Environmental Therapy for Pierce's Disease of Grapevines

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ABSTRACT

PURCELL, A. H. 1980. Environmental therapy for Pierce's disease of grapevines. Plant Disease 64:388-390.

The hypothesis that cold climates are therapeutic for Pierce's disease was tested by overwintering diseased grapevines at Prosser, Washington, and at four sites at different altitudes in California. None of the surviving vines at Prosser, which had the coldest winter, developed symptoms after 6 mo in a greenhouse. At California sites, most of the diseased vines at Blodgett but few vines exposed to the moderate climate at Berkeley recovered from Pierce's disease. However, recovery rates at Blue Canyon and Coloma, which had lower minimum temperatures than those at Blodgett, were inconsistent with the hypothesis.

Additional key word: epidemiology

In the United States, Pierce's disease of grapevines apparently occurs only in moderate or subtropical climates (2,5). Comparison of the geographic boundaries within which the disease occurs and the contours of climate suggests that severe winter climates limit the range of the disease (2,5). The severity of outbreaks also varies with the severity of winter temperatures; severity decreases following colder winters (2). Brief exposures of small, potted grapevines with Pierce's disease to subfreezing temperature (5) suggested that cold temperatures are important in its epidemiology.

The purpose of this study was to determine if Pierce's disease would persist in winter climates colder than those in which the disease occurs naturally.

Work supported in part by the Napa Valley Viticultural Research Fund, Cal Aggie Alumni Fund.

00191-2917/80/04038803/$03.00/0

MATERIALS AND METHODS

All diseased plants were inoculated by the leafhopper *Graphocephala atropuntata* (Signoret) (= *Hordnia circellata*), and plants were diagnosed as previously described (5,6). Test plants were rooted from dormant cuttings obtained from the Foundation Plant Materials Service at the University of California, Davis, and grown in plastic pots. All plants used in this study were inoculated in April through June 1976.

Grapevines with well-developed symptoms and uninfected controls that had been placed in outdoor cages at Berkeley in September to October 1976 were placed in five different locations from early November 1976 until late March 1977. The sites were the University of California, Berkeley; 2 mi northwest of Coloma, California; University of California Blodgett Experimental Forest; Blue Canyon, California; and Washington State University Irrigation and Extension Center, Prosser. These locations were selected to provide mild to severe winter climates.

Vines were enclosed in screenhouses at Prosser and Blodgett and in screen cages at other locations. At Coloma and Prosser, half of the plants were exposed above ground level and half were buried in soil up to the top edge of each pot. All plants at Blue Canyon were buried

similarly, and all at Berkeley and Blodgett were kept above ground.

Maximum and minimum temperature records were taken from the nearest weather station. The Coloma and Blue Canyon sites were approximately 4–6 km from the nearest temperature recording stations. At the other sites, temperatures were recorded within 1 km.

In March 1977, all grapevines were returned to the greenhouse at Berkeley and maintained until Pierce's disease was diagnosed or until November 1977. The causal bacterium was isolated from vines with symptoms from each location, using methods described previously (1). Attempts to isolate the bacterium were made from all symptomless grapevines after they had been held at the different sites.

RESULTS AND DISCUSSION

The recovery rate for infected vines that survived the winter ranged from 2% recovery at Coloma, 5% at Berkeley, and 14% at Blue Canyon to 98% recovery at Blodgett and 100% at Prosser (Table 1). The number of plants killed by overwinter exposure was low at Berkeley and substantial at the other sites (Table 1). For example, 34 of 59 (58%) plants exposed at Prosser did not survive. More diseased than healthy vines died at Coloma and Blue Canyon. No significant difference in survival was evident between plants that were buried in soil and plants not buried.

Equal numbers of cultivars Barbera and Cabernet Sauvignon were sent to Prosser. At other locations approximately equal numbers were used of cultivars Ruby Cabernet, Cabernet Sauvignon, Pinot chardonnay, Chenin blanc, Pinot noir, Flora, White Reisling, and Thompson Seedless. At Berkeley, an additional 13 Barbera and three Sylvaner vines were exposed, but the only cultivars there that recovered from Pierce's disease were Cabernet Sauvignon (one recovery among 10 plants) and White Reisling (five among 13). At Coloma the only vine to recover was one of the 10 White Reisling. All seven White Reisling plants held at Blue Canyon and all 10 at Blodgett failed to recover.

One diseased plant of each cultivar sent to Prosser and maintained in the greenhouse through the winter retained distinct symptoms. No uninoculated check plants (Table 1) developed symptoms. Isolations were attempted from 17 plants with symptoms, and the bacterium was isolated from all 17 but not from any of the previously diseased plants that had no symptoms after 6 mo in the greenhouse.

The recovery of plants with Pierce's disease after exposure to the winter climates of Blodgett and Prosser is consistent with the hypothesis that low temperatures limit the geographical range of the disease. Recovery of some of

Table 1. Recovery of grapevines with Pierce's disease after overwinter exposure

Site	Grapevine status	Died	Cured	Not cured	Total
Berkeley, CA					
Above ground	PD[a]	16	6	110	132
	Check[b]	0	...	...	15
Coloma, CA					
Above ground	PD	11	0	26	37
	Check	1	...	...	6
Below ground	PD	9	1	25	35
	Check	0	...	...	5
Blodgett, CA					
Above ground	PD	26	40	1	67
	Check	4	...	...	7
Blue Canyon, CA					
Below ground	PD	15	5	31	51
	Check	0	...	...	6
Prosser, WA					
Above ground	PD	15	14	0	29
Below ground	PD	19	11	0	30

[a] PD = plants with Pierce's disease.
[b] Check = uninoculated plants without symptoms.

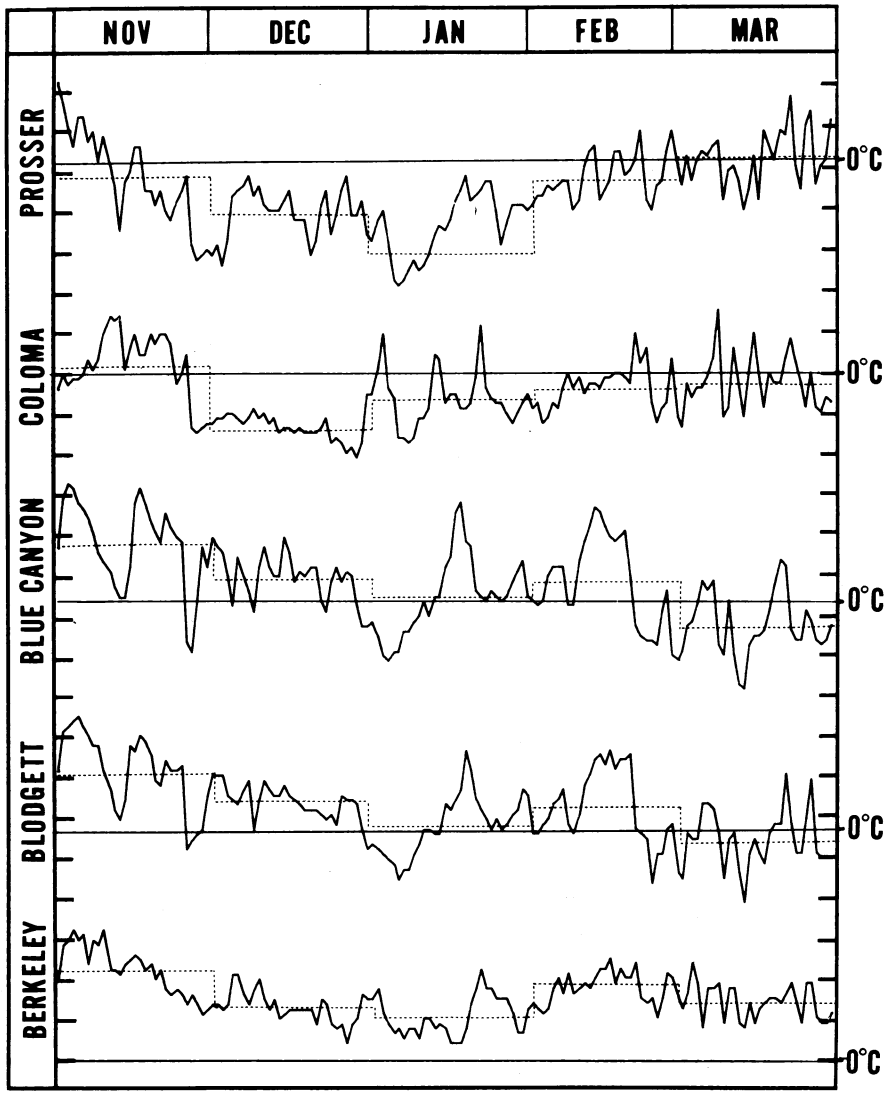

Fig. 1. Daily minimum temperatures at five sites during exposure of grapevines. Dotted line is monthly average minimum temperature. Data from U.S. Weather Bureau and experiment station records.

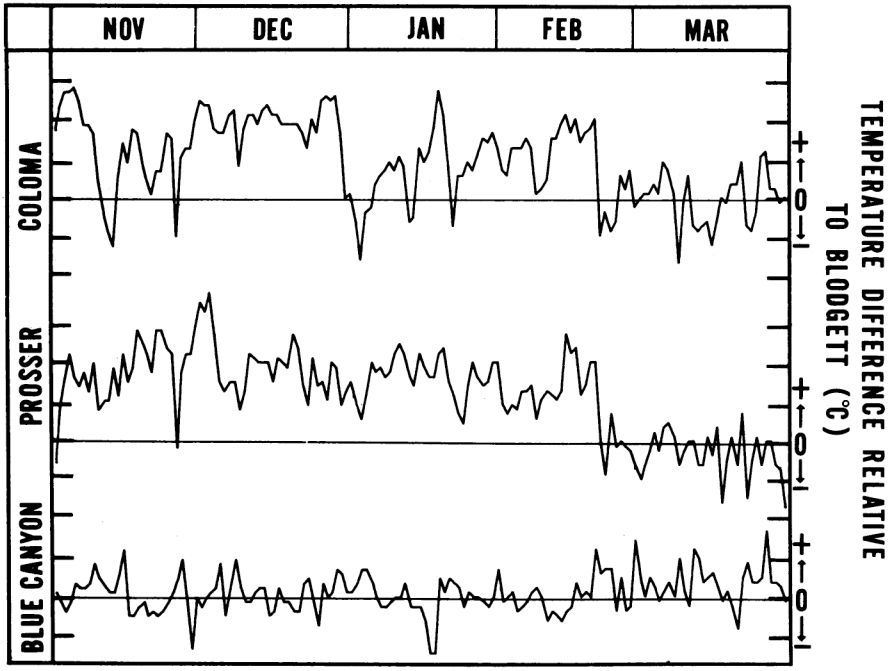

Fig. 2. Differences in daily minimum temperatures at Prosser, Blue Canyon, and Coloma compared with those at Blodgett. Values above the zero-difference line are number of degrees that Blodgett was warmer on the same date.

the plants maintained in the mild climate of Berkeley (Fig. 1) was not altogether unexpected, because previous studies suggested that many late season infections do not persist through the dormant season (4), which would account for the apparent recovery of some vines the year after infection is noticed (3). The low recovery rates at Coloma and Blue Canyon, however, do not support the hypothesis that cold temperature alone is therapeutic.

The sites at Coloma, Blodgett, and Blue Canyon were chosen to provide progressively colder climates because of their altitude differences, even though these sites are all within a 17-mile radius. However, Coloma, which had the lowest recovery of the three sites, was slightly colder (Fig. 2). Blue Canyon was slightly colder than Blodgett but also had a low recovery rate.

The inverse correlation of average minimum temperature and the percentage of plants cured of disease at the Blodgett, Coloma, and Blue Canyon sites suggests that some factor other than temperature may have eliminated the causal bacterium. As previously suggested (5), temperature may act indirectly to induce recovery—for example, by reducing xylem moisture through deeper cold dormancy—rather than directly acting on the causal bacteria. The results from this experiment indicate that cold alone is unlikely to be therapeutic for Pierce's disease. At Blodgett and Prosser, the plants were stored in screenhouses without supplemental watering, whereas plants at the other sites received precipitation (Blue Canyon) or watering by hand (Coloma, Berkeley). Low moisture may have contributed to the recovery rates at these sites, but further investigations will be needed to clarify this point.

ACKNOWLEDGMENTS

I thank Gaylord Mink, Washington State University, Prosser, for maintaining plants and providing meteorological information. Grape cuttings were provided by the Foundation Plant Materials Service, University of California, Davis. I thank Allan Finlay for technical assistance and George Nyland for helpful comments on the manuscript.

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