ASSESSMENT OF SORGHUM GENOTYPES FOR RESISTANCE TO FOLIAR ANTHRACNOSE *(COLLETOTRICHUM GRAMINICOLA)* UNDER FIELD CONDITIONS

P.S. Marley, S. C. Gupta" and D.A. Aba"'

Department of Crop Protection,
Institute for Agricultural Research/Faculty of Agriculture,
Ahmadu Bello University, Zaria.

West African Sorghum Improvement Program,
International Institute for Semi-Arid Tropics,
Bagauda, Kano, Nigeria.

Department of Plant Science,
Institute for Agricultural Research,
Ahmadu Bello University,
Samaru, Zaria, Nigeria.

ABSTRACT

One hundred and fifty nine (159) sorghum genotypes from the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), West African National Agricultural Research Systems (NARS) and local collections were evaluated at Samaru, Nigeria for resistance to foliar anthracnose under field conditions during the 1996, 1997 and 1998 wet seasons. Disease reaction was observed six weeks after planting and disease severity assessed when plants had reached physiological maturity using a 1-9 visual rating scale. Results show that 42 genotypes showed resistant reaction while 20 and 97 genotypes showed moderately resistant and susceptible reactions respectively. Resistant genotypes included 14 ICRISAT sorghum varieties (ICSV), 4PB lines, 8 IS lines, 5 West African NARS lines, 2 SAMSORG varieties, 3NR varieties and 6 local varieties. Results herein indicate the availability of germplasm with stable resistance to foliar anthracnose. The need for assessment of these germplasm for panicle anthracnose resistance is highlighted.

INTRODUCTION

Foliar anthracnose of sorghum (*Sorghum bicolor* (L.) Moench), caused by *Colletotrichum graminicola* (Ces.) G.W. Wilson (= *C. sublineolum* Henn. in Kab. & Bulba) is a serious disease in Nigeria (Tyagi, 1980, Pande *et al.*, 1993), West Africa (Thomas *et al.* 1996) and elsewhere (Ali and Warren, 1992). The fungus infects leaves, stalks, peduncles, panicle and the grain either separately or together (Pastor-Corrales and Frederiksen, 1980), develops on both live and dead tissues (Pande *et al.*, 1991) and is transmitted through mycelium and conidia on crop residue (Ali and Warren, 1992), spore dispersal by rain splash (Edmunds *et al.*, 1970) and through seed transmission (Basu Chaudhary and Mathur, 1979; Sanoussi, Marley & Anas, unpublished data). Anthracnose is reported to cause considerable losses of upto 47% in Nigeria (Marley, 1997a, Tyagi 1980) and up to 67% in other parts of West Africa (Thomas *et al.*, 1996) and elsewhere (Ali *et al.*, 1987).

Although Ali *et al.* (1987) suggested that the effect of foliar anthracnose on yield was influenced by sorghum genotype amongst other factors such as aggressiveness of the pathogen and environmental conditions, the use of resistant sorghum germplasm continues to be the single most important method of control of the disease especially in developing countries where it is cultivated under

subsistence levels (Pastor-Corrales and Frederiksen, 1980).

In West Africa, many local land races and introduced varieties lack satisfactory resistance to anthracnose, hence the apparent need for continuous evaluation of sorghum germplasm within the region for use in breeding programmes to complement other management practices. This paper reports on field evaluation of sorghum germplasm for resistance to foliar anthracnose under natural infection conditions.

MATERIALS AND METHODS

Field Management and Experimental Design

The experiment was conducted at the Institute for Agricultural Research (IAR) Research fields at Samaru, Zaria, Nigeria (11° 11'N 07° 38E). One hundred and fifty nine (159) sorghum accessions of diverse origin, maintained by ICRISAT Genetic Resources Unit and IAR Breeding Unit were screened in 3 wet seasons from 1996 to 1998 for their reaction to foliar anthracnose. The site of the trial in each year was harrowed twice and ridged 0.75m apart. Seed of each line was planted 30cm apart and thinned to two plants per hill four weeks after crop emergence. Split application of fertilizer with 64kg N/ha of N:P:K (20:10:10) was carried out. First application was at two weeks after emergence while the second application was carried out six weeks after crop emergence. Manual weeding was done at 2 weeks after sowing while moulding up was carried out at second fertilizer application. The experimental design was a randomised complete block with two replications. Plots consisted of two rows, 4m long, spaced 0.75m apart and within row spacing was 0.4m.

Disease assessment

Six weeks after planting, plants were rated for their reaction type as R, MR or S where R (resistant) = no symptoms, or presence of chlorotic flecks; MR (moderately resistant = hypersensitive lesions, red spots or necrotic spots without acervuli; and S (susceptible) = lesions with acervuli. Further, when the plants had reached physiological maturity, disease severity assessment on whole plant based on five randomly selected plants per plot was carried out using a 1-9 visual rating scale for disease severity (Thakur *et al.*, 1998) where 1 = no symptoms on leaf surface; 2 = 1-5% of leaf area of plant damaged by disease; 3 = 6 - 10% leaf area of plant damaged by disease; 4=11 - 20% leaf area of plant damaged by disease; 5= 21-30% leaf area of plant damaged by disease; 6=31-40% leaf area of plant damaged by disease; 7=41-50% leaf area damaged by disease; 8=51-75% leaf area of plant damaged by disease and 9=>75% leaf area of plant damaged by disease.

RESULTS AND DISCUSSION

The main aim of this evaluation was to identify sources of stable resistance to foliar anthracnose under natural conditions during the rainy season at a location where disease pressure is high enough to determine resistance as stated by Tinline *et al.*, (1989). These conditions which further include warm and high relative humidity during the wet season (Pande *et al.*, 1994) were prevalent during these evaluations. Rainfall quantity and distribution (Figure 1) were good for crop growth and disease development. Total rainfall at Samaru during the three growing seasons were 825.9mm in 1996 spread over 64 days between May to October; 1062.2mm

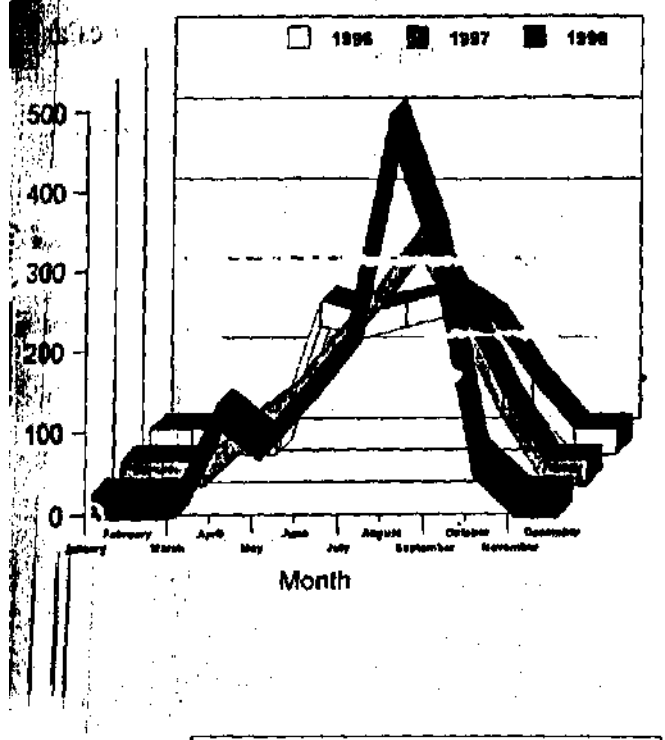

Fig. 1. Rainfall and relative humidity at Samaru, Zaria during the 1996, 1997 and 1998 cropping seasons.

in 1997 spread over 79 days between April and October while in 1998, total rainfall was 1349.2mm spread over 79 days between April and October.

Foliar anthracnose appeared early in the season (28 DAS) on the susceptible check SAMSORG 3 (BES- Bauchi Early Selection =KSV4) and disease ratings were very high, 6.5 in 1996; 7.8 in 1997 and 8.3 in 1998 while on IRAT 204 a regional susceptible check, disease ratings were 8.0 in 1996, 9.0 in 1997 and 9.0 in 1998. The disease did not appear on the resistant check SAMSORG 14 (KSV 8).

Significant ($P = 0.005$) differences in the reaction of the various genotypes to the disease was observed in each year. However, there were no significant ($P=0.05$) interactions between genotype x years indicating that genotype behaviour appeared to be similar and yearly differences in abiotic conditions did not influence the reaction of the genotypes to the disease pressure.

In this study, 14 ICRISAT sorghum varieties (ICSV), 4 PB lines, 8 IS lines, 5 West African NARs lines, 2 SAMSORG varieties, 3 NR lines and 6 local varieties constituting about 27% of total lines showed resistance to foliar anthracnose (Table 1). These include ICSV 424, ICSV 1049, ICSV 93027, ICSV 95072, ICSV 95043, ICSV 95044, ICSV 95045, ICSV 95046 and ICSV 95957 which exhibited complete resistance (Table 2). Among the PB lines, PB 15833-1-1, PB 14844-1, PB 155020-2-2-2 and PB 15828-2-1-11 were highly resistant to the disease. Lines IS 854, IS 8354, IS 3758, IS 3552, IS 1006 and IS 12447 were also highly resistant. Local varieties including *Gaya Early, Bagauda Farafara, YarDu, Jawo Sanda, Kaura* and *Mori* showed high resistance to the disease. Five IAR improved lines and cultivars such as SAMSORG 17, SAMSORG 14, NR 71198, NR 71176 and NR 71137 were also resistant to foliar anthracnose.

Many of the ICRISAT sorghum varieties with resistance to the disease have been released to farmers in some parts of the world, while many of them and IS lines identified are used in the ICRISAT breeding programme. The two SAMSORG varieties with resistance have been released to farmers in Nigeria (Aliyu and Adedipe, 1997) and are

TABLE 1 Summary of sorghum germplasm obtained from different locations/countries and evaluated for their reaction to foliar anthracnose at Samaru, 1996-1998

Genotype source	Total tested	Reaction type[1]		
		R	MR	S
ICRISAT, Nigeria				
ICSV (ICRISAT sorghum varieties)	86	14	14	58
PB (Pure breeder lines)	10	4	3	3
IS (ICRISAT sorghum)	20	8	3	9
ICSH (ICRISAT sorghum hybrids)	2	0	0	2
Local	5	4	0	1
IAR, Samaru				
West Africa NARS Lines	18	5	0	13
Samsorg Varieties	3	2	0	1
NR (Nwasike restorer lines)	13	3	0	10
Local	2	2	0	0
Total	159	42	20	97

[1]Reaction type R= resistant, MR = moderately resistant, S = susceptible.

currently grown on a wide scale. Furthermore, the local germplasm identified with resistance are grown in certain locations where they are popular. This further underscores the fact that many of Nigeria's local cultivars have adapted and are resistant to anthracnose. However, because of their inherent low yields, the need for improved varieties with higher yields becomes paramount. Many of these improved materials that have been released to farmers are however, susceptible to the disease, making the continuous search for stable resistance to the disease very important to enable their incorporation into new varieties currently being developed.

Twenty genotypes were moderately resistant to the disease, 14 of these belong to the ICSV group. Many of the genotypes (e.g. ICSV 95096, ICSV 95127, ICSV 95068 and ICSV 95071) that exhibited this level of resistance had slow disease development (data not shown). This attribute is reported to be useful for host resistance to anthracnose (Casela *et al.*, 1993; Neya and Le Normand, 1998). Thus these genotypes are also very useful in the search for host plant resistance as they serve as sources of resistance in our breeding programmes in the effort to select and introduce new sorghum germplasm which

TABLE 2 Sorghum germplasm with stable resistance to foliar anthracnose at Samaru, 1996-1998

Genotype		Disease severity		
		1996	1997	1998
PB	15929	1.5	1.5	1.5
PB	15881-3	1.0	1.0	1.5
PB	15856	1.3	1.0	1.5
PB	15833-1-1	1.0	1.0	1.0
PB	14844-1	1.0	1.0	1.0
PB	155020-2-2-2	1.0	1.0	1.0
PB	15828-2-1-11	1.0	1.0	1.0
ICSV	424	1.0	1.0	1.0
ICSV	745	1.3	1.0	1.5
ICSV	1049	1.0	1.0	1.0
ICSV	93027	1.0	1.0	1.0
ICSV	93028	1.0	1.8	1.0
ICSV	93060	1.0	1.3	1.5
ICSV	93038	1.0	1.5	1.0
ICSV	93051	1.0	1.0	1.0
ICSV	95072	1.0	1.0	1.0
ICSV	95095	1.0	2.0	1.0
ICSV	95096	2.5	1.0	2.0
ICSV	95098	1.0	2.5	1.0
ICSV	95127	2.5	1.0	2.0
ICSV	95043	1.0	1.0	1.0
ICSV	95044	1.0	1.0	1.0
ICSV	95045	1.0	1.0	1.0
ICSV	95046	1.0	1.0	1.0
ICSV	95047	1.0	1.0	1.0
ICSV	95054	1.0	1.0	1.5
ICSV	95055	1.0	2.5	1.0
ICSV	95057	2.0	1.5	2.5
ICSV	95058	2.0	3.0	1.5
ICSV	95060	3.0	1.8	3.0
ICSV	95061	2.0	1.0	2.3
ICSV	95067	1.0	2.0	1.0
ICSV	95071	2.0	1.5	2.5
ICSV	93082	1.5	3.0	1.5
ICSV	735	3.0	1.0	2.5
IS	8354	1.0	1.0	1.0
IS	3758	1.0	1.0	1.0
IS	3552	1.0	1.0	1.0
IS	2508	1.0	2.0	1.0
IS	6928	1.0	1.0	2.0
IS	854	1.0	1.0	1.0
IS	1006	1.0	1.0	1.0
IS	12467	1.0	2.0	1.0
IS	17141	1.5	1.5	2.0
IS	18760	1.0	1.0	1.5
IS	12447	1.0	1.0	1.0

Table 2 Cont'd in P. 22

Table 2 Cont'd in P. 21

Genotype	Disease severity		
	1996	1997	1998
Gaya Early	1.0	1.0	1.0
Baganda Farafara	1.0	1.0	1.0
Yar Du	1.0	1.0	1.0
Jawo Sanda	1.0	1.0	1.0
Framida	1.0	1.0	1.0
SAMSORG 14 (KSV 8)	1.0	1.0	1.0
SAMSORG 17 (SK 5912)	1.0	1.0	1.0
Kaura (Local)	1.0	1.0	1.0
CSM 219-E	1.0	1.0	1.0
NR 71198	1.0	1.0	1.0
NR 71176	1.0	1.0	1.0
NR 71137	1.0	1.0	1.0
Singe 2	1.0	1.0	1.0
84-W-830	1.0	1.0	1.0
84-5-130	1.0	1.0	1.0
Mori (Local)	1.0	1.0	1.0
SAMSORG 3 (susceptible check)	6.5	7.8	8.3
IRAT 204 (regional susceptible check)	8.0	9.0	9.0
Mean[2]	3.72	3.99	4.15
SEM (±)	1.13	0.39	0.29
CV%	30.32	9.66	7.10
DF Error	158	158	158
LSD	2.22	0.76	0.58

[1]Visual rating scale of 1-9, where 1 = no symptoms on leaf surface; 2 = 1-5% of leaf area of plant damaged b disease; 3-6 - 10% leaf area of plant damaged by disease; 4=11 - 20% leaf area of plant damaged by disea 5= 21-30% leaf area of plant damaged by disease; 6=31-40% leaf area of plant damaged by disease; 7=41-50 leaf area damaged by disease; 8=51-75% leaf area of plant damaged by disease and 9= >75% leaf area wi disease.

[2]Mean, SEM, CV(%), DF Error and LSD are values obtained from analysis of variance of seveity data of 1 genotypes evaluated.

are high-yielding, adaptable to the various ecological zones and with resistance to biotic constraints. Therefore, based on the results of a survey of the Nigerian savanna in 1996, in which it was observed that panicle anthracnose (affecting the peduncle, rachis, glumes and grains) was prevalent on local and improved varieties in farmers fields (Marley, 1997b), it became desirable that genotypes identified in this study should be further evaluated for resistance to panicle anthracnose. This is subject to further investigations.

The main aim of this evaluation was to identify sources of stable resistance to foliar anthracnose under natural conditions during the rainy season at a location where disease pressure is high enough to determine resistance as stated by Tinline *et al.*, (1989). These conditions which further include warm and high relative humidity during the wet season (Pande *et al.*, 1994) were prevalent

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