Twig blight can disfigure trees such as the live oak at left, but the disorder is seldom fatal. Disease severity may be related to the level of pit scale infestations, which were often found in association with the small black pustules containing *C. cinerescens* (below).

Twig blight of oaks in California

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Twig blight of landscape oak trees was reduced to an acceptable level by pruning or by pruning plus treatment with a fungicide.

A recently recognized disease called "twig blight" has become a serious problem on oaks in California. Coast live oak (*Quercus agrifolia*) appears to be the principal host, but infections have also been found on valley oak (*Q. lobata*), interior live oak (*Q. wislizenii*), blue oak (*Q. douglasii*), and Oregon white oak (*Q. garryana*).

Twig blight fungi invade the current season's growth and usually cause infected shoots to die. Trees with heavy infestations become unsightly and lose vigor. Seedlings, young nursery plants, and small trees may be particularly vulnerable to severe injury. Urban oaks, grown for their beauty, may suffer in appearance and value because of twig blight injury.

Symptoms are most noticeable in the summer and fall (July to October). Leaves on blighted shoots turn a straw-brown and typically remain attached to the shoot for several months. Dieback of leaves and shoots is usually scattered throughout the tree crown, although the greatest injury often occurs on the lower half. In some trees, only a few shoots are affected; in others, almost all shoots may be blighted. A general thinning of the crown is obvious in the year following infection, but twig blight does not kill large branches or entire sections of the crown.

Twig blight severity varies from year to year and among individual oak trees. It is more severe in wet years, and individual trees show varying degrees of susceptibility; some are heavily infected while others remain seemingly disease-free. Susceptible and apparently resistant trees can be found growing next to each other.

At least two fungi have been implicated in twig blight infections: *Cryptocline cinerescens* and *Discula quercina*. Other fungi, including *Diplodia quercina*, may also be involved, but pathogenicity tests were inconclusive except in the case of *Diplodia*.

Wounded and unwounded seedlings were inoculated with spore suspensions of *C. cinerescens* and *Discula quercina* in the greenhouse, kept in a mist system in a 60°F room for 5 to 7 days, then transferred to an 80°F room where they were watered twice a week. Symptoms appeared on both groups after 8 to 10 days, acervuli (fruiting bodies) were visible after 6 to 8 weeks, and the fungi were re-isolated from the infected twigs. Repeated attempts to inoculate mature trees and trunk sprouts in the field were unsuccessful, however. In the field, acervuli appear as small black pustules erupting through the bark in the early fall, but they do not contain mature spores until October.

Twig blight and pit scale

Many trees with twig blight also had pit scale (*Asterolecanium minus*) infestations. Frequently, both twig blight and pit scale infestations were greater on the lower parts of the crown than on the upper parts.

Microscopic examination of twigs showed that acervuli of *C. cinerescens* were often located on or near the rim of the pit formed by the scale. Isolations from 50 surface-sterilized scale insects failed to yield any fungi, but tissue isolations indicated the presence of *Diplodia quercina*, *C. cinerescens*, *Discula quercina* and other fungi in necrotic areas surrounding 42% of 328 pit scales examined. Previous studies from Virginia and Pennsylvania indicate that similar associations between pit scale and canker fungi (*Dothiorella quercina* and *Botryodiplodia* sp.) occur on chestnut oak (*Q. prinus*) and white oak (*Q. alba*). However, the nature of an interaction between pit scale activity and the canker fungi is not known.

To determine if there is a correlation between pit scale infestation and twig blight severity, we conducted a field study in six locations in northern California. Coast live oak trees (112) were rated for twig blight severity and pit scale infestation.

The results showed a positive correlation (r=0.93) between disease severity and insect infestation (fig. 1). Twig blight was generally most severe when pit scale infestations were greatest.

Control studies

We tested 16 fungicides in the laboratory for activity against *C. cinerescens* and *Discula quercina*. Baycor (bitertanol), Rubigan (fenarimol), Fungaflor (imazalil), Banner (propiconazole), Actidione (cycloheximide), and Benlate (benomyl) inhibited growth of both fungi from 60% to 100%.

Petri dishes were seeded with a spore suspension of the fungi and a penicillin assay disk dipped in a known concentration of fungicide was placed in the center. The fungi were left to grow for 10 to 14 days and the zone of inhibition surrounding each disk was measured and compared with a control.

Seedlings in the greenhouse were sprayed with suspensions of these six fungicides and then sprayed with spore suspensions of the two fungi. Levels of infection were compared with those of unsprayed seedlings.

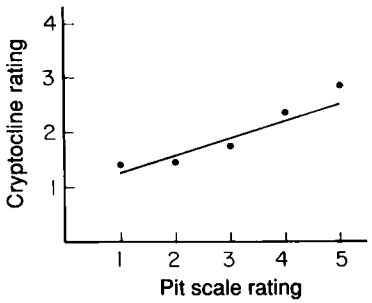

Fig. 1. Correlation between pit scale infestation and *Cryptocline* severity on coast live oak (r=0.93). Rating values indicate least (1) to most severe twig blight (4) or greatest pit scale infestation (5).

TABLE 1. Treatments of live oaks for twig blight, Stanford Arboretum

Treatment*	Spray applications			
	Fall	Spring	Fall	Spring
Benlate 50WP 4 lb/ 100 gal (1X)	1985	1986	NA	NA
Benlate 4 lb/ 100 gal (2X)	1985	1986	1986	1987
Benlate 4 lb/ 100 gal (1X)	NA	NA	1986	1987
Pruning + Benlate 4 lb/100 gal (2X)	1985	1986	1986	1987
Benlate 1 lb/ 100 gal (1X)	NA	NA	1986	1987
Pruning + Benlate 1 lb/100 gal (1X)	NA	NA	1986	1987
Pruning only, 1986	NA	NA	NA	NA

NOTE: Readings taken before treatments in fall 1985, after 1 year in fall 1986, and after 2 years in the fall of 1987.

* The registered rate for Benlate application to ornamental trees is 1 lb (50 WP)/100 gal water. The 4 lb rate was used for experimental purposes only.

NA = not applicable.

At Yountville, Orinda, and Palo Alto, individual branches or halves of tree crowns were sprayed in the field with fungicide during 1983-87. Levels of natural infection were recorded and the persistence of fungicides was determined using a penicillin assay test. Benlate was detected routinely for at least 12 months, Banner and Rubigan for up to 3 months, and the others for only 1 month after spraying. Benlate was chosen for further trials because of its persistence and because it is registered for use on oaks.

Mature coast live oak trees in the Stanford Arboretum with visible symptoms of twig blight were selected for treatment. The crowns of individual trees were visually divided vertically into halves, one half for treatment and the other half as the control. Divisions were made so that approximately equal amounts of twig blight could be found on each half. Disease ratings were made independently by two of the authors and averaged. Care was taken to distinguish between twig blight injury and insect injury. Initial ratings were made before treatment and then one year, or in some cases two years, after treatment.

Treatments included Benlate, pruning plus Benlate, and pruning alone (table 1). Treatment sides of trees were sprayed in November 1985, again at budbreak in February 1986, and for a second experiment in November 1986 and March 1987.

Fifteen trees were treated in 1985-86, and an additional 22 trees in 1986-87. Because the number of diseased trees was limited, there were only five or six replications. Assignment of treatments to individual trees was random. All parts of the trees were sprayed with *Bacillus thuringiensis* (Dipel) in the spring of each year to control oak worm (*Phryganidia californica*) and tussock moth (*Orgyia vetusta*).

Blighted shoots and dead wood were removed and disposed of during pruning. Small trees (10 to 15 feet tall) were selected for pruning. Trees with Benlate treatments were sprayed within 7 days after pruning.

Results

Comparison of disease ratings between treatments and their respective controls showed significant disease reduction after 1 year from the treatments combining pruning with 4 pounds Benlate and pruning with 1 pound Benlate (fig. 2). Benlate at 4 pounds in 1985-86 and 1986-87 also worked well, although not as well as in the first experiment. The 1-pound Benlate treatment showed no significant effects. Pruning alone achieved a substantial reduction in disease, but it was not significant at the 5% level.

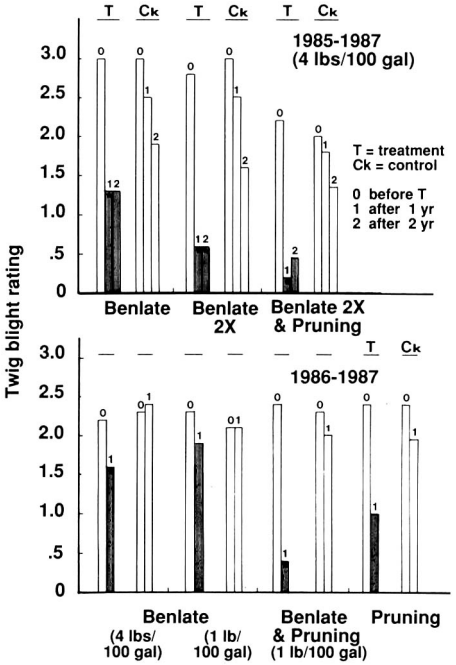

Fig. 2. Disease severity following fungicide and/or pruning treatments (shaded bars = treatment; see table 1). Treatments consisted of one fall and one spring application, except where indicated by 2X, in which fall and spring applications were repeated the following year. Ratings: 0 = 0-5% of crown affected; 1 = 6-20%; 2 = 21-69%; 3 = 70-100%.

After 2 years, significant control resulted when the 4-pound Benlate solution was reapplied in the second year but not when applied in the first year only. In addition, the effects of pruning plus 4 pounds of Benlate were no longer significant after the second year. Although there was a considerable reduction in disease from this treatment in the second year, it was not significantly different from the control.

Conclusions

Our field trials indicate that twig blight of live oak can be reduced to a visually acceptable level (20% or less of the crown affected) for at least a year by pruning alone, by treatment with Benlate at 1 or 4 pounds per 100 gallons water, or by pruning plus Benlate at 1 or 4 pounds. Effects of the stronger solution carried over to a second year, and re-treatment with Benlate in the second year was also effective. Assessment of second-year effects was complicated by the generally low level of natural infection in 1987, a relatively dry year.

Choice of treatment depends on cost/benefit considerations. Pruning is time-consuming and difficult in large trees. Spraying requires special equipment, and Benlate is currently registered for use only at 1 pound per 100 gallons for oaks. Trees vary in the degree to which they are damaged by twig blight, and the extent of blight varies from year to year. People with oaks may want to keep records of which trees are highly susceptible and to restrict control applications to those trees in which unacceptable disease buildup is imminent. Pruning vs. spraying may depend on initial levels of infection, especially when disease is so severe that pruning would have to be extensive.

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