

desuetude. Only here and there occasional efforts are made to protect peach orchards, generally by the older methods. There can be no doubt that by the application of the newer methods of protecting orchards most of the crop failures since 1890 could have been avoided, and it is unfortunate that peach growers have not kept abreast of the times in this respect.

The reasons for this notable lack of interest in the subject at present may be stated as follows:

1. A lack of knowledge of the newer and more efficient methods of orchard protection now successfully used in the West, which depend not so much on the protection afforded by smoke as on the actual warming up of the air in the orchard.

2. Lack of faith in the efficiency of the newer methods.

3. The expense involved, since it is known that devices for heating the air are expensive; their value depends upon a comparatively still air and numerous well-distributed fires. The cheapness of fuel and labor in Georgia, however, should not be forgotten.

4. It is thought that peach trees can not bear full crops in successive years, therefore a full crop is not expected more than once in three years. The profits during the full years overbalance the losses during the lean years.

5. The lack of cooperation among neighboring orchardists.

In the early part of the year 1914 this matter was brought to the attention of about 60 of the largest peach growers in Georgia, by the official in charge of the local office of the Weather Bureau at Atlanta, and bulletins on the subject were widely distributed.

The use at present made of the frost warnings in Georgia, as far as known, is limited to efforts to protect small fruits, chiefly strawberries, of which 1,262,000 quarts were produced in 1909; also to protect truck crops and tobacco beds in the springtime by the usual methods of covering with straw, pine needles, cloth, or earth. In the aggregate the resulting saving must be considerable. The frost warnings when issued with the daily forecasts are available by free telephone distribution to over 75,000 people. The special frost warnings, however, are issued to only 23 addresses. In autumn the frost warnings are utilized not to protect, but to enable a farmer to gather as quickly as possible the crop threatened, as, for example, bell peppers and tomatoes, which are left on the plants as long as possible.

It is evident that in Georgia a much greater utilization of the frost warnings is possible.

the Northwest. This means the importation of cold air from the north accompanied by a settling of cold air from higher altitudes, and as this condition is usually attended by wind, therefore protection by orchard heaters is very difficult.

The fruit districts center around the following places: Tremonton, Brigham, Ogden, Salt Lake City, and Provo, all on the western slope of the Wasatch Mountains and in the Great Salt Lake drainage area. During the frost period in the spring telegraphic reports are received from the above-named places every day, and an attempt is made from this data and the weather map to forecast the probable minimum temperatures which will occur at those places on the following morning. In a country of such diversified topography as Utah, there is considerable difference in temperature within short distances. The growers, to take advantage of the frost warnings, study their local conditions as compared with the "key stations." The forecasts are given for the key stations, and if a grower has found that his place is consistently warmer or colder than the key station he can then act intelligently when warning for his key station is received.

The method of protection is by heating with the orchard heater, using either coal or oil as fuel. It can not be said that protecting the fruit from frost is universal in Utah. As a matter of fact, only a few farmers, comparatively, are convinced of the practicability of this method or any other method of protecting their fruit. There is a sufficient number, however, who have faith in the oil pot or coal pot, so that the Weather Bureau cooperates with them, as some have very large orchards.

The temperatures obtained by cooperative observers will not indicate very accurately the period at which protection of tomatoes and alfalfa seed in the fall is needed. These crops grow low, and at the special key stations, Willard, Roy, Nephi, Mills, and Desert, the thermometer shelters are placed on the ground so that the thermometers will indicate the temperature of the surrounding vegetation more nearly than if mounted in their usual position 4 feet above the ground.

The tomato-growing industry is very large and is encouraged by the presence of large canneries in this State. Tons of tomatoes are raised every year, and frequently the last of the crop is spoiled by fall frost, if not protected. Tomatoes, onions, etc., are protected by smudges which are quite effective as very little wind accompanies early fall frosts. The alfalfa seed crop is protected in a much different manner. When alfalfa becomes frosted the seed is blackened, in which condition it sells at a much lower price than the bright, unfrosted seed. It is said, however, that its germinating quality is uninjured. The alfalfa seed grower as soon as he learns that frost of sufficient intensity to blacken the seed is expected, puts to work in the field all the mowers he can, then he stacks the grass. Only a small percentage of the seed is frosted when in this condition, and the crop will then have a high selling value.

It may be asked: Why does not the grower cut his seed earlier? Alfalfa seed matures very unevenly, therefore, an early fall frost catches the seed in all stages of growth, part being in the ripe stage, part fully developed but full of sap, and part not far enough advanced to germinate. During this period, about 10 or 15 days before the crop should be cut, the seed increases in weight from 50 to 100 pounds per acre every 24 hours. The grower, therefore, is tempted to allow the plant to remain standing until the last minute in order to secure this increase, and as seed is now selling for about 12 cents a pound, the increase in weight is valued at from \$6 to \$12 per acre per day.

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PROTECTION FROM FROST IN UTAH.

By ALFRED H. THIESSEN, Section Director.

[Dated Weather Bureau, Salt Lake City, Utah, Nov. 27, 1914.]

There are two seasons in Utah when agricultural products are subject to frost. The first is in the spring, from April 1 to May 15, when apricots, cherries, peaches, and sometimes apples need protection. The second is in early fall, when flowers, tomatoes, onions, and alfalfa seed are in danger.

The temperatures as obtained from the ordinary records of cooperative observers give a very accurate idea as to the period when fruit may be menaced by frost in spring, as the thermometers are exposed at about the same elevation as the zone of greatest fruit production. The condition to be most feared is that with a low pressure area over Colorado and a high pressure area over

The Weather Bureau places thermometers in alfalfa and tomato fields every fall about August 20 and receives telegraphic reports daily from all stations of their temperatures, and the information is handled in the same way as with fruit in the spring.

IX.

551501.612 (708)

NOTES ON FROST PROTECTION IN THE VICINITY OF KNOXVILLE, TENN.

By J. F. VOORHEES, Local Forecaster.

[Dated Weather Bureau, Knoxville, Tenn., Nov. 28, 1914.]

Protection from frost has not been practiced in this State except on a small scale and generally in a more or less experimental way. A few orchardists have fired their orchards regularly for several seasons and a number of others have built fires occasionally. In most cases there has followed a crop of fruit where the firing was done, but usually some of those who did not fire have also had a crop which makes it very hard to determine just what the benefit of the firing has been. The general opinion, however, seems to be that firing pays, and the amount of firing done each year is, I believe, on the increase.

The topography here is such that it is impossible, except in rare cases, for orchardists to cooperate, as the orchards are widely scattered, each on its own hillside.

A variety of fuels have been used with about equal success as far as protection was concerned. It appears, therefore, that the cost of fuel and work of handling it would be the factor that would determine which is best for any individual.

The principal fuels used here are straw, old stumps, coal, and crude oil. Where there are many stumps in an orchard they should of course be used, as by that means the stumps are removed economically. Soft coal has been the favorite fuel in this region so far, because for a given amount of heat it is much cheaper than crude oil at prevailing prices. The oil is being used in some cases because of the greater ease in handling, but in one experiment at the University of Tennessee Fruit Farm, when a cold wave arrived during a snowstorm, the oil failed because the falling snow caused it all to pop out of the container in which it was burning.

The need for frost protection is very irregular. In some years no protection is needed while other years occur in which several firings would be necessary to save a fruit crop. Sometimes the freeze comes on a still night when protection is comparatively easy, and again it comes with a high wind that makes protection very difficult if not impossible.

Under these conditions it is difficult to get any but those whose living depends on the orchard to take the trouble to prepare to protect from frost. Still the number who try to protect their fruit is increasing and should be increased many fold.

protection. Frost warnings are of no benefit to farmers who do not protect their crops. I judge that not over 10 per cent of the fruit growers use protective measures, but as the crop runs into millions of dollars this 10 per cent amounts to several hundred thousand dollars.

Two classes of frost forecasts are made here: One wherein the information is conveyed in general terms, e. g., light, heavy, or killing frost expected, and the other in specific terms, by the statement that the minimum temperature next morning will be 26°, 28° or 30°, as the case may be. The latter forecast is sent to a central point where protection work is done, such as Medford, Oreg., North Yakima, Wash., and Boise, Idaho. When received at these places a local man amplifies it to fit still more restricted localities; and when the distribution is made, which is done by telephone, practically every horticulturist in the neighborhood knows just what temperature to expect, and can prepare himself accordingly. By means of these forecasts many orchardists have saved a crop that would otherwise have been a total loss. Just what credit the Weather Bureau should receive can not be accurately determined. It is probable it will amount to \$100,000 or more every year when damaging frosts occur. Some of the orchardists would save their crops if they did not get the warnings, as they always are on the watch for frosts and get very little sleep on this account during the frost season, but the majority depend upon Weather Bureau warnings and at times they would suffer severely without them.

Most of the orchardists use oil burners to heat their orchards, but a few use wood. A great many use prunings for their first fire, and after they are burned no more protection work is done, consequently they are prepared for only one frost, and if another occurs they lose their crop and have nothing to show for the work previously done.

Orchard-heating systems are slowly improving. The first mistakes were in not having enough pots to the acre. After these were increased it was found that the style in use gave the most heat shortly after being lighted, whereas early in the morning when the most heat was wanted the fires were burning low and not enough was obtained. As fast as improvements are being made in the heating apparatus the number of orchardists engaged in the work increases.

It has been proved that the temperature can be raised by 6° or even 10°F. in an orchard by heating methods, and this is sufficient in every case, so far as I know, to save a crop in the North Pacific States, where on frosty mornings the temperatures never go more than 10° below the freezing point.

Some think the orchard business has been overdone in the North Pacific States; hence during the last two years not so many new orchards have been planted. For the preceding five or six years the increase of orchard acreage had been enormous. During the next two or three years the new trees then coming into bearing will make the necessity for frost warnings greater than ever.

Orchard heating is used mostly by the apple growers, less by those who raise pears, and still less by the peach, prune, and cherry growers.

The localized districts now in operation are known as the Rogue River Valley, with Medford, Oreg., as the central point; the Yakima Valley, with North Yakima, Wash., as the central point; the Boise Valley, with headquarters at Boise, Idaho. A new district will be operated next spring to take in the orchards in the neighborhood of Walla Walla, Wash. In this latter district the trees are just coming into bearing and these orchardists were not heretofore interested in protection work.

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FROST FORECASTS AND PROTECTION IN OREGON, WASHINGTON, AND IDAHO.

By EDWARD A. BEALS, District Forecaster.

[Dated Weather Bureau, Portland, Oreg., Nov. 28, 1914.]

Those receiving the most benefit from frost warnings are the horticulturists who have commercial orchards. No one else is prepared to do anything in the way of