

# Evaluation of wild *Helianthus annuus* for resistance to Septoria leaf blight

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## Introduction

Sunflowers are native to North America, and grow wild throughout much of the United States, Mexico, and Canada. Approximately 50 species of annual and perennial types have been identified (Heiser et al., 1969; Seiler and Gulya, 2004), with *Helianthus annuus* as the most diverse species in terms of geography and habitat (Rogers et al., 1982). Nearly all sunflower diseases are present in North America, and therefore, wild sunflowers surviving in disease-favorable environments are a potentially valuable source of disease resistance.

Septoria leaf blight of sunflower, caused by *Septoria helianthi* Ellis and Kellerman, is widely distributed throughout the world with reports from Europe, Asia, Africa, Australia, North and South America (Frandsen, 1948; Kubenkova, 1980; Liu and Lu, 1988; Petrov and Arsenijevic, 1996; Rashid and Platford, 1992 and 1994; Saharan and Singh, 1976; Yang et al., 1988). The disease is a major contributor to sunflower yield losses in China, India, and Thailand, and is most destructive under conditions of abundant rainfall (Liu and Lu, 1988; Saharan and Singh, 1976; Yang et al., 1988). Septoria leaf blight is not normally a serious problem in the main sunflower producing areas of the U.S. and Canada because rainfall in these areas is often limiting. Some variation for resistance has been reported among inbred lines (Carson, 1985; Carson, 1987).

The objectives of this study were (1) to evaluate a representative portion of the wild *H. annuus* germplasm collection for Septoria leaf blight resistance, and (2) to compare the frequency of resistance by geographic region of seed collection to determine if certain regions of the U.S. were more suitable than others for finding leaf blight resistant germplasm.

## Materials and Methods

One hundred twenty-eight wild *Helianthus annuus* accessions, from the USDA sunflower collection maintained at Ames, IA, were evaluated in field trials during 2000 and 2001. The accessions were selected from approximately 1000 wild *H. annuus* accessions in the USDA collection to represent seven broadly defined geographic regions of the U.S. (Fig. 1). The seven regions were Texas (TX, 21 accessions), Arizona-New Mexico (AZ-NM, 20 accessions), California (CA, 20 accessions), Kansas (KS, 20 accessions), North and South Dakota (ND-SD, 20 accessions), the Pacific Northwest (PNW, 19 accessions) and Illinois (IL, 8 accessions).

Accessions were grown in single-row plots with eight plants per row, and four replications arranged as randomized complete blocks. Rows were spaced 1.5m apart with a length of 4.6m. Plantings were made on 16-May-2000 and 7-Jun-2001. Many of the 128 accessions planted in 2000 were found to be highly susceptible to Septoria leaf blight. Therefore only a subset of 50

accessions was evaluated in 2001. The accessions selected included 45 with an average score of 2.75 or lower on a 1-4 rating scale, and five susceptible accessions for use as controls.

Natural field infection by *S. helianthi* was widespread in both 2000 and 2001. However, to ensure uniform inoculum distribution throughout the field, the plants were spray-inoculated with conidia from a local *S. helianthi* isolate; two inoculations were made in 2000, and three inoculations were made in 2001. Spore concentrations were adjusted to 1000 to 5000 conidia per ml using deionized water containing one drop of Tween 20 per liter.

Disease ratings were made in August when seed fill was in progress and disease development was near its peak. Each plant was rated on a 1-4 scale, with values of 1 and 2 corresponding to highly and moderately resistant plants, respectively, and 3 and 4 corresponding to moderately and highly susceptible plants, respectively. Individual plant scores were averaged to obtain a plot mean, and the four plot means were averaged to obtain the overall rating for each accession.

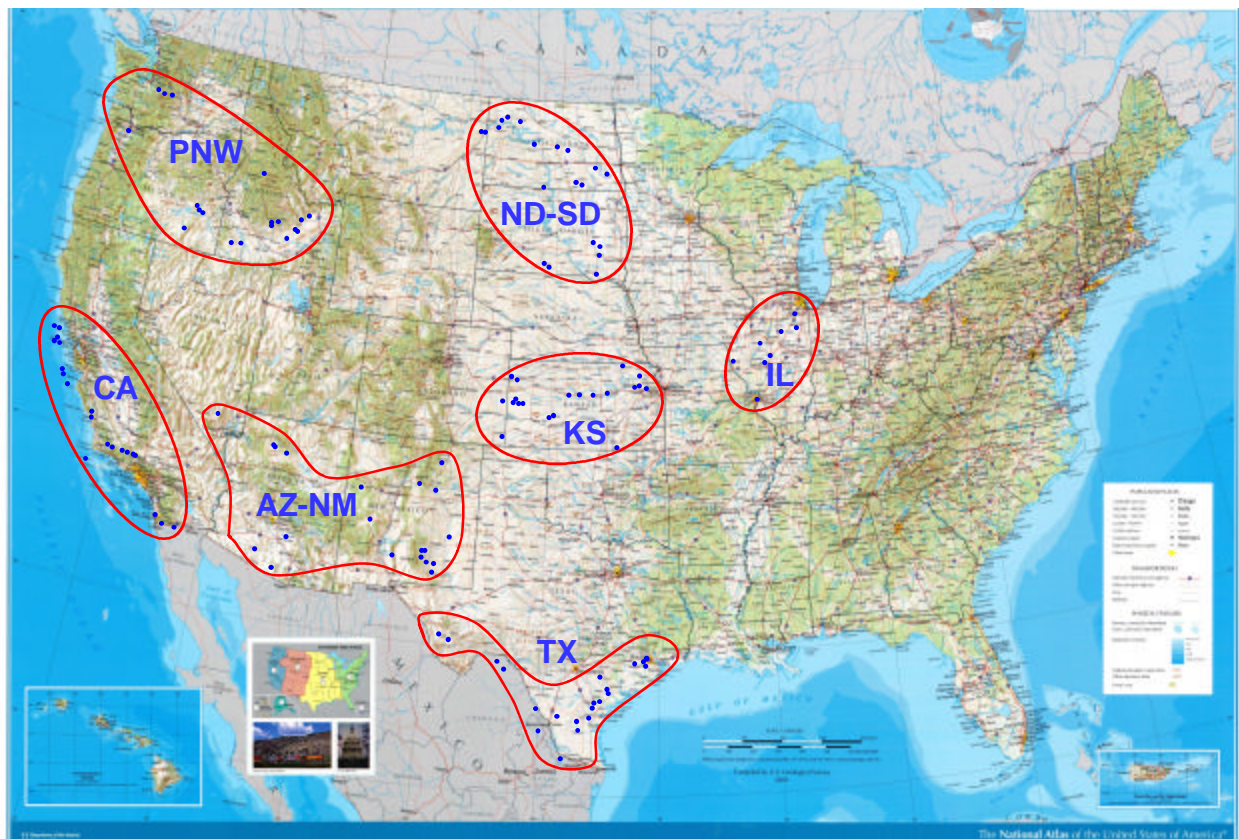


Figure 1. Seven groups of accessions and their geographic regions.

## Results and Discussion

All 39 accessions from California and the Pacific Northwest were found to be extremely susceptible (Table 1). Plants from these accessions were virtually defoliated or killed by mid-August, and averaged almost 4.0 on the rating scale. Sixteen of the 20 accessions in the AZ-NM group and 13 of 20 from the ND-SD group were also quite susceptible, with ratings above 3.0.

The climates in the Western and Southwestern U.S. locations where these accessions originated tend to be dry to desert-like environments. Germplasm from such areas would be unlikely sources of *Septoria* leaf blight resistance due to lack of disease pressure.

Table 1. Average *Septoria* rating for accessions from each geographic region.

Location	Number of accessions	Average <i>Septoria</i> rating <sup>z</sup>
Pacific-NW	19	3.99 a
California	20	3.96 a
Arizona-NM	20	3.40 b
N-S Dakota	20	3.19 c
Texas	21	2.41 d
Kansas	20	2.41 d
Illinois	8	2.26 d

<sup>z</sup> Means followed by the same letter are not significantly different according to the Waller-Duncan test (K-ratio=100). Minimum significant difference = 0.166.

The KS, IL, and TX groups of accessions showed significantly better resistance than accessions from any of the other regions, averaging below 2.5 on the rating scale (Table 1). A closer examination showed a wide range of resistance, particularly among accessions within the KS and TX groups (Fig. 2). These accessions were populations with somewhat variable plant types and disease reactions, and thus, a mix of 2 and 3 rating scores within a plot or even 1, 2, and 3 ratings was not unusual. It is important to distinguish between plants rating a two versus a three because the difference is significant. A two rating was used for plants with few leaf spots and minor leaf loss while a three rating was used for plants that were heavily infected, with up to 50% leaf loss.

An arbitrary cutoff value of 2.25 was used to select accessions that contained a high proportion of resistant plants (values of 1 and 2), but still allowed for the occasional three rating. Twenty-one accessions had two-year averages below 2.25, nine from Kansas (Fig. 3), seven from Texas (Fig. 4), four from Illinois (Fig. 3), and one from South Dakota (Fig. 3). At the most resistant end (yellow bars in Fig. 2) were three accessions from Texas (PI 435419, PI 435427, and PI 468511) and one accession from Kansas (PI 586863).

The approximate geographic locations and PI numbers for the 21 most resistant accessions are shown in Figs. 3 and 4. It is notable that all of the resistant Texas accessions originated along the Gulf coast (Fig. 3). This Gulf coast was expected to be a potential source of resistant germplasm because of its high rainfall and humidity. Sunflower diseases in this area have not been catalogued, and we are not sure if *Septoria helianthi* occurs naturally, but the environment is suitable for disease development.

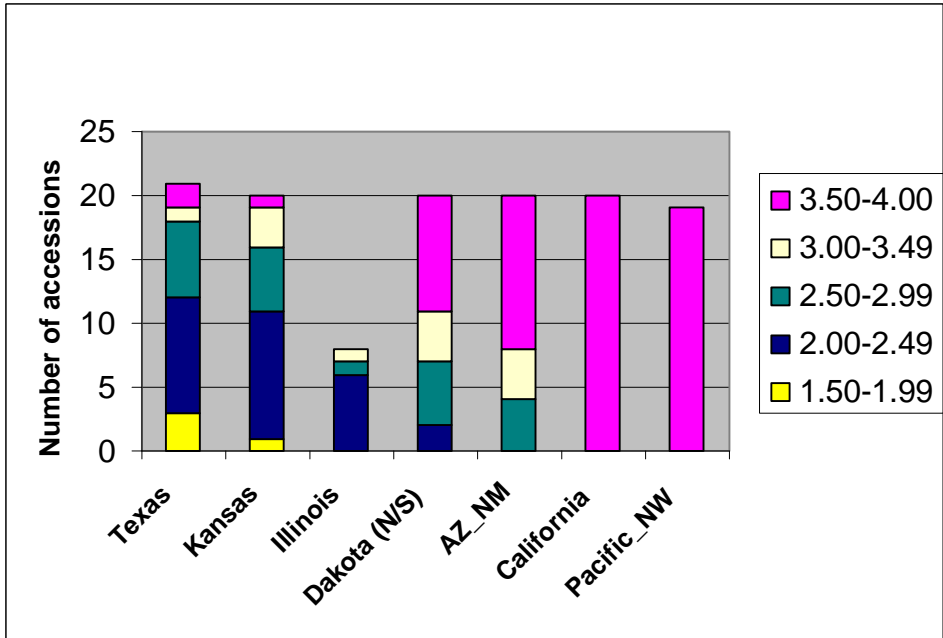


Figure 2. Number of accessions with *Septoria helianthi* resistance levels from each geographic region.

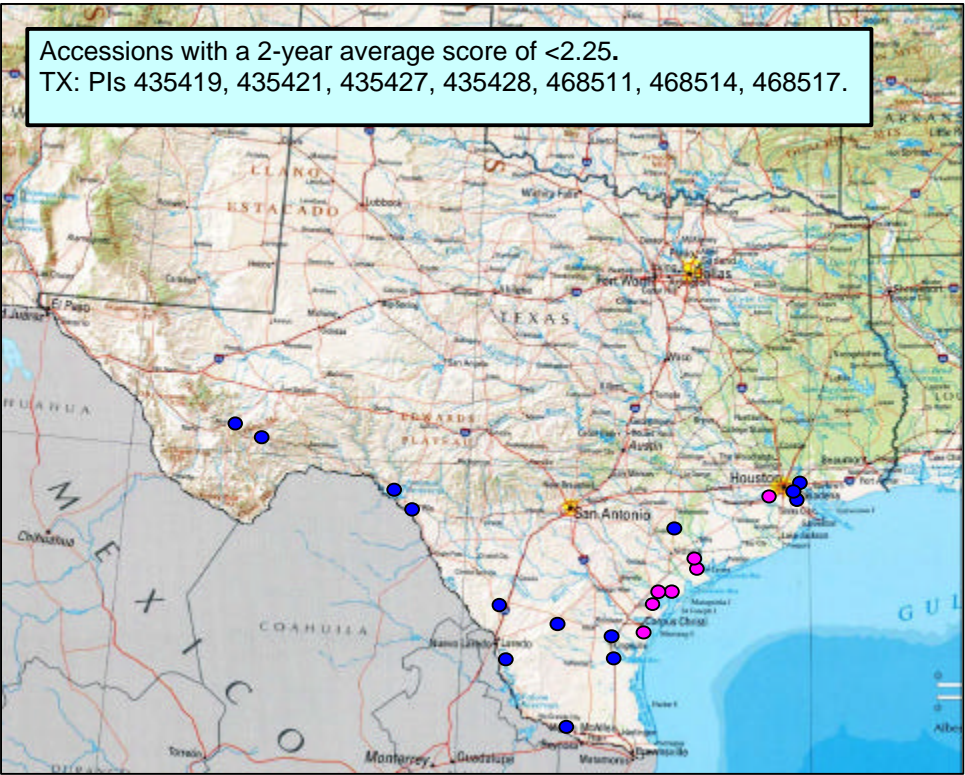


Figure 3. Location of TX accessions with superior disease resistance in both 2000 and 2001. Pink dots indicate locations of seven accessions (see inset) with a 2-year average score of  $<2.25$ .



While *Septoria* resistance in some of the Gulf coast material was anticipated, the generally good resistance in the sunflowers from the Midwest was not expected. The western Kansas accessions tended to be quite susceptible, but there was surprisingly good resistance in eastern Kansas. Most of the accessions from North and South Dakota were moderately to highly susceptible; however, PI 597893 (from SD) performed well in both years. Four of the Illinois accessions were represented in the resistant group (<2.25), but seven of the eight had good scores, averaging 2.5 or better for two years (data not shown).

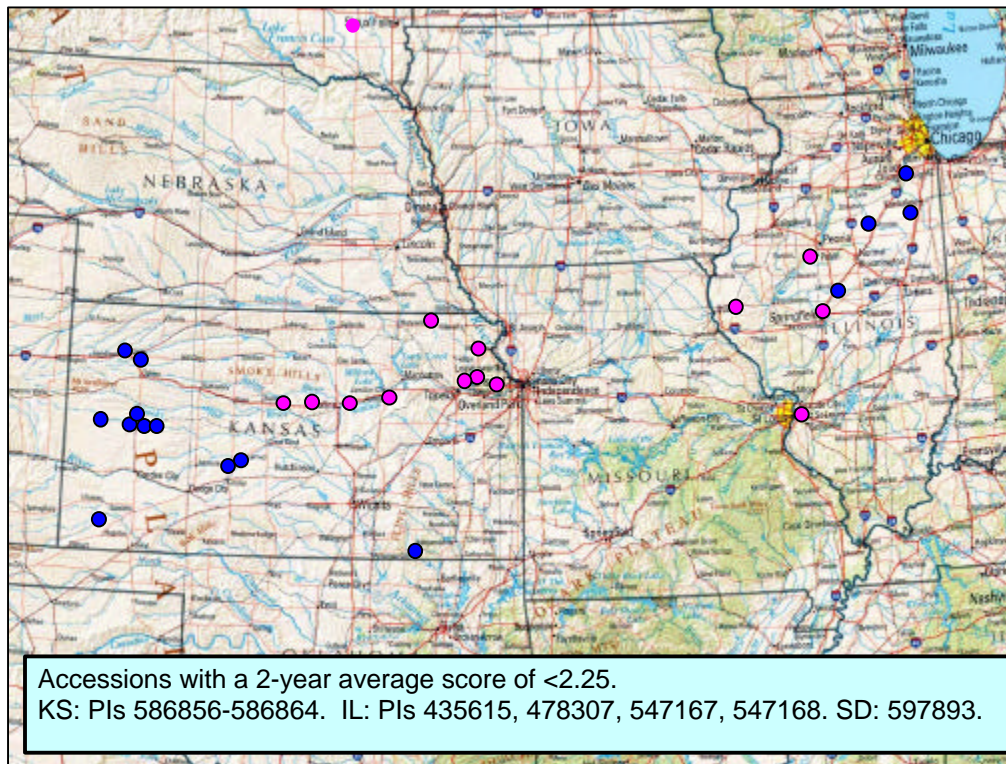


Figure 4. Location of KS and IL accessions with superior disease resistance in both 2000 and 2001. The pink dots indicate locations of 14 accessions (see inset) with a 2-year average score of <2.25.

## Summary and Conclusions

Resistance to *Septoria* leaf blight was fairly common, and was clustered in accessions from Texas and the central Midwest. There are many untested wild *H. annuus* accessions from these areas in the sunflower germplasm collection and they would be potential candidates for further disease resistance evaluations. Although no accessions from Missouri were tested, the resistance of the Kansas and Illinois material indicates that resistance is likely to be found in Missouri accessions and probably Iowa accessions as well. The genetic nature and inheritance of *Septoria* leaf blight resistance is not known, nor is it certain that resistance would be as effective in cultivated sunflower as it is in the wild species. Nevertheless, wild *H. annuus* germplasm contains potentially useful disease resistance genes that could be used to improve cultivated sunflowers without the need for interspecific hybridization.

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