

# WIND MACHINES for Frost Protection

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In Arizona, very little performance data have been obtained on wind machines until 1954-1955 when an unusually cold winter provided an opportunity to obtain information on 14 nights around a rotating machine in the center of the 40-acre University of Arizona Citrus Experiment Station tract near Phoenix. The machine had two 75 brake-horsepower gasoline motors powering 13.5-foot propellers.

## Air Drift

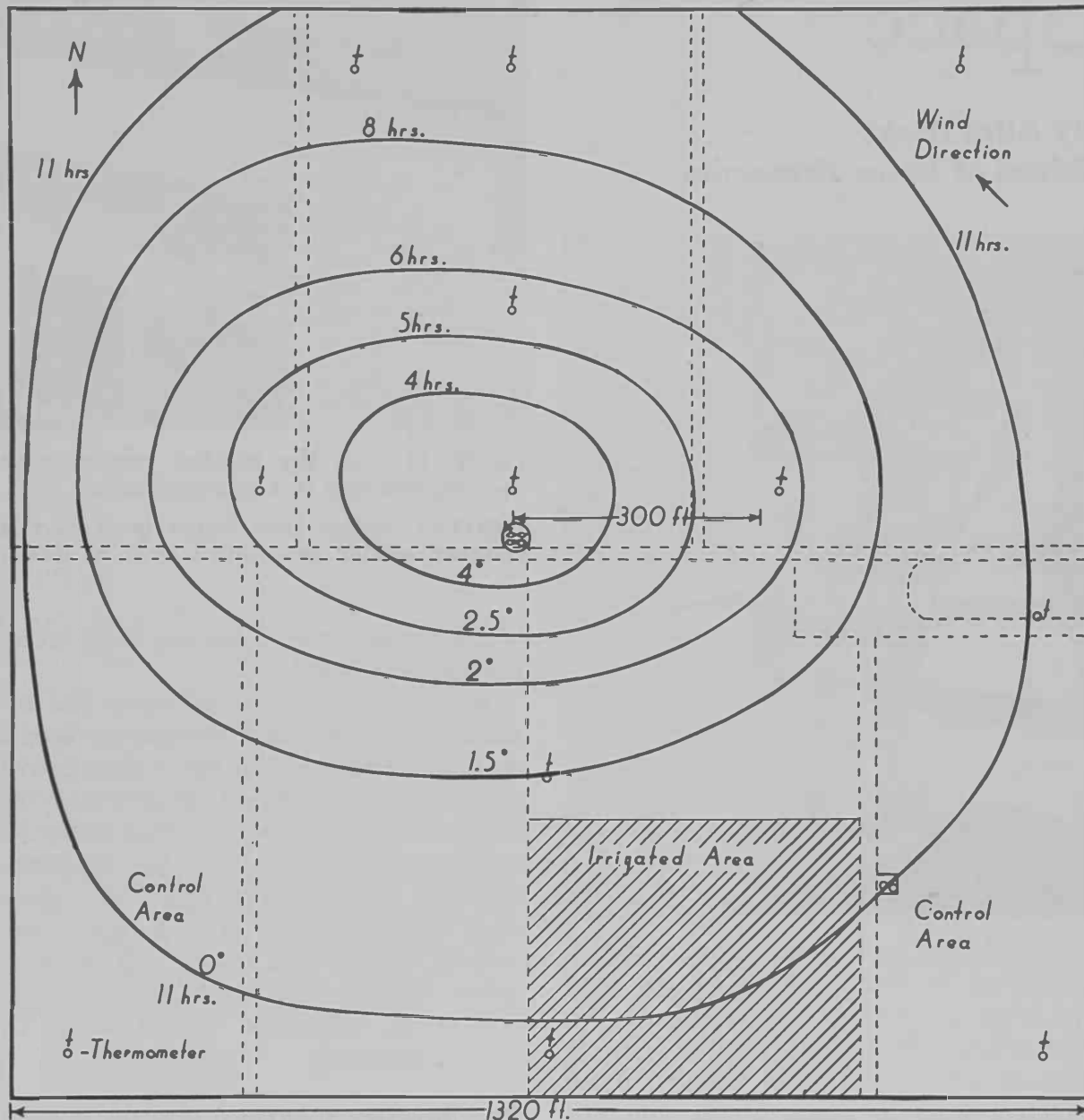
The machine raised temperatures the most to the northwest because of the air drifts from the southeast. On one night the temperature just outside the area influenced by the machine dropped rapidly to 26 degrees and gradually and rather uniformly thereafter to a low of 20 degrees. The wind machine retarded the rate of drop so that the number of hours below 26 was reduced from 11 on the south side of the tract to five within 300 feet of the machine on the northwest side. The pattern of protection was reflected in the fruit injury which occurred in oranges and grapefruit and the defoliation of lemon trees.

## Loss Variation

A complete loss of fruit and 100 percent defoliation of lemons occurred in the 8- to 11-hour zone, excepting the irrigated area. The damage became progressively less as the number of hours below 26 degrees was reduced. Within the five-hour zone about 10 percent defoliation occurred on lemons and although "slush ice" formed in oranges, freezing injury did not develop and the fruit showed no signs of frost damage. In the 5- to 8-hour zone variable degrees of damage developed. The most seriously damaged fruit was graded out. About 60 percent of the crop was packed as first grade.

## Irrigation Affects Temperature

Irrigation water at 59 degrees applied to healthy vigorous Valencia orange trees raised the temperature between 2-3 degrees and, even though "slush ice" developed in fruit on that night and repeatedly in subsequent freezes, about 75 percent of the fruit was packed as first grade.



TOP: Wind machine used in tests.

BOTTOM: Pattern of temperature increases with hours below 26°F. around wind machine in center of 40-acre tract. Outer circle represents 11 hours below 26° with minimum temperatures of 18-20°F. Average temperature inversion 9.5°F.

The irrigation water increased the moisture content of the leaves early in the morning following the freeze. This suggests that high soil moisture may also induce a physiological change which provides more cold tolerance within the fruit and leaves.

Data obtained on all of the 14 cold nights reveals that the increase in temperatures approximated the average on the downdrift side of the machine. The increase in temperature was always markedly greater downwind from the machine rather than upwind.

## Temperature Inversion

The temperatures of the air at 50 feet and at 5 feet above the ground were

measured to determine the amount of the temperature increase caused by the wind machine. When this inversion difference was more than nine degrees, from 2.3 to 3.7 degrees increase in temperature occurred 300 feet downdrift, whereas when the inversion was below seven degrees a lift of 1.3 to 2.2 degrees was obtained.

It is clear that both the area of protection provided by a wind machine and the increase in temperature will vary with climatic conditions. Air drift was not consistent and in this location wind machines could not be distributed symmetrically without reference to the "prevailing" drift. It is necessary to provide supplemental heat for more complete protection.