EPIDEMIOLOGY AND RESISTANCE TO SCLEROTINIA HEAD ROT IN WILD SUNFLOWER SPECIES

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Abstract

Field trials were conducted in 2002 and 2003 to study the epidemiology of Sclerotinia infections on wild sunflower heads and stems, to establish methodology for assessing wild sunflower germplasm, and to identify sources of resistance. Forty-eight populations of two wild perennial sunflowers, *Helianthus maximiliani* Schrader and *H. nuttallii* Torrey and Gray from Canada were evaluated using artificial inoculation with ascospores, fungal mycelia, and ground infected millet seed at three-week intervals starting at flowering time. Plants were covered for 14 days after inoculation with light brown paper bags, sunflower pollination bags, and thin plastic bags. The ground Sclerotinia-infected millet inoculum resulted in the highest level of infection followed by ascospores and fungal mycelia. The paper bag covering resulted in the highest infection levels. The combination of ground infected millet inoculum and the paper bag covers resulted in 88% infection in 2002 and 55% in 2003. Fifteen wild sunflower populations remained healthy under the various artificial inoculation methods in both years of this study.

Introduction

Sunflower head rot results from infection by ascospores that are produced by carpogenic germination of sclerotia of *Sclerotinia sclerotiorum* (Lib.) de Bary under saturated soil moisture conditions (Figure 1). Lack of genetic resistance has led to a steady rise in prevalence (65%) and incidence (up to 50%) of head rot in sunflower production areas of the USA and Canada in recent years. The commercial sunflower hybrids are susceptible to Sclerotinia infection with varying levels of susceptibility depending on various factors, including flowering time and duration, canopy structure, and the environmental factors affecting production of ascospores and the infection process. Wild sunflower species have been the source of resistance genes for other diseases such as rust and downy mildew in sunflower. This study aimed to understand the epidemiology of head rot in wild sunflower species, and to identify sources of resistance in the wild populations.

Materials and Methods

Field experiments were conducted in 2002 and 2003 using 48 populations of two wild perennial sunflower species, *Helianthus maximiliani* and *H. nuttallii* collected from southern Manitoba, Canada. A split-split plot design was used with 4 replicates. Main plots were inoculum type and head covering, inoculation dates were secondary plots, and wild sunflower populations were tertiary plots for a total of 384 plots. Plots consisted of a group of 10-15 plants grown in hills 0.5 m apart.

Artificial inoculum consisted of ascospores applied at $2x10^5$ per ml with 15 ml per plot; ground mycelia applied at 15 ml of suspension per plot; and ground infected millet seed dusted at the rate of 3 grams per plot. Plots infected with ground Sclerotinia-infected millet seed were sprayed with water prior to dusting with the inoculum. Plots were covered with a light brown paper bag, a thin transparent plastic bag, a perforated pollinating bag, or left open without any covering. Artificial inoculation was done at three periods of plant growth: early flowering (week 1), mid-flowering (week 3), and late flowering (week 5). A few puffs of water were sprayed into each covering using a hand-held sprayer at the second and third day after inoculation to maintain high humidity and enhance the infection and disease development processes.

A total of 96 populations of *H. maximiliani* and *H. nuttallii* were assessed for reaction to Sclerotinia head rot infections. These populations were inoculated with ascospores and ground sclerotinia-infected millet seed, and covered with paper bags, with puffs of water sprayed into the bags on the second and third day.

Plots were assessed weekly for head and stem infections starting one week after the first inoculation, using a disease index scale of 0 to 5; 0=no sign of infection, and 5=moderate to heavy infection on 50% or more of the heads or stems. The area under the disease progress curve was calculated for each treatment.

Results and Discussion

Very little infection and typical head rot symptoms occurred on the wild sunflower heads. Stems and peduncles below the heads were infected and showed typical symptoms of bleaching, shredding, and the formation of tiny cylindrical sclerotia inside the stems. Wild sunflower heads are very small and mature rapidly. Infected heads and those on infected peduncles were shriveled with very low seed set.

The results from the various treatments were similar in both years in spite of the lower severity of infection in 2003 compared to 2002 (Table 1). There were minor differences in the reactions of the two species, *H. maximiliani* and *H. nuttallii*, to the various inoculation treatments and types of head covering. The natural infection in control plots was nil in both years. The ground millet inoculum resulted in the highest disease indices for both wild sunflower species; 4.8 in 2002 and 3.3 in 2003, followed by the ascospore inoculation and fresh ground mycelia as the source of inoculum. The light brown paper bags provided the most favourable conditions for infection and disease development in both years of testing. Disease inoculations at mid- and late flowering produced better results than inoculations done at early flowering in 2002, more so in 2002 than in 2003.

Table 1. Efficiency of inoculation procedures and inoculum type on the head rot disease index in wild sunflower species.

Inoculum Type	Bags for Head Cover	2002			2003		
		Week 1	Week 2	Week 3	Week 1	Week 2	Week 3
Ascospores	Open	0*	0	0.3	0	0	0
	Paper	0	3.3	2.8	0.5	0	0.1
	Plastic	0	0	0.6	0	0	0
	Pollinating	0	0.9	1.1	0	0	0
Ground Sclerotinia-Infected Millet Seed	Open	0.3	0	0	0	0.6	0
	Paper	2.9	4.8	4.5	3.3	1.1	0.4
	Plastic	0.3	0.4	1.1	0	0	0
	Pollinating	2.3	1.5	3.8	0.4	0.3	0
Mycelia	Open	0	0	0	0	0	0
	Paper	1.9	3.0	3.1	0.1	0.1	0.5
	Plastic	0	0	0.3	0	0	0
	Pollinating	0	0.6	1.0	0	0	0
Control	Open	0	0	0	0	0	0
	Paper	0	0.4	0.4	0	0	0.1
	Plastic	0	0	0.1	0	0	0
	Pollinating	0.1	0	0	0	0	0
LSD(0.5%)		0.3	0.3	0.3	0.2	0.2	0.2

*Disease index = 0 (no sign of infection) to 5 (moderate to heavy infection on 50% or more heads or stems).

The results from assessing the 96 populations of the two wild species resulted in the identification of eight populations of *H. maximiliani* and seven of *H. nuttallii* with no Sclerotinia infection of the heads or stems in both years of this study. An additional five populations of *H. maximiliani* and eight of *H. nuttallii* were identified with moderate resistance to Sclerotinia head and stem infection with a disease index of <1, on the scale of 0 to 5.

This study demonstrated that artificial epidemics can be created in wild sunflower species using ground Sclerotinia-infected millet seed or ascospores at the early or mid-flowering growth stage, aided by covering the inoculated plants with light brown paper bags for 10 days. This methodology was effective in screening for resistance, and 15 populations of wild sunflowers were identified with resistance to head and stem infections. Future research will focus on investigating the genetics of this resistance, and transferring these traits to *H. annuus* and commercial hybrids.

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