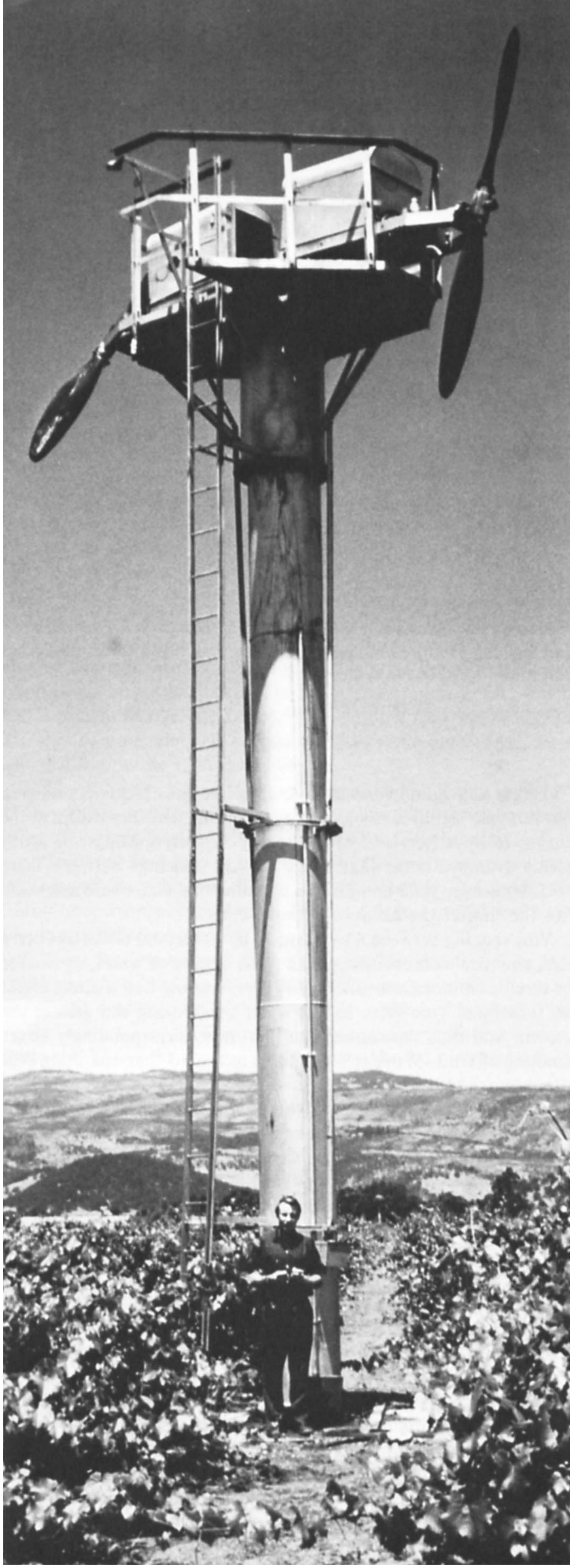

Wind machines protect vineyards by mixing warm air from above with colder ground-level air. If there is little temperature difference, wind machines without heaters are ineffective.

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

a variety of devices

Bruce E. Bearden

design for an overhead sprinkling system that provided frost protection to temperatures well below those of existing methods. Overhead sprinkling of vineyards was the first frost protection method that fully utilized the heat potential in water, including the heat of fusion released as water turns to ice.

Cultural practices

Spring radiation frosts can be modified by 1 to 2 degrees by improving the daytime heat-absorbing potential of the vineyard soil. This amounts to storing more of the heat radiated by the sun for release at night.

Air movement of only 3 to 4 miles per hour mixes the warmer air above the vineyard with the colder air close to the ground. Removing or thinning of border trees helps promote air movement and usually reduces the frost hazard.

Double pruning can delay bud break on selected buds for a week or ten days. After the tip buds on the cane begin growth and before they are ½ inch long, the vines are repruned back to the desired two or three basal buds that have not yet begun to grow.

A. N. Kasimatis

Mixture of ice and water on vines provides heat of fusion, keeping the temperatures of vine tissue one degree above the point at which damage begins.

Frost protection methods

Permanent-set overhead sprinklers have emerged as the method of choice for difficult conditions. As long as there is a mixture of ice and water on the vines, providing the heat of fusion, the temperature of the ice-water mixture and the tissue below it will remain at 32° F, just one critical degree above the point where the vine damage begins.

Overhead sprinkler systems apply 0.11 inch of water per hour, or 55 gallons per minute per acre. At this rate, full protection of vineyards to temperatures in the mid-twenties has been achieved.

Overhead sprinkler systems are expensive and require a substantial water supply. They do not require extensive labor to operate, are clean and quiet in operation, do not use large amounts of fossil fuels, and can be used for irrigation, pest and disease control, heat suppression, vineyard establishment, and spring and fall frost protection. They have made it possible for vineyards to be expanded to locations that were previously too frost-prone for grape production.

Bruce E. Bearden is Farm Advisor, Cooperative Extension, Mendocino County, Ukiah, CA 95482.

A. N. Kasimatis

Heaters are almost always used with wind machines. U. C. Extension engineers adapted citrus orchard heaters for vineyard use and promoted clean-burning, efficient operation.

A. N. Kasimatis

Overhead sprinkling of vineyards, perfected by U. C. Extension engineers, was the first frost protection method to fully utilize the heat potential in water.