Reactions of Sunflower Inbred Lines to Two Foliar Diseases

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ABSTRACT

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Twenty-four inbred lines of sunflower (*Helianthus annuus*) were evaluated for resistance to Alternaria blight and 18 inbred lines were evaluated for resistance to Septoria leaf spot in the field during the 1982 and 1983 growing seasons. Significant differences ($P \leqslant 0.05$) were detected between inbred lines for reactions to both diseases, as measured by the percentage of leaf area infected. The inbred line × year interaction term was significant in the combined analysis for both diseases. No significant differences were detected between fertile sunflower inbred lines and their cytoplasmically male sterile counterparts in resistance to Alternaria blight. Resistance to the two diseases was significantly positively correlated.

Additional key words: *Alternaria helianthi, Septoria helianthi*

Sunflower (*Helianthus annuus* L.) has become a major oilseed crop in the United States in recent years, particularly in Minnesota and the Dakotas. Concomitant with the increase in sunflower production has been an increased incidence and severity of sunflower diseases. Two foliar diseases, Alternaria blight (incited by *Alternaria helianthi* (Hansf.) Tubaki & Nishihara) and Septoria leaf spot (incited by *Septoria helianthi* Ell. et Kell.), are becoming increasingly common in sunflower fields in the Minnesota-Dakotas region. Alternaria blight has been reported to cause significant yield losses in Africa, Australia, India, and Yugoslavia (2–4,14,15). In the United States, Alternaria blight has been reported to cause damage to sunflower in Florida, Minnesota, Mississippi, Ohio, South Dakota, and Wisconsin (5,6,10,12,13; M. L. Carson, *unpublished*). Losses as great as 60% were obtained in a yield-loss study in South Dakota (5). In addition to seed yield losses, reductions in seed oil percentage have also been reported (2–5; M. L. Carson, *unpublished*).

Septoria leaf spot is also quite common, although it appears to be less damaging to sunflower than Alternaria blight. Preliminary studies indicate that Septoria leaf spot may reduce sunflower seed yields by as much as 10–15% (M. L. Carson, *unpublished*).

Genetic resistance would be the most economic means of reducing losses in sunflower to these two foliar diseases. Resistance to Alternaria blight has been reported (1,8,9). Greenhouse studies indicate high levels of resistance in several perennial relatives of *H. annuus* (9). Field studies indicate that resistance in *H. annuus* is expressed quantitatively as a reduction in leaf area infected (1,8). Significant genetic variability for Alternaria blight resistance has been found in two elite sunflower populations (8).

Resistance to Septoria leaf spot has also been reported, but the sources of resistance have not been published (15). Significant variation for Septoria leaf spot reaction has been reported in the two sunflower populations mentioned previously (8).

The objective of this study was to determine what, if any, variability exists for reaction to Alternaria blight and Septoria leaf spot among sunflower inbred lines representative of germ plasm used in the major sunflower production area of the United States.

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MATERIALS AND METHODS

Twenty-four and 18 sunflower inbred lines were evaluated in separate field experiments for resistance to Alternaria blight and Septoria leaf spot, respectively, during the 1982 and 1983 growing seasons on the Plant Science Research Farm at Brookings, SD. The inbred lines were selected as being representative either of germ plasm used in commercial hybrids or sources of resistance to other diseases. All inbred lines were assumed homozygous and appeared uniform. Individual plots consisted of single rows 3 m long and either 101 cm (1982) or 76 cm (1983) apart. Twenty seeds per row were hand-planted on 1 June (1982) and 6 June (1983); stands were not thinned. Actual final plant populations varied from plot to plot because of erratic plant emergence, but there were at least 10 plants per plot. A randomized complete block design with two replicates was used for both experiments in both years.

Plants were inoculated by placing 10–20 grains of a barley or sorghum grain culture of either *A. helianthi* or *S. helianthi* into the leaf whorl at the V_1–V_2 and V_5–V_6 growth stages (12) in 1982 and the V_2–V_3 and V_5–V_6 growth stages in 1983. No seedlings were killed by *A. helianthi*. Whole plots were later assessed visually for the percentage of leaf area infected in 1982, whereas in 1983, the Horsfall-Barratt scale (7) was used. The 1983 data were later converted to a formula percentage with Elanco conversion tables (Eli Lilly & Co., Indianapolis, IN). Alternaria blight severity was assessed on 18 August (R5–R6 growth stages) and 15 September (R9 growth stage) in 1982 and on 30 July (R2–R3 growth stages) and 18 August (R5–R6 growth stages) in 1983. Septoria leaf spot severity was assessed on 2 August (R3–R4 growth stages) and 18 August (R5–R6 growth stages) in 1982 and on 30 July (R2–R3 growth stages) and 18 August (R5–R6 growth stages) in 1983.

Data were analyzed by the analysis of variance, and Fisher's LSD ($P \leqslant 0.05$) was used to compare treatment means. Alternaria blight severities on 15 September 1982 and 18 August 1983 and Septoria leaf spot on 18 August 1982 and 18 August 1983 were used in the combined analyses over years. The inbred line × year interaction terms, all significant ($P \leqslant 0.05$), were used as the error terms in detecting significant differences between inbred line disease reactions over the 2-yr period. The simple correlation coefficient between mean reactions to the two diseases was also calculated.

RESULTS AND DISCUSSION

The sunflower inbred lines varied in their reactions to both Alternaria blight and Septoria leaf spot (Table 1). Alternaria blight had not developed sufficiently by 18 August 1982 for significant differences to be detected between inbred lines, but by 15 September, mean severities ranged from 30% (cms HA 89) to 95% (RHA 298 and RHA 299), and significant ($P \leqslant 0.05$) differences were detectable. In 1983, disease development was sufficiently rapid that significant differences in Alternaria blight reaction were detected on 30 July. On 18 August 1983, disease severities ranged from 19% (HA 89, cms

Table 1. Reactions of sunflower inbred lines to Alternaria blight and Septoria leaf spot during the 1982 and 1983 growing seasons at Brookings, SD

	Disease reaction[a]									
	Alternaria blight					Septoria leaf spot				
	1982		1983		Av.[b] 15 Sept. 1982/	1982		1983		Av.[b] 18 Aug. 1982/
Inbred line	18 Aug.	15 Sept.	30 Jul.	18 Aug.	18 Aug. 1983	2 Aug.	18 Aug.	30 Jul.	18 Aug.	18 Aug. 1983
CM 100	18[b]	80	19	50	65	25	30	19	50	40
CM 361	20	75	9	50	63	10	13	9	23	18
CM 400	15	70	38	63	66	13	15	19	63	39
HA 61	8	70	19	50	60	5	5	9	38	21
HA 89	5	45	7	19	32	13	15	9	28	22
cms HA 89	5	30	7	19	24	...	...	...	...	...
HA 99	10	60	14	38	49	13	13	9	28	20
cms HA 124	5	45	5	28	37	...	...	...	...	...
HA 234	8	35	19	50	43	8	13	38	38	25
HA 300	4	35	9	28	32	4	8	9	14	11
cms HA 300	5	35	9	28	32	...	...	...	...	...
cms HA 301	4	65	23	63	64	...	...	...	...	...
HA 302	12	55	9	19	37	8	18	9	19	18
cms HA 302	5	45	9	28	37	...	...	...	...	...
HA 303	15	65	14	63	64	1	8	19	38	23
cms HA 303	15	40	9	63	51	...	...	...	...	...
HA 338	15	75	19	91	83	15	25	9	63	44
HIR 34	15	80	19	63	71	13	15	38	63	39
RHA 265	8	75	9	28	52	1	7	5	28	18
RHA 273	8	85	14	50	68	2	4	9	41	23
RHA 274	5	75	9	28	52	10	10	9	38	24
RHA 297	5	70	7	38	54	13	15	19	38	27
RHA 298	13	95	14	28	62	2	3	5	19	11
RHA 299	8	95	12	50	73	2	5	5	28	17
FLSD (0.05)	NS	35	11	24	31	6	7	16	24	19

[a]Data are estimated percent disease severities. In 1982, whole plots were assessed visually for percentage of leaf area infected. In 1983, the Horsfall-Barratt scale (7) was used; 1983 data were later converted to a formula percentage with Elanco conversion tables.
[b]Mean of two replicates per year.

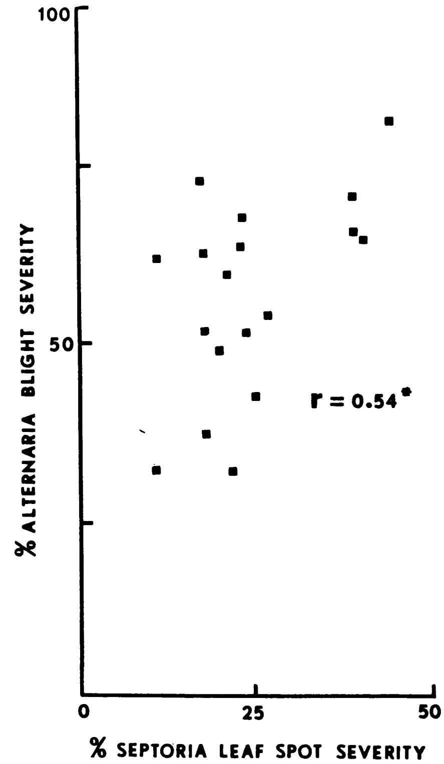

Fig. 1. Scattergram of relationship of Alternaria blight and Septoria leaf spot reactions of 18 common sunflower inbred lines. Reactions are the means of two replicates in both 1982 and 1983 (four replicates total). * = Correlation coefficient is statistically different from zero at $P \leqslant 0.05$.

HA 89, and HA 302) to 91% (HA 338). Combined over years, mean Alternaria blight ratings ranged from 24% (cms HA 89) to 83% (HA 338). Although Septoria leaf spot development was less than that of Alternaria blight, significant differences in disease severity on inbred lines were detected at both rating dates in both years. Mean severities ranged from 1% (HA 303 and RHA 265) to 25% (CM 100) on 2 August and from 3% (RHA 298) to 30% (CM 100) on 18 August in 1982. There was greater Septoria leaf spot development in 1983 than in 1982; disease severities ranged from 5% (RHA 298 and RHA 299) to 38% (HA 234 and HIR 34) on 30 July and from 14% (HA 300) to 63% (CM 400, HA 338, and HIR 34) on 18 August. Combined over years, mean Septoria leaf spot severities ranged from 11% (HA 300 and RHA 298) to 44% (HA 338).

A significant ($P \leqslant 0.05$) inbred line × year interaction was detected in the combined analyses for both diseases, indicating expression of resistance is environmentally dependent and that caution should be exercised in interpreting disease reactions from a single environment. Increased replication and sampling of environments would be necessary to detect small differences in levels of Alternaria blight and Septoria leaf spot resistance among sunflower inbreds.

The hybrid sunflower seed industry in the United States is currently dependent on a single source of cytoplasmic male sterility for economic hybrid seed production. Hence, all hybrid sunflowers grown in the United States are cytoplasmically uniform. No significant differences in Alternaria blight reactions were detected between four fertile female inbred lines and their cytoplasmically male sterile (cms) counterparts (Table 1). No cms lines were evaluated for Septoria leaf spot reactions.

A significant ($P \leqslant 0.05$), positive phenotypic correlation ($r = 0.54$) was detected between reactions to the two diseases (Fig. 1). This agrees with results obtained by Mehdi et al (8), who found significant, positive phenotypic and genotypic correlations between reactions of S_1 lines from two open-pollinated populations to these two diseases. Therefore, selection for resistance to one disease should result in improved response in resistance to the other. This does not mean, however, that inbred lines resistant to Alternaria blight are automatically resistant to Septoria leaf spot or vice versa. The inbred lines RHA 298 and RHA 299, for example, are quite susceptible to Alternaria blight but were among those judged most resistant to Septoria leaf spot (Table 1).

Even though significant differences were detected among sunflower inbred lines for reactions to these two diseases, the usefulness of these levels of resistance in reducing disease losses is uncertain. The inbred line cms HA 89 was among those judged most resistant to Alternaria blight and yet has been shown to sustain yield losses as great as 60% after artificial inoculation with *A. helianthi* (5; M. L. Carson, *unpublished*). The search for better sources of resistance to both of these diseases should continue. The resistance reported here is expressed quantitatively as a reduction in disease severity, because no qualitative differences in reactions to the two diseases were observed. This does not preclude the possibility that qualitative or lesion-type resistance might not be found in the great diversity of *H. annuus* germ plasm available. Until specific information is available on the inheritance of these quantitative resistances to these two diseases, the use of artificial inoculation methods in conjunction with a recurrent selection scheme based on some sort of progeny test is probably the best strategy for developing source populations that will yield inbred lines with high levels of resistance.

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