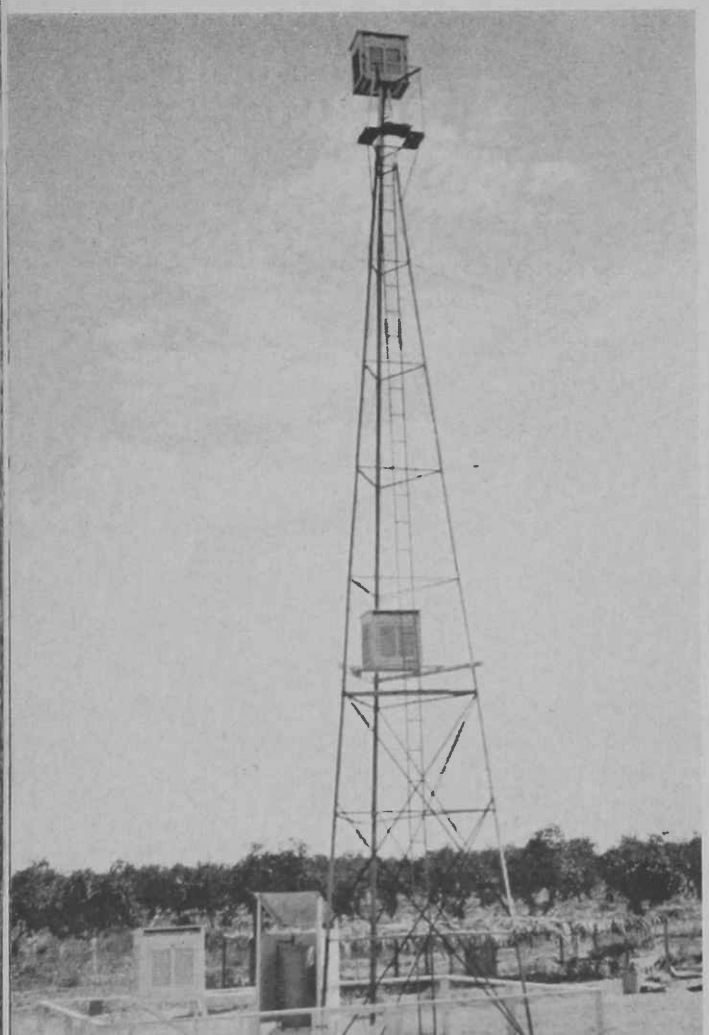
# Frost Protection For *Arizona?*

## Problem of Heating Citrus Orchards Is Under Study in Salt River Valley

By Robert H. Hilgeman

Freezes during the past two winters destroyed an estimated 700,000 boxes of Valencia oranges — 75 per cent of the Arizona crop. This means an economic loss to the industry of about 3⅓ million dollars. During this period California orange and lemon growers saved a large percentage of their crop through frost-protection methods. One of the reasons orchard heaters and wind machines have not been used in Arizona is that growers have thought a "ceiling" does not exist here.

**Figure 1.** U. S. Weather Bureau equipment mounted on 50-foot tower, to study temperature inversion.



A ceiling, or temperature inversion as it is technically known, occurs in the following manner. During the day the radiant heat from the sun warms the earth, which in turn warms the air directly in contact with it. This warm air, being lighter, rises and is replaced by more cold air which is warmed, thus setting up small currents which gradually warm the air to elevations of 300 to 1800 feet.

After sunset, the earth loses heat by radiation to the sky and the soil becomes colder. The air in contact with the soil also becomes colder. Since cold air is heavier than warm air, a layer of cold air is gradually built up, so that an inversion of temperature takes place.

To study this phenomena under Arizona conditions, official Weather Bureau equipment and thermographs were installed at different elevations on a fifty-foot tower (Figure 1). Between November 1938 and April 1945 records were obtained through the cooperation of Carlos and Glynn Stannard at their grove on Chicago Avenue at the Arizona Canal. In 1945 the tower was moved to the University of Arizona Citrus Experiment Station on Highline Drive near Baseline Road where records are obtained at present.

Experience in the Salt River Valley has indicated that damage to oranges does not occur until air temperatures drop to at least 26°.

At the Stannard Ranch on 28 nights, the average inversion between 5 feet and 50 feet was 9.7°; a maximum of 17° and a minimum of 7° indicates the range. A temperature gradient existed so that at the 20 foot level an inversion of 4.6° occured.

The data from the Citrus Experiment Station are somewhat different. The winters of 1946-47, 1947-48 and 1948-49 were much colder than any between 1938-45 so 66 nights were available for study. The average 5 to 20 and 5 to 50 foot inversions were respectively 4.9° and 6.9°. A maximum inversion of 12° and a minimum of 2° were recorded. In all cases temperatures were higher at 50 feet than at 5 feet.

Observations from thermometers on captive balloons indicate that several degrees more inversion occurs at elevations of 300 to 500 feet.

In the freeze of January 3-6, 1949, a cold mass of air moved into the valley so that day temperatures were low and inversion was less than average. Thermograph traces of the two coldest nights shown in Figure 2 illustrate several typical inversion features.

First, maximum inversion occurs early in the evening.

Second, winds mix the upper air with the lower air causing sharp raises in lower air temperature. This is shown on Janary 3-4 by increases in temperature between 8 and 11 P.M. and between 2 and 6 A.M.

Third, the minimum temperature for the night at 50 feet usually occurs 1 to 2 hours prior to the minimum at the 5 foot level.

Fourth, inversion is greater on calm nights. On January 4-5 air movement was less than during the previous night. With less mixing of air, greater inversion occured throughout the major part of the night. This mixing of the warmer upper air with the colder ground air appears to be one of the major factors producing the differences in temperature observed in different parts of the valley on cold nights.

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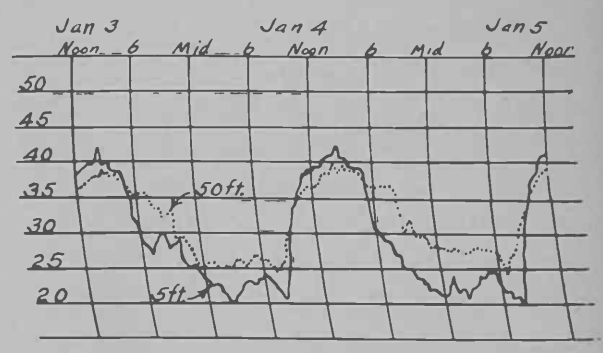


**Figure 2.** Thermograph traces obtained during the January 3-6, 1949, freeze.

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Fifth, the duration of low temperatures is less at 50 feet than at 5 feet. On January 3-4 there were 11 hours below 26° at 5 feet and 3½ hours at 50 feet. On the next night a greater difference existed with 13 hours and 1 hour respectively.

These studies indicate that temperature inversion in the Salt River Valley is sufficient to provide favorable conditions for the use of frost-protection devises. Inversion appears to be similar to that which occurs in many areas in California where orchard heating is practiced. From the meteorological viewpoint, heating can be accomplished here. The economic aspects of heating, however, involve many other factors which should be carefully considered by the growers.

*—Robert H. Hilgeman is Associate Horticulturist.*

## They Learn to Teach Arizona's Farmers

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education of a successful teacher of agriculture. The findings of research in agriculture and the development of new practices in teaching require continuous study on the part of the progressive teacher.

To teachers on the job, the College of Agriculture offers the following services: assistance through individual and group conferences conducted throughout the state, bulletins and other teaching aids for teachers and their students, and special summer-school short courses to meet the specific needs of Arizona teachers.

The graduate short courses are arranged to enable teachers to pursue a continuous program of advanced study even though their work is a year-around job. In recent years, a total of nineteen different short courses have been offered by various dements in the College. Each summer about half of the teachers in the state enroll for these courses.

*—R. W. Cline is head of the Department of Agriculture and Home Economics Education.*

## Extension Service Teaches in Field

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islation establishing research divisions in the Land Grant Colleges, known as Experiment Stations.

Although the first incentive for research in agriculture in these institutions was for student use, it soon became evident that results of agricultural research would be of great value to farmers if the information could be applied. In this movement to reach farm people there developed a plan in the field of education known as farmers' institutes.

A system of printing and mailiing bulletins to farmers was also set up, but both of these efforts were unsuccessful in that neither contained a process to bring about the application of this research information to the farm. Farmers attended the institutes and read the bulletins, but a link in the educational process was missing. People learn by seeing - by doing. Someone conceived the idea of the demonstration method, in some respects resembling the methods used in teaching the natural sciences.

The idea also included a provision for the demonstration system to be operated by a teaching division of the Land Grant College consisting of teachers living with the farm people — knowing them and their problems. So, there came into being in 1914 under the Smith Lever Act the Agricultural Extension Service, a third division of each of the forty-eight Land Grant Colleges.

Without local volunteer leaders the Extension Service could not function as it does. In fact, Extension's widespread unpaid local leaders and cooperators are a unique contribution to this field of education.

The Extension system has been tested and revised through two world wars and the peace following these wars. It has adjusted its programs to periods of boom and depression. Today it touches a high percentage of the homes and farms in rural Arizona.

The work of the Extension Service can be expected to change to meet the new problems of homemaking and of agricultural production, involving new crops, new insects, new diseases, and probably new weeds.

The chief objective of the entire Extension Staff is that the County Agent's office will continue to help local farm people to meet their problems of agriculture.

*—Chas. U. Pickrell is Director of the Agricultural Extension Service.*

## Growth Patterns Are Studied

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he became identified. Any deviation even for a month or two was cause of examination.

A group of 61 girls, 12 and 13 years of age living in southern Arizona most of their lives but living at the time in one school district in Tucson, was studied last year by Mrs. Elizabeth B. Hurley, graduate student. Instead of the above rate of advance she found 23% of her cases following the 2% age schedule (as shown on page 5), 84% following the 67% schedule, and 100% the 82% schedule. None was in the 98% or retarded schedule.

These girls were classified also into 9 general body types of physique referred to, respectively, as $A_4$-$A_3$-$A_2$-$A_1$-M-$B_1$-$B_2$-$B_3$-$B_4$; $A_4$ representing the very fat, $B_4$ the very thin, and M the average type. (See photos, page 5). Of the Tucson group, fewer cases were classified as being types $A_4$ to $A_2$ than those of the midwestern group with more being $B_1$ to $B_3$. With this trend to the slender type, together with advanced age schedules of growth, more of the girls are expected to reach the taller statures at adulthood if they continue to conform to the age schedules of the northern girls. However the Arizona schedules may be somewhat modified by the fact that in post-adolescence, of the two groups, the Arizona girls show the greater drop in metabolic rate. It is of interest also that 82% of these 12- and 13-year-old girls had made, at the time of the study, 90% or more of their predicted full growth.

Continued observation of the girls studied by Mrs. Hurley to cessation of growth will give us the full picture. We should know then to what extent this marked acceleration in growth in preadolescence is characteristic of postadolescence resulting in the higher statures of adulthood.

*—Ethel M. Thompson is Professor of Nutrition in Home Economics.*