

ORCHARD HEATING IN ARIZONA

W. F. Wilson, '29

Low Temperatures Occur at Periodic Intervals; Methods of Preventing Frost Injury to Citrus Trees

WHEN the fruit producing industry was small and the value of the crops commensurably low, the losses caused were not of great magnitude. With the rapid extension of fruit culture which has characterized the past three decades and the great increase in the value of the crops produced, losses from frost damage have become exceedingly important, amounting to millions of dollars during the past five years. Few if any localities are entirely free from the danger of low winter and spring temperatures and with minor exceptions every fruit crop of commercial importance is subject to occasional loss from this cause.

The greatest and most frequent losses occur with the sub-tropical fruits, on account of their greater susceptibility to frost damage due to the fact that they are nearly all grown out of the natural environment. This is particularly the case with the ever-green sub-tropicals such as citrus which has been found to 'run-wild' only in the tropics, which never enters a condition of complete dormancy and which normally matures its fruit during the winter or spring months. With this class of fruits therefore, losses may arise not only from the destruction of part or all of the crop but from the killing of a part of the fruit-bearing wood as well. With mature trees, the damage of the fruit-bearing wood may be sufficient to delay fruit production for several years, and with young trees may so impair their usefulness as to render them practically worthless, sometimes even resulting in death.

In the Citrus industry, the importance of losses from low winter temperatures is widely recognized and the protection of the orchards, as much as practicable, against such losses, is now generally admitted to be one of the essentials of success. Since there are practically no frostless areas in Arizona or California, there is reason to believe that orchard heating may also be regarded as a necessary factor in the permanent and successful culture of many of the other sub-tropical fruits

grown in these regions. Arizona Orchard Heating is not so necessary due to the fact that a number of our varieties mature early and are harvested before freezing weather occurs. Orchards are now being established in Arizona in regions where orchard heating will no doubt be necessary.

Direct losses suffered by the growers consist in the partial or entire destruction of the crop for the current season and, in the case of the ever-green sub-tropicals, destruction for one or more years to come. It is common for growers who have recently installed orchard heating equipment to reap a return from the saving of one crop sufficient to pay for a cost of the equipment and the overhead costs of its maintenance for a period of years. This is explained by the fact that on the year when a freeze comes the crop is so materially reduced that the prepared grower often receives double the ordinary price for his fruit.

The losses to the community are no less serious than the losses to grower. So well has this importance been recognized that in some districts of California orchard heating has become a community problem.

The sudden loss of a citrus crop ready for market results in serious losses to all individuals, agencies and organizations concerned in packing, shipping and marketing the crop. The frost damage occurs after arrangements have been completed for the purchase of packing materials, appropriations have been made for national advertising, and schedules for moving the crop have been worked out with the rail roads. The necessity of cancelling orders for material, and services results in losses of a widespread character.

There are many areas in Arizona and California where the occurrence of temperatures occasioning severe damage is so infrequent that the savings effected by the use of heaters would not in the long run equal the costs of installing and operating the heating equipment. It is also probable that there are certain localities planted to fruit where frost

damage is so extensive and so frequent in occurrence that over a period of years the cost of heating would exceed the value of the crops saved. Groves so situated should be top-worked to varieties either more resistant to frost damage, or on account of later blooming or earlier maturing of the crop, offer fewer hazards.

The primary factors which would determine the advisability of orchard heating are the overhead and operating costs involved, and the probable savings which may result. The overhead costs of orchard heating can be determined with some degree of accuracy from the extensive experience at hand. Operating costs can be estimated with a fair degree of accuracy providing the average number of hours of heating per year required to save the crop is known. Estimates should be based upon available data and in all cases should be liberal.

The factors of production per acre and average price received for the fruit are of great importance in determining the probable profits from orchard heating. With a given cost of heating over a ten-year period, it may prove to be profitable investment if large crops are produced, even though prices are not abnormally high. The average overhead of orchard heaters is \$25.00 per acre whether they are lighted or not, each year.

The heat from the sun comes to the earth in the form of waves, a method of heat transfer which is known as radiation. Heat is also lost to the intensely cold upper limits of the atmosphere by this same process or radiation. The earth loses heat by radiation continuously both day and night, but during the day the amount of heat lost is everbalanced by the amount received from the sun, and the temperature rises. Radiant heat passes through clear dry air without much heating of the air itself. Air is warmed much more by contact with a warmer body, that is by conduction of heat from the body to the cooler air in contact with it. The trans-

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DISEASES OF THE ROSE IN ARIZONA.

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are found especially after rains or where the soil is moist on the surface.

Root rot is a most difficult disease to control as it persists in the soil for years and attacks so many other plants—even weeds. It advances through the soil so that an infected spot becomes the center of an area which spreads in every direction and endangers the entire planting. The only possible methods of control in rose garden are either to remove the infected soil or to treat the soil chemically to destroy the root rot organism. The principal difficulty is in determining the exact area of infection and determining the area which it is necessary to treat. The area increases very rapidly as the radius from the point of infection is increased—an eight foot circle has four times the area of a four foot circle, and the radius has been increased only two feet. Since the cost of treatment is in proportion to the area, it is necessary to limit the area treated.

Removal of the soil to a depth of

three feet is perhaps the best method where the area infected is small. It is especially recommended where the soil is not particularly good in texture and fertility as it gives an opportunity to replace it with a deep layer of fertile soil which will grow excellent roses.

The best method of applying chemical to destroy the fungus is to remove the soil to a depth of 18 to 24 inches and apply a 5 percent solution of commercial sulphuric acid at the rate of one gallon per square foot to the bottom of the hole. When this has soaked in, replace half the soil and treat this with more 5 percent solution—one-half gallon to the square foot, and repeat with the remainder of the soil. In diluting acid, always pour the acid slowly into the water stirring constantly. The solution will corrode metal containers—use wood, glass or stoneware.

Stem Canker

This fungus disease while not common has been found in the state. The first symptoms are small pale-yellow or reddish spots on the bark which gradually increase in size. Both bark and wood become dry and cracked forming a canker which often girdles and kills the stem.

The best method of control is the pruning out and burning of all infected parts, and the painting of all pruning wounds as infection usually occurs at that point. Sprays are of little value.

Brown Canker

This disease resembles stem canker on the stems but may also attack leaves and blossoms. The cankers are a darker brown and may have a purplish margin.

The pruning and burning of infected parts is recommended. It may be necessary to spray the bushes with Bordeaux mixture 4-4-50 to protect foliage and blossoms from infection by small cankers which have been overlooked.

Blossom Blights

In some seasons the blossoms of certain varieties will show a soft rot of the outer petals which spoils the blossoms. This usually occurs following rains and there is no known method of control. Often the outer petals will dry out and harden preventing the blossom from opening properly.

White and other light-colored roses are sometimes disfigured by brownish lesions on the petals, especially at the base. If the injury

is severe the blossom will not open. This injury is caused by thrips, small sucking insects, and the Entomologist can suggest control measures.

Foliage Defects

Chlorosis—Rose bushes showing a yellowing or chlorosis of the foliage are usually suffering from poor drainage, excess moisture, poor soil, or excessive amounts of fresh manure. Bushes set in small holes dug in a hard caliche formation often show this condition. It will be necessary to determine which cause is operating before a remedy can be recommended.

Shedding of foliage—Loss of foliage during July and August is not always a sign of disease but often a characteristic of certain varieties when grown in a hot climate. Some growers recommend that application of water be reduced and the plants allowed to become dormant during midsummer. They claim that better growth is secured than when the plant is forced throughout the summer.

There is also a partial or total loss of foliage in some varieties during the coldest part of winter, the usual dormant season.

In some varieties which do not shed their leaves in summer, the foliage develops a bronze to blackish discoloration which is often mistaken for symptoms of disease, but is due to weathering of the leaves under the hot sun.

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fer of heat by radiation occurs at the speed of light while conduction is a slow process.

During a clear, calm day the radiant heat from the sun heats the ground surface until its temperature is higher than that of the air in contact with it. As soon as this occurs, heat is slowly conducted from the ground into the surface layer of air, which soon becomes warmer than the air at higher elevations. Warm air being lighter than the cold air, a circulation is thus established, in which cool upper air is progressively brought into contact with the warmer ground, heated by conduction, and then forced upward to make room for more cool air. By sunset the air to a height of 300 to 1000 feet has been heated to some

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extent. The fact that heating the air reduces its density, operates to prevent the heat received from the sun being concentrated in the surface layer of air alone, and causes distribution of the heat through a layer of considerable thickness. The transference of heat as described above from one portion of a liquid or gaseous medium such as the air to another thru the circulation of portions of the medium is known as convection.

Since air conducts heat very slowly, atmospheric cooling does not extend to great heights as a result of which the temperature of the air 300 feet above the ground changes but little during the night. Thus on a level plain on a clear, calm night there is a relatively thin layer of cold air near the ground, with an increase in temperature to an altitude of between 300 and 800 feet. This phenomenon, is now known as temperature inversion.

The difference in temperature between the air near the ground and that at higher levels on a frosty night is what makes orchard heating possible and practicable. If the atmosphere were uniformly cold up to great heights, the air heated by the fires in the orchard would rise rapidly above the orchard without materially benefitting the trees or fruit. As a matter of fact, the warmed air from the heaters rises, cooling at the same time until it reaches the height where its temperature is the same as that of the surrounding air. As the hot gases leave the fires, they mix rapidly with the surrounding colder air, so that the resulting temperature of the whole mass is not very high. So long as the mixture of gases rising from the fires is warmer than the surrounding air it will continue to rise; but as soon as it reaches an elevation where its temperature is the same as that of the surrounding air it will stop and remain stationary.

The amount of temperature inversion varies greatly on different localities. It is mainly determined by the range in temperature from afternoon to early morning. If the afternoon temperature is high and the temperature falls to the freezing point in the following morning the inversion in temperature is

likely to be great. Since the thickness of the layer of air to be heated, in order to obtain a given rise in temperature following a warm afternoon than following a cold, windy day.

The amount of moisture that the atmosphere can hold depends upon the temperature. As air is warmed its moisture holding capacity is increased, as it cools its capacity for moisture is decreased. If the air contains water vapor up to the limit of its capacity, it is said to be "saturated." If the temperature of saturated air is reduced, a portion of the moisture is condensed. This is what occurs when dew or white frost forms. At night the temperature of the air is deposited on exposed surfaces. The temperature at which moist dew or white frost forms is called the "dew point." By measuring the amount of moisture in the air at any time, we are able to tell its dew point; in other words, we can know in advance at what temperature dew or white frost will begin to form if the cooling of the air continues.

The formation of dew or frost, or ice gives off heat in proportion to the amount of moisture condensed. When the ground over a large area is wet from previous heavy rains, the amount of heat given off in the freezing of the surface moisture is sometimes sufficient to hold the temperature stationary near the freezing point for two or three hours. The great danger of extremely low temperature comes when the soil and the air are both very dry. A heavy blanket of clouds composed of particles of liquid moisture practically eliminates the radiation of heat from the ground for which reason there is little danger of frost so long as clouds of this type exist. The occurrence of a heavy frost accompanied by a high wind is extremely rare. Frost usually occurs on calm nights and even a light gust of wind usually causes the temperature to rise rapidly above the danger point. This effect is due to the mixing of the warmer air above the orchards with the cold air down among the trees. However blizzards which occur ever fifteen or twenty-five years make the use of wind breaks and orchard heaters a necessity to prevent the trees from being killed to the ground.

The important requirements for the occurrence of frost, a clear sky and little wind, are present during

the passage of an area of high barometer. As the first-mentioned type of disturbance the area of low barometer with overcast skies and rain, nearly always precedes the area of high barometer, the local belief that frosts are likely to follow a rain has some basis. In many cases, however, the rain area does not reach the southwest and extremely severe frosts may occur in that section without any rain preceding them.

Orchards heating has been most successfully carried out by the use of a relatively large number of small fires per acre, usually 50 heaters to the acre so arranged that one-fourth of them are lighted at first and so on by fourths as the temperature continues to go down.

The most satisfactory type of heater is probably that having a nine gallon tank and a tapered stack ranging from two to four feet in length. This type is wickless and if properly regulated, burns smokeless, to capacity, for over 18 hours. The size of the tank is of a great deal of importances as it allows for ample time to refill, as well as afford-

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MORSE'S SEEDS

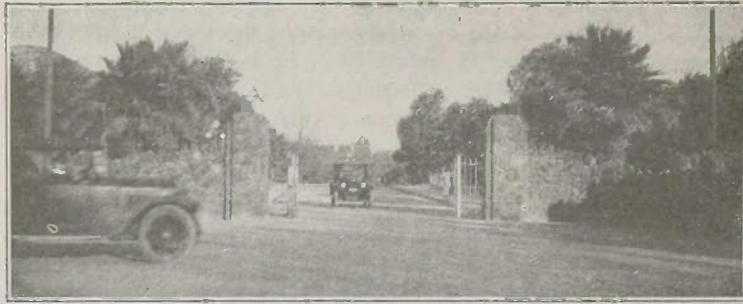
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CAMPUS ACTIVITIES

GUY MURPHY, '31

HORTICULTURAL JUDGING TO BEGIN SOON

With the first shipment of fruit arriving from the east, it will be possible for the students interested in Horticulture judging to begin preparations, for the National Judging Contest to be held at Columbus, Ohio, the latter part of November.

Preliminary plans for this work will be discussed at a meeting to be held October 16. As previously announced this judging is open to all students registered in the College of Agriculture.

Due to the courtesy of other educational institutions it has been possible to obtain all of the fruit needed for this work free of charge. Before the preparatory work is completed the students will have judged and identified one thousand apples of twenty-five varieties. In as much as this fruit is from all sections of the country, Arizona will not be handicapped through lack of fruit.

All of the fruit judged at the National Contest will be selected by the coaches of the various colleges competing in accordance with the rules of the National Pomological Society; the governing body at the National Show.

There will be no "catches in the

AGGIE CLUB HOLDS ITS FIRST MEETING

The Aggie Club held its first meeting of the school year on September 26. President Young welcomed the new members in a talk in which he outlined the purpose of the Club. Elections were held to fill two vacancies, the following being elected; J. E. Rohrer as custodian of the pitchfork and J. S. Thornber treasurer. Following the election Professor Wharton gave a talk on the Horticulture Judging Team. He gave some of the rules of the contest and urged all of the aggie students to turn out for the team.

Following the business meeting of the Club, Dr. H. L. Shantz gave a very interesting talk on "Agriculture in Central Africa." Dr. Shantz told about the agricultural methods of the different tribes giving the ways by which they planted and harvested their crops. He told about the marriage customs and living customs of the different tribes in Central Africa. After the meeting refreshments were served, in the dairy laboratory.

contest and with a little hard work Arizona should place high among the winners.

Aggie Ice Cream Sales

With the warm weather of the past week the aggie ice cream sales have increased somewhat over those of previous weeks. At present all of the ice cream sold is made in the dairy laboratory, and everybody can be assured of a high quality product. This year the aggie club is also handling fresh Arizona dates along with the ice cream.

The flavors of the ice cream are changed every week, and, as in the past strawberry has been the favorite. With the student body support of this project there is no doubt, but that Arizona will again go east on a judging tour.

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ing a great amount of storage per acre.

"Heater Oil" that is prepared by all of the big oil companies seems to give the greatest number of B.T.U.'s, for the least cost in Arizona and California. In the latter state the cost is as low as four to six cents per gallon.

Plenty of good safe torches with a sufficient supply of freshly mixed torch-oil should be on hand whenever there is danger of frost. Torch-oil is composed of one-half gasoline and one-half kerosene and if not freshly mixed the gasoline will have evaporated and the kerosene will not light on a cold night. Ample storage both in the heater capacity and in the large reservoir is very important to successful orchard heating, for if freezing weather continues for a number of days and a grower runs out of oil on the last night his efforts are lost. Oil is extremely hard to get when one needs it most because it is right then that everyone else wants it.

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