

# Reaction of *Helianthus* Species to *Alternaria helianthi*

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## ABSTRACT

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Among the 21 annual and 37 perennial *Helianthus* taxa and a closely related annual taxon, *Tithonia rotundifolia*, tested for resistance to *Alternaria helianthi* in the greenhouse, only *H. hirsutus*, *H. rigidus* subsp. *subrhomboideus*, and *H. tuberosus* were moderately resistant. This resistance may be transferable to cultivated sunflower (*H. annuus*) by backcross breeding of the inbred lines with the resistant perennial species.

*Alternaria helianthi* (Hans.) Tub. and Nish. has caused a destructive disease of cultivated sunflower (*Helianthus annuus* L.) in Florida (V. E. Green, Jr., unpublished), Mississippi (6), Minnesota (5), Wisconsin (4), and Ohio (2) in the United States and in other sunflower-growing countries (4). Field plants infected with *A. helianthi* have dark brown oval necrotic spots on the heads, leaves, petals, petioles, and stems. Other leaves have dark brown necrotic spots with chlorotic halos. Several of the plants with the stems severely infected were killed. Although inbred lines of sunflower are known to be similar in their reaction to *A. helianthi*, resistance of *Helianthus* spp. to *A. helianthi* has not been studied. This paper reports the reaction of *Helianthus* spp. to infection by *A. helianthi* in the greenhouse.

## MATERIALS AND METHODS

The reaction to infection by *A. helianthi* of *Helianthus* species and subspecies and *Tithonia rotundifolia* Blake available at the USDA Conservation and Production Research Laboratory, Bushland, TX, is shown in Table 1 (see tables for botanical names). One to 23 plants of each species and subspecies were grown in a soil mixture (2 parts soil + 1 part perlite + 1 part peat moss) in 26-cm-

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diameter pots or in 35.6-cm-diameter plastic dishwasher buckets in the greenhouse. Four wood stakes were placed in each bucket 7 cm apart to separate rows, one to 12 plants per pot or one to 12 plants per row per bucket. Plants were inoculated at the four- to 10-leaf stage.

**Table 1.** Reaction of annual *Helianthus* and *Tithonia* species to *Alternaria helianthi* in the greenhouse

Species	Disease index <sup>a</sup>
<i>Helianthus agrestis</i> Pollard	4.3
<i>H. annuus</i>	5.0
<i>H. anomalus</i> Blake	5.0
<i>H. argophyllus</i> Torrey & Gray	3.8
<i>H. bolanderi</i> Gray	5.0
<i>H. debilis</i> subspecies <i>cucumerifolius</i> (Torrey & Gray) Heiser	3.9
<i>H. debilis</i> subsp. <i>debilis</i> Nutt.	5.0
<i>H. debilis</i> subsp. <i>silvestris</i>	3.0
<i>H. debilis</i> subsp. <i>vestitus</i> (Watson) Heiser	4.5
<i>H. deserticola</i> Heiser	5.0
<i>H. exilis</i> Gray	5.0
<i>H. neglectus</i> Heiser	5.0
<i>H. niveus</i> subsp. <i>canescens</i> (Gray) Heiser	5.0
<i>H. niveus</i> subsp. <i>tephrodes</i> (Gray) Heiser	5.0
<i>H. paradoxus</i> Heiser	5.0
<i>H. petiolaris</i> subsp. <i>fallax</i> Heiser	4.8
<i>H. petiolaris</i> subsp. <i>petiolaris</i> Nutt.	5.0
<i>H. porteri</i> (A. Gray) Heiser	5.0
<i>H. praecox</i> subsp. <i>hirsutus</i> Heiser	5.0
<i>H. praecox</i> subsp. <i>praecox</i> Engelman & Gray	5.0
<i>H. praecox</i> subsp. <i>runyonii</i> Heiser	5.0
<i>Tithonia rotundifolia</i> Blake	4.2

<sup>a</sup> Combined average disease index of one to 23 plants. Disease indexes: 0 = immune, 0.1-1.4 = resistant, 1.5-2.4 = moderately resistant, 2.5-3.4 = moderately susceptible, 3.5-4.4 = susceptible, and 4.5-5.0 = very susceptible (see text for derivation of index from severity ratings).

*A. helianthi* was initially isolated from infected sunflower plants by G. W. Simone, Plant Pathology Department, University of Florida, Gainesville 32611. The pathogen was maintained on plants of *Helianthus* spp. and the susceptible commercial sunflower hybrid 894 in the greenhouse at Bushland.

For the inoculation tests, the pathogen

**Table 2.** Reaction of perennial *Helianthus* species to *Alternaria helianthi* in the greenhouse

Species	Disease index <sup>a</sup>
<i>Helianthus angustifolius</i> L.	2.9
<i>H. arizonensis</i> R. Jackson	2.6
<i>H. atrorubens</i> L.	5.0
<i>H. carnosus</i> Small	4.6
<i>H. ciliaris</i> DC	2.7
<i>H. cusickii</i> Gray	5.0
<i>H. decapetalus</i> L.	3.6
<i>H. divaricatus</i> L.	3.3
<i>H. eggertii</i> Small	5.0
<i>H. floridanus</i> Gray ex Chapman	4.8
<i>H. giganteus</i> L.	2.8
<i>H. glaucophyllus</i> Smith	4.0
<i>H. gracilentus</i> Gray	5.0
<i>H. grosseserratus</i> Martens	3.0
<i>H. heterophyllus</i> Nutt.	4.6
<i>H. hirsutus</i>	2.4
<i>H. laciniatus</i> Gray	2.8
<i>H. × laetiflorus</i> Pers.	4.9
<i>H. laevigatus</i> Torrey & Gray	5.0
<i>H. longifolius</i> Pursh	5.0
<i>H. maximiliani</i> Schrader	3.6
<i>H. microcephalus</i> Torrey & Gray	2.7
<i>H. mollis</i> Lam.	5.0
<i>H. nuttallii</i> subsp. <i>nuttallii</i> Torrey & Gray	4.2
<i>H. occidentalis</i> subsp. <i>occidentalis</i> Riddell	4.8
<i>H. occidentalis</i> subsp. <i>plantagineus</i> (Torrey & Gray) Heiser	4.0
<i>H. pumilus</i> Nutt.	5.0
<i>H. radula</i> (Pursh) Torrey & Gray	4.1
<i>H. resinousus</i> Small	4.1
<i>H. rigidus</i> subsp. <i>rigidus</i> (Cass.) Desf.	2.8
<i>H. rigidus</i> subsp. <i>subrhomboideus</i>	1.7
<i>H. salicifolius</i> Dietr.	3.7
<i>H. silphoides</i> Nutt.	5.0
<i>H. simulans</i> Wats.	2.6
<i>H. smithii</i> Heiser	3.5
<i>H. strumosus</i>	3.5
<i>H. tuberosus</i>	1.8

<sup>a</sup> Combined average disease index of one to 23 plants. Disease indexes: 0 = immune, 0.1-1.4 = resistant, 1.5-2.4 = moderately resistant, 2.5-3.4 = moderately susceptible, 3.5-4.4 = susceptible, and 4.5-5.0 = very susceptible (see text for derivation of index from severity ratings).

was reisolated from the infected sunflower leaves on potato-dextrose agar (PDA) (BBL, Cockeysville, MD 21030, or Difco, Detroit, MI 48232). Spore suspensions ( $10^4$ – $10^5$  spores/ml) prepared from 2- to 4-wk-old cultures on PDA were sprayed onto leaves of each plant with a Paasche H #1 airbrush (Paasche Air Brush Co., Chicago, IL 60614). No differences in plant response to different spore concentrations were observed in preliminary experiments. Each leaf was sprayed for 3 sec at a distance of 5–7 cm from the leaf surface. Plants were incubated in a moist chamber at 16–29.4 C and 100% relative humidity for 2 days after inoculation and for an additional 7 days in the greenhouse, where temperatures varied from 7.8 to 41 C and relative humidity from 12 to 98%. Because of limited space in the moist chamber and greenhouse, the experiments were done at different seasons. This was responsible for the extreme variation in greenhouse temperature and humidity. The susceptible sunflower hybrid 894 was included in each inoculation test to verify the virulence of *A. helianthi*. Disease severity was recorded 9 days after inoculation.

A numerical rating system was used to record the severity of infection: 0 = no infection, 1 = 0.1–5% of the leaf area infected, 2 = 6–25% of the leaf area infected, 3 = 26–50% of the leaf area infected, 4 = 51–75% of the leaf area infected, and 5 = 76–100% of the leaf area infected or dead. The percent leaf area infected was determined by visually examining each leaf.

A disease index for each *Helianthus* spp. was determined by averaging the disease severity ratings derived for individual plants. In this study, disease

indexes were 0 = immune, 0.1–1.4 = resistant, 1.5–2.4 = moderately resistant, 2.5–3.4 = moderately susceptible, 3.5–4.4 = susceptible, and 4.5–5.0 = highly susceptible.

## RESULTS AND DISCUSSION

The reactions of *Helianthus* spp. to *A. helianthi* in the greenhouse experiments are shown in Tables 1 and 2. All the annual species were susceptible. The perennial *Helianthus* spp. were susceptible except for *H. hirsutus* Raf., *H. rigidus* subsp. *subrhomboideus* Heiser, and *H. tuberosus* L., which were moderately resistant. The control-susceptible hybrid 894 plants were highly susceptible.

Most of the *Helianthus* spp. died 9 days or later after inoculation. Other plants showed chlorosis with brown to black spots and malformation on the leaves. Whether *H. hirsutus*, *H. rigidus* subsp. *subrhomboideus*, and *H. tuberosus* will be resistant to *A. helianthi* in the field remains to be determined not only in Florida but in other areas suitable for infection by *A. helianthi* (*A. helianthi* has not been observed on sunflower under field conditions in Texas). These selected types resistant to *A. helianthi* should also be tested as mature plants to ensure that resistance is maintained throughout the life of the plant.

Cultivated sunflower may have a relatively restricted germ plasm base (1). Consequently, new sources of variability, primarily for disease resistance, will probably be needed as new pests or races of pests arise (1). American and Canadian scientists have confirmed observations of Soviet workers that disease resistance occurs in different taxa of wild species through interspecific hybridization,

primarily with *H. tuberosus* (1). The PI 274518 (presumably (*H. tuberosus* × *H. annuus*) × *H. strumosus* L.), previously tested by us in a different experiment, is resistant to *A. helianthi* in the greenhouse.

Among the three moderately resistant and 12 susceptible *Helianthus* taxa, only *H. debilis* subsp. *silvestris* Heiser and *H. hirsutus* are cross-compatible with *H. annuus* (3). Extensive investigations concerning cross-compatibility among and between *Helianthus* taxa are needed because resistance to *A. helianthi* exists in several cross-incompatible *Helianthus* species and subspecies. Investigations should also be conducted on ways to get around such incompatibilities.

We have begun crossing resistant *Helianthus* taxa with inbred cytoplasmic male-sterile line HA 89 and backcrossing to investigate the inheritance of resistance to *A. helianthi* under greenhouse conditions.

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