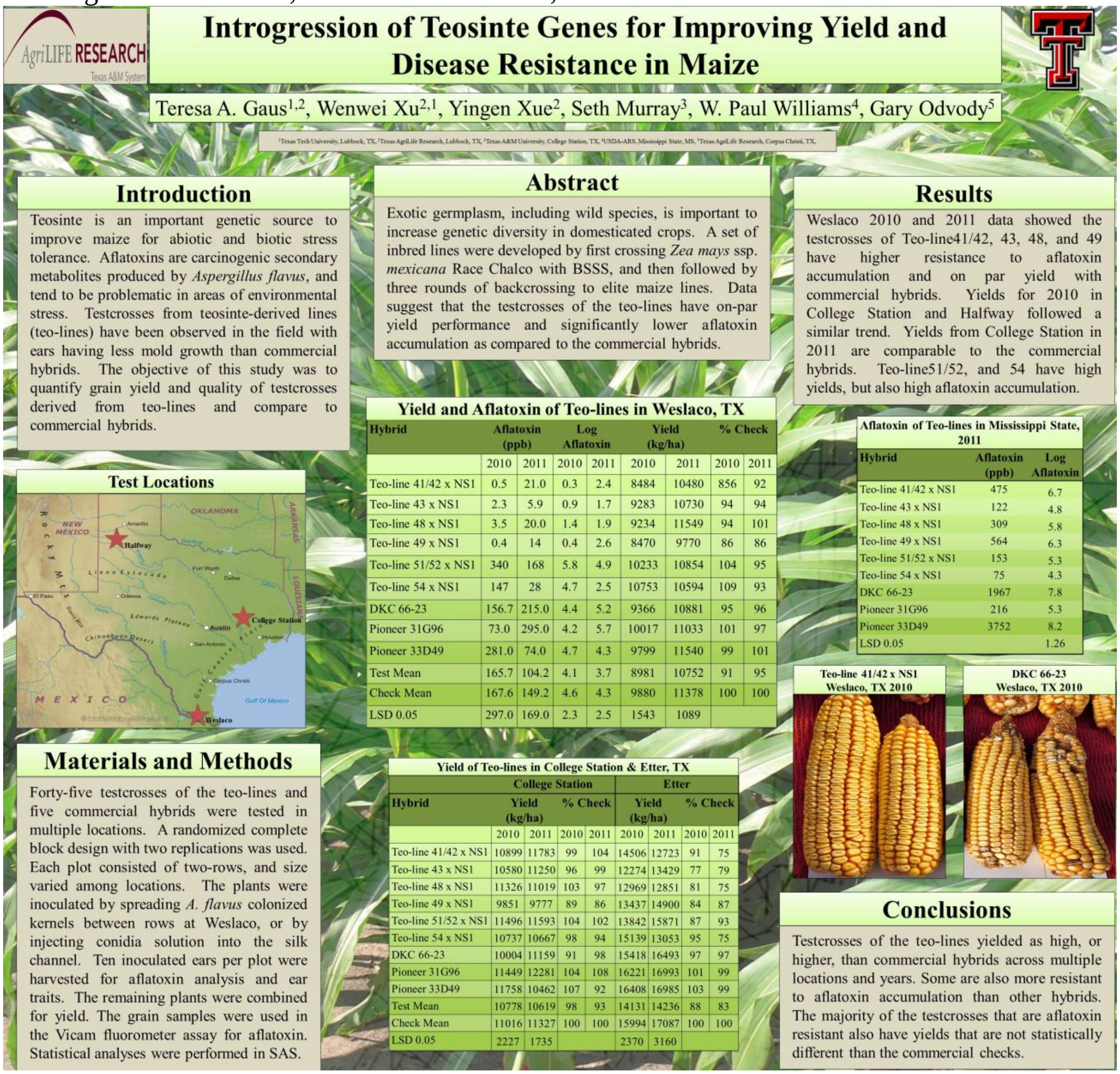
SS3 is a proprietary stiff stalk tester line.

Table 4. Means of forage yield adjusted to 65% moisture and agronomic traits of the State Silage Corn Performance Test at Etter, Texas in 2011. Four Texas A&M experimental hybrids (WXY10F, WXY11C, WXY11D, and WXY11E) have GEM germplasm. WXY10F is the testcross of a brown midrib line that was developed from a breeding cross made with the GUAT209:N19. WXY11C is the testcross of a line derived from BR52051:N04. WXY11D and and WXY11E are the testcrosses of a line from CUBA117:S15.

| Hybrid | Company | Days to anthesis | Plant ht., cm | Ear ht., cm | Moist % | Yield Tons/ac | Yield rank |
|---|---|---|---|---|---|---|---|
| TMF2L872 | Mycogen | 79.0 | 306 | 127.7 | 68.3 | 33.26 | 21 |
| T20911 | Mycogen | 78.0 | 307 | 123.3 | 66.3 | 35.35 | 4 |
| F2F714 | Mycogen | 77.0 | 311 | 130.7 | 64.3 | 29.61 | 41 |
| F2F622 | Mycogen | 74.7 | 296 | 118.0 | 63.0 | 28.88 | 42 |
| GAX-6152 | Golden Acres | 74.7 | 271 | 103.7 | 66.0 | 31.48 | 35 |
| 28V71 | Golden Acres | 75.3 | 287 | 107.0 | 62.1 | 33.23 | 22 |
| 28V81 | Golden Acres | 74.7 | 268 | 117.0 | 63.9 | 35.08 | 6 |
| 28Z47 | Golden Acres | 77.0 | 316 | 128.0 | 65.3 | 35.48 | 3 |
| CF 6120 RR | Golden Acres | 79.7 | 309 | 136.3 | 68.8 | 33.94 | 13 |
| CF 6126 GT | Golden Acres | 79.7 | 301 | 126.7 | 69.8 | 31.89 | 32 |
| BH 8895 VTTP | B-H Genetics | 76.0 | 281 | 101.3 | 63.9 | 30.46 | 40 |
| BH 9018 VTTP | B-H Genetics | 77.0 | 278 | 109.0 | 60.0 | 34.95 | 7 |
| BH 8719 RR/HXT | B-H Genetics | 77.0 | 293 | 131.0 | 66.1 | 32.44 | 28 |
| X11152 VTTP | B-H Genetics | 74.7 | 271 | 103.3 | 65.6 | 34.84 | 9 |
| X10065 VT3 | B-H Genetics | 72.7 | 257 | 102.3 | 62.3 | 33.40 | 18 |
| X10080 GT | B-H Genetics | 80.3 | 281 | 111.7 | 64.5 | 33.62 | 15 |
| XP 8711 | B-H Genetics | 76.0 | 292 | 104.7 | 63.5 | 32.43 | 29 |
| BH 8860 GT | B-H Genetics | 77.0 | 288 | 111.3 | 59.0 | 33.07 | 23 |
| X8021 | B-H Genetics | 78.0 | 289 | 108.0 | 63.8 | 33.32 | 20 |
| X10110GTBT11 | B-H Genetics | 75.3 | 284 | 121.0 | 62.1 | 32.93 | 24 |
| DKC 67-88 | Monsanto | 77.0 | 288 | 123.3 | 61.2 | 35.13 | 5 |
| DKC 64-69 | Monsanto | 74.0 | 278 | 100.7 | 62.7 | 30.72 | 39 |
| Integra 9650 | Wilbur-Ellis | 76.0 | 300 | 114.7 | 62.6 | 33.57 | 16 |
| Integra 9682 | Wilbur-Ellis | 78.0 | 296 | 128.3 | 67.2 | 34.77 | 10 |
| D56VP69 | DynaGro | 76.0 | 270 | 106.7 | 61.0 | 34.36 | 12 |
| V5683 VT3 | DynaGro | 79.7 | 287 | 108.7 | 63.1 | 36.19 | 1 |
| CX 11615 | DynaGro | 76.0 | 286 | 103.3 | 64.2 | 30.96 | 37 |
| CX 11417 | DynaGro | 74.7 | 276 | 110.0 | 64.8 | 31.75 | 34 |
| 70R50 | Blue River | 72.7 | 260 | 93.3 | 60.4 | 28.25 | 43 |
| 71M36 | Blue River | 74.7 | 287 | 115.7 | 65.5 | 32.78 | 25 |
| 73B33 | Blue River | 76.0 | 288 | 104.3 | 64.9 | 32.76 | 26 |
| 76H50 | Blue River | 77.0 | 272 | 105.3 | 64.4 | 33.56 | 17 |
| WXY10D | Texas A&M | 78.0 | 294 | 131.3 | 69.5 | 34.44 | 11 |
| WXY10F | Texas A&M | 79.0 | 297 | 116.3 | 66.5 | 31.11 | 36 |
| WXY11D | Texas A&M | 77.0 | 274 | 121.7 | 63.0 | 34.94 | 8 |

| Hybrid | Company | Days to anthesis | Plant ht., cm | Ear ht., cm | Moist % | Yield Tones/ac | Yield rank |
|---|---|---|---|---|---|---|---|
| WXY11A | Texas A&M | 77.0 | 289 | 117.3 | 67.7 | 32.12 | 31 |
| WXY11B | Texas A&M | 77.0 | 293 | 118.0 | 67.8 | 33.33 | 19 |
| WXY11C | Texas A&M | 77.0 | 301 | 129.0 | 65.2 | 35.66 | 2 |
| WXY11D | Texas A&M | 74.7 | 283 | 106.7 | 63.5 | 31.83 | 33 |
| WXY11E | Texas A&M | 76.0 | 279 | 105.3 | 64.0 | 32.66 | 27 |
| | | | | | | | |
| 17254 | Triumph | 74.7 | 292 | 110.7 | 66.2 | 33.72 | 14 |
| 2288H | Triumph | 81.0 | 302 | 127.0 | 68.2 | 30.89 | 38 |
| 1956H | Triumph | 78.0 | 294 | 122.0 | 64.5 | 32.24 | 30 |
| | | | | | | | |
| Test mean | | 76.6 | 288 | 114.9 | 64.6 | 32.96 | |
| CV% | | 1.7 | 4.3 | 11.6 | 3.0 | 6.85 | |
| LSD 0.05 | | 2.2 | 19.9 | 21.6 | 3.1 | 3.66 | |

Appendix 1. A presented at the 2011 International Meeting of ASA-CAAS-SSSA Annual Meetings in San Antonio, TX on October 16-20, 2011.



AgriLIFE RESEARCH
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# Introgression of Teosinte Genes for Improving Yield and Disease Resistance in Maize

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## Introduction

Teosinte is an important genetic source to improve maize for abiotic and biotic stress tolerance. Aflatoxins are carcinogenic secondary metabolites produced by *Aspergillus flavus*, and tend to be problematic in areas of environmental stress. Testcrosses from teosinte-derived lines (teo-lines) have been observed in the field with ears having less mold growth than commercial hybrids. The objective of this study was to quantify grain yield and quality of testcrosses derived from teo-lines and compare to commercial hybrids.

## Abstract

Exotic germplasm, including wild species, is important to increase genetic diversity in domesticated crops. A set of inbred lines were developed by first crossing *Zea mays* ssp. *mexicana* Race Chalco with BSSS, and then followed by three rounds of backcrossing to elite maize lines. Data suggest that the testcrosses of the teo-lines have on-par yield performance and significantly lower aflatoxin accumulation as compared to the commercial hybrids.

## Results

Weslaco 2010 and 2011 data showed the testcrosses of Teo-line41/42, 43, 48, and 49 have higher resistance to aflatoxin accumulation and on par yield with commercial hybrids. Yields for 2010 in College Station and Halfway followed a similar trend. Yields from College Station in 2011 are comparable to the commercial hybrids. Teo-line51/52, and 54 have high yields, but also high aflatoxin accumulation.

## Test Locations



**Yield and Aflatoxin of Teo-lines in Weslaco, TX**

| Hybrid | Aflatoxin (ppb) | | Log Aflatoxin | | Yield (kg/ha) | | % Check | |
|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 |
| Teo-line 41/42 x NS1 | 0.5 | 21.0 | 0.3 | 2.4 | 8484 | 10480 | 856 | 92 |
| Teo-line 43 x NS1 | 2.3 | 5.9 | 0.9 | 1.7 | 9283 | 10730 | 94 | 94 |
| Teo-line 48 x NS1 | 3.5 | 20.0 | 1.4 | 1.9 | 9234 | 11549 | 94 | 101 |
| Teo-line 49 x NS1 | 0.4 | 14 | 0.4 | 2.6 | 8470 | 9770 | 86 | 86 |
| Teo-line 51/52 x NS1 | 340 | 168 | 5.8 | 4.9 | 10233 | 10854 | 104 | 95 |
| Teo-line 54 x NS1 | 147 | 28 | 4.7 | 2.5 | 10753 | 10594 | 109 | 93 |
| DKC 66-23 | 156.7 | 215.0 | 4.4 | 5.2 | 9366 | 10881 | 95 | 96 |
| Pioneer 31G96 | 73.0 | 295.0 | 4.2 | 5.7 | 10017 | 11033 | 101 | 97 |
| Pioneer 33D49 | 281.0 | 74.0 | 4.7 | 4.3 | 9799 | 11540 | 99 | 101 |
| Test Mean | 165.7 | 104.2 | 4.1 | 3.7 | 8981 | 10752 | 91 | 95 |
| Check Mean | 167.6 | 149.2 | 4.6 | 4.3 | 9880 | 11378 | 100 | 100 |
| LSD 0.05 | 297.0 | 169.0 | 2.3 | 2.5 | 1543 | 1089 | | |

**Aflatoxin of Teo-lines in Mississippi State, 2011**

| Hybrid | Aflatoxin (ppb) | Log Aflatoxin |
|---|---|---|
| Teo-line 41/42 x NS1 | 475 | 6.7 |
| Teo-line 43 x NS1 | 122 | 4.8 |
| Teo-line 48 x NS1 | 309 | 5.8 |
| Teo-line 49 x NS1 | 564 | 6.3 |
| Teo-line 51/52 x NS1 | 153 | 5.3 |
| Teo-line 54 x NS1 | 75 | 4.3 |
| DKC 66-23 | 1967 | 7.8 |
| Pioneer 31G96 | 216 | 5.3 |
| Pioneer 33D49 | 3752 | 8.2 |
| LSD 0.05 | | 1.26 |

Teo-line 41/42 x NS1
Weslaco, TX 2010

DKC 66-23
Weslaco, TX 2010

## Materials and Methods

Forty-five testcrosses of the teo-lines and five commercial hybrids were tested in multiple locations. A randomized complete block design with two replications was used. Each plot consisted of two-rows, and size varied among locations. The plants were inoculated by spreading *A. flavus* colonized kernels between rows at Weslaco, or by injecting conidia solution into the silk channel. Ten inoculated ears per plot were harvested for aflatoxin analysis and ear traits. The remaining plants were combined for yield. The grain samples were used in the Vicam fluorometer assay for aflatoxin. Statistical analyses were performed in SAS.

**Yield of Teo-lines in College Station & Etter, TX**

| Hybrid | College Station Yield (kg/ha) | | College Station % Check | | Etter Yield (kg/ha) | | Etter % Check | |
|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 |
| Teo-line 41/42 x NS1 | 10899 | 11783 | 99 | 104 | 14506 | 12723 | 91 | 75 |
| Teo-line 43 x NS1 | 10580 | 11250 | 96 | 99 | 12274 | 13429 | 77 | 79 |
| Teo-line 48 x NS1 | 11326 | 11019 | 103 | 97 | 12969 | 12851 | 81 | 75 |
| Teo-line 49 x NS1 | 9851 | 9777 | 89 | 86 | 13437 | 14900 | 84 | 87 |
| Teo-line 51/52 x NS1 | 11496 | 11593 | 104 | 102 | 13842 | 15871 | 87 | 93 |
| Teo-line 54 x NS1 | 10737 | 10667 | 98 | 94 | 15139 | 13053 | 95 | 75 |
| DKC 66-23 | 10004 | 11159 | 91 | 98 | 15418 | 16493 | 97 | 97 |
| Pioneer 31G96 | 11449 | 12281 | 104 | 108 | 16221 | 16993 | 101 | 99 |
| Pioneer 33D49 | 11758 | 10462 | 107 | 92 | 16408 | 16985 | 103 | 99 |
| Test Mean | 10778 | 10619 | 98 | 93 | 14131 | 14236 | 88 | 83 |
| Check Mean | 11016 | 11327 | 100 | 100 | 15994 | 17087 | 100 | 100 |
| LSD 0.05 | 2227 | 1735 | | | 2370 | 3160 | | |

## Conclusions

Testcrosses of the teo-lines yielded as high, or higher, than commercial hybrids across multiple locations and years. Some are also more resistant to aflatoxin accumulation than other hybrids. The majority of the testcrosses that are aflatoxin resistant also have yields that are not statistically different than the commercial checks.

Appendix 2. 2011 State Silage Corn Performance Test on the Teas High Plains.

# 2011 State Silage Corn Performance Test on the Texas High Plains

Wenwei Xu[1], Thomas Marek[2], Yongtao Yu[3], Andy Cranmer[4], Brent Bean[5], and Dennis Pietsch[6]

## Introduction

Silage corn production is an important part of the economy in Texas High Plains. In 2010, Texas planted a total of 2.3 million acres of corn for both grain and silage, and harvested 140,000 acres for silage with an average silage yield of 18.0 tons per acre (USDA National Agricultural Statistical Services, www.nass.usda.gov). Most of the silage corn in Texas is grown on the High Plains where a number of dairies and cattle feedlots are located. The Texas State Silage Corn Performance Test in the High Plains was initiated in 2007, and has been conducted at the North Plains Research Field at Etter and the Texas AgriLife Research Station at Halfway (Xu et al, 2007; 2009, 2010). Commercial seed companies have an opportunity to enter hybrids at either or both test sites on a fee basis. To our knowledge, this is the only public field testing available on the Texas High Plains. Our goal is to provide producers with timely and unbiased production information on yield, quality, and agronomic traits.

## 2011 State Silage Corn Performance Test at Etter

**Field operation**: The Texas Panhandle test was conducted under a center pivot system at the Texas AgriLife North Plains Research Field near Etter. It involved 35 commercial hybrids and seven experimental hybrids from the Texas AgriLife Research corn breeding program located in Lubbock (Table 1). Hybrids F2F622 and F2F714 contain the brown midrib trait. This test used a randomized complete block design with three replications, four-row plots, 18 feet in length, a 30-inch row spacing, and 2-foot alleys. The test was planted on April 29 and harvested on September 3, 2011. Granular urea and mono-ammonium phosphate were broadcast on March 21 at the rate of 336 lbs N/ac and 157 lbs P/ac ($P_2O_5$). Fertilizers were incorporated into the soil by disking twice. Seedbeds were listed on April 11 using a lister-bottom plow. Rows were concentric to the pivot tracks, but the plots were generally oriented with a north to south direction. The previous crop was wheat, followed by summer fallow. A mix of Bicep II Magnum at the rate of 2.1 qt./ac and Balance Flex at the rate of 3 oz./ac was applied on May 4, 2011, and incorporated into soil by using a rolling cultivator. Lorsban 15G was applied at 6.5 lbs/ac at planting to control corn rootworm. At the three-leaf stage, seedlings were hand-thinned to a uniform target population of 32,912 plants/a. Due to the lack of seasonal rainfall and limited startup soil moisture, the field was irrigated prior to planting and irrigation was applied throughout the season in a total of 20 irrigation events. A total of 34.3 acre-inches water was pumped from planting to harvest with effective irrigation computed at 30.8 inches due to the abnormally intense and sustained meteorological conditions. In-season rainfall only totaled 2.4 inches with effective crop rainfall being computed as 0.8 inches. Seasonal irrigation timing and management was maintained at no more than a 55% depletion level of field capacity between irrigations to prevent water stress.

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**Texas AgriLife Research and Extension-Lubbock Center Technical Report No. 11-4.**

Data was recorded on stand, flowering dates, plant and ear height, root and stalk lodging, and moisture content at harvest. The two center rows of each plot were harvested on September 3 (average milk line being at 50%) using a John Deere 5200 small-plot silage chopper equipped with a Hagie silage plot weighing system. Plants were cut 5 inches above the ground surface. Approximately 2 lbs of a chopped sub-sample were collected from each plot, weighed for fresh weight, dried at $50^0$C, weighed for dry weight, and then analyzed for silage quality using NIR methods by the Dairy One Forage Lab (Ithaca, NY). The moisture content was calculated by using the fresh and dry weight of the sub-samples.

**Results:** Weather during the 2011 crop season was highly unusual: consistently windy, cool from planting to early-May, hot from late-May through harvest, and very low rainfall during the season. The cold and windy conditions lasted several days after planting, and as a result, plants in most plots were below the target population of 32,912 plants per acre.

Most hybrids had a reported relative maturity of 116-118 days. The average day from planting to pollen shedding was 77 days. A few hybrids flowered much earlier or later (Table 1). Plant height ranged from 8.4 ft to 10.4 ft. Stalk and root lodging at the harvest time was either zero or negligible, and therefore, not reported.

Forage yields of the 43 hybrids tested at the Etter location differed significantly, ranging from 28.3 to 36.2 tons/ac, with an average of 33.0 tons/ac at the adjusted 65% moisture level. The top five yielding hybrids were DynaGro V5683 VT3 (36.2 tons/ac), Texas AgriLife WXY11C (35.7 tons/ac), Golden Acres 28Z47 (35.1 tons/ac), Mycogen T20911 (35.4 tons/ac), and Monsanto DKC67-88 (35.1 tons/ac). But no hybrids yielded significantly higher than the test mean. Two hybrids (Blue River 70R50 and Mycogen F2F622) yielded significantly lower than the test mean, primarily due to lower plant counts per plot.

The whole plant moisture at harvest was 64.6% ranging from 59.0% (BH8860GT) to 69.5% (CF6126 GT). The low C.V. values of 6.98% for forage yield and 3.0% for forage moisture indicated that this was, in general, a good and uniform test.

Silage quality was assayed with NIR. Most of the quality traits were significantly different among the entries (Table 2). Nutritionists use different quality traits depending on their needs, but TDN and IVTD24 are commonly used to represent forage digestibility. In this test, IVTD24 values ranged from 69.67% to 82.33% with an average of 76.7%. Mycogen F2F714 is a brown midrib silage hybrid and had the highest IVTD24 value among the 43 hybrids. A high value of TDN and IVTD24 means higher digestibility per ton of silage. Digestibility of corn silage is highly correlated to the amount of grain produced and chemical composition of stalks. A good silage hybrid should have high values in the tonnage, protein, starch, and digestibility and low values in ADF, NDF, and lignin.

### 2011 State Silage Corn Performance Test at Halfway

This test was conducted under a center pivot system field at the Texas AgriLife Research Station at Halfway and had 27 commercial hybrids and 8 experimental hybrids from the Texas AgriLife Research corn breeding program located in Lubbock. Design and data collection was similar to the Etter test. Unfortunately, the test plots were located in a sloped area of the center pivot. The extremely hot weather and low well capacity lead to uneven plant growth and development. After the test was harvested and data analyzed, it was determined that there were confounding factors from the data and it was subsequently decided to not publish the results because of these impacts.

These results are available at the State Crop Performance Test Program (http://varietytesting.tamu.edu) and the Texas AgriLife Research Lubbock Center websites (http://lubbock.tamu.edu). These results will help producers, Extension specialists and consultants select commercial hybrids best suited for the Texas High Plains.

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Table 1. Means of forage yield adjusted to 65% moisture and agronomic traits of the State Silage Corn Performance Test at Etter, Texas in 2011.

| ENO | Hybrid | Company | RM | Trait | Stand % | Days to anthesis | Plant ht., in | Ear ht. in | Moist % | Yield tons/ac | % Test mean | Yield rank | Duncan's test |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TMF2L872 | Mycogen | 119 | HX1/RR | 80.1 | 79.0 | 120.6 | 50.3 | 68.3 | 33.3 | 100.9 | 21 | a-j |
| 2 | T20911 | Mycogen | 118 | HX1/RR | 82.6 | 78.0 | 120.7 | 48.6 | 66.3 | 35.4 | 107.3 | 4 | a-d |
| 3 | F2F714 | Mycogen | 112 | HXT/RR/BMR | 90.2 | 77.0 | 122.6 | 51.4 | 64.3 | 29.6 | 89.9 | 41 | j-l |
| 4 | F2F622 | Mycogen | 110 | HXT/RR/BMR | 83.8 | 74.7 | 116.7 | 46.5 | 63.0 | 28.9 | 87.6 | 42 | kl |
| 5 | GAX-6152 | Golden Acres | 118 | VT3P | 91.7 | 74.7 | 106.8 | 40.8 | 66.0 | 31.5 | 95.5 | 35 | e-l |
| 6 | 28V71 | Golden Acres | 117 | VT3P | 81.1 | 75.3 | 113.0 | 42.1 | 62.1 | 33.2 | 100.8 | 22 | a-j |
| 7 | 28V81 | Golden Acres | 118 | VT3P | 76.3 | 74.7 | 105.4 | 46.1 | 63.9 | 35.1 | 106.4 | 6 | a-e |
| 8 | 28Z47 | Golden Acres | 118 | RR | 91.4 | 77.0 | 124.4 | 50.4 | 65.3 | 35.5 | 107.7 | 3 | a-c |
| 9 | CF 6120 RR | Golden Acres | 122 | RR | 79.5 | 79.7 | 121.7 | 53.7 | 68.8 | 33.9 | 103.0 | 13 | a-i |
| 10 | CF 6126 GT | Golden Acres | 120 | GT | 79.8 | 79.7 | 118.4 | 49.9 | 69.8 | 31.9 | 96.8 | 32 | c-l |
| 11 | BH 8895 VTTP | B-H Genetics | 118 | GENVT3P | 84.6 | 76.0 | 110.5 | 39.9 | 63.9 | 30.5 | 92.4 | 40 | i-l |
| 12 | BH 9018 VTTP | B-H Genetics | 119 | GENVT3P | 87.1 | 77.0 | 109.3 | 42.9 | 60.0 | 35.0 | 106.0 | 7 | a-e |
| 13 | BH 8719 RR/HXT | B-H Genetics | 117 | RR/HXT/LL | 82.1 | 77.0 | 115.2 | 51.6 | 66.1 | 32.4 | 98.4 | 28 | b-k |
| 14 | X11152 VTTP | B-H Genetics | 117 | GENVT3P | 83.8 | 74.7 | 106.7 | 40.7 | 65.6 | 34.8 | 105.7 | 9 | a-e |
| 15 | X10065 VT3 | B-H Genetics | 116 | VT3 | 97.0 | 72.7 | 101.1 | 40.3 | 62.3 | 33.4 | 101.3 | 18 | a-i |
| 16 | X10080 GT | B-H Genetics | 115 | GT | 83.6 | 80.3 | 110.6 | 44.0 | 64.5 | 33.6 | 102.0 | 15 | a-i |
| 17 | XP 8711 | B-H Genetics | 116 | NONE | 90.4 | 76.0 | 114.8 | 41.2 | 63.5 | 32.4 | 98.4 | 29 | b-k |
| 18 | BH 8860 GT | B-H Genetics | 116 | GT | 88.4 | 77.0 | 113.4 | 43.8 | 59.0 | 33.1 | 100.3 | 23 | a-j |
| 19 | X8021 | B-H Genetics | 115 | None | 91.4 | 78.0 | 113.8 | 42.5 | 63.8 | 33.3 | 101.1 | 20 | a-i |
| 20 | X10110GTBT11 | B-H Genetics | 116 | GT/CB/LL | 88.6 | 75.3 | 111.9 | 47.6 | 62.1 | 32.9 | 99.9 | 24 | a-j |
| 21 | DKC 67-88 | Monsanto | 117 | GENVT3P | 92.7 | 77.0 | 113.5 | 48.6 | 61.2 | 35.1 | 106.6 | 5 | a-e |
| 22 | DKC 64-69 | Monsanto | 114 | VT3 | 93.4 | 74.0 | 109.6 | 39.6 | 62.7 | 30.7 | 93.2 | 39 | h-l |
| 23 | Integra 9650 | Wilbur-Ellis | 115 | VTPRO | 97.2 | 76.0 | 118.2 | 45.1 | 62.6 | 33.6 | 101.8 | 16 | a-i |
| 24 | Integra 9682 | Wilbur-Ellis | 118 | VT3 | 72.5 | 78.0 | 116.4 | 50.5 | 67.2 | 34.8 | 105.5 | 10 | a-f |
| 25 | D56VP69 | DynaGro | 116 | RR/CB/CRW | 92.2 | 76.0 | 106.2 | 42.0 | 61.0 | 34.4 | 104.3 | 12 | a-h |

Table 1. Means of forage yield adjusted to 65% moisture and agronomic traits of the State Silage Corn Performance Test at Etter, Texas in 2011 (continued).

| ENO | Hybrid | Company | RM | Trait | Stand % | Days to anthesis | Plant ht., in | Ear ht., in | Moist % | Yield Tons/ac | % Test mean | Yield rank | Duncan's test |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | V5683 VT3 | DynaGro | 116 | RR/CB/CRW | 85.4 | 79.7 | 113.1 | 42.8 | 63.1 | 36.2 | 109.8 | 1 | a |
| 27 | CX 11615 | DynaGro | 115 | GT/CB | 89.4 | 76.0 | 112.6 | 40.7 | 64.2 | 31.0 | 93.9 | 37 | g-l |
| 28 | CX 11417 | DynaGro | 117 | RR/CB/CRW | 80.6 | 74.7 | 108.8 | 43.3 | 64.8 | 31.8 | 96.3 | 34 | d-l |
| 29 | 70R50 | Blue River | 114 | None | 78.0 | 72.7 | 102.4 | 36.7 | 60.4 | 28.3 | 85.7 | 43 | l |
| 30 | 71M36 | Blue River | 114 | None | 82.1 | 74.7 | 113.0 | 45.5 | 65.5 | 32.8 | 99.4 | 25 | a-j |
| 31 | 73B33 | Blue River | 115 | None | 91.4 | 76.0 | 113.5 | 41.1 | 64.9 | 32.8 | 99.4 | 26 | a-j |
| 32 | 76H50 | Blue River | 115 | None | 90.4 | 77.0 | 107.1 | 41.5 | 64.4 | 33.6 | 101.8 | 17 | a-i |
| 33 | WXY10D | TX AgriLife | | None | 79.8 | 78.0 | 115.7 | 51.7 | 69.5 | 34.4 | 104.5 | 11 | a-g |
| 34 | WXY10F | TX AgriLife | | None | 75.3 | 79.0 | 117.1 | 45.8 | 66.5 | 31.1 | 94.4 | 36 | f-l |
| 35 | WXY11D | TX AgriLife | | None | 94.4 | 77.0 | 107.9 | 47.9 | 63.0 | 34.9 | 106.0 | 8 | a-e |
| 36 | WXY11A | TX AgriLife | | VT3 | 65.4 | 77.0 | 113.8 | 46.2 | 67.7 | 32.1 | 97.5 | 31 | b-k |
| 37 | WXY11B | TX AgriLife | | VT3 | 79.3 | 77.0 | 115.4 | 46.5 | 67.8 | 33.3 | 101.1 | 19 | a-i |
| 38 | WXY11C | TX AgriLife | | None | 93.7 | 77.0 | 118.4 | 50.8 | 65.2 | 35.7 | 108.2 | 2 | ab |
| 39 | WXY11D | TX AgriLife | | VT3 | 88.1 | 74.7 | 111.5 | 42.0 | 63.5 | 31.8 | 96.6 | 33 | c-l |
| 40 | WXY11E | TX AgriLife | | VT3 | 96.7 | 76.0 | 109.8 | 41.5 | 64.0 | 32.7 | 99.1 | 27 | a-j |
| 41 | 17254 | Triumph | 117 | HX1/RR | 92.2 | 74.7 | 115.1 | 43.6 | 66.2 | 33.7 | 102.3 | 14 | a-i |
| 42 | 2288H | Triumph | 118 | HX1/RR | 63.9 | 81.0 | 118.8 | 50.0 | 68.2 | 30.9 | 93.7 | 38 | g-l |
| 43 | 1956H | Triumph | 122 | HX1/RR | 76.0 | 78.0 | 115.7 | 48.0 | 64.5 | 32.2 | 97.8 | 30 | b-k |
| | Test mean | | | | 85.2 | 76.6 | 113.3 | 45.2 | 64.6 | 33.0 | 100.0 | | |
| | CV% | | | | 6.7 | 1.7 | 4.3 | 11.6 | 3.0 | 6.9 | | | |
| | LSD 0.05 | | | | 9.2 | 2.2 | 19.9 | 21.6 | 3.1 | 3.7 | | | |

Note: ENO = entry number, RM = relative maturity, YG= Yield Guard insect resistance, HX= Herculex insect resistance, RR2= Roundup Ready Corn 2 herbicide resistance; VT3 = CRW + RR2 + YG. BM3 = brown midrib conferred by *bm3* gene.
Stand = Percent of the target plants 32,912 plants per acre. Hybrid yields with the same letters are not significantly different from each other at 5% level.

Table 2. Forage quality of the State Silage Corn Performance Test at Etter, Texas in 2011.

| ENO | Hybrid | Company | CP | ADF | NDF | Lignin | Starch | TDN | IVTD24 | IVTD24 rank | Duncan's test | NDFD24 | MILK1 | MILK2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TMF2L872 | Mycogen | 8.5 | 28.0 | 46.7 | 4.1 | 25.1 | 70.0 | 75.3 | 30 | b-h | 47.3 | 2971.0 | 3173.7 |
| 2 | T20911 | Mycogen | 8.2 | 27.1 | 45.0 | 3.7 | 30.6 | 72.0 | 75.3 | 31 | b-h | 45.7 | 2955.0 | 3203.0 |
| 3 | F2F714 | Mycogen | 9.0 | 23.6 | 39.5 | 3.7 | 35.9 | 75.0 | 82.3 | 1 | a | 54.0 | 3148.7 | 3439.3 |
| 4 | F2F622 | Mycogen | 8.6 | 24.7 | 43.2 | 3.4 | 32.1 | 74.0 | 79.7 | 6 | a-d | 53.0 | 3076.7 | 3337.3 |
| 5 | GAX-6152 | Golden Acres | 8.8 | 23.5 | 40.0 | 3.7 | 33.3 | 74.0 | 79.7 | 7 | a-d | 49.7 | 3027.3 | 3296.7 |
| 6 | 28V71 | Golden Acres | 8.7 | 23.9 | 40.7 | 3.5 | 33.3 | 73.0 | 77.3 | 20 | a-g | 44.3 | 2968.3 | 3238.7 |
| 7 | 28V81 | Golden Acres | 8.6 | 25.9 | 44.2 | 4.1 | 29.9 | 71.0 | 74.7 | 36 | b-h | 43.3 | 2910.3 | 3152.0 |
| 8 | 28Z47 | Golden Acres | 8.7 | 23.0 | 39.3 | 3.6 | 37.4 | 74.0 | 78.7 | 12 | a-f | 46.0 | 3022.7 | 3325.3 |
| 9 | CF 6120 RR | Golden Acres | 9.3 | 28.8 | 47.3 | 4.6 | 23.3 | 69.0 | 74.3 | 37 | c-h | 45.7 | 2981.0 | 3170.0 |
| 10 | CF 6126 GT | Golden Acres | 8.9 | 31.9 | 51.1 | 4.8 | 18.4 | 64.0 | 69.7 | 43 | h | 41.0 | 2562.3 | 2712.0 |
| 11 | BH 8895 VTTP | B-H Genetics | 8.2 | 21.9 | 37.7 | 3.0 | 39.4 | 75.0 | 80.0 | 5 | a-c | 47.0 | 3025.0 | 3344.7 |
| 12 | BH 9018 VTTP | B-H Genetics | 8.4 | 26.4 | 45.1 | 3.8 | 30.7 | 72.0 | 75.7 | 28 | b-g | 46.0 | 2938.7 | 3187.7 |
| 13 | BH 8719 RR/HXT | B-H Genetics | 8.3 | 26.5 | 43.8 | 3.9 | 30.1 | 71.0 | 75.3 | 32 | b-h | 44.0 | 2892.7 | 3136.7 |
| 14 | X11152 VTTP | B-H Genetics | 8.7 | 22.4 | 39.4 | 3.4 | 34.9 | 76.0 | 79.7 | 8 | a-d | 47.7 | 3143.0 | 3426.3 |
| 15 | X10065 VT3 | B-H Genetics | 8.6 | 24.8 | 41.7 | 3.9 | 32.4 | 73.0 | 77.0 | 23 | a-g | 45.3 | 3017.0 | 3279.7 |
| 16 | X10080 GT | B-H Genetics | 8.7 | 27.6 | 45.9 | 4.1 | 27.6 | 70.0 | 74.0 | 39 | d-h | 43.3 | 2850.3 | 3073.7 |
| 17 | XP 8711 | B-H Genetics | 8.2 | 24.6 | 41.2 | 3.7 | 36.2 | 74.0 | 78.7 | 13 | a-f | 48.0 | 3075.0 | 3368.3 |
| 18 | BH 8860 GT | B-H Genetics | 7.8 | 26.1 | 44.3 | 3.5 | 32.8 | 72.0 | 75.7 | 29 | b-g | 44.3 | 2901.0 | 3167.3 |
| 19 | X8021 | B-H Genetics | 8.6 | 25.3 | 42.5 | 3.4 | 32.7 | 73.0 | 77.3 | 21 | a-g | 47.0 | 2996.7 | 3262.0 |
| 20 | X10110GTBT11 | B-H Genetics | 8.3 | 22.3 | 38.6 | 3.5 | 38.5 | 74.0 | 78.3 | 14 | a-f | 43.3 | 2977.0 | 3289.0 |
| 21 | DKC 67-88 | Monsanto | 8.5 | 24.8 | 42.9 | 3.5 | 32.0 | 73.0 | 77.3 | 22 | a-g | 46.7 | 2991.7 | 3250.7 |
| 22 | DKC 64-69 | Monsanto | 8.4 | 22.0 | 38.0 | 3.5 | 37.8 | 75.0 | 80.3 | 2 | ab | 48.7 | 3075.7 | 3382.3 |
| 23 | Integra 9650 | Wilbur-Ellis | 7.6 | 25.9 | 43.2 | 3.3 | 33.2 | 71.0 | 75.3 | 33 | b-h | 43.3 | 2833.3 | 3102.3 |
| 24 | Integra 9682 | Wilbur-Ellis | 9.3 | 21.8 | 37.7 | 3.7 | 35.5 | 75.0 | 80.3 | 3 | ab | 48.7 | 3149.7 | 3437.0 |
| 25 | D56VP69 | DynaGro | 8.5 | 24.8 | 42.5 | 3.4 | 32.9 | 74.0 | 78.0 | 16 | a-g | 48.0 | 3063.0 | 3329.7 |

Table 2. Forage quality of the State Silage Corn Performance Test at Etter, Texas in 2011 (continued).

| ENO | Hybrid | Company | CP | ADF | NDF | Lignin | Starch | TDN | IVTD24 | IVTD24 rank | Duncan's test | NDFD24 | MILK1 | MILK2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | V5683 VT3 | DynaGro | 9.4 | 24.9 | 43.5 | 3.3 | 32.5 | 73.0 | 78.0 | 17 | a-g | 49.3 | 3024.0 | 3287.3 |
| 27 | CX 11615 | DynaGro | 8.3 | 22.7 | 38.9 | 3.5 | 37.0 | 75.0 | 79.7 | 9 | a-d | 46.7 | 3048.0 | 3347.7 |
| 28 | CX 11417 | DynaGro | 8.0 | 30.5 | 50.4 | 4.1 | 25.6 | 68.0 | 72.3 | 42 | gh | 45.0 | 2795.7 | 3003.3 |
| 29 | 70R50 | Blue River | 8.7 | 23.2 | 39.6 | 3.4 | 35.4 | 76.0 | 79.7 | 10 | a-d | 48.3 | 3130.0 | 3417.3 |
| 30 | 71M36 | Blue River | 8.4 | 27.4 | 45.8 | 3.6 | 28.9 | 72.0 | 76.7 | 24 | a-g | 49.0 | 3008.0 | 3242.3 |
| 31 | 73B33 | Blue River | 8.8 | 24.1 | 41.2 | 3.2 | 33.7 | 74.0 | 78.0 | 18 | a-g | 46.7 | 3040.7 | 3313.7 |
| 32 | 76H50 | Blue River | 9.0 | 24.1 | 40.9 | 3.6 | 34.0 | 73.0 | 78.3 | 15 | a-f | 46.7 | 3005.0 | 3280.3 |
| 33 | WXY10D | TX AgriLife | 9.2 | 22.1 | 38.0 | 3.7 | 35.1 | 75.0 | 80.3 | 4 | ab | 48.3 | 3148.0 | 3432.7 |
| 34 | WXY10F | TX AgriLife | 9.0 | 25.8 | 43.6 | 3.7 | 30.5 | 72.0 | 77.7 | 19 | a-g | 48.7 | 3009.7 | 3257.0 |
| 35 | WXY11D | TX AgriLife | 8.7 | 25.6 | 43.0 | 3.6 | 32.3 | 72.0 | 76.7 | 25 | a-g | 46.3 | 2946.3 | 3208.0 |
| 36 | WXY11A | TX AgriLife | 8.5 | 27.8 | 47.1 | 3.8 | 25.1 | 70.0 | 75.0 | 35 | b-h | 47.0 | 2936.0 | 3139.0 |
| 37 | WXY11B | TX AgriLife | 9.1 | 22.9 | 38.7 | 3.6 | 34.5 | 74.0 | 79.0 | 11 | a-e | 46.3 | 3054.3 | 3333.7 |
| 38 | WXY11C | TX AgriLife | 8.2 | 28.0 | 46.7 | 3.7 | 29.6 | 71.0 | 75.3 | 34 | b-g | 47.0 | 2947.3 | 3187.7 |
| 39 | WXY11D | TX AgriLife | 8.4 | 25.1 | 42.8 | 3.5 | 31.3 | 71.0 | 76.3 | 27 | b-g | 44.3 | 2877.0 | 3131.3 |
| 40 | WXY11E | TX AgriLife | 8.0 | 28.5 | 47.5 | 4.0 | 26.8 | 68.0 | 73.0 | 41 | f-h | 42.7 | 2772.0 | 2989.3 |
| 41 | 17254 | Triumph | 8.5 | 26.3 | 44.6 | 3.7 | 30.5 | 72.0 | 76.7 | 26 | a-g | 47.7 | 2972.7 | 3220.0 |
| 42 | 2288H | Triumph | 9.0 | 27.7 | 46.9 | 3.9 | 25.4 | 71.0 | 74.3 | 38 | c-h | 45.3 | 2967.3 | 3172.7 |
| 43 | 1956H | Triumph | 8.3 | 27.8 | 46.3 | 3.9 | 28.8 | 69.0 | 73.3 | 40 | e-h | 42.3 | 2768.3 | 3001.7 |
| | Test mean | | 8.6 | 25.7 | 43.4 | 3.7 | 30.6 | 71.6 | 76.7 | | | 46.3 | 2961.3 | 3209.8 |
| | CV% | | 5.4 | 14.2 | 12.2 | 10.1 | 18.6 | 4.3 | 4.6 | | | 6.3 | 5.1 | 5.8 |
| | LSD 0.05 | | 0.8 | ns | ns | 0.6 | 9.6 | 5.1 | 5.7 | | | 4.8 | 245.3 | 306.1 |

1. IVTD24: *In vitro* true digestibility (IVTD) after 24 hours of incubation in rumen fluid. It measures digestibility and can be used to estimate energy. A higher value of IVTD 24 hr presents a better forage quality.
2. Forage nutritional values based on NIR analysis.

ADF: Acid detergent fiber, a measure of cellulose and lignin. ADF is negatively correlated with overall digestibility.
CP: Crude protein, the total protein in the sample including true protein and non-protein nitrogen.
Lignin: indigestible plant component and has a negative impact on cellulose digestibility.
NDF: Neutral detergent fiber, a measure of hemicellulose, cellulose and lignin representing the fibrous bulk of the forage. NDF is negatively correlated with intake
NFC: Percentage of non-fibrous carbohydrates; estimates the amount of rapidly digestible carbohydrates in a forage.
NDFD24: Percentage of NDF that is digestible by *in vitro i*ncubation.
MILK 1: Estimated lbs. of milk produced per ton of dry matter.
MILK 2: Estimated lbs. of milk produced per ton of processed dry matter.
Starch: primarily in the grain, later maturing hybrids have lower starch since all hybrids were harvested at the same time.
TDN: Total digestible nutrients. It represents the sum of the digestible protein, digestible nitrogen-free extract, digestible crude fiber and 2.25X the digestible fat.
Milk lbs./ton of DM: an estimated potential milk yield per ton of forage dry matter based on digestibility and energy content of the forage.