Development of Gray Leaf Spot on Sorghum in Burkina Faso

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ABSTRACT

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The development of gray leaf spot on sorghum, caused by *Cercospora sorghi*, was monitored between 1986 and 1988 for a total period of 5 wk each year. The top four leaves of tagged plants infected by natural inoculum were rated weekly for disease severity on a 1–6 scale. Symptoms of gray leaf spot first appeared either shortly before or several days after anthesis. Thereafter, the progress of the disease was slow and symptoms became more severe toward physiological maturity. Final disease severity ratings on the fifth week in 1986 were 3.3, 3.6, and 3.9 for the sorghum lines ICSV 1001 BF, ICSV 16-3 BF, and ICSV 20-1 BF, respectively. In the following years, disease ratings on the fifth week were 4.8, 5.6, and 6.0 in 1987 and 2.4, 3.6, and 5.5 in 1988 for ICSV 1001 BF, ICSV 16-3 BF, and IS 18696, respectively. Area under the disease progress curve was largest for ICSV 1001 BF in 1986 and for IS 18696 in 1987 and 1988. The late appearance of gray leaf spot in West Africa implies that the disease may have little effect on yield.

Gray leaf spot on sorghum (*Sorghum bicolor* (L.) Moench), caused by *Cercospora sorghi* Ellis & Everh., occurs in sorghum growing regions where warm, wet weather prevails during the growing season, and it is probably the most widely distributed foliar disease of sorghum (6). Gray leaf spot is considered among the more serious diseases of sorghum in Mexico (2), the Philippines (3), and Venezuela (7).

Gray leaf spot is widespread on sorghum in the Northern Guinean Zone (1,000–1,200 mm of annual rainfall) and in the wetter parts of the Sudanian Zone (500–1,000 mm of annual rainfall) of semiarid West Africa. Zummo (10) considered the disease as probably the most widespread of all sorghum diseases in West Africa. In a limited survey of farmers' fields in Burkina Faso, gray leaf spot was recorded in 18 of 28 farms in 1985 and in all 25 farms surveyed in 1986 (*unpublished data*). General observations of numerous local and improved sorghum genotypes in Burkina Faso, Côte d'Ivoire, and Mali indicated that symptoms of gray leaf spot first appear toward anthesis and that the disease becomes severe only at physiological maturity (*unpublished data*). The widespread occurrence of the disease and the susceptibility of many local and improved genotypes warrant studies on the effect of the disease on sorghum. Precise data on the progress of gray leaf spot in relation to the growth stages of sorghum and the effect of the disease on yields are lacking for West Africa. The objective of this study was to follow the development of gray leaf spot to determine at which sorghum growth stage epidemics were most severe. A preliminary report has been published (1).

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MATERIALS AND METHODS

Field experiments were conducted at the Farako-Ba experimental station in 1986 and at the Niangoloko station in 1987 and 1988. Farako-Ba and Niangoloko are in the Northern Guinean Zone in southwest Burkina Faso. Plants were sown in 4-m rows, with 80 cm between rows and 40 cm between hills, with two plants per hill.

The 1986 experiment. Three medium-duration improved sorghum inbred genotypes (ICSV 1001 BF, ICSV 16-3 BF, and ICSV 20-1 BF) susceptible to gray leaf spot were sown on 20 June in three-row plots in a randomized block design replicated three times. Gray leaf spot severity from natural inoculum was assessed on five tagged plants randomly selected from the center row of each plot. Disease severity ratings were based on a scale of 1–6, where 1 = no symptoms, 2 = up to 5%, 3 = 6–25%, 4 = 26–50%, 5 = 51–75%, and 6 = more than 75% of the leaf area infected. The flag leaf and the three successive lower leaves were rated separately. For the five plants in a given plot, disease ratings began when symptoms first appeared on any plant in that plot and continued on a weekly basis for 5 wk. The disease severity ratings of each leaf for a given plant were combined and averaged to give a single rating per plant. The mean disease ratings from the five plants for each plot were used in the analysis of variance. Disease severity ratings were also plotted against time in weeks, and the area under the disease progress curve (AUDPC) was calculated for each genotype in a given plot from the relationship, $\sum_{i=1}^{n} [(D_{i+1} + D_i)/2][t_{i+1} - t_i]$, where D_i = disease severity ratings at the ith observation, t_i = time in days at the ith observation, and n = total number of observations (8). Least significant differences were calculated for all data and comparisons were made at $P \leq 0.05$.

The 1987 and 1988 experiments. The experiments were sown on 26 June 1987 and 1 July 1988. The genotype ICSV 20-1 BF was replaced with germ plasm line IS 18696. Experimental procedures were as described for 1986, except that each plot consisted of seven rows and disease severity ratings were taken from 20 plants in the three central rows of each plot; however, in 1988, only 18 were assessed per plot for ICSV 16-3 BF. Disease assessment started at 77 and 76 days after sowing in 1987 and 1988, respectively. In 1988, evaluation of the leaf area infected was difficult on IS 18696 because of the presence of leaf anthracnose (caused by *Colletotrichum graminicola* (Ces.) Wils.).

RESULTS

1986. Symptoms of gray leaf spot first appeared on the top four leaves of the five tagged plants on the average of 2 and 9 days before 50% flowering for ICSV 1001 BF and ICSV 20-1 BF, respectively, and at 9 days after 50% flowering for ICSV 16-3. Disease progress was slow after flowering, and final disease ratings did not exceed 3.9 for any genotype. Eor example, the sixth and final disease severity ratings were 3.3 for ICSV 1001 BF, 3.6 for ICSV 16-3 BF, and 3.9 for ICSV 20-1 BF (Fig. 1). These disease ratings were taken on the average at 33, 34, and 26 days after 50% flowering, respectively.

1987 and 1988. In 1987, symptoms first appeared on the top four leaves between 9 and 22 days after 50% flowering for all tagged plants in all plots for all three genotypes. The disease progressed slowly until about 30 days after 50% flowering for ICSV 16-3 BF and IS 18696 and 36 days after 50% flowering for ICSV 1001 BF. The development of the disease was more uniform and rapid in IS 18696. The disease became severe only toward physiological maturity. Final disease severity ratings were 4.8 for ICSV 1001 BF, 5.6 for ICSV 16-3 BF, and 6.0 for IS 18696 (Fig. 2A). They were taken at 50 days after 50% flowering for ICSV 1001 BF and IS 18696 and 44 days after 50% flowering for ICSV 16-3 BF.

A similar trend in the general development of gray leaf spot occurred in 1988 but disease progress was slower. Final disease severity ratings were 2.4 for ICSV 1001 BF, 3.6 for ICSV 16-3 BF, and 5.5 for IS 18696 (Fig. 2B), taken at 39 days after 50% flowering for ICSV 1001 BF and IS 18696 and 41 days after 50% flowering for ICSV 16-3 BF.

AUDPC. In 1986, the AUDPC was largest for ICSV 1001 BF, followed by ICSV 20-1 BF, and lowest for ICSV 16-3 BF; however, the differences were not significant ($P \leq 0.05$) (Table 1). The AUDPC for 1987 and 1988 at Niangoloko allowed comparisons to be made between genotypes and between seasons. The largest AUDPC for both 1987 and 1988 was obtained for IS 18696 and, in 1987, the value was significantly larger ($P \leq 0.05$) than those for ICSV 1001 BF and ICSV 16-3 BF. Although the AUDPC for ICSV 1001 BF was smaller than that for ICSV 16-3 BF in both years, the differences were not significant ($P \leq 0.05$) (Table 1).

DISCUSSION

Though it had been suggested that gray leaf spot appears late in the season, precise data were lacking in support of this observation. Results of this study produced the first experimental data to show that, under West African conditions, gray leaf spot symptoms first appear relatively late. First appearance occurred toward anthesis, and the disease progressed slowly, becoming more severe only toward physiological maturity (Figs. 1 and 2). In an experiment conducted at Farako-Ba in 1988, nine of 12 genotypes were susceptible to gray leaf spot with disease severity ratings between 3.2 and 6.0 at the end of a 5-wk period. At the fourth week when all nine genotypes were between 28 and 37 days after 50% flowering, only two genotypes had disease ratings of more than 5.0 (*unpublished data*). Similar conclusions based on general observations have been made by others. Zummo (10) observed that gray leaf spot generally occurred late in the growing season after the crop was mature and suggested that the disease was of minor importance. However, Frederiksen and Franklin (4) believed that the late appearance of gray leaf spot might be attributable to the lack of initial source of inoculum and less to host maturity. In this study, it is not known whether symptoms appeared late because the plants were resistant at the earlier growth stages. It would be useful to compare AUDPC from both natural and artificially prepared inoculum on many more sorghum genotypes under different climatic conditions. Differences in the total amount of disease between genotypes and seasons were detectable from AUDPC (Table 1).

The results and conclusions in this paper are based on disease severity ratings from the top four leaves. The reason for this is twofold. First, lower leaves senesce early and are more often attacked by other fungi, making evaluation more difficult. Second, based on work on yield loss on barley from *Rhynchosporium secalis* (Oudem.) J. J. Davis, James (5) suggested that one or two leaves were often adequate for assessment in cereals. Also, the period of disease assessment in this study was limited. For example, the final disease ratings for 1986, 1987, and 1988 were carried out on the average between 26 and 34, 44 and 50, and 39 and 41 days after 50% flowering, respectively. The time from anthesis to physiological maturity varied from 31 to 56 days in several sorghum genotypes (9). Leaf disease assessment carried out beyond physiological maturity would be meaningless, because grain filling would have ceased, and would also be inaccurate, because of natural senescence and the presence of other microorganisms on the leaf surface.

If gray leaf spot epidemics start toward flowering and become severe only toward grain maturity, the implication is that the disease may not cause serious losses in yield. Extensive foliar damage could result from infection by *C. sorghi* in susceptible cultivars, but the economic impact is hard to assess because epidemic development usually occurs near crop maturity (6). Zummo (10) is of the opinion that little loss results from gray leaf spot and, therefore, control measures are not warranted. If this is true, then lower priority should be given to gray leaf spot of sorghum in crop improve-

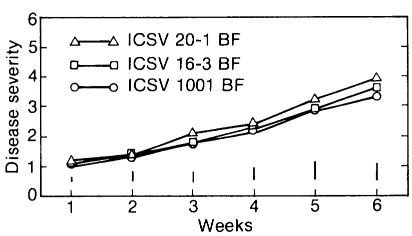

Fig. 1. Progress of gray leaf spot in the top four leaves from natural inoculum for three sorghum genotypes (ICSV 1001 BF, ICSV 16-3 BF, and ICSV 20-1 BF) at Farako-Ba, Burkina Faso, in 1986. Disease severity based on a 1–6 scale, where 1 = no symptoms, 2 = up to 5% of the leaf area infected, 3 = 6–25%, 4 = 26–50%, 5 = 51–75%, and 6 = more than 75% of the leaf area infected. The first week corresponded on the average to 2 and 9 days before 50% flowering for ICSV 1001 BF and ICSV 20-1 BF, respectively, and to the same day as 50% flowering for ICSV 16-3 BF. Vertical bars are LSD values ($P = 0.05$).

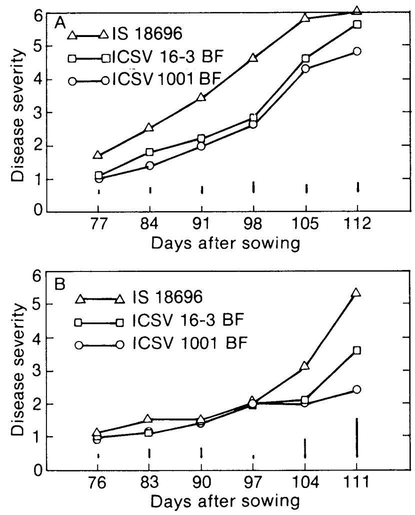

Fig. 2. Progress of gray leaf spot in the top four leaves from natural inoculum for three sorghum genotypes (ICSV 1001 BF, ICSV 16-3 BF, and IS 18696) at Niangoloko, Burkina Faso, in **(A)** 1987 and **(B)** 1988. Disease severity based on a 1–6 scale, where 1 = no symptoms, 2 = up to 5% of the leaf area infected, 3 = 6–25%, 4 = 26–50%, 5 = 51–75%, and 6 = more than 75% of the leaf area infected. Times to 50% flowering were 62 days after sowing for ICSV 1001 BF and IS 18696 and 68 days for ICSV 16-3 BF in 1987 and 72 days for ICSV 1001 BF and IS 18696 and 69 days for ICSV 16-3 BF in 1988. Vertical bars are LSD values ($P = 0.05$).

Table 1. Mean area under the disease progress curve (AUDPC) for gray leaf spot on four sorghum genotypes from natural inoculum at Farako-Ba and Niangoloko in Burkina Faso, 1986–1988

	AUDPC[z]		
	Farako-Ba	**Niangoloko**	
Genotype	**1986**	**1987**	**1988**
ICSV 1001 BF	224 a	244 a	152 a
ICSV 16-3 BF	196 a	271 a	173 ab
IS 18696	···	355 b	222 b
ICSV 20-1 BF	201 a	···	···

[z] AUDPC $= \sum_{i=1}^{n} [(D_{i+1} + D_i)/2]\,[t_{i+1} - t_i]$, where D_i = disease severity rating at the ith observation, t_i = time in days at the ith observation, and n = total number of observations (8). Based on ratings of the top four leaves using a 1–6 scale, where 1 = no symptoms and 6 = more than 75% of the leaf area infected. In a column, values followed by the same letter are not significantly different using LSD ($P \leq 0.05$).

ment programs in West Africa. However, precise measurements of actual yield losses must be determined.

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