Annual Report: Screening Sorghum Varieties for Resistance to Anthracnose and other Foliar Diseases

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PRIORITY AREA: Management strategies for corn and sorghum pests: Diseases of sorghum
STATUS: Year 3 (Terminating)
OBJECTIVES:

1. To survey diseases of sorghum in Arkansas to better ascertain their identity and severity of the most significant.
2. To screen hybrids for resistance to anthracnose caused by *C. sublineolum*.
3. To test cultivars of sorghum for resistance to anthracnose in replicated field tests inoculated with several strains of the anthracnose fungus and determine the epidemiology of the disease.
4. To collect and construct a working collection of isolates *Colletotrichum sublineolum* representing as many pathogenic haplotypes as possible and to use genetic fingerprinting techniques in conjunction with pathogenicity to determine the pathogenic variation of this important pathogen on sorghum.

PROGRESS REPORT.

Objective 1. At least six diseases of sorghum were found common to both test sites. These diseases included anthracnose, bacterial leaf spot, bacterial leaf streak, charcoal rot, head blight and zonate leaf spot. One bacterial disease, caused by *Xanthomonas campestris* pv. *holicola*, appeared early in the season in Southeast Arkansas on several hybrids due to weather conditions, but remained at very low incidence. Zonate leaf spot caused by *Gloeocercospora sorghi*, was found throughout the tests Rohwer and Pine Tree. Target leaf spot caused by *Bipolaris sorghicola* was found in 2001 and caused severe problems at Pine Tree on all lines and hybrids in the tests over the entire year. The results of the surveys indicate that Zonate Leaf Spot, Target Spot, Charcoal Rot and Leaf Blight are full season diseases, that anthracnose and head blights are most severe in late season, and that the bacterial diseases are early season diseases. Full and late diseases are the most problematic.

Objective 2. The resistance of selected high-yielding hybrids to several diseases of sorghum were evaluated in the field tests at Rohwer and Pine Tree, Arkansas in 2001. These hybrids were selected from the Arkansas Variety Test Program and include Asgrow A571, DeKalb 53, DeKalb 54, DeKalb S5190, FFR332, Mycogen 444E, Pioneer 8313, Pioneer 83G66, Southern States SS800, Triumph TR461, Triumph 82G, Terral TV 9421, Terral TV1050 and Terral TVX99317. Additional hybrids were evaluated for resistance to anthracnose, zonate leaf spot and head blight in cooperative tests with the Arkansas Variety Test Program. In addition, 19 hybrid selections and 204 selected hybrids and breeding line entries were evaluated in inoculated plots for resistance to anthracnose, zonate leaf spot and head blight in cooperative tests with Texas A&M University. Methods for evaluating and reporting resistance of hybrids to anthracnose and zonate leaf spot include inoculation of each line with infested sorghum grains at 45 to 60 days after inoculation and rating the disease response independent of severity. Portions of the data for selected hybrids have been assembled into

a uniform reporting system and provided to the Extension Service (Tables 1 and 2) . This information will also be posted on the web site in the Department of Plant Pathology and the end of the 2001 season. Resistance to anthracnose caused by current strains of the pathogen is available to producers in several excellent commercial hybrids.

Objective 3. Field and greenhouse evaluation of the resistance of three sorghum hybrids, Pioneer 8313, BTX623 and Cargill 888Y were conducted in replicated field plots in 2000 and 2001. The results also show that anthracnose becomes increasingly severe after flowering and especially after seed set (Figure 3) suggesting that delaying harvest should be avoided because it may affect yield and seed quality. Our research also shows that the specific strains and/or lineages in a field change while the disease develops. These findings have significance on determining the distribution and importance of the lineages in fields and perhaps on how resistance should be used or in selecting hybrids to grow.

Objective 4. An examination of the genetic variability of the anthracnose pathogen has continued and is contributing to better evaluation of hybrids for resistance to anthracnose in the field because we are including isolates from within all lineages rather than just randomly selecting strains. Molecular fingerprinting of 90 isolates collected in Arkansas and in other countries has confirmed the presence of 38 lineages, but only four lineages are in Arkansas. We are now beginning to determine if isolates within lineages all infect the same hybrids in greenhouse tests. This will help us to screen for resistance by reducing the need to use so many different isolates. Discovery of a fourth lineage suggests we do not have a complete inventory of Arkansas lineages

Plans for 2002.

1. Continue to survey for diseases throughout the state using the Variety Test Program. We are going to classify them as early season, late season and full season diseases.
2. Expand the evaluation of the highest yielding hybrids from two locations to three locations (Rohwer, Pine Tree and Marianna) and increase the number of hybrids screened from 10 to 20 hybrids in response to requests from Station Managers and producers.
3. Continue to examine the epidemiology of anthracnose and determine is potential for anthracnose to reduce yields and seed quality during and after seed set.
4. Continue to examine the lineages of this fungus to help us improve screening for resistance and to make better recommendations on resistance in hybrids to producers.
5. Obtain isolates of the target spot pathogen and to begin to evaluate all hybrids available for resistance to this full season disease.
6. Develop a web site for free access to information developed on this project.

Personnel supported completely or in part by this project:

1. C. Taylor, research assistant. Fingerprinting Arkansas and US anthracnose isolates, determine disease reactions to anthracnose.
2. S. Ware, MS Student, fingerprinting and VCG methods, world collection.
3. Y. Li, PhD Student, epidemiology and molecular ecology of anthracnose strains.
4. S. Paine. MS Student. Determine if resistance genes are effective after flowering.
4. D. TeBeest. Survey, collection and identification of pathogens on sorghum. Field tests.

Table 1. Disease ratings for selected high yielding sorghum hybrids in replicated field tests conducted in 1999 and 2000.

	Disease**				
Hybrid	Anthracnose	Leaf Blight	Zonate Leaf Spot	Charcoal Rot	Head Blight
AP9850	R [1]	R	MR	NA ***	MR
Asgrow A603	MS	MR	R	NA	R
Cargill 888Y	R	R	R	NA	R
DK54	MR	R	R	NA	R
DK55	MR	R	R	NA	R
Pioneer 8282	R	R	R	NA	R
Pioneer 8305	R	MR	R	NA	R
Pioneer 8313 *	MS	R	R	NA	R
Terrel 1050	MR	R	R	NA	R
Triumph 82G	R	MR	MR	NA	R

[1] R = resistant; MR = moderately resistant; MS = moderately susceptible; S = susceptible.

* Pioneer 8313 was used as a susceptible check for anthracnose

** All hybrids were grown in four replicated plots at Rohwer and Pine Tree, Arkansas, and all plots were inoculated with inoculum for anthracnose and zonate leaf spot 45 to 50 days after planting.

*** Not available because charcoal rot not found in these plots in 2000

Outcomes and Impact of Disease Survey and Screening

* Provide a clearer picture of prevalent diseases

* Data was provided to the Cooperative Extension Service to assist in developing recommendations and work with producers.

* Provides producers with more complete information about the major diseases that may be expected on important hybrids.

* Reduce the impact of disease on yield and seed quality for Arkansas producers.

Table 2. Reactions of some common sorghum hybrids to common diseases in Arkansas.

Hybrid	Test	Year	Anthracnose	Blight	Charcoal Rot	Head Blight	Zonate Leaf Spot
Agripro AP2838	3	1999	R			1	
Agripro A 9850	3	1999	MR			1.5	
Agripro Cherokee	3	1999	MR			2.5	
Agripro HSC1225	3	1999	MR			3	
AP 9850	2	2000	R	R	N	MR	MR
Asgrow A459	1	2000	MS	5	N	1	R
Asgrow A459	3	1999	MR			3	
Asgrow A570	3	1999	R			2	
Asgrow A571	1	2000	R	2.5	N	1	R/MR
Asgrow A581	1	2000	R/MR	2.5	N	1	MR
Asgrow A581	3	1999	R/MR			1.5	
Asgrow A603	2	2000	MS	MR	N	R	R
Asgrow A603	3	1999	MR			2	
Asgrow Missile	1	2000	MR	2	N	1	R/MR
BoMar 9300	1	2000	R/NR	4	N	1	R/MR
BoMar 9322	1	2000	MR	2.5	3	1	R/MR
Cargill 833	3	1999	MR			2.5	
Cargill 888Y	2	2000	R	R	N	R	R
DeKalb 50A	3	1999	R/MR			1.5	
DeKalb 52	1	2000	MR/MS	3	N	1	MR/MS
DeKalb 52	3	1999	R			2.5	
DeKalb 53	1	2000	R	2.5	N	1	R/MR
DeKalb 53	3	1999	R/MR			2.5	
DeKalb DK54	1	2000	R	3.5	N	1	MR/MS
DeKalb DK54	2	2000	MR	R	N	R	R
DeKalb DK54	3	1999	R			1	
DeKalb 55	2	2000	MR	R	N	R	R
DeKalb 55	3	1999	R			2	
DeKalb DKS51-9	1	2000	R	2	N	1	MR/MS
Dyna Gro 751B	1	2000	MS	2.5	2	1	R/MR
Dyna Gro 751B	3	1999	MR			1.5	
DynaGro 762B	1	2000	R	3	N	1	MR/MS
DynaGro 762B	3	1999	MR			3.5	
Dyna Gro 780B	1	2000	MR/MS	2.5	N	1	R/MR
Dyna Gro 780B	3	1999	MR			1.5	
FFR 321	1	2000	MR/MS	2	N	1	MR/MS
FFR X320	1	2000	MS	3	N	1	R
FFR 322	1	2000	MR/MS	4	3	1	MR/MS
Mycogen 3694	3	1999	R/MR			1	
Mycogen 444E	1	2000	R/MR	5	N	1	R
Mycogen 3700	3	1999	R			2	
NK KS585	3	1999	MS			4	
NK K73-J6	3	1999	MR			3	
NK KS735	3	1999	MR			3	
Pioneer 83G66	1	2000	MR	3	N	1	R/MR

Pioneer 8282	1	2000	**R**	1.5	**N**	1	**MR/MS**
Pioneer 8282	2	2000	**R**	R	**N**	R	**R**
Pioneer 8282	3	1999	**MR**			2.5	
Pioneer 8305	2	2000	**R**	MR	**N**	R	**R**
Pioneer 8305	3	1999	**MR**			1.5	
Pioneer 8313	1	2000	**MR/MS**	2	**N**	1	**MR/MS**
Pioneer 8313	2	2000	**MS**	R	**N**	R	**R**
Pioneer 83G66	3	1999	**MR**			1	
Southern States 560	1	2000	**MR/MS**	2	**N**	1	**MR/MS**
Southern States 560	3	1999	**MR**			3	
Southern States 600	1	2000	**MR/MS**	3	**N**	1	**MR/MS**
Southern States 650	1	2000	**MR/MS**	3	**N**	1	**MR/MS**
Southern States 800	1	2000	**MR/MS**	4.5	**N**	1	**MR/MS**
Terral TVX 00453	1	2000	**R/MR**	3	**N**	1	**R/MR**
Terral TVX 00454	1	2000	**R/MR**	4	**N**	1	**MR**
Terral TVX 00459	1	2000	**MR**	3	**N**	1	**R**
Terral TVX 1050	1	2000	**R**	4	**N**	1	**MR/MS**
Terral TVX 1050	2	2000	**MR**	R	**N**	R	**R**
Terral TVX 1050	3	1999	**MR**			3	
Terral TVX 9421	1	2000	**R/MR**	4.5	**N**	1	**R/MR**
Terral TVX 9421	3	1999	**MR**			3	
Terral TVX 91490	3	1999	**MR**			2.5	
Terral TVX 91790	3	1999	**MR**			1	
Terral TVX 99314	1	2000	**R/MR**	5	**N**	1	**R**
Terral TVX 99317	1	2000	**R/MR**	4	**N**	1	**MR**
Triumph TR82G	1	2000	**R/MR**	4.5	**2**	1	**R/MR**
Triumph TR82G	2	2000	**R**	MR	**N**	MR	**R**
Triumph TR82G	3	1999	**R/MR**			1.5	
Triumph TR459	3	1999	**MR**			3	
Triumph TR461	1	2000	**MS**	5	**N**	1	**R**

Test 1: Conducted at Rohwer as part of the Arkansas Variety Test Program/ uninoculated

Test 2. Conducted at Rohwer and Pine Tree as part of the Arkansas best sorghum hybrids tests. Inoculated

Test 3. Conducted in 1999 at Rohwer and Pine Tree as part of Arkansas Variety Test Program/ uninoculated.

N = no information available, disease not present

Disease reactions may differ according to location due to pathogenic variability of different pathogens and

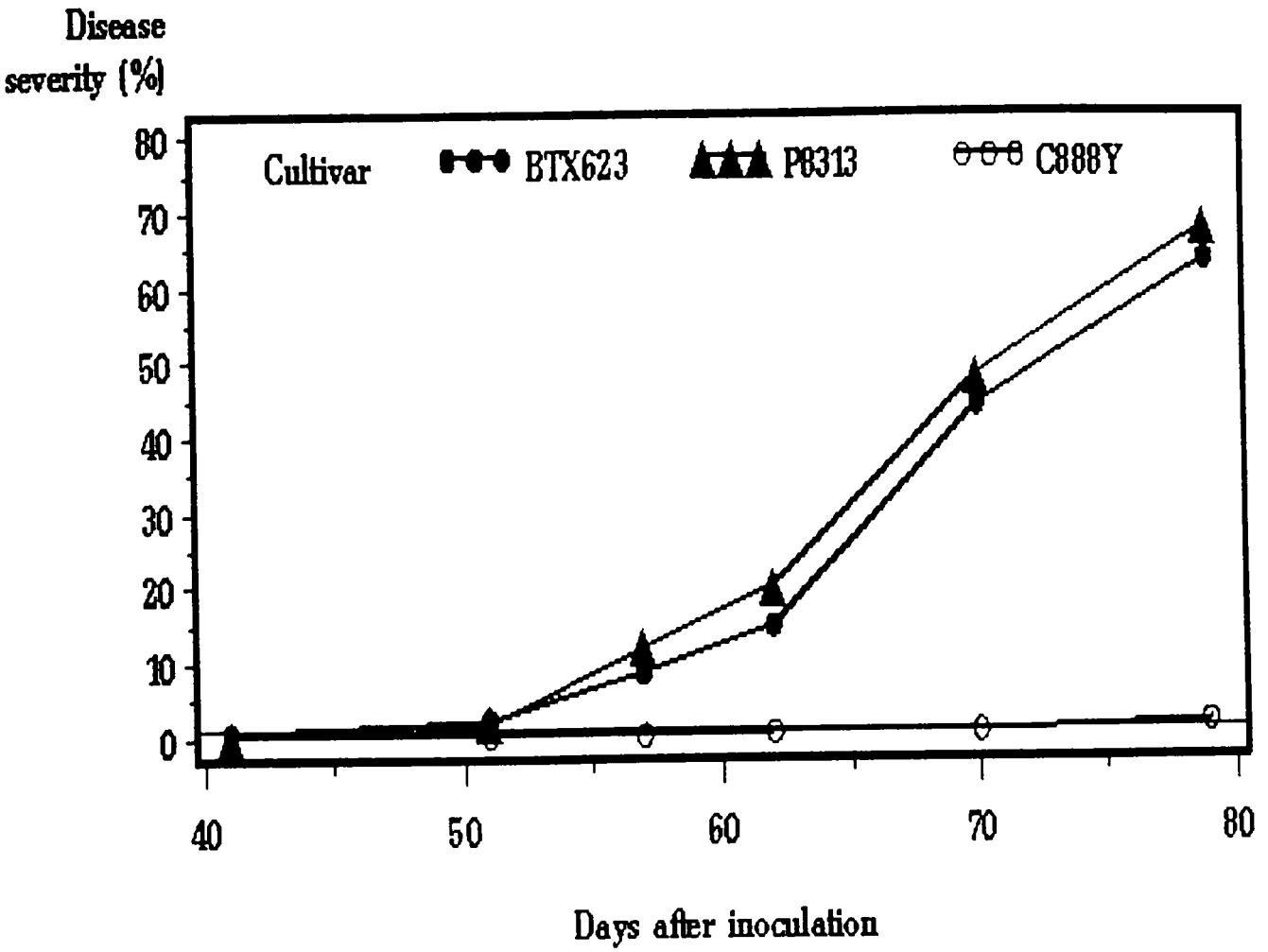
Anthracnose: R equals resistant, a few small non-expanding lesions.

MR Equals moderately resistant; lesions exhibiting some chlorosis and expansion, spores sometimes evident on lesions, and

S = susceptible; lesions expansive, extensive chlorosis and tissue death, clear evidence of sporulation.

Head Blight: 0 equals no evidence of seed blanking; midge damage or signs of Fusarium or other head blight fungi, to 5 where entire head is seedless with evidence of severe fungal infestations. A three indicates approximately 25 - 50% of the seeds affected.

Figure 1. A graph showing how anthracnose develops on susceptible and resistant sorghum hybrids in Arkansas. Flowering occurred approximately 55 days after inoculation or approximately 95 days after planting.



Outcomes and Impacts

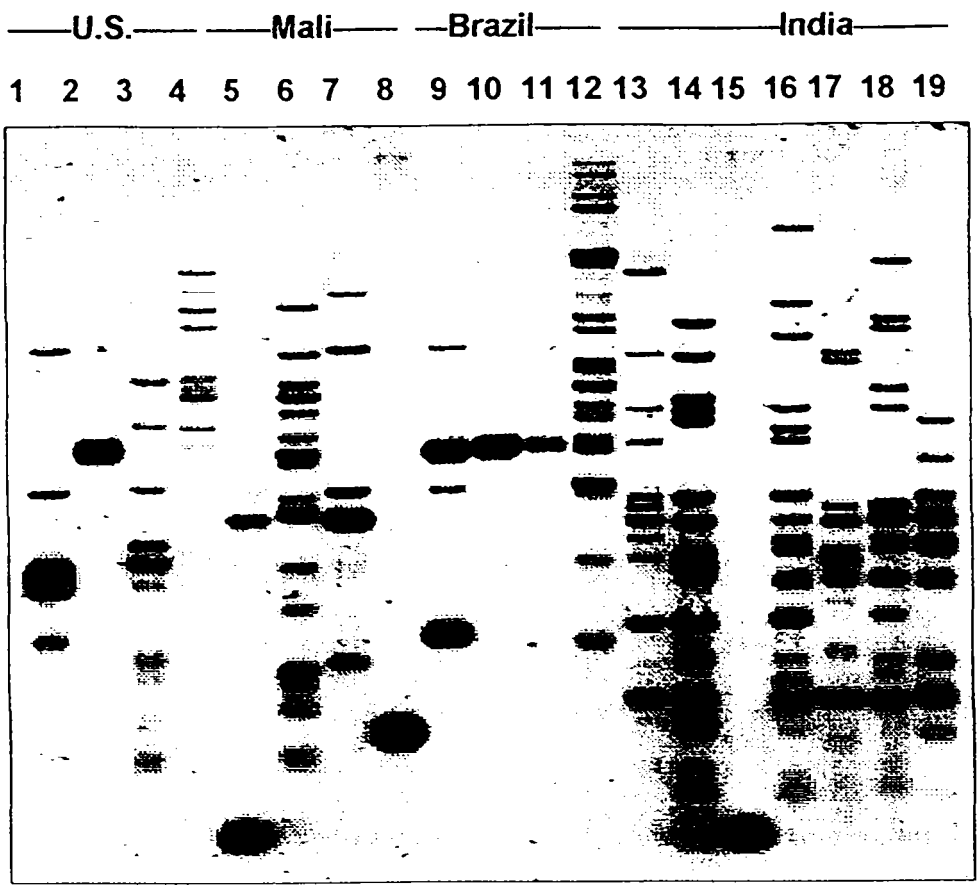
* Sorghum anthracnose is a late season disease. The disease begins to develop rapidly to severe levels after flowering begins.

* Anthracnose continues to develop for as long as seed heads remain in the field.

* Harvesting sorghum at maturity might help to reduce yield and quality losses as a result of increased infection by this fungus.

* Resistant hybrids such as Cargill 888Y appear to be effective in preventing infection.

Figure 2. The photograph shows a representative sample of the fingerprint technology that we have developed for the anthracnose fungus. Isolates from Arkansas, Mali, Brazil and India are shown. There are only 4 known lineages in Arkansas and one of these corresponds to a lineage found in Brazil.



Lanes 1-11 and 13-19 are the isolates of *C. sublineolum*. 1=SS-1, 2=430-98, 3=54, 4=250, 5=M3, 6=M5, 7=M9, 8=M11, 9=13B, 10=15C, 11=30C, 13=I8, 14=I9, 15=I17, 16=I19, 17=I29, 18=I47, 19=I48. Lane 12 is 1.98, a *C. graminicola* isolate.

Outcomes and Impacts.

* We have developed a unique fingerprint technology for this important pathogen

* The technology may help us categorize strains into useful groups representative of virulence to sorghum lines.

* Grouping isolates may help us more efficiently choose strains to screen for resistance and resistance genes.

* The technology may help us identify the strains in a given field and be better able to recommend specific hybrids.