Sclerotinia Rot of Pears in Oregon

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ABSTRACT

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Record rainfall occurred in the Hood River Valley during spring of 1993. In late spring, lesions up to 2 cm in diameter were observed on d'Anjou pear fruitlets on the calyx end or where senescent flower parts adhered to the fruits. *Sclerotinia sclerotiorum* was consistently isolated from infected tissue. Koch's postulates were tested, and *S. sclerotiorum* was confirmed as the cause of the disease. Mycelial growth of the pathogen on acidified potato dextrose agar was optimum at 20°C, and the average growth rate was about 10 mm per day. Five pear cultivars were ranked in order of increasing resistance to Sclerotinia rot as follows: d'Anjou, Bosc, Columbia Red d'Anjou, Bartlett, and Comice. Among eight fungicides tested, only iprodione provided good control of fruit infection.

Sclerotinia sclerotiorum (Lib.) de Bary is a soilborne plant pathogen with a host range of 148 plant species (5). *S. sclerotiorum* has been reported to cause calyx-end rot of apple fruit (6,8) and a leaf spot of apple (2). The fungus was listed as a storage pathogen of *Malus* and *Pyrus* in New Zealand in 1932 (3), but no additional information was provided. The list was published prior to taxonomic revisions of the genus *Sclerotinia*, making the identity of the listed pathogens uncertain (7).

The spring of 1993 was unusually wet in the Hood River Valley. Rainfall from April through June totaled 17.8 cm, which was double the 107-year average. In early June, field infections of d'Anjou pear fruits were observed on about 1% of the fruits in most of the valley's 2,400 ha of d'Anjou pear orchards. Most of the infected fruit dropped from the trees prior to harvest.

The objectives of this research were to study infection of pear fruit with *S. sclerotiorum* in the orchard, the effect of temperature on mycelial growth, cultivar susceptibility, and control with fungicides. An abstract of this study has been published (9).

MATERIALS AND METHODS

Pathogenicity tests. Three-millimeter-square blocks were cut from the margins of 7-day-old cultures of *S. sclerotiorum* (isolated from pear fruits) growing on potato dextrose agar acidified with 1.5 ml of 85% lactic acid per liter (APDA). Blocks were pressed, mycelium side down, onto the calyx end of 10 d'Anjou pear fruits per tree on three replicate trees in an orchard at the Mid-Columbia Agricultural Research and Extension Center. Blocks of APDA were placed on control fruits. Inoculated and control fruits were covered with polyethylene bags that were then overlaid with aluminum foil for 48 h. Inoculations were done on 10 June, 16 July, and 16 August 1993. Lesion size was measured after 7 days, and fruit drop was determined at harvest on 10 September.

Effect of temperature on mycelial growth. Three isolates of *S. sclerotiorum* were isolated from fruit from commercial orchards in April to June, 1993. Five-millimeter-diameter mycelial plugs were removed from the margins of 7-day-old cultures on APDA and transferred to APDA petri dishes that had been preconditioned for 12 h at 0, 5, 10, 15, 20, 25, and 30°C. One plug was placed in the center of each dish, mycelium side down. Three replicate plates were used at each temperature for each isolate. Plates were sealed in plastic bags and incubated for 4 days, after which colony radii were measured.

Cultivar susceptibility. On 10 June 1993, 10 August 1994, and 17 June 1996 immature pear fruits of cultivars Bartlett, Bosc, Columbia Red d'Anjou, Comice, and d'Anjou were harvested. Fruits were surface sterilized with sodium hypochlorite (100 µg of total available chlorine per ml), and rinsed with tap water. Ten fruits per cultivar were inoculated with mycelial blocks of *S. sclerotiorum* and 10 control fruits of each cultivar with blocks of sterile APDA. One block was placed on the side of each fruit. Fruits were placed in plastic boxes lined with moist paper towel and incubated at 23°C. Lesions were measured after 7 days. Data were analyzed with analysis of variance and protected least significance difference tests after $\log_{10}$ (n + 1) transformation to obtain a random distribution of residuals and correctly handle zero values (10).

Control of Sclerotinia rot with fungicides. d'Anjou pear fruits were harvested, surface sterilized as described above, and allowed to air dry. Fungicides commonly used in commercial pear production were selected, and suspensions were prepared according to label rates (Table 1). Three replicates of 10 fruits each were immersed in each fungicide suspension. After air drying, fruits were inoculated with mycelial blocks of *S. sclerotiorum* as described above. Fruits were incubated at 22°C for 7 days in plastic moist chambers, and lesion diameters measured. The experiment was done on 24 June, 1993, 4 August 1994, and 19 June 1996. Data were analyzed with analysis of variance and protected least significance difference tests after $\log_{10}$ (n + 1) transformation.

RESULTS

Symptoms. Lesions were brown, 1 to 2 cm in diameter, sometimes with a darker border, and occasionally appeared target-like (Fig. 1A). Infected tissue was firm. By harvest in September, the infected tissue (at calyx end in photo) was dry, and the fruit misshapen (Fig. 1B). A spotting on leaves (Fig. 1C) and pinpoint spots on fruit (Fig. 1D) were also observed. Lesions and spotting always were associated with senescent flower parts that adhered to the fruit (Fig. 1A) or leaves. *S. sclerotiorum* was isolated consistently from infected tissues of about 12 fruits. The identity of the fungus was confirmed by the International Mycological Institute (Egham, Surrey, UK).

Pathogenicity tests. Eighty-three, 100, and 100% of fruits inoculated in the orchard on 10 June, 16 July, and 16 August, respectively, were infected with *S. sclerotiorum*. Average lesion diameters for these dates were 9, 95, and 73 mm, respectively. At commercial harvest on 10 September, 100, 97, and 93% of infected fruits inoculated on the above respective dates had dropped from the trees.

Effect of temperature on mycelial growth. Growth of the three isolates was similar (Fig. 2). None of the isolates grew at 0°C, and all three had an optimum growth temperature of 20°C. Growth rate at 20°C was about 10 mm per day.

Cultivar susceptibility. d'Anjou fruit were in the most susceptible group in all 3 years, and Bosc was also highly suscepti-

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ble in 2 of the 3 years (Table 2). Comice and Bartlett were the most resistant in all 3 years. Columbia Red d'Anjou appeared of intermediate susceptibility, ranking with the most susceptible in all years but also with the resistant group in 2 years (Table 2). In general, smaller lesions developed in the 1996 inoculations than in the 1993 and 1994 inoculations.

Control of Sclerotinia rot with fungicides. The incidence of fruit infection was reduced significantly ($P = 0.01$) only with iprodione in 1993, 1994, and 1996, compared with all other treatments (Table 1). In all 3 years, iprodione significantly ($P = 0.01$) reduced lesion size (Table 1), compared with all other treatments. Lesions in fruit treated with fenarimol (1994 and 1996), dodine (1994), and thiabendazole (1994) also were significantly ($P = 0.01$) smaller than those in the water control, but iprodione was the most effective of the four fungicides (Table 1). In a separate preliminary test, benomyl at 0.53 g a.i./liter was compared with thiabendazole (1996 only) and was found more effective, i.e., 0 versus 21% decay, with 48% decay in the water control (R. A. Spotts, *unpublished data*).

DISCUSSION

Apart from a brief host range list from New Zealand in 1932 (3), this is the first study of infection of pear fruit by *S. sclerotiorum*. In spring, 1993 infection was widespread in the Hood River Valley. The high rainfall (8.7 cm in April; 5.9 cm in May), along with cool temperatures (9.4°C in April; 15.8°C in May) provided favorable conditions for *S. sclerotiorum*. Apothecia are produced only in saturated or near-saturated soil at an optimum temperature of 10°C (1). Ascospores are present in apple orchards from just before bloom until about 3 weeks after bloom (6). An exogenous energy source is required for infection (1) and is often provided by withered petals adhering to fruit or leaves (2,6). In canola, weather conditions and petal infestation during flowering are related to disease incidence (13). The optimum temperature for mycelial growth varies from 20 to 25°C (1,4,11) and is in agreement with the 20°C optimum for our three isolates. We found that pear fruit are highly susceptible to infection during summer months, but lack of inoculum and an exogenous energy source as well as dry weather greatly reduce the probability of infection. The high susceptibility of d'Anjou in these tests may correspond with field observations in which infection of varieties other than d'Anjou was rarely observed. However, incidence of decay in the field should not be used as confirmation of innate cultivar differences indicated by data from laboratory tests since other field factors such as retention of senescent flower parts or perhaps the overlap of bloom periods and infection periods also may be involved.

Sclerotinia rot was often found in orchards that had a regular commercial fungicide program, including up to four applications of mancozeb during the bloom period. Iprodione gives good control of white mold of bean caused by *S. sclerotiorum* (12) and was effective on pear fruit. Iprodione is not registered for use on pear. In a preliminary test, benomyl gave good control of *S. sclerotiorum* on pear. Benomyl is not registered for postharvest use on pome fruits in the Pacific Northwest and is not used preharvest because of potential resistance problems that would lessen the effectiveness of another benzimidazole, thiabendazole, which is an important postharvest fungicide for pome fruits.

Over 90% of infected fruit dropped from the trees prior to harvest but this was not a problem commercially because of the low incidence of infection. Lesion size did not increase in cold storage although *S. scle-*

Table 1. Control of *Sclerotinia sclerotiorum* infection of d'Anjou pear fruit with fungicides

Fungicide and rate (g a.i./liter)	Fruit infected (%)[z]			Lesion diameter (mm)[z]		
	1993	1994	1996	1993	1994	1996
Iprodione 1.20	0.0 a	0.0 a	20.0 a	0.0 a	0.0 a	0.3 a
Dodine 1.17	63.3 b	100.0 b	66.7 b	9.5 b	20.6 b	2.8 bc
Ziram 2.40	70.0 bc	100.0 b	76.7 b	11.0 b	39.4 d	3.0 bc
Thiabendazole 0.53	76.7 bcd	100.0 b	63.6 b	11.0 b	28.0 c	3.0 bc
Fenarimol 0.06	80.0 bcd	100.0 b	63.3 b	10.6 b	20.1 b	2.4 b
Triadimefon 0.15	86.7 bcd	100.0 b	66.7 b	8.7 b	33.3 cd	2.7 bc
Mancozeb 2.88	93.3 cd	100.0 b	66.7 b	9.3 b	33.6 cd	4.0 bc
Water	86.7 bcd	100.0 b	63.3 b	10.9 b	39.1 d	4.5 c
Morestan 0.75	100.0 d	100.0 b	63.3 b	11.5 b	32.2 cd	3.5 bc

[z] Numbers followed by the same letter within columns are not significantly different at $P = 0.01$ according to least significant difference. Diameter data were transformed to $\log_{10}$ before analysis.

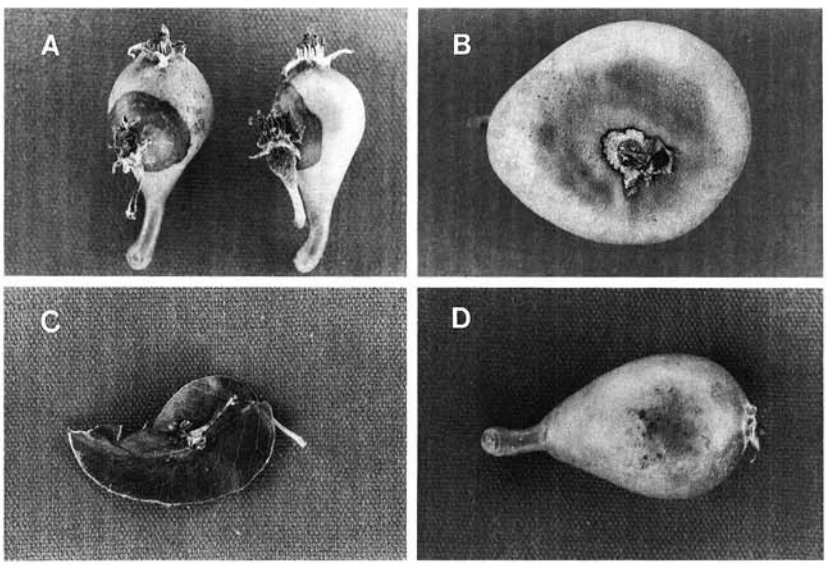

Fig. 1. Sclerotinia rot caused by *Sclerotinia sclerotiorum* of immature **(A)** and calyx end of misshapen, mature **(B)** d'Anjou pear fruit, lesions on leaves **(C)**, and pinpoint spotting on fruit **(D)**.

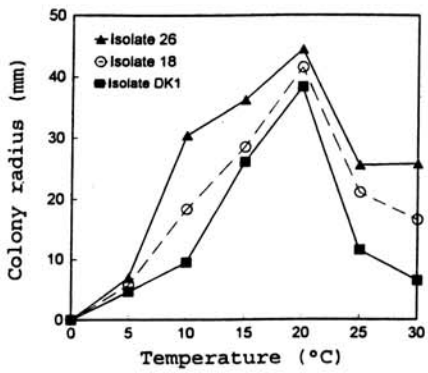

Fig. 2. Effect of temperature on the mycelial growth of three isolates of *Sclerotinia sclerotiorum* on acidified potato dextrose agar.

Table 2. Susceptibility of fruit of pear cultivars to *Sclerotinia sclerotiorum*

Cultivar	Lesion diameter (mm)[z]		
	1993	1994	1996
Comice	6.0 a	13.4 a	1.4 a
Bartlett	7.6 ab	14.0 a	1.3 a
Columbia Red d'Anjou	11.2 bc	20.2 ab	1.7 ab
Bosc	13.3 c	13.5 a	5.2 b
d'Anjou	15.3 c	29.0 b	5.1 ab

[z] Numbers followed by the same letter within columns are not significantly different at $P = 0.01$ according to least significant difference of $\log_{10}$-transformed lesion diameters.

rotiorum could be isolated from infected fruits after 6 months storage –1°C (R. A. Spotts, *unpublished data*). For these reasons, Sclerotinia rot is not expected to pose a problem to stored fruit.

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