Canker on the main stem of a Monterey pine.

Relative Susceptibility of Five Landscape Pines to Pitch Canker Disease, Caused by *Fusarium subglutinans* f. sp. *pini*.

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Pitch canker, caused by *Fusarium subglutinans* f. sp. *pini*, was first described in 1946 in the southeastern United States, and was discovered in California in 1986. Since its arrival in California, pitch canker has spread rapidly through both urban and native forests of Monterey pine.

The initial symptom of pitch canker, fading of needles near the tips of young branches, is the result of branch and/or cone infections that develop into girdling lesions. Repeated infections, that eventually include older branches and the main stem, render trees unattractive and prone to premature death. In urban forests this necessitates a costly process of removal and replacement.

In California, most infections appear to result from feeding by various insect associates of conifers that carry the pitch canker pathogen. Principal among these insect vectors are engraver beetles, *Ips* spp., twig beetles, *Pityophthorus* spp., the cone beetle, *Conophthorus radiatae* Hopkins, and the dry twig and cone beetle, *Ernobius punctulatus* Fall.

The extreme susceptibility of Monterey pine to pitch canker has greatly diminished its utility as a landscape tree in areas where this disease is prevalent. In order to identify suitable alternatives for landscape plantings, our study was undertaken to evaluate the relative susceptibility to pitch canker of five species: Monterey pine, Aleppo pine, Canary Island pine, Italian stone pine and Japanese black pine. For all five species, quantitative differences in response to mechanical inoculations were characterized, and, for all but Japanese black pine (which did not occur in the survey area), we recorded the incidence of disease on these species under field conditions.

Susceptibility to Pitch Canker

To test the susceptibility under controlled conditions, potted trees between 3 and 4 years of age were inoculated in a greenhouse. Second year wood of young branches was inoculated by placing an aqueous suspension of pathogen spores into a small wound. Each tree was inoculated once with each of three different spore suspensions, corresponding to either 25, 250 or 2500 spores. Each inoculation was placed on a separate branch. Three inoculation experiments were conducted, each including five trees of each of five pine species. For the first two experiments, 35-40 days after inoculation, bark was removed from the area surrounding the inoculation site and the length of the lesion (discolored area) was measured. In the third experiment, inoculated branches were allowed to remain on the trees for 135 days, when a final rating was taken for chlorosis and/or death of needles distal to the point of inoculation.

In both the first two experiments, the mean lesion length on Monterey pine was significantly greater than that on each of the other four species (Fig. 1). Only very small lesions were evident on Canary Island, Italian stone and Japanese black pines (even on branches inoculated with 2500 spores); Aleppo pine has lesions intermediate in length (Fig. 1).

In the third experiment, foliar symptoms were

Diseased Monterey pine (left) has numerous infected branches. Infected branch of a Monterey pine (below).

evaluated 60 days after inoculation. At that time, 60% (3/5) of the Monterey pine branches inoculated with 2500 spores bore yellowing needles at and distal to the inoculation site. At 90 days after inoculation, the remaining two Monterey pine branches inoculated with 2500 spores were symptomatic, as were 60% (3/5) of the branches inoculated with 250 spores and 20% (1/5) of those inoculated with 25 spores. At 135 days after inoculation, no additional Monterey pine branches and none of the inoculated branches on any of the other four pine species showed any foliar symptoms.

Frequency of Natural Infections in the Field

The incidence and severity of pitch canker in pines planted along roadways in Fremont and Union City, Alameda Co., CA were assessed in January 1997. Four routes were selected along which all pines were rated for symptoms of pitch canker. These routes were chosen in areas where pitch canker was known to occur and where the trees were planted in proximity to public roads, facilitating evaluation of their disease status.

Pitch canker infections were identified visually. Individual branch infections were recognized as tips with reflexed discolored needles or tips from which needles had fallen. Cankers on the main stem were identified by their copious production of resin, which flowed down the stem. The severity of pitch canker was characterized by placing trees into one of three categories based on the number of branch tips with symptoms of pitch canker: 1) no infections, 2) 1-10 symptomatic tips, or 3) >10 symptomatic tips. The number of cankers on the main stem and larger branches of the tree was classified as zero, 1-3 or >3 per tree. A total of 736 trees was included in the survey.

Monterey pine, Aleppo pine, Canary Island pine and Italian stone pine were all encountered during the survey. Branches showing symptoms of pitch canker were observed only on Monterey, Canary Island and Aleppo pines (Table 1). Main stem cankers were observed only on Monterey pine (Table 1). Based on the percentage of trees with at least one symptomatic branch, Monterey pine was the most susceptible and Italian stone pine was the least susceptible.

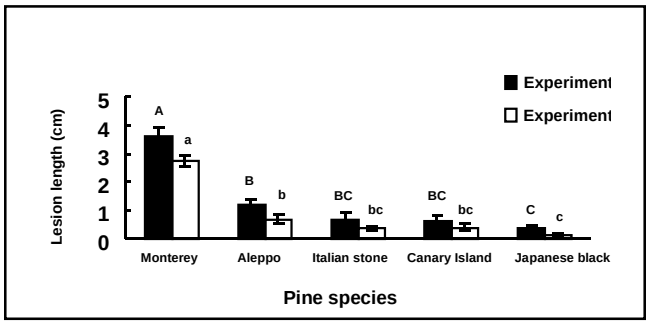
Conclusions

The results of this study indicate that several species well adapted to Mediterranean climates are either moderately or highly resistant to pitch canker. The correspondence between the extent of lesion development in mechanical inoculations and frequency of infection in the field suggests that greenhouse screening tests are predictive of resistance under natural conditions. Of the species tested, Japanese black pine appears to be the most resistant, based on the extent of lesion development. However, both Canary Island and

Host species	Percentage of trees in each severity class based on number of: Infected branches[2]			Infections on main stem[3]		
	0	1-10	>10	0	1-3	>3
Monterey pine (n=170)	35	36	29	68	16	16
Aleppo pine (n=94)	91	9	0	100	0	0
Canary Island pine (n=320)	97	3	0	100	0	0
Italian stone pine (n=152)	100	0	0	100	0	0

Severity of pitch canker disease on four species of pine[1]. Branches showing symptoms of pitch canker were observed only on Monterey, Canary Island and Aleppo pines. (Table 1)

[1]The pines evaluated were street trees encountered along four survey routes in Fremond and Union City (Alameda County, California).
[2]Severity classes are based on the numbers of infected branch tips: zero, between one and ten, or greater than ten.
[3]Severity classes are based on the numbers of cankers on the main stem of the tree: zero, between one and three, or greater than three.



In both the first two experiments, the mean lesion length on Monterey pine was significantly greater than that on each of the other four species. Only very small lesions were evident on Canary Island, Italian stone and Japanese black pines (even on branches inoculated with 2500 spores); Aleppo pine has lesions intermediate in length. (Fig. 1)

Italian stone pine were comparable with Japanese black pine in greenhouse tests, and natural infections on these two species are very rare. Consequently all three species would be expected to sustain little or no damage from pitch canker and would therefore be appropriate for landscape plantings where this disease is prevalent. Of course, none of these species is necessarily free of other pest problems; this consideration, along with general horticultural requirements for a landscape tree, should be taken into account in selecting the appropriate species for a particular location.

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