Cercospora sojina Race 5: A Threat to Soybeans in the Southeastern United States

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ABSTRACT

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Severe frogeye leafspot was found on soybeans (*Glycine max*) at widely separated locations in Georgia during the 1978 growing season. The reaction of several soybean cultivars to *Cercospora sojina* isolated from these plants indicated that it differed from previously described races. The isolate from Georgia was designated race 5. Cultivar Bragg and other widely grown cultivars are susceptible to race 5. The reactions of many cultivars grown in the southeastern USA are presented.

Frogeye leafspot of soybeans (*Glycine max* (L.) Merr.) caused by *Cercospora sojina* Hara first occurred on soybeans in the USA in the 1920s (4–6, 11). By the late 1940s, it had become a serious disease in parts of the Midwest (2). The widespread use of resistant cultivars greatly reduced the incidence of this disease until the late 1950s when race 2 appeared (3). In the mid 1960s, races 3 and 4 were found in North Carolina (10), but frogeye has not become a widespread threat to soybean production in the southeastern USA.

During the 1978 season the newly released cultivar GaSoy 17 was found to be seriously diseased in three widely scattered locations in Georgia, despite weather conditions which were apparently unfavorable for development of a foliar disease. A field of cultivar Bragg growing nearby also had serious frogeye leafspot at one location. Frogeye has recently been considered a minor disease in Georgia (7), but since over 60% of the soybean hectarage is planted in Bragg, we decided to determine the race of *C. sojina* present.

MATERIALS AND METHODS

Initially, conidia scraped from naturally infected leaves of the cultivar Bragg were used to inoculate the cultivars GaSoy 17, Roanoke, Hood, Lee, and Davis. Single lesion isolates from GaSoy 17, Bragg, Roanoke, and Hood were used to inoculate 12 cultivars. Since all cultivars reacted identically to each of the four isolates, a single lesion isolate from Bragg was used in all subsequent inoculations.

Cultures of *C. sojina* were maintained and inoculum was produced on a medium composed of equal parts of soybean stem agar (1) and lima bean agar (Difco). Conidial suspensions were made by flooding colonies of the fungus growing on agar in petri plates with sterile water and lightly scraping to dislodge conidia. The suspensions were passed through several layers of cheesecloth to remove large mycelial fragments. Conidial suspensions from agar cultures were adjusted to a concentration of 6×10^4 spores per milliliter. Twelve replicate plants at the two or three trifoliolate leaf stage were inoculated by atomizing a conidial suspension (2.5 ml per plant) onto the upper and lower leaf surfaces. Inoculated plants were placed in a moist chamber for 72 hr at 25–30 C then returned to the greenhouse bench.

The number and size of lesions were recorded 14 days after inoculation. In most experiments the plants were inoculated a second time to be certain that those without lesions were not escapes. During these experiments the greenhouse temperature was maintained between 25 and 30 C. Relative humidity was not controlled but it was nearly always above 50%.

Field inoculations were made by the same procedure, and the reactions were determined in July and early August before uninoculated soybeans in the area showed any symptoms of frogeye leafspot. Since these plants could not be placed in a moist chamber, they were inoculated late in the day. Two days of predominately overcast skies with periods of light rain followed both field inoculations.

RESULTS AND DISCUSSION

The initial inoculations of the cultivars GaSoy 17, Bragg, Roanoke, Hood, Lee, and Davis with conidia from naturally infected Bragg leaves resulted in numerous large spreading lesions on GaSoy 17, Bragg, Roanoke, and Hood, but no lesions developed on Lee and Davis.

The reactions of differential cultivars to the Bragg isolate indicated that it was different from races 1, 2, 3, or 4. Since cultures of races 1, 3, and 4 were unavailable, we relied on published descriptions of the reactions of differential cultivars to these races (3,10). The highly susceptible reaction of Hood and Roanoke distinguished the Bragg isolate from race 1, 2, and 3, and the resistant reaction of Lee and Hill distinguished it from race 4 (Table 1). The Bragg isolate was designated race 5 and deposited with the American Type Culture Collection (ATCC No. 42654).

In some greenhouse experiments, cultivars Davis, Kanrich, and Kent inoculated with race 5 developed small lesions or flecks 3–4

TABLE 1. Reaction of selected soybean cultivars to the known races of *Cercospora sojina*

Cultivar	Reaction to race					
	1[a]	2[a]	2[b]	3[a]	4[a]	5[c]
Hood	R[d]	R	R	R	S	S
Roanoke	R	R	R	R	S	S
Lee	R	R	R	S	S	R
Hill	R	R	R	S	S	R
Blackhawk	S	S	S	S	S	S
Kanrich	R	R	R	R	R	R
Davis	R	R	R	R	R	R
Bragg	R	R	R	R-S	-	S
Lincoln	R	S	S	R	-	R
Kent	R	R-S	R	R	-	R

[a] Reaction to races 1, 2, 3, and 4 as reported by Athow et al (3), and Ross (10).

[b] Reaction determined in the field.

[c] Reaction determined in both the greenhouse and in the field.

[d] S = susceptible, with numerous large spreading lesions; R = resistant, with either no lesions or a few small lesions or flecks.

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wk after inoculation; however, these cultivars clearly were resistant (Fig. 1) and showed no symptoms in field tests. Thus, the reaction of all cultivars was rated the same for both greenhouse and field inoculations with race 5.

Our results from field inoculations with race 2 (Table 1) generally agree with those previously reported for race 2 (3,10). Cultivar Kent, which Athow et al (3) found resistant and Ross (10) found susceptible, was resistant to race 2 in our tests.

There were differences among the susceptible cultivars in the number of lesions that developed on plants sprayed with a standard amount of inoculum (Table 2). Although GaSoy 17 developed nearly three times as many lesions per plant as Blackhawk, both cultivars were clearly susceptible to race 5, with large spreading lesions (Fig. 1) which caused leaf drop 2–3 wk after symptoms appeared. Under the same conditions resistant cultivars Kanrich, Lee, Davis, and Hill averaged less than one small lesion per plant. We sprayed the entire plant with conidial suspensions but, numerous lesions developed only on one or two trifoliolate leaves that were expanding at the time of inoculation. Differences in the size of the expanding leaves at inoculation could account for some of the differences in numbers of lesions on susceptible cultivars. This probably does not account for all the cultivar differences and the data in Table 2 may indicate degrees of susceptibility among the susceptible cultivars.

Because of the reduction in variance resulting from the low numbers of lesions on the resistant cultivars, we reanalyzed the data summarized in Table 2 and included the resistant and susceptible cultivars in separate analyses. By either method, Duncan's multiple range test indicated the same significant differences among cultivars.

If the plants were held 3–4 wk after inoculation, stem lesions sometimes developed on susceptible cultivars (Fig. 1). These stem lesions were very similar to those described by Lehman (5).

The reaction to inoculation with race 5 of many of the important soybean cultivars grown in the southeastern USA as well as several that have been used to differentiate races of *C. sojina* are presented in Table 3. Cultivars susceptible to race 5 account for a high percentage of the soybean production in the southeastern USA. In recent years, Bragg has been planted in over 60% of the Georgia hectarage and has been extensively planted in other southeastern states.

We do not know how long race 5 has been present or its distribution, but the dry weather during the latter parts of recent growing seasons in Georgia and some other parts of the southeastern states may have prevented extensive disease development. In a growing season more favorable for disease

TABLE 2. Relative numbers of lesions on soybean cultivars inoculated with *Cercospora sojina* race 5

Resistant cultivars	Lesions/plant (avg no.)	Susceptible cultivars	Lesions/plant (avg no.)
Kanrich	0.3 a[z]	GaSoy 17	93.3 d
Lee	0.7 a	Bragg	73.9 c
Davis	0.2 a	Roanoke	65.3 c
Hill	0.0 a	Jackson	59.0 c
		Hood	40.0 b
		Blackhawk	33.0 b

[z] Values for cultivars followed by the same letter do not differ significantly according to Duncan's multiple range test, $P = 0.05$.

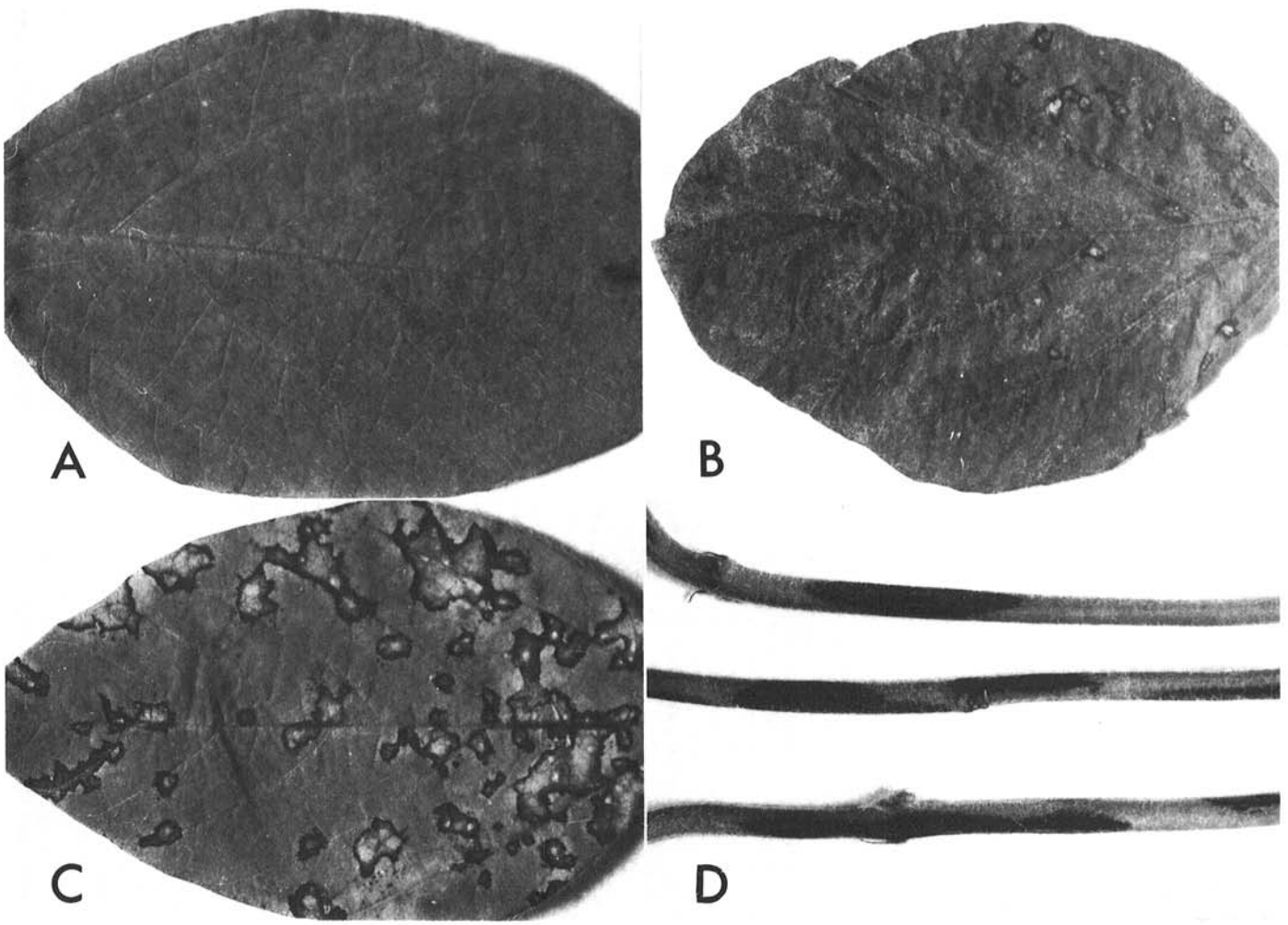

Fig. 1. Reaction of soybeans to inoculation with *Cercospora sojina* race 5. **A,** A resistant reaction showing no lesions. **B,** A resistant reaction showing a few small lesions or flecks. **C,** A susceptible reaction showing numerous large spreading lesions. **D,** A susceptible reaction showing stem lesions. (×1.5).

TABLE 3. Soybean cultivars resistant or susceptible to *Cercospora sojina* race 5

Resistant		Susceptible	
Bossier	Kent[a]	Blackhawk[a]	Govan
Centennial	Lancer	Bragg[a]	Hood[a]
Cobb	Lee[a]	Braxton	Hood 75
Coker 136	Lee 74	Brooks	Hutton
Coker 338	Lincoln[a]	Coker 156	Jackson
Davis[a]	Ogden	Coker 237	Mack
FFR 666	Ransom	Dare	McNair 500
Hill[a]	Tracy	Dowling	McNair 600
Kanrich[a]	Wright[a]	Essex	McNair 800
		Flambeau	RA 601
		Forrest	Roanoke[a]
		GaSoy 17[a]	

[a] Tested in both the greenhouse and in the field. All other cultivars were tested only in the greenhouse.

development, race 5 might cause serious losses.

Single major dominant genes condition resistance to race 1 and race 2 of *C. sojina* (2,8,9) and the inheritance of resistance to races 3 and 4 is unknown. We are in the process of determining the inheritance of resistance to race 5 and its relationship to the gene conditioning resistance to race 2.

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