PROFIT - Productive Rotations On Farms In Texas
Annual Report

1. Project title and leader(s): Development of sorghum-midge resistant hybrids with increased grain yield potential
2. Primary agency affiliation: Texas Agricultural Experiment Station
3. Primary location: Corpus Christi, Lubbock, and Halfway
4. Contact information

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Non-technical report

1. Project description and results

Sorghum midge, *Stenodiplosis sorghicola*, can be an economic problem for the 20% of sorghum acreage usually planted two to four weeks later than normal, particularly in Central and South Texas. One sorghum midge per panicle is the economic threshold in susceptible sorghum, which includes 100% of Texas sorghum acres. TAES developed resistant hybrids that express excellent grain yield potential when the pest is present but only average potential when the insect pest is absent. Studies on sorghum midge-resistant hybrid performance for a range of planting dates show that, in comparison with common susceptible hybrids, a resistant hybrid will produce 12.7% less grain when planted at the normal time. When planted two weeks later than normal resistant hybrids out yield susceptible hybrids by 16.3%, and when planted four weeks later resistant hybrids out yield susceptible hybrids by 760.6%. Project objectives are to (1) expand the TAES sorghum midge resistance breeding program to incorporate multiple planting dates for screening, and (2) develop methodology to improve selection for improved grain yield potential while maintaining sorghum midge resistance. Breeding nurseries were planted at four locations to select for high sorghum midge resistance and improved grain yield potential along with other traits needed in hybrids. A total of 2,862 breeding nursery selections were made beginning with the F2 generation. A replicated line test (to identify elite advanced lines) and hybrid test (to evaluate elite hybrid parents) was grown at five locations - Corpus Christi normal planting, Corpus Christi 2-weeks later, Corpus Christi 4-weeks later, Lubbock, and Halfway. Midge population density at anthesis was insignificant, and no differences between resistant and susceptible lines or hybrids for resistance were identified. Hybrid test results supported previous research that most susceptible hybrids will out yield resistant hybrids when midges are not present. Several resistant hybrids were identified with grain yield potential equal to or not significantly different than that of susceptible hybrids.

2. Benefit to producers

The concept of this long-term research was to develop resistant hybrids with grain yield potential equal to that of susceptible hybrids that require less or no insecticide application to control sorghum midge. The methodology employed was multiple nurseries representing different environments to select for improved grain yield potential while maintaining a high level of resistance. However, this project was not selected for funding in the 2001-03 Biennium and has been terminated.

TECHNICAL REPORT

1. Project: Research support

2. Project Objectives:
    1. Expand the TAES breeding/entomology program for sorghum midge resistance to include use of multiple planting dates.
    2. Develop methodology to facilitate selection of sorghums with improved grain yield potential while maintaining sorghum midge resistance.

3. Methodology:

Sorghum midge is a difficult insect to develop resistance to because of its life cycle and nature of damage. Midges damage sorghum at anthesis with only larvae causing economic damage. Insecticidal control for midges suppresses adults and not larvae. Thus insecticide application for control does not affect the insect stage causing damage. Sorghum midge cannot be artificially reared, so cultural practices (late planting) must be used to increase the probability of damaging infestation levels at maturity. Additionally, plots of susceptible hybrids are planted at regular intervals throughout a nursery to provide a reservoir of early flowering sorghum. Finally, experimental plots are planted four weeks later than normal to increase the likelihood of flowering at a time of high midge population density. While facilitating selection for high levels of resistance, a yield plateau is selected for through 1)early flowering genotypes and 2)selection in one production environment (late planting), although, the lines would most likely be utilized in another environment (early planting) with a longer growing season.

Nurseries were planted at the following locations:

1. Corpus Christi medium late - planted 2 weeks (March 19) after normal planting to select for grain yield potential under moderate midge density. Few midges were present in 2001.
2. Corpus Christi late - planted 4 weeks (April 3) after normal planting to select for high resistance levels. Few midges were present in 2001.
3. Halfway - planted June 26 to select for grain yield potential under irrigated temperate conditions. No midges were present in 2001.
4. Lubbock - planted June 29 to select for grain yield potential under limited irrigation temperate conditions. Sorghum midge are usually not present at this location.

Planted at each location was a three replication Midge Line Test, a three replication Midge Hybrid Test, a line introduction from other breeding programs, and a breeding nursery. The Midge Line Test (85 entries x 3 replications) is composed of standard resistant and suceptible checks and advanced breeding lines. The Midge Hybrid Test (60 entries x 3 replications) is composed of standard resistant and susceptible hybrid checks and experimental resistant hybrids. Additionally, a Midge Line Test and Midge Hybrid Test was planted at the normal planting time to enable a comparison of line and hybrid performance over planting dates. Introductions from other programs were evaluated in a 30 entry x 2 replication test. The breeding nursery (3,127 plots) is composed of material in segregating generations.

At maturity, the replicated trials were visually scored for sorghum midge damage (MDR) on a scale of 1 = 0-10% damaged kernels, 2 = 11-20% damaged kernels, up to 9 = 81-100% damaged kernels. Grain yield was obtained by harvesting 1/1000 acre and the results were converted to pounds per acre. Selections in the breeding nursery are made based upon resistant, agronomic traits, and

maturity.

4. Results and Discussion

The Corpus Christi locations provided an excellent environment to evaluate for grain yield potential in both planting dates. An additional midge line test and midge hybrid test was planted at a normal planting date (early March). Planting the replicated test three times (normal planting, two weeks later, and four weeks later) should provide the opportunity to evaluate performance of resistant germplasm and hybrids in a range of planting dates. Additionally, weather was hotter and dryer than normal and the trials were subjected to severe stress that resulted in reduced grain yield. The Lubbock and Halfway nurseries provide excellent temperate locations for evaluation of experimental material. Midge damage ratings will not be presented in this report as few sorghum midge were present at anthesis and neither the susceptible or resistant entries sustained measurable damage.

Grain yield in the Midge Hybrid Test was less in 2001 than in 2000 for all locations. Lower grain yield was attributed to environmental conditions, primarily hot and dry weather. Few sorghum midge were present at anthesis and did negligible damage. The tests thus provided an opportunity to evaluate grain yield potential of resistant versus susceptible hybrids in a range of planting dates. The highest yielding hybrids in all tests were generally the susceptible hybrids (partial results in Table 1). In each test, resistant hybrids were identified with grain yield not significantly different from the resistant checks. However, a susceptible check produced the highest grain yield in four of the five tests. Grain yield of resistant experimental entries was generally better that the resistant checks, although the relationships varied over locations. Results confirm previous observations and results from 2000 - most resistant hybrids will not produce grain yield equal to susceptible hybrids in earlier planting but will out-yield susceptible hybrids in later plantings. The differences are not consistent and performance of specific hybrids will vary with location and year.

Weight (grams) of 100 seeds for selected entries in the 2001 Midge Hybrid Test are shown in Table 2. Data shown is from the Corpus Christi medium late and late planted locations. Susceptible checks generally had larger kernels within and over locations. In both tests a susceptible check had the highest seed weight. In many comparisons seed weight of the resistant entry with the largest kernels were less than the smallest resistant check. This also confirms previous observations that sorghum midge resistant hybrids produce smaller seeds than susceptible hybrids.

This is the situation this project was developed to address in a breeding research program. Selections were made in breeding nurseries planted two weeks and four weeks later than normal at Corpus Christi (normally with moderate and high sorghum midge population density) and in temperate conditions at Lubbock and Halfway. Due to negligible midge damage, agronomic characteristics were emphasized when selecting in segregating generations. The primary selection objective in the breeding nurseries is usually to select for higher grain yield potential under more favorable agronomic conditions. The breeding nursery consisted of 3,127 plots (including standard checks) planted at 4 locations. A total of 2,862 were made in all nurseries.

This project was not selected for continuation in the 2001-03 Biennium. The expanded research activity supported by PROFIT has been terminated. The TAES breeding program has conducted research on sorghum midge resistance for 30-years. The program has identified many resistance sources, incorporated several into agronomically improved lines, and released many improved resistant lines. The released lines generally have a high level of midge resistance but in hybrid

combination produce at least 10-15% less grain than susceptible hybrids. While the grain yield potential of resistant hybrids increases with additional research, so does the grain yield of susceptible hybrids. Thus, the yield deficiency of susceptible versus resistant hybrids has not been eliminated. Progress continues in improving the grain yield of resistant hybrids, but there is a question of whether the yield deficiency can ever be eliminated. Additionally, seed set of midge resistant A-lines in open-pollinated hybrid production blocks is poor. The seed set may be at a level that sorghum midge resistant hybrids cannot be economically produced.

5. Technology transfer and education activity
   a. Technology developed and available for producers - This is a long-term research program to develop improved parental lines with the characteristics and traits needed for hybrid seed production. Improved lines developed and released to commercial seed companies would have been available to produce hybrids for farmers.
   b. Publications - none
   c. Presentations -
      Peterson, G.C. 2001. Performance of sorghum-midge resistant and susceptible hybrids in different planting dates. 22nd Biennial Grain Sorghum Research and Utilization Conference, Feb. 18-20, 2001, Nashville, TN.
   d. Student education - undergraduate students from Texas Tech University were employed in this research project.

Table 1. Grain yield and days to 50% anthesis of selected entries in the 2001 Midge Hybrid Test.

		Grain Yield					Days to 50% Anthesis		
Hybrid	Status[†]	Corpus Late	Corpus Medium-Late	Corpus Normal	Lubbock	Halfway	Corpus Late	Corpus Medium-Late	Corpus Normal
		----------lb/ac----------							
ATx399*Tx430	S-CK	2689	3261	1542	3915	966	65	68	75
ATx2755*97M14		2465	2319	1473	3958	3067	65	72	76
A8PR1013*MB108B		2366	2620	1012	3666	1104	64	70	83
ATx2752*Tx2862	S-CK	2355	2747	2088	4900	1734	66	67	77
A0PR11*Tx2882		2231	2576	2130	3500	1538	66	73	84
ATx2755*97M9		2201	1930	1713	3232	1400	65	72	78
A8PR1011*9MLT180		2178	2192	1744	3569	957	66	70	82
A8PR1013*Tx2882		2120	1820	877	3808	1581	65	71	78
A8PR1013*9MLT164		2032	1858	902	4054	1704	65	66	77
A8PR1011*MB108B		2019	3687	1924	3672	1075	66	69	81
A8PR1019*Tx2882		1990	2007	1629	3457	2797	64	67	76
A8PR1011*Tx2880		1976	1980	895	3546	1902	65	68	75
A8PR2145*Tx2882		1975	2761	1491	3310	2587	67	71	81
ATx2755*MB108B		1940	3229	1758	4045	984	67	70	79
A8PR1013*Tx2880		1929	2201	1246	3422	1838	65	66	77
A8PR1011*9MLT157		1921	1937	1662	2891	2270	66	68	79
A0PR13*Tx2880		1916	2741	2675	3098	2643	66	71	82
A8PR1015*Tx2880		1905	4047	2509	4822	2615	69	71	81
A8PR1013*9MLT180		1867	2344	1445	3230	1952	67	68	79
A0PR15*Tx2880		1860	2778	2297	4333	1305	67	70	80
A35*Tx430	S-CK	1847	4187	2479	2805	615	67	71	81
A0PR11*Tx2880		1821	2891	2067	3998	1744	66	72	85
ATx2752*Tx2783	S-CK	1808	2845	2179	4492	938	66	70	77
A8PR1011*9MLT164		1792	1879	1093	3620	1938	64	66	77
A9PR2141*Tx2880		1789	1924	1431	2873	1590	65	70	77
ATx2755*97M17		1785	2420	1377	3075	2458	66	72	77
A8PR1013*9MLT176		1775	1720	1230	2235	1551	65	64	78
ATx2755*Tx2882	R-CK	1713	1963	1168	3515	1593	68	70	77
ATx2752*Tx430	S-CK	1688	1248	2090	4463	1394	65	71	81
A1*Tx430	S-CK	1642	2131	1882	3364	2074	68	71	78
A35*Tx2862	S-CK	1460	3188	2598	3885	806	69	74	86
ATx2755*Tx2767	R-CK	1336	2038	1135	4103	1886	66	69	83
ATx2755*Tx2880	R-CK	1312	1846	1200	3079	2813	67	67	76
A1*Tx2862	S-CK	1265	1303	1731	4669	2189	71	74	81
MEAN		1696	2401	1733	3651	1745	67	70	80
LSD .05		556	817	839	1071	925	3	1.9	3.6

[†] R = resistant; S = susceptible; Ck = check.

Table 2. 100 seed weight of selected entries in the 2001 Midge Hybrid Test.

Hybrid	Status[†]	100 seed weight	
		Corpus Medium-Late	Corpus Late
ATx399*Tx430	S-CK	1.88	2.84
ATx2755*97M14		1.44	2.07
A8PR1013*MB108B		1.86	1.61
ATx2752*Tx2862	S-CK	1.94	1.91
A0PR11*Tx2882		1.24	1.90
ATx2755*97M9		1.55	2.22
A8PR1011*9MLT180		1.49	1.64
A8PR1013*Tx2882		1.20	1.81
A8PR1013*9MLT164		1.44	1.47
A8PR1011*MB108B		1.65	1.81
A8PR1019*Tx2882		1.30	1.49
A8PR1011*Tx2880		1.42	1.52
A8PR2145*Tx2882		1.38	1.76
ATx2755*MB108B		1.75	2.00
A8PR1013*Tx2880		1.40	1.58
A8PR1011*9MLT157		1.45	1.64
A0PR13*Tx2880		1.40	1.45
A8PR1015*Tx2880		1.88	2.27
A8PR1013*9MLT180		1.15	1.52
A0PR15*Tx2880		1.33	2.14
A35*Tx430	S-CK	1.93	2.23
A0PR11*Tx2880		1.42	2.10
ATx2752*Tx2783	S-CK	1.58	2.08
A8PR1011*9MLT164		1.61	1.42
A9PR2141*Tx2880		1.41	2.10
ATx2755*97M17		1.21	2.25
A8PR1013*9MLT176		1.49	1.67
ATx2755*Tx2882	R-CK	1.25	2.16
ATx2752*Tx430	S-CK	1.61	2.33
A1*Tx430	S-CK	1.87	2.16
A35*Tx2862	S-CK	2.08	1.97
ATx2755*Tx2767	R-CK	1.82	2.09
ATx2755*Tx2880	R-CK	1.31	1.97
A1*Tx2862	S-CK	1.74	2.18

[†] R = resistant; S = susceptible; ck = check.