

safely. Protection by oil pots is an expensive undertaking, the cost of equipment per acre being in excess of \$180, with \$33 for maintenance and deterioration. Cost of labor and oil would be additional. Coal baskets are favored by an inconsiderable number of orchardists. There is one feature in their favor, and this is that there is no oil leakage in the grove. Oil drippings in the groves are detrimental to the trees, so that great care has to be exercised to prevent such damage. The piping of fuel oil and the use of burners is thought to be impracticable for the reason that it is difficult to obtain a good pipe joint, and the leakage then being so near the roots would injure the trees. Various systems of covering the groves have been tried, cloth in Pomona (fig. 17) and Corona (fig. 33), lath at San Fernando (fig. 12), and glass at Fillmore (note on fig. 8). The only available thermograph records as to temperatures within and without an orchard covering have been made by Cooperative Observer J. E. Adamson, of Pomona. Traces of thermograms are reproduced in figure 17. It was found that the minimum temperature within the inclosed portion of the grove was from 2° to 8° higher than the outside minimum, and that during warm days the minimum within the inclosure was also from 3° to 4° warmer than outside. The experiments have not proved satisfactory to those who have conducted them. The experimenters feel that some sort of covering is desirable to protect from the drying winds as well as from the cold, but the ideal shelter is yet to be constructed. In this, and in all other lines, intelligence of a high order has been brought to bear on the many problems constantly confronting the citrus orchardist. For example, elaborate thermometer tests are carried out in scores of orchards (fig. 30), air-drainage observations are being made (fig. 26), and only once during his visits did the writer find an instance of misdirected effort (fig. 24).

(i) *Necessity of closer relations between orchardists and the Weather Bureau.*—The orchardists appreciate the aid given them by the Weather Bureau. Being intelligent men, they realize the limitations of the endeavors made to serve them. They do not ask the impossible. In closing this report it is suggested that efforts be continued along the lines of more specific forecasts, including in the frost warning more than the mere statement that frost is expected. It is desired that, when possible, probable relative humidity values be included, as well as other pertinent information. Forecasts as to the drying winds of late autumn, winter, and early spring (fig. 22) would also be valuable as additional protection and in planning irrigation.

In conclusion it may be stated that there is a unanimous desire for closer relationship, leading to helpful cooperation, between the orchardists and the bureau.

III.

LETTER ON FROST AND FROST PREVENTION.

By J. W. GARTHWAITE, Manager.

[Dated Corona, Cal., Feb. 4, 1914.]

I have been through Prof. Humphreys's very interesting paper [see above, p. 562] with great care and feel that from a general point of view he has covered the subject extremely well. From the standpoint of the citrus grower I may offer a few suggestions.

We have all had a general understanding that, as Prof. Humphreys says, the temperature of the air a few

feet above the ground will be found a good deal higher than that at the surface. The results of the freezes of December, 1911, and January, 1913, were such as to indicate that, in this section at least, damage was general in all parts of the trees; in some cases seeming to have been more severe at the top. This condition could be accounted for by the fact that there is often more tender growth at the top than in other parts of the tree. Of course in many orchards all the fruit was frozen, regardless of location; but in such as were more fortunate the good fruit was not to be found more on the higher branches than on the lower, but rather where the particular piece of fruit was protected by a covering leaf or branch. However, these two freezes are probably not to be taken as typical, since they did more damage to high ground than low; but as they are the only freezes that have done serious damage in this section they are the only ones that I can cite.

The well-recognized frost indications of which he speaks do not seem to be reliable in this district. For instance, a low temperature at 8 p. m. is very often a false alarm, while a high thermometer at the same time in the evening is often followed by frost. A clear sky is, of course, a bad sign; also a few times this winter I have retired feeling that all was lovely because of clouds or even a dense fog, only to be awakened at some cruel and unusual hour by the frost alarm to find clouds or fog gone the way of all flesh. And the same thing applies to wind. At no time this winter have I observed a dew point below 36°F., and yet on 19 nights the temperature has dropped to 32°F., or lower. On December 28, 1913, the dew point at 5 p. m. was 48°; at 6 p. m. it was 46°; at 8 p. m., with the temperature at 40°F., I found dew forming; at 10 p. m., with the temperature at 42°F., I found that the dew had disappeared and the dew point was 41°; at 3 a. m. dew began again to form at 33°; the minimum was 30°F. This is a fair sample of the way the humidity behaves in this benighted region. These facts probably account for the very frequent finding of frozen dew here.

The keeping of the ground clear and rolled, as suggested, is not practical in most citrus districts, owing to the necessity of growing humus crops and that of winter irrigation during seasons of insufficient rain.

Prof. Humphreys suggests the possibility of building a wall or growing a close hedge to prevent the setting in of cold air, and this calls to mind the fact that last winter many orchards were saved by eucalyptus wind-breaks on the north side. This was due, no doubt, to the fact that a great deal of the damage was done by a cold heavy gale from the north.

The objection that spraying trees with water would injure the bloom by washing away the pollen would not seem to be a consideration in the case of citrus trees; no damage ever having been noted after spraying, with all kinds of chemicals, during the blooming season even under pressure of from 175 to 200 pounds and perhaps higher. Such spraying is practiced about San Diego at all times of the year. And was reported by the writer last spring for the control of red spider.

Under the head of irrigation there are one or two points which it might be well to consider. In the central part of the State, and probably in other parts as well, a great many growers seem to have all the water they need from deep wells, which on a frosty night would be considered quite warm. This water would seem to be available at all times and so might be useful. In general, however, there is no doubt that Prof. Humphreys is right in objecting to this means of preventing frost. However,

it would be particularly bad where used as a help to the usual firing method, as it might make the ground so soft as to render refilling of the pots a very difficult opera-

dry desiccating winds of the season of 1912-13 greatly damaged the citrus crop. This wind is strong and steady and apparently free from swirls or squalls.

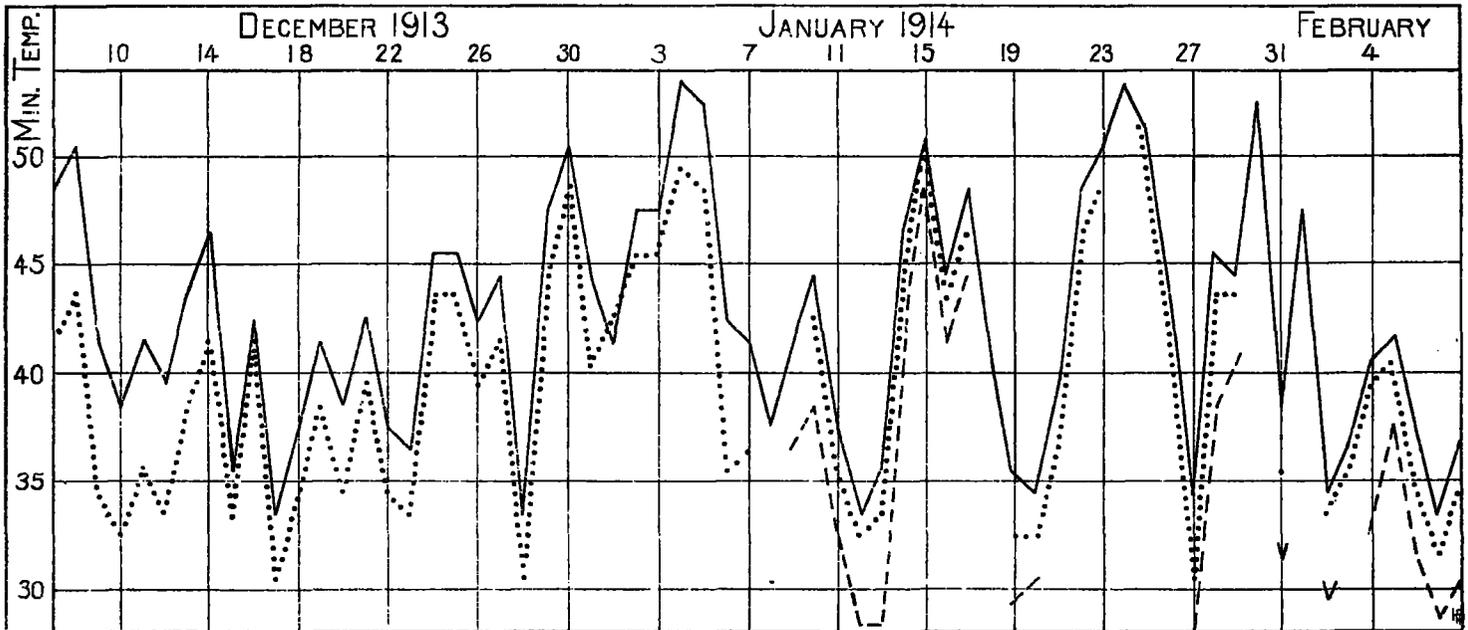


Fig. 1.—Diagram showing comparative temperatures in December, January, and February, 1913-14, at the Garthwaite ranch, Corona, Cal. (By J. W. Garthwaite, cooperative observer, Mar. 22, 1914.)
 — Thermograph record in shelter. Minimum thermometer readings in open, near shelter. - - - - - Minimum thermometer readings in the open, 100 feet from the shelter and at the bottom of an arroyo 14 feet deep.

tion. In the case, too, of most of the growers in southern California the water supply would be too uncertain, as here we irrigate for only a couple of days in each month and the stream is then passed on to the next ranch; in seasons when there is rain enough to warrant it the water is shut off completely during the winter months—as it is now [in February] in this district.

Above all, it would seem that in a paper on frost prevention the reader should be constantly warned to be ready—or, better yet, to be ready for frost at any time. Every one should be made to understand that conditions change in a very short time and that a fine springlike day may be followed by a cold night. No one should wait for warnings or indications, but, whatever his means of protection, he should be prepared to put them in operation at any hour during any night in the cold season.

The local effect of air drainage will be seen in the

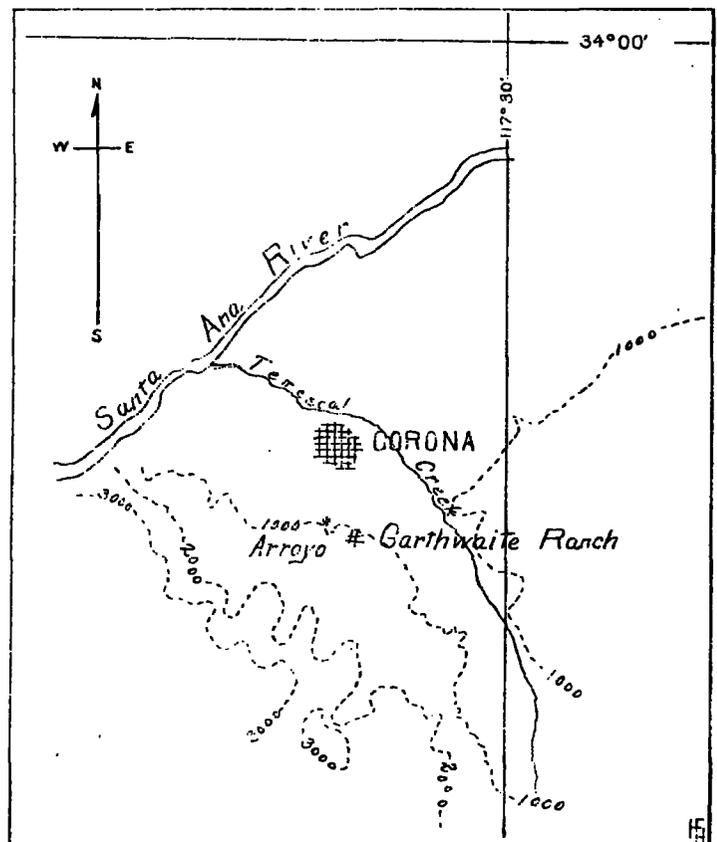


Fig. 2.—Sketch by Garthwaite, showing the topography in the vicinity of his ranch at Corona, Cal. Mount Wilson is north of Corona. Contour interval, 1,000 feet; * the arroyo mentioned in figure 1; # Garthwaite ranch.

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IV.

MEMORANDUM ON AIR DRAINAGE IN THE VICINITY OF THE CORONA DISTRICT, CAL.

By FORD A. CARPENTER and J. W. GARTHWAITE.

[Dated Los Angeles, Mar. 23, 1914.]

The general effect of air drainage is noticed in the distribution of local winds during "norther" conditions. The north wind, by reason of the topography, assumes a northeasterly and later a southeasterly direction. It is locally called a "Santa Ana" for the reason that the wind is blowing down the valley (fig. 2) of the Santa Ana River. As an accompanying view (fig. 3, p. 570) shows, the first effect of the wind is shown by the formation of the dust cloud far in advance of the wind; as the wind becomes stronger and the disturbed air of greater vertical thickness, the cloud becomes general and obliterates everything. In passing, I would observe that the

profile (fig. 1) of minimum temperature thermometers