ably less than 1 inch at many stations, the minimum being 0.12 inch at Hilliard; St. Georges, Valona, and Brunswick, neighboring stations in Georgia, also received less than 1 inch. Outside of Florida, however, the rainfall was pretty uniformly distributed. The number of days with rain was somewhat less than the normal in all sections, except North Carolina and Virginia.

The most general rains occurred from the 5th to 7th, 18th to 24th, and on the 28th and 29th, and were associated with well-defined barometric depressions, but local rains were frequent on intermediate dates, especially during the last decade. The only stations in the district that reported amounts exceeding 2.50 inches in 24 hours were: Ashville, Ala., 2.53 inches on the 6th, and Butler, Ga., 2.54 inches on the 27–28th.

The snowfall for the month was small, except in Virginia, where the average depth unmelted was 4.6 inches; the largest monthly amount was 14 inches at Charlottsville, Va., and the greatest 24-hourly fall, 10 inches on the 28th at Collaville, Va. The maximum amount in North Carolina was 7.5 inches at Reidsville; in Georgia, 3.2 inches at Toccoa; and in Alabama, 2.5 inches at Gadsden.

### RIVER CONDITIONS.

All streams in the district were very low at the beginning of January, but higher stages occurred in most of the rivers toward the close of the month as a result of the general rains during the last decade. No dangerous rises were reported nor was the flood stage passed at any important point. A rise of 10 feet in 24 hours took place in the Roanoke River at Weldon, N. C., on January 23, with a maximum stage next morning of 23.7 feet (flood stage 30 feet). The rather heavy rains of the 28th in central Georgia, averaging about 1.50 inch over the upper basins of the Ocmulgee and Oconee rivers, caused a moderate rise to 14 feet at Macon and to 16 feet at Milledgeville, Ga., on January 29, for which advisory warnings were issued by the official in charge at Macon. The highest stages generally occurred so late in the month that the averages for the month remained very low.

### MISCELLANEOUS PHENOMENA.

Severe local thunderstorms were associated with the depression central in Georgia on the morning of January 28, occurring mainly in southern Georgia and northern Florida. A brief storm burst over the city of Jacksonville at 11 a. m. of the 28th, with high winds from the southwest reaching a maximum velocity of 54 miles an hour. Many telegraph and telephone poles were blown down as well as a number of trees in various parts of the city. One large building was unroofed. Similar storms occurred at Live Oak, Fla., and at Cordele, Ga., with considerable damage to property. At Two Mile Swamp, near Orangeburg, S. C., a severe wind storm occurred at 11:30 a. m. A school house full of children was blown down and four persons were injured. It was a straight blow from west to east with a path of destruction about 120 feet wide, and all prostrated trees pointed due east. At Columbia, S. C., the wind attained a velocity of 55 miles for one minute at 11:28 a. m. on the same date, that is to say, about 2 minutes earlier than at Orangeburg.

The prevailing winds for the month were from the southwest in Virginia and North Carolina, from the west in South Carolina and Georgia, and from northerly directions in other States in the district. The following wind velocities exceeding 40 miles an hour were reported: Raleigh, N. C., 42 miles west on the 7th; Hatteras, N. C., 59 miles south, 29th; Columbia, S. C., 42 miles southwest, 18th; Savannah, Ga., 42 miles west, 21st; Jacksonville, 54 miles southwest, 28th; Key West, 42 miles southwest, 28th; Jupiter, 44 miles west, 21st; and Pensacola, 44 miles northwest, 21st. The number of clear days averaged about 15 throughout the district, except in Virginia where more cloudy weather was experienced. Dense fog prevailed on many mornings, covering the greatest area on the 4th, 5th, and 6th, and again on the 25th and 26th.

## EFFECTS OF LOW TEMPERATURES ON CITRUS TREES AND FRUITS.

By A. J. MITCHELL, Section Director, Jacksonville, Fla.

In studying the effects of freezing temperatures on citrus trees and on fruits it is important to take into consideration the character of the weather preceding the freeze, whether the temperature has been above or below normal and how long, the amount of precipitation, and the number of rainy days. Even the fertility of the soil in which the trees are growing has some influence. Other important factors are the physical condition of the trees as indicated by their stage of growth and the location of the groves with reference to large bodies of water. Trees of inferior vigor or infested with white fly have powers of resistence on a par with a man suffering from general debility. Trees laden with fruit are less able to resist low temperatures than those free from such burden. Tender early growth is more liable to injury than older wood of the tree.

The ameliorating influence of large neighboring bodies of water is very marked. Orange groves located on the east and south sides of large lakes or rivers are safer from damage by frost than those located at distances from water even a hundred miles farther south; in other words, for small distances the proximity of water is a greater protective factor than the higher temperature resulting from the lower latitude.

The cold wave of December 30 and 31, 1909, which was severe in northern and central Florida, causing much damage to orange groves and considerable loss of fruit, gave occasion to investigate more fully the ability of orange fruit and trees to withstand temperatures below freezing, and a number of questions on this topic were submitted to experts in the citrus industry, the replies to which appear below.

1. How long can orange trees or fruit endure temperatures between 32° and 25° without serious damage?

With dry and moderately cold weather for a month or more before the cold wave, well nourished and matured trees will not be injured by a temperature as low as 25° for three or four nights—some growers say indefinitely—provided the cold nights are followed by day temperatures of about 45° to 50°. On the other hand, if warm rainy weather has preceded the cold wave, a temperature of 25° for a few nights will kill tender growth and injure young trees. Under normal conditions a temperature of 25° need not cause serious apprehension.

In regard to the possible injury to fruit, it may be stated that a gradual fall from 32° to 25° will cause considerable damage in from 4 to 6 hours, the extent depending on the length of time freezing conditions prevail before the temperature of 25° is reached. If the fall in temperature be sudden the damage will be less than if it begins to freeze before midnight.

2. How long can trees or fruit withstand temperatures between 25° and 20°?

If the fall months have been dry and cool no serious injury will result from exposure to such low temperature for only 4 to 6 hours, except the loss of foliage, though immature young trees may be killed to the "bank." Trees are banked by heaping dirt or sand around the base of the tree above the point where budded as a protection against severe freezes. Temperatures of 20°, or slightly below, for 5 or 6 hours usually defoliate trees and cause injury of a serious character. Some young trees will be killed.

During a rapid fall of temperature to 25° or slightly lower taking place after midnight, fruit protected by heavy foliage may escape but the marketable qualities of the fruit will be much impaired should the low temperature continue for 1 or 2 hours. It may be stated that a temperature of 28° 5 feet from

the ground is the alarm signal for orange growers and the work of "firing" groves begins at once.

Lower temperatures than 20° are disastrous both to fruit and trees. In December, 1894, when the temperature fell to 14° at Jacksonville, citrus trees in the northern and central portions of the State lost their foliage and the fruit was destroyed. In the following February a temperature of 14° again occurred at Jacksonville, and from 17° to 25° over most of the citrus belt, and as the trees were bare their destruction was inevitable. The cold wave of February, 1899, during which the temperature at Jacksonville fell to 10°, was also disastrous.

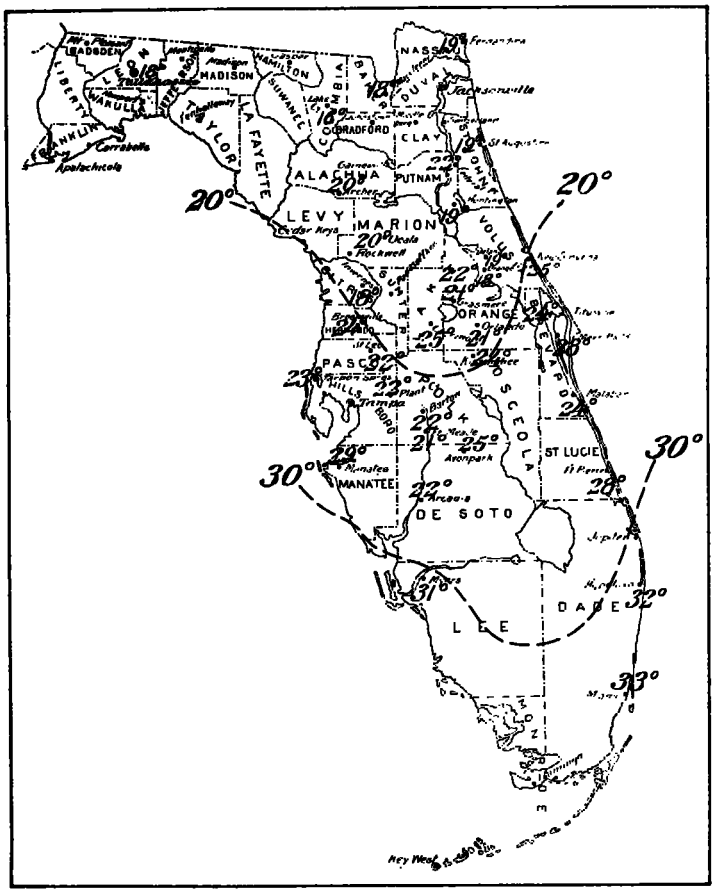


FIG. 1.—Showing the lowest temperatures recorded in Florida during the cold weather of December 30–31, 1909.

The chart (fig. 1) shows the minimum temperatures that occurred during the cold wave of December 30–31, 1909. It will be noted that the line of 20° extends to about parallel 28° 30′, and the 30° line to about parallel 25°. Under the influence of these temperatures it is safe to assert that 90 per cent of the groves in the interior south to the 26th parallel, where they did not enjoy unusual immunity as a consequence of water protection, or where they were not protected by fires, showed ice and consequent damage.

Attention is invited to the following description of an experiment made by Civil Engineer Frank Merriwether, at Winter Park, Fla., during the freeze of December, 1909, to determine the temperature at which oranges will freeze:

Mr. Merriwether sat up the entire night of the 29-30th of December to watch an interesting experiment that he was making in his orange grove. Through a small hole made in the rind of an orange hanging upon a tree, he pushed the cylindrical bulb of a thermometer into the pulp, the rind fitting closely around the stem of the instrument and recorded the reading at specified times as follows: 9:00, 43°; 10:00, 40°; 11:00, 37°; 12:00, 35°.

At midnight he suspended another thermometer, whose readings and those of the one partly within the orange are identical when subjected to like conditions, near the orange, in order to get the temperature of the atmosphere and the following readings were made:

*Temperatures at Winter Park, Fla., December 29–30, 1909.*

| | Midnight. | 12:30 a. m. | 1:00 a. m. | 1:30 a. m. | 2:00 a. m. | 2:30 a. m. | 3:00 a. m. | 3:30 a. m. | 4:00 a. m. | 4:30 a. m. | 5:00 a. m. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| Immersed bulb ... | 35 | 33 | 33 | 32 | 31 | 30 | 29 | 29 | 28 | 28 | 27 |
| Free bulb... ..... | 32 | 31 | 30 | 29 | 29 | 28 | 27 | 27 | 26 | 26 | 25 |

| | 5:30 a. m. | 6:00 a. m. | 6:30 a. m. | 7:00 a. m. | 7:30 a. m. | 8:00 a. m. | 8:30 a. m. | 9:00 a. m. | 10:00 a. m. | 11:00 a. m. | Noon. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| Immersed bulb... . | 26 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 32 | 40 |
| Free bulb..... | 24 | 23 | 23 | 24 | 25 | 27 | 30 | 32 | 35 | 35 | 40 |

It will be seen that the orange must have begun to freeze at 5:30 a. m. when the mercury in the thermometer with the immersed bulb stood at 26°, and that in the other at 24°, because after that time the mercury in the immersed bulb instrument rose several degrees, this being due to the heat given off in the freezing of the orange.

Two very interesting facts are, therefore, obvious from these results: first, that a temperature of 26° is necessary to freeze an orange under ordinary conditions; and, second, when the temperature is falling at the rate of 1½° an hour, about 5½ hours (from 12 to 5:30 in this case) are required for oranges to reach the temperature required to freeze them.

At the usual rate of fall of the temperature during cold waves the danger point to citrus fruits is generally reached in about 5 or 6 hours after the air temperature has reached the freezing point. Often, however, owing to diminished wind movement and strong outward radiation, the most serious injury to citrus fruits occurs on the second night of the cold wave.