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EVALUATION OF HELIANTHUS SPP. FOR RESISTANCE TO RHIZOPUS HEAD ROT

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INTRODUCTION

Rhizopus head rot is one of the most important diseases of cultivated sunflower in Texas, especially when heads are predisposed to infection by mechanical injury (1, 3). The pathogens of *Rhizopus* head rot in Texas are *R. arrhizus* Fischer (2), *R. oryzae* Went and Prinsen-Geerligs (1), and *R. stolonifer* (Ehrenb ex Fr.) Vuill (2). *Rhizopus arrhizus* is more prevalent and virulent than *R. stolonifer* in Texas (2). Inoculation tests in the field and greenhouse showed that *R. oryzae* is as virulent as *R. arrhizus*. (Yang and Thomas, unpublished data).

Resistance of wild species of *Helianthus* to *Rhizopus* spp. is unknown. Yang et al. (2) reported that some of the plants of an *H. annuus* × *H. petiolaris* population, following inoculation with a spore suspension of *R. arrhizus* and *R. stolonifer* through a scalpel injury, showed the head rot restricted to the inoculation site.

This paper reports on the reevaluation of the resistance of these hybrids and the reactions of other sunflower hybrids and wild species to *R. arrhizus* and *R. oryzae* in the field.

MATERIALS AND METHODS

Sunflower hybrid varieties 894, 896, 27 interspecific hybrids selected from *H. annuus* × *H. petiolaris* populations, sunflower

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hybrids from A. Luciano, Argentine, and wild species of *Helianthus* were planted in the experimental plots and nurseries at Bushland, Texas.

Inocula included *R. arrhizus* and *R. oryzae*. *Rhizopus arrhizus* was isolated from diseased sunflower heads in Texas, and *R. oryzae* was supplied by J.M. Klisiewicz, USDA-SEA-AR, Davis, California. The inocula were prepared 4 to 10 days earlier, from *Rhizopus* cultures, which had been transferred to wheat-grain medium. The wheat-grain medium was prepared by leaving 20 g of wheat grains in 300 ml of tap water in a 500-ml flask overnight. The grain was then washed twice in tap water, decanted; 60 ml of tap water were added, and the medium was autoclaved for 2 hr at 121 C on 2 consecutive days.

Inoculations were made at full-bloom stage by the insertion-inoculation technique. The insertion inoculation technique which Yang and Thomas found to be an effective technique for screening greenhouse-grown sunflower for resistance to *Rhizopus* spp. (unpublished data), was used. The mycelial mat on wheat grains was inserted into the receptacle with forceps. Flowers of some wild species were too small for insertion inoculation. The receptacle of such flowers was injured first by the forceps and the inoculum (mycelial mat with wheat grains) was then fastened with a strip of adhesive tape to the site of injury on the receptacle. The sunflower heads were covered with plastic bags to maintain a high level of moisture. Sunflower hybrids 894 and 896 inoculated with the same pathogens were used as susceptible controls. Heads of each hybrid and species injured by sterile forceps only served as uninfected controls. Each treatment was replicated at least 5 times.

Disease ratings were taken 7 to 14 days after inoculation unless otherwise stated. A numerical system of 0 to 5 was used to rate the severity of rot on the head: 0, no rot; 1, rot near the inoculation injury area; 2, rot exceeding the site of inoculation but covering less than 1/4 the area of the receptacle; 3, rot exceeding 1/4 but covering less than 1/2 of the receptacle; 4, rot exceeding 1/2 but covering less than 3/4 of the receptacle; and 5, rot encircling the peduncle or greater than 3/4 the area of the receptacle. The rot index was calculated as follows:

$$\text{Rot Index} = \frac{\sum (\text{Rot rating class} \times \text{N}^\circ \text{ of heads in that class})}{\text{Total N}^\circ \text{ of heads}}$$

RESULTS AND DISCUSSION

All of the inoculated heads of sunflower plants of the 27 interspecific hybrids selected from the *H. annuus* × *H. petiolaris* population in 1978 were severely decayed (Rot index 5) by both *Rhizopus* species when inoculated by the insertion-inoculation technique. Conversely, only limited rot occurred on heads when inoculation was made by the scalpel-injury inoculation technique (2). Rot developed in 18 hr and spread to the entire head in 3 days, and some of the heads dropped to the ground within 7 days after inoculation. Their resistance in 1978 apparently was an escape from infection due to the use of an ineffective inoculation technique.

Twenty sunflower hybrids from Argentine and the five *Verticillium* resistant varieties from J.A. Hoes, Morden, Canada, were also susceptible to both *Rhizopus* species. Severe rot (Rot index, 4 and 5) occurred on all of the inoculated heads in 3 days after inoculation and some of the rotten heads were on the ground within 7 days.

The reactions of inoculated sunflower hybrids 894 and 896 and 32 wild species and subspecies and of inoculated *Viguiera porteri* to *R. arrhizus* and *R. oryzae* separately in the field are shown in Table 1. Fourteen days after inoculation, *H. divaricatus*, *H. hirsutus*, *H. × laetiflorus*, and *H. resinosus* showed rot on less than 1/4 of the receptacle of the inoculated heads. The rest of the tested wild species and subspecies were moderately (Rot index 3), to severely (Rot index 4 and 5), attacked by the two *Rhizopus* species. The responses of these four wild species of sunflower to artificial inoculation in the field suggest the possibility of control of *Rhizopus* head rot by breeding for resistance.

All of the inoculated susceptible controls (hybrids 894 and 896) were severely infected, but all of those serving as uninoculated controls remained uninfected during the test. Several heads were selected for reisolation of *Rhizopus* spp. Both *Rhizopus* species were reisolated from the inoculated heads as appropriate. No *Rhizopus* species were isolated from the uninoculated heads which served as control 14 days after inoculation.

ABSTRACT

The resistance of sunflower to *Rhizopus arrhizus* and *R. oryzae* was studied. All of the cultivated hybrids tested were susceptible to *Rhizopus* head rot. Four of the 32 wild species and subspecies tested

were resistant when inoculated separately with *R. arrhizus* and *R. oryzae*. The remaining taxa tested showed moderate to severe rot following inoculation. The resistant response of some wild species to the two most destructive *Rhizopus* pathogens of sunflower suggests the value of further screening of sunflower for resistance to *Rhizopus* head rot.

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Table 1
Reaction of *Helianthus* spp. and hybrids to *Rhizopus arrhizus*
and *R. oryzae*.

Entry	<i>R. arrhizus</i>	<i>R. oryzae</i>	No. <i>Rhizopus</i>
Hybrid 894	5 ^a	5	0
Hybrid 896	5	5	0
<i>H. annuus</i>	4	5	0
<i>H. debillis</i> ssp. <i>debillis</i>	5	5	0
<i>H. praecox</i> ssp. <i>runyonii</i>	3	5	0
<i>H. pumilus</i>	5	5	0
<i>H. arizonensis</i>	3.6	4	0
<i>H. laciniatus</i>	4.6.	5	0
<i>H. ciliaris</i>	4.4	3.8	0
<i>H. mollis</i>	5	5	0
<i>H. occidentalis</i> ssp. <i>occidentalis</i>	4	4	0
<i>H. occidentalis</i> ssp. <i>plantagineus</i>	5	5	0
<i>H. divaricatus</i>	2	2	0
<i>H. hirsutus</i>	2	2	0
<i>H. decapetalus</i>	5	5	0
<i>H. strumosus</i>	4	4.4	0
<i>H. tuberosus</i>	3.6	5	0
<i>H. × laetiflorus</i>	2.2	2.6	0
<i>H. grosseserratus</i>	4.4	4.0	0
<i>H. nuttallii</i>	5	5	0
<i>H. maximiliani</i>	4.4	4.8	0
<i>H. salicifolius</i>	4	5	0
<i>H. californicus</i>	5	5	0
<i>H. resinosus</i>	2.6	1.4	0
<i>H. schweinitzii</i>	5	5	0
<i>H. microcephalus</i>	4	4.2	0
<i>H. glaucophyllus</i>	5	5	0
<i>H. laevigatus</i>	5	5	0
<i>H. smithii</i>	5	5	0
<i>H. angustifolius</i>	5	5	0
<i>H. simulans</i>	3.5	3.4	0
<i>H. silphioides</i>	5	5	0
<i>H. atrorubens</i>	3.6	4.4	0
<i>Viguiera porteri</i>	5	5	0
<i>H. × multiflorus</i>	5	5	0

^a Average rot index calculated from 5 heads. 0 = no rot; 1 = resistant; 2 = moderately resistant; 3 = moderately susceptible; 4 and 5 = highly susceptible.