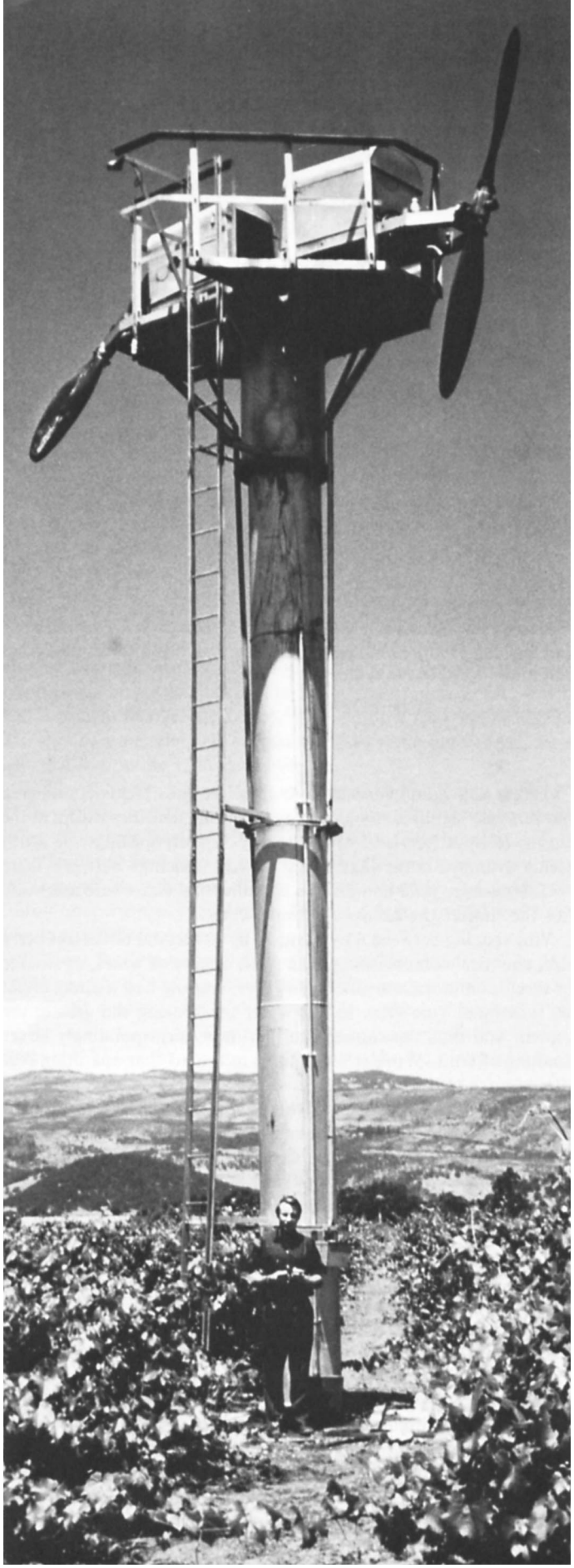

Wind machines protect vineyards by mixing warm air from above with colder ground-level air. If there is little temperature difference, wind machines without heaters are ineffective.

Frost protection uses

Both spring and fall low temperature injury to vines is common in parts of California. Temperatures that cause winter kill of fully dormant vines—10° F (-12° C)—rarely occur in the grape-growing regions.

Spring frosts that injure developing shoots and reduce the current season's crop are the low-temperature damage of greatest concern to growers. Cold injury to green growth begins at air temperatures of 31° F for a duration of ½ hour. Air temperatures of 26° to 28° F lasting several hours kill all actively growing green parts of the vine, including buds that have begun to open.

Spring and fall cold injury to the trunks of young vines may be severe. Damage usually occurs during the first fall or spring after training up to the stake. Damage is mainly confined to the live bark and may be very obvious or quite subtle. In the more obvious cases, spring shoot growth quickly becomes stunted or irregular. Longitudinal cracks appear in the bark, and in many cases aerial crown gall infection takes place in the cracks.

What causes cold damage

Cold damage is generally considered to be caused by the rupturing or injury to plant cells or cell membranes when their contents freeze and expand. The contents of the cell expand by 8 to 9 percent when freezing occurs, while other plant tissues tend to contract as they get colder. After freezing, the damaged cells can no longer control their liquid contents, and dehydration takes place.

The formation of ice crystals in tissue is by no means consistent; it depends on several factors besides the air temperature and its duration. Under some conditions, actively growing grape tissue can be supercooled to temperatures below freezing without the formation of ice crystals and without subsequent damage. The amount of stored carbohydrate in the tissue plays a part in retarding ice formation and is often referred to an "antifreeze."

The discovery that certain bacteria provide a nucleus for ice crystal formation has led to one entirely new approach to frost protection under investigation by Dr. Steven Lindow, plant pathologist at the University of California, Berkeley. He has found that, without a plentiful supply of these bacteria, ice forms at temperatures several degrees lower than when they are present. Laboratory evaluations using a cold chamber indicate a significant difference between tissue treated with a bactericide and untreated tissue in response to cold temperatures.

Vineyard frost protection

Not until the mid 1950s did the value of wine grapes become great enough to justify frost protection. Up to that time growers relied on location and various cultural practices devised and recommended by viticulturists and engineers to mitigate frost damage. Spurred by the beginnings of a boom in the wine grape industry, frost protection technology, already well developed by U.C. agricultural engineers in citrus and other fruits, was transferred into the grape industry, primarily by U.C. Cooperative Extension.

In the early sixties, industry and the University began to develop the frost protection system that was to revolutionize the industry in the cooler frost-prone grape-growing regions. During the sixties and seventies Extension engineer Larry Booher, working with private irrigation engineers Paul Junker and others, perfected a

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Germplasm collection at University of California, Davis, contains virtually all the important wine, table, and raisin grapes in world culture. Included in the collection of about 2,000 plants are European or vinifera specimens, some obtained 100 years ago; the largest single collection of French hybrids, used for their hardiness and disease resistance; and Russian, Greek, and Middle Asian varieties now largely unavailable from original sources. The 25 known North American wild species of vinifera are present, as are wild and cultivated forms of the native rotundifolia (muscadines) of the Southeast and the only known grouping of wild Mexican *Vitis*.