

# *Sphaeropsis sapinea* Cankers on Stressed Red and Jack Pines in Minnesota and Wisconsin

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## ABSTRACT

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Outbreaks of *Sphaeropsis sapinea* infections in red and jack pine plantations were studied in Minnesota and Wisconsin. The incidence and impact of the disease was documented on study plots with low site indices. Tree mortality ranged from 2 to 51% on study plots and was consistently associated with *S. sapinea*. Cankers occurred more frequently on trees exposed to environmental stresses such as poor site conditions, drought, hail, snow, and insect wounds.

The fungus *Sphaeropsis sapinea* (Fr.) Dyko & Sutton (= *Diplodia pinea* (Desm.) J. Kickx.) is a destructive pathogen of conifers worldwide. Repeated infections reduce growth, deform, and often kill trees (9). In the United States, losses have been reported in windbreaks of native and exotic pine species, Christmas tree and ornamental plantings, and nurseries (7). Stem cankers were first reported in red pine (*Pinus resinosa* Ait.) plantations in Minnesota and Wisconsin in 1976 (6). Previously, cankers were reported only in New Zealand and Australia (3,4,12).

*S. sapinea* grows on dead twigs, branches, needles, and cones of at least 20 pine species (9) and white fir (*Abies concolor* (Gord. & Glend.) Lindl.) (5). Stems become infected when the fungus invades the tree through branch stubs or wounds caused by pruning, hail, and insects (2,9). Poor site conditions and drought predispose trees to infection (1,3).

In 1976, areas of Minnesota, Michigan, and Wisconsin experienced a severe drought. Red pine and jack pine (*P. banksiana* Lamb.) mortality was noted in late fall of 1976 and again in spring of 1977. Close examination of trees in initial stages of decline revealed scattered dead branches within tree crowns. This pattern contrasted with that usual for drought-stricken trees, in which dieback occurs first in the tops (11). The presence of fruit bodies and recovery of the fungus from isolations confirmed the presence of *S. sapinea* in declining trees (8). This study documented the incidence and impact of *Sphaeropsis* canker on red and

jack pines in plantings with low site indices (site index 45) during and after the drought of 1976.

## MATERIALS AND METHODS

**Plantation survey.** Beginning in 1976, we rated plantation-grown red and jack pines for the incidence and impact of *S. sapinea*. A total of 217 red pines (each 19 years old) in Jackson and Adams counties, Wisconsin, were monitored five times between October 1976 and June 1980. In addition, we monitored 100 jack pines (each 10–15 years old) in Jackson County three times between May 1977 and November 1978. (More than 2,024 ha of mature red and jack pines in Jackson County were affected by the fungus.) Rainfall data for the Jackson County site were obtained from Wisconsin Department of Natural Resource records; data for the other sites were obtained from the National Weather Service. Each study tree was marked with a numbered aluminum tag to allow for determining the progress of the disease by reading individual trees. At each reading date, we rated the condition of each tree using the following descriptive categories: 1) healthy, 2) scattered dead branches, 3) dead top, 4) dead top and scattered dead lower branches, and 5) dead. We also examined possible entry courts for the fungus.

In 1978, we did a single rating for 273 jack pines (each 5–10 years old) in Jackson County, Wisconsin, and 307 red pines (each 10–15 years old) in Cass and Wadena counties, Minnesota, and Douglas County, Wisconsin. Each tree was rated for disease incidence and impact as described previously.

**Windbreak survey.** The impact of *S. sapinea* in a 35-year-old red pine windbreak in Green County, Wisconsin, was evaluated in July 1977. We rated 6,611 trees using the following descriptive categories: 1) healthy, 2) diseased, or 3) dead. We examined trees in both a north-

south and an east-west windbreak. Three hundred cones were examined for the presence of *S. sapinea* pycnidia.

## RESULTS

**Plantation survey.** Between October 1976 and June 1980, disease incidence and severity increased on red pines in study plots in Jackson and Adams counties, Wisconsin. Red pine mortality ranged from 6 to 30% (Table 1). Tree mortality was due to multiple *Sphaeropsis* cankers that girdled branches and stems. Red and jack pines progressively declined over time as indicated by their net change in condition (Tables 1 and 2). Most red pines exhibited the greatest increase in disease severity in 1977, 1 yr after the onset of the 1976 drought. The rainfall average for the Jackson County site is 78 cm/yr, but in 1976 the rainfall was only 55 cm (23 cm below average) during the growing months. National Weather Service records showed similar rainfall deficits at the other study sites.

By 1978, infection by *S. sapinea* caused the deaths of 25% of the 10- to 15-year-old jack pines monitored three times in Jackson County, Wisconsin (Table 2). At another Jackson County site, 51% of the five- to ten-year-old jack pines examined once in 1978 were killed by *S. sapinea*. Mortality among red pines examined once in 1978 in Douglas County, Wisconsin, and Cass and Wadena counties in Minnesota ranged from 2 to 15% (Table 3). In Wisconsin, infection was usually associated with hail wounds. In Minnesota, most of the infection was associated with insect wounds or wounds around branch collars caused when heavy snow pulled branches away from stems. Bark beetles (*Ips* spp.), present in all three plantations, infested from 2 to 57% of the infected trees.

General symptoms on red pines included elongated, depressed areas on affected stems (Fig. 1) with pitch on the bark surface of the canker face and below the canker. *S. sapinea* pycnidia were present in the bark near the upper margin of nearly every canker examined. The wood beneath the infected bark of all cankers was resin-soaked (Fig. 2). Cross sections of stems cut through cankers revealed grayish, pie-shaped wedges of infected tissues from the cambium to the center of the stem (Fig. 3a). In 1980, surviving trees began to form callus around canker margins, but stems

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remained depressed where the cambium was killed (Fig. 3b).

**Windbreak survey.** Of the red pine windbreak trees examined once in July in Wisconsin, 80% were healthy, 14% had branch flagging, and 6% were dead. In almost every instance, branch flagging and mortality were associated with *S. sapinea*. Of the 2,701 trees in the east-west windbreak, 44% were healthy, 39% had branch flagging, and 17% were dead. Of the 3,910 trees in the north-south windbreak, 96% were healthy, 3% had branch flagging, and 1% were dead. More hail wounds were observed on trees with the east-west orientation due to the prevailing winds of a hail storm. Branch infection of windbreak trees frequently originated at hail wounds or at the point where infected cones were attached. Our examination of 300 cones in the windbreaks revealed that 84% of cones two

years of age or older had *S. sapinea* pycnidia on their scales, regardless of windbreak orientation.

## DISCUSSION

*S. sapinea* was responsible for the observed damage and mortality of red and jack pines in Minnesota, Michigan, and Wisconsin that began in late 1976. Trees were predisposed to *S. sapinea* infection by severe drought, poor sites, and wounds caused by hail, heavy snow, and insects. Our observations are similar to those of Chou (3) who observed that severe outbreaks of *S. sapinea* were associated with wounds and prolonged drought in young *P. radiata* D. Don plantations. Water stress can predispose woody plants to attack by pathogens and influence the incidence and severity of diseases (10).

**Table 1.** Progression of *Sphaeropsis sapinea* in 19-year-old red pines from five readings taken between October 1976 and June 1980 in Jackson and Adams counties, Wisconsin (N = 217)

Tree condition	First reading <sup>a</sup>		Second reading <sup>b</sup>		Net change	
	Mean (%)	Range (%)	Mean (%)	Range (%)	Mean (%)	Range (%)
Healthy	32	5-48	22	5-42	-10	-16-0
Scattered dead branches	39	30-46	34	30-36	-5	-10-0
Dead top	7	3-25	6	2-20	-1	-5-4
Dead top and scattered dead lower branches	14	6-25	16	5-27	+2	-10-8
Dead	8	6-15	22	13-30	+14	4-23

<sup>a</sup>October 1976.

<sup>b</sup>June 1980.

**Table 2.** Progression of *Sphaeropsis sapinea* in 10- to 15-year-old jack pines from May 1977 to November 1978 in Jackson County, Wisconsin (N = 100)

Tree condition	Reading			Net change (%)
	1 <sup>a</sup>	2 <sup>b</sup>	3 <sup>c</sup>	
Healthy	22	8	8	-14
Scattered dead branches	7	4	3	-4
Dead top	46	38	35	-11
Dead top and scattered dead lower branches	6	27	29	+23
Dead	19	23	25	+6

<sup>a</sup>10 May 1977.

<sup>b</sup>26 October 1977.

<sup>c</sup>7 November 1978.

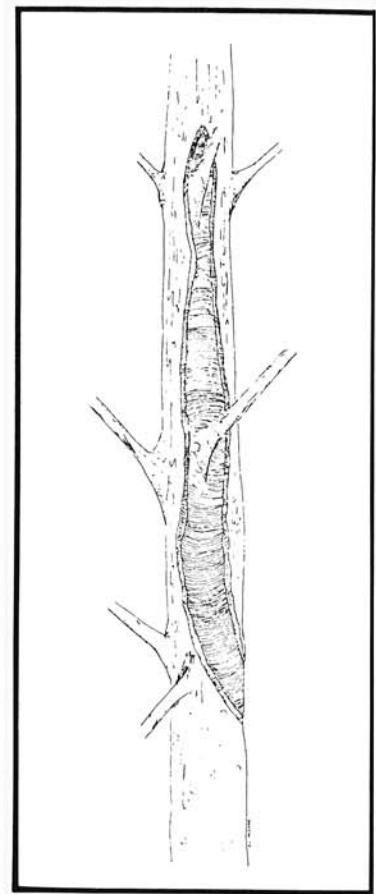
**Table 3.** Conditions of 10- to 15-year-old red pines in three plantations in Minnesota and Wisconsin, 1978

Location	Date	Sample size	Healthy (%)	Scattered dead branches (%)	Dead top (%)	Dead top and scattered dead lower branches (%)	Dead (%)
Douglas County, Wisconsin	19 April	120 <sup>a</sup>	35	46	3	1	15
Cass County, Minnesota	2 May	90 <sup>b</sup>	67	13	5	13	2
Wadena County, Minnesota	3 May	97 <sup>c</sup>	58	17	11	4	10

<sup>a</sup>Hail damage on 99% of trees; 17% had bark beetles.

<sup>b</sup>No hail damage; 29% had branches pulled away from bole by heavy snow; 2% had bark beetles.

<sup>c</sup>No hail damage; 7% had branches partially pulled away from bole by heavy snow; 57% had bark beetles.



**Fig. 1.** Elongated cankers developed on stems of red pine infected by *Sphaeropsis sapinea*. Cankers originated at the base of branches, often girdling several or all branches at a whorl. Many trees had multiple cankers.



**Fig. 2.** *Sphaeropsis sapinea* canker on red pine stem with the bark removed to reveal the resin-soaked wood.

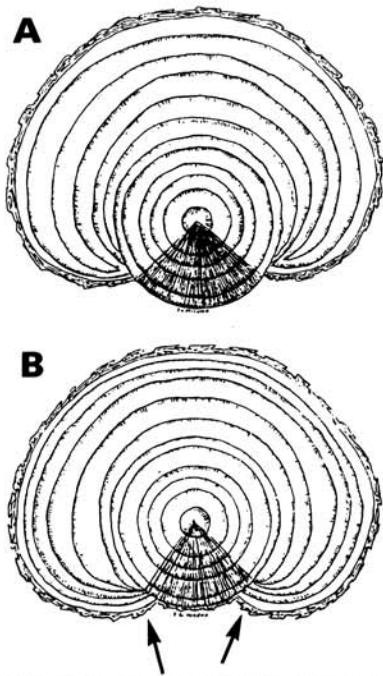


Fig. 3. (A) Cross section through a canker on red pine showing the pie-shaped wedge of infected tissues. (B) Cross section from a red pine that developed callus around canker margins. Surviving trees formed extensive callus at canker margins (arrows) after resumption of normal rainfall.

Our results underscore the opportunistic nature of *S. sapinea* on trees under stress from a variety of factors.

The presence of abundant pycnidia on branches, stems, and cones of infected trees illustrates the potential of this fungus to rapidly reach epidemic levels when conditions are favorable for infection and disease development.

The condition of the study trees changed over time as they progressed through various stages of decline. Surviving trees formed callus tissue around stem cankers after resumption of normal rainfall. However, most of these infected trees were severely deformed and will be of little or no commercial value.

Outbreaks of *S. sapinea* have occurred periodically throughout the world. No direct control measures are known for this pathogen in plantations. Wounding of trees should be minimized during cultural practices to reduce the incidence of infection by *S. sapinea*. Most importantly, land managers need to consider the risk of planting red and jack pines on poor sites, which may subject trees to stresses that can predispose them to infection and damage by *S. sapinea*.

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#### LITERATURE CITED

1. Bachi, P. R., and Peterson, J. L. 1985. Enhancement of *Sphaeropsis sapinea* stem invasion of pines by water deficits. *Plant Dis.* 69:798-799.
2. Chou, C. K. S., and MacKenzie, M. 1988. Effect of pruning intensity and season on *Diplodia pinea* infection of *Pinus radiata* stem through pruning wounds. *Eur. J. For. Pathol.* 18:437-444.
3. Chou, C. K. S. 1987. Crown wilt of *Pinus radiata* associated with *Diplodia pinea* infection of woody stems. *Eur. J. For. Pathol.* 17:398-411.
4. Gilmour, J. W. 1965. *Diplodia* whorl canker of *Pinus radiata* in New Zealand. *Commonw. Phytopathol. News*. Part 3:1.
5. Luley, C. J., and Gleason, M. L. 1988. *Diplodia* canker (*Sphaeropsis sapinea*) of *Abies concolor* in Iowa. *Plant Dis.* 72:79.
6. Nicholls, T. H., Ostry, M. E., and Prey, A. J. 1977. *Diplodia pinea* pathogenic to *Pinus resinosa*. (Abstr.) *Proc. Am. Phytopathol. Soc.* 4:110.
7. Palmer, M. A., and Nicholls, T. H. 1985. Shoot blight and collar rot of *Pinus resinosa* caused by *Sphaeropsis sapinea* in forest tree nurseries. *Plant Dis.* 69:739-740.
8. Palmer, M. A., and Nicholls, T. H. 1983. How to identify and control *Diplodia* shoot blight, collar rot, and canker of conifers. U. S. For. Serv. NC For. Exp. St. 8 pp.
9. Peterson, G. W. 1981. *Diplodia* blight of pines. U. S. For. Serv. For. Insect Dis. Leaflet. 161. 7 pp.
10. Schoeneweiss, D. F. 1981. The role of environmental stress in diseases of woody plants. *Plant Dis.* 65:308-314.
11. U. S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 1983. Christmas Tree Pest Manual. St. Paul, MN. 108 pp.
12. Wright, J. P., and Marks, G. C. 1970. Loss of merchantable wood in radiata pine associated with infection by *Diplodia pinea*. *Aust. For.* 34:107-119.