THE TWO FREEZES OF 1894-95 IN FLORIDA, AND WHAT THEY TEACH.

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RECORD OF FREEZES.

The winter of 1894–95 was rendered memorable in Florida by two of the most severe freezes which have taken place since careful records have been kept. The injuries to the fruit industries were very great, orange, lemon, and many tropical trees being generally killed to the ground in all parts of the State except in the extreme southern portion and on the keys. Certain well-protected localities in the central part of the peninsula also escaped without serious damage, but on the whole, latitude was the only modifying influence of importance. As the blizzards swept southward their severity gradually decreased. Judging from reliable temperature records and from the effects of the cold on vegetation, the isothermal lines in both freezes ran almost directly east and west across the State. From experience and observation in these freezes many important points have been noted as to ways in which plants may be protected against the effects of frost, and the best methods for quickly restoring fruit trees which have been frozen down. These will be discussed in this paper.

On December 27, 1894, the first blizzard began to be felt. This culminated December 29, when the temperature[1] fell to 14° above zero at Jacksonville, one degree lower than during the great freeze of January 12, 1886. The fall in temperature was accompanied by a strong wind, which, at most stations, reached a maximum velocity of from 25 to 30 miles per hour. At most places throughout the northern and central parts of the State killing frosts and freezing temperatures occurred for three days in succession—December 27, 28, and 29. For several days after this blizzard the weather was generally clear and comparatively cold.

The second blizzard, which was very similar to the first, extended over three days—February 7, 8, and 9, 1895. The lowest temperature recorded was on the morning of February 8, when at Jacksonville it again fell to 14°. The reports from stations throughout the orange belt showed a temperature ranging from 16° to 19°. This freeze

[1]All temperature records given in this paper are according to Fahrenheit.

also was accompanied by a strong wind, the maximum velocity of which was from 30 to 35 miles an hour. Killing frosts were reported from almost all stations in northern and central Florida on February 8 and 9, and in various parts of these sections of the State snow and sleet fell. For several days after this freeze the weather was generally clear throughout the State.

The following are the minimum temperatures recorded at various selected stations during the freezes of 1886 and 1894–95, the stations being arranged in order of latitude from north to south:

Minimum temperatures recorded during the freezes of 1886 and 1894–95.

Place.	Latitude.	Minimum temperature.		
		January 12, 1886.	December 29, 1894.	February 8, 1895.
	° ′	°	°	°
Jacksonville	30 19½	15	14	14
St. Augustine	29 53½	17	16	16
Federal Point	29 45		17	16
De Land	29 00¾	17[1]	16	17
Eustis	28 51½	18[1]	16	16
Sanford	28 48	21	18	18
Titusville	28 36¾		18	19
Orlando	28 32½	19 and 20[1]	18	19
Merritts Island	28 22½		22	22
Melbourne	28 05½		22[1]	
Tampa	27 57		19	22
Avon Park	27 36½		21	23
Manatee	27 30		19	23
Jupiter	26 56½		24	27
West Palm Beach	26 43	32[1]	25[1]	29[1]
Myers	26 39		24	30
Hypoluxo	26 35½		26	32
Key West	24 38½	41.43[1]	44	49

[1] Records are not official.

These records will serve to show the comparative severity of the two freezes of last winter and that of 1886, and the gradual abatement of the severity of each as it progressed southward. From a comparison of the locations given in the table above it will be seen that in any given latitude practically the same temperature prevailed in localities whether in the western part of the State, in the interior, or on the east coast. The Manatee region, protected on the north by the broad Manatee River and Tampa Bay, shows almost the same temperature as Avon Park, in about the same latitude, in the interior, and Melbourne on the east coast. Again, Myers, on the west coast, protected on the north by the broad Caloosahatchee River, and West Palm Beach, on the east coast, protected on the west by the waters of the Everglades, show nearly the same temperature.

Since the blizzards of last winter the fact that killing freezes have occurred before in Florida has been brought prominently to notice.

It is known that severe freezes occurred in the winters of 1747, 1766, 1774, 1799, 1828, 1835, 1850, 1857, 1880, 1884, and 1886, and many lesser freezes are also known to have taken place. Those which were remarkably severe, however, and which are spoken of as "the great freezes," occurred on February 7 and 8, 1835, and January 12, 1886. In the former, the only one which in severity and destructiveness compares with those of last winter, the thermometer, it is said, fell to 8° at Jacksonville. This freeze is reported to have killed orange trees from 40 to 50 years old at St. Augustine and Mandarin. The freeze of 1886 destroyed most of the orange crop, killed young orange trees, and froze all trees back somewhat. Although the damage from this freeze was very great, it was mostly repaired the next year, as the crop that season was larger than ever before. The recorded temperatures of either of the freezes of the winter of 1894–95 are but slightly lower than those of 1886, and consequently either one alone would not have done much greater damage. Their extremely disastrous effects were due to the fact of their having occurred so close together.

From the above statements it appears that many disastrous freezes have occurred in the past, and it is reasonable to assume that similar freezes will take place in the future. It therefore behooves Florida growers to profit by past experiences and take such precautions as are possible to avoid future losses from this source.

EXTENT OF INJURY TO THE CITRUS INDUSTRY.

Damage caused by the first freeze.—At the time of this freeze, December 27–29, 1894, the orange and other citrus trees were largely dormant and the injury was thus not so great. At the time the blizzard occurred it is estimated that there were about 3,000,000 boxes of oranges still on the trees. These, of course, were almost a total loss. When cut open the morning of the 29th, the fruits were found to be a solid mass of ice, the pulp having the appearance of watery snow.

The same was true of all lemons, pomeloes, and other citrus fruits which remained on the trees. The leaves were frozen stiff and rattled in the wind. The vegetation as a whole did not begin to wither until December 30, which was a bright day. Thin, fragile leaves, like the common guava (*Psidium guajava*) and castor-oil bean (*Ricinus communis*), withered very quickly in the sun, but thick-leaved plants, like the eucalyptus, Cattley guava (*Psidium cattleyanum*), and orange, were slow to show the effect of the frost. When protected from the direct rays of the sun, many orange leaves remained green and apparently fresh for five or six days. All leaves were killed, however, except in a few protected groves on the south side of large lakes, like Lake Eustis and Lake Harris, and in the southern part of the State. The leaves did not fall immediately, as is their wont in case of slight injuries, but remained attached to the tree

until about January 7, at which time they were dry and crisp. After this the dropping was gradual, and was caused entirely by outside forces, such as the wind. The fruit began dropping about January 10. This was also very gradual, being caused, as in the case of the leaves, by the wind, etc.

The frozen oranges and pomeloes remained firm and solid for fully a month after the freeze, and were eaten in great numbers and also shipped to Northern markets. It is safe to say that there has never been a time in the history of Florida or America when so many oranges were eaten in so short a time. The cautions of physicians were unheeded, but the result was not disastrous, as many feared. Indeed, such sickness as occurred from eating frozen oranges was unquestionably due to excessive indulgence. Many of the frozen oranges were sent to Northern markets and placed on sale while still juicy and palatable. In some cities their sale was forbidden by the health authorities, who claimed that they were injurious, but this claim has been thoroughly disproved by their extensive use, as above described.

In frozen oranges white specks, frequently as large as half a millimeter in diameter, form in the membranes between the segments and in the membranes of the pulp vesicles. They are so invariably present in frozen oranges, even where the fruit is but slightly injured, that they may be considered as evidence of the effect of freezing. These specks are apparently masses of hesperidin crystals, separated from the cell sap by chemical changes caused by freezing. These characteristic specks are also found in frozen lemons and pomeloes, and probably in all citrus fruits.

The lemon and citron were the first of the citrus plants to show the effects of the freeze. The leaves withered and turned brown in about two days after the freeze, and the fruits became soft and watery, and hung as flabby, misshapen masses as soon as thawed out. Frequently the bark of lemon, citron, and pomelo trees burst open on the trunk, large fissures being formed. Very few sweet or sour orange trees were found to be injured in this manner. Practically all lemon trees in the northern and central portions of the State were killed to the ground by the first freeze. Many pomelo trees were also killed, but others escaped with the loss of most of their limbs.

About January 18 the buds of orange trees began to push, and in a few days numerous sprouts were growing vigorously. By this time the injured wood had become plainly marked in most cases. An examination of many orange groves made at this time showed that small sweet seedlings and budded orange trees were in most cases killed to the ground. The budded trees suffered somewhat more than the seedlings, the point of union between stock and graft being apparently very easily injured. However, it was found that budded or seedling sweet-orange trees which had reached a diameter of from

4 to 6 inches or over were seldom seriously injured. It was also found that where budded trees had reached this size, and the point of union of stock and bud was not injured, the tops were, as a rule, not so much injured as those of seedling trees. The small twigs were killed back from 12 to 18 inches, while the seedlings were apparently killed much farther back. The budded trees of the size mentioned also showed much more vigor in reviving than seedlings, starting growth sooner and growing more rapidly.

The period for two weeks preceding the second freeze was, unfortunately, fine growing weather, the night temperature not falling below 50°, and the day temperature usually reaching 80°. The result was a very rapid growth, especially in budded trees. At the time of the second freeze, commencing February 7, 1895, this growth had reached a length of from 1 to 4 inches, and flower buds were forming on many

FIG. 16.—An old orange grove killed down by the cold and throwing up sprouts from the base of the trunk. The tops were cut off shortly after the second freeze. Photographed October 25, 1895.

of the trees; the orange groves had begun to look promising, and growers felt much encouraged and were quite elated by the fact that the orange tree had shown itself capable of resisting such a low temperature.

Disastrous results of the second freeze.—Such were the conditions when, on February 7, 8, and 9, 1895, the second blizzard swept over the State. No fruit was now left to be destroyed, but the rapidly growing trees, stripped of their normal dense foliage, were exposed to the full strength of the cold blast, and the little life left was entirely destroyed in many of them. The oldest and youngest trees, whether sweet or sour, were alike killed to the ground throughout the greater part of the State. In many groves this was true of large budded and seedling orange trees from 20 to 40 years old or more (fig. 16), while in

other groves, frequently in the same vicinity, sprouts have been thrown out on the old trunks for some distance up. This is particularly true of hammock groves, which seem to have suffered least.

The extent of the damage to orange trees did not become apparent for some months after the freeze. Many of the large trees threw out sprouts on the trunks some distance up. These struggled along for a time, making considerable growth, but in many cases subsequently died back entirely, the bark having been killed below. This sprouting out and dying back continued more or less throughout the summer, but the growth which remained healthy until July has in most instances continued to the present time (November 1, 1895).

The effect of water protection was in many cases very noticeable. In groves on the south side of Lake Harris and Lake Eustis, for instance, several rows of trees nearest the water retained some of their leaves, and the effects of the protection afforded was apparent for about half a mile back from the lakes. On Terraceia Island, in Tampa Bay, even lemons escaped unhurt, and in some groves on the mainland bordering on the bay orange trees were almost entirely unharmed and lemon trees only slightly injured. Passing away from the bay, however, the effect of even this broad expanse of water gradually disappeared, being hardly noticeable 2 miles distant. The orange groves south of Braidentown and Manatee, and 2 miles distant from the broad Manatee River, were about as badly injured as groves in the interior of the State in the same latitude.

The effects of the freezes were also considerably ameliorated by forest protection. This was particularly noticeable in groves where large numbers of palmettoes and some oaks and magnolias were allowed to stand among the orange trees. Again, thick wind-breaks perceptibly protected a few rows of trees nearest to them.

Orange trees not protected were injured as far south as Myers (26° 39′). The damage south of the twenty-seventh parallel of latitude, however, was not serious, consisting merely of injury to a few of the top leaves and young branches. The mandarin, tangerine, and Satsuma oranges (*Citrus nobilis*) in general suffered about the same as the common sweet orange. The pomelo and shaddock (*C. decumana*) are much tenderer than the orange. The large pomelo trees which were not killed by the first freeze were almost invariably split open and killed to the ground by the second. It is difficult to find a tree where any portion of the trunk was saved. In well-protected regions, like Palmetto, trees which lost all leaves and many branches are in some cases bearing fruit this year. At Bartow the trunks of some of the large trees were saved, and in the town of Myers, which has good water protection, the trees were practically uninjured. East of Myers, and farther away from the river, they were injured, but not seriously. At Jensen buds 3 years old were killed down. The latitude below which the pomelo escaped serious

injury can hardly be determined, owing to lack of trees from which to judge. It can probably be placed at about 26° 30′. Lemons (*C. limonum*) and limes (*C. limetta*) throughout the northern and central parts of the State were killed to the ground. In the Manatee River region the trees, when near the water, were not seriously injured; at Myers they suffered but little; at Palm Beach they escaped injury; and south of the twenty-sixth parallel they evidently were not severely affected. Every citron (*C. medica*)[1] and kumquat (*C. japonica*) in the State, so far as known to the writer, was killed. In the extreme southern part of the State they would probably have escaped serious injury. The trifoliate orange (*C. trifoliata*) is the only citrus species which escaped injury from the two freezes.

LESSONS TAUGHT BY THE FREEZES.

The experience of last winter has taught some valuable lessons as to ways by which the extent of damage caused by severe freezes may be lessened. In a few cases where growers had banked their trees up some distance around the trunk with earth, covering the union of bud and stock, it was found that the buds and a portion of the trunk were saved. This shows that it would unquestionably be a wise policy to make a practice of banking up the trees every winter in this way, say by the middle of December, removing the soil about the 1st of March. The expense of doing this would be very slight, probably not more that one-half cent per tree. Care should also be taken to have the point of union between the stock and bud or graft near the soil. On thoroughly drained, porous soils there is no objection to having the union slightly below the surface. This would insure the safety of the buds in the most severe freezes, especially if the trees were slightly banked. On poorly drained soils, where the trees are subject to foot rot, sour-orange stocks, budded above the ground, should be used. When lemon or pomelo stock is used, the union should by all means be placed low, as these stocks are very easily injured by cold.

Careful observations have shown that the method of training the trunk is also important. Trees having a single main trunk were much less injured by the cold than those of the same size growing under similar conditions but having several trunks. This was quite noticeable in protected regions after the first freeze, but of course the two freezes in most places were enough to kill almost any trunk. This shows clearly that where possible it is very desirable to train the trees so that a single main trunk is formed up as high as is consistent with a well-shaped tree. By following this rule a much larger trunk can be saved in case of a severe freeze (figs. 17 and 18).

Dividing groves into small plats of 4 or 5 acres and leaving windbreaks between and surrounding these has also proved to be a good practice. This can easily be done by leaving strips of the original

[1] Since this paper was written uninjured citron trees have been seen by the writer at Cocoanut Grove and Elliotts Key.

forest when clearing the ground. In many hammock groves in which palmettoes, magnolias, and other forest trees were allowed to stand among the orange trees, the protection they afforded was plainly noticeable. Where the soil is rich enough to allow of this method of culture, it should be adopted as a protection against cold and frosts.

Several groves, in various parts of the State, were protected to some extent by fires distributed through them at regular intervals. These fires were made by lighting brush piles already in the grove, or by distributing and igniting pots of resin prepared for this purpose. The trials made of these methods were fairly successful, and indicate that much can be gained even from the little protection thus afforded. During light freezes in the northern part of the State the fruit has often been saved by such fires.

The well-recognized slight differences in hardiness shown by varieties of oranges was scarcely perceptible in the last hard freeze. In

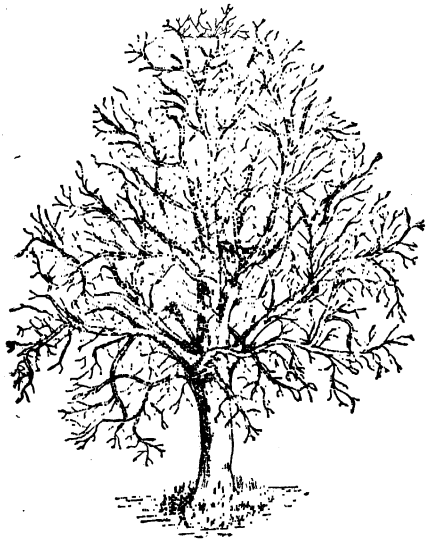

FIG. 17.—A properly trained trunk.

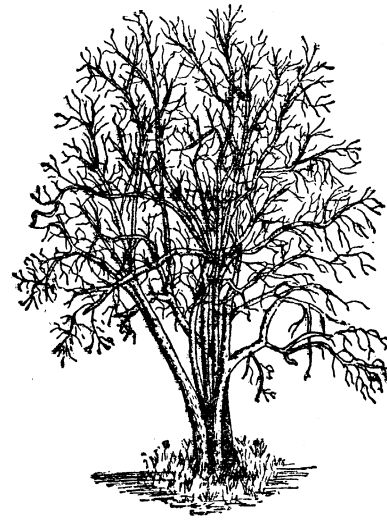

FIG. 18.—An improperly trained trunk.

protected regions, like Palmetto and Braidentown, and in the southern part of the State, however, some difference could be observed. Harts Late is reported by most growers to have withstood the cold better than any other variety, and the Jaffa and Majorica were also found to be quite hardy. The Mediterranean Sweet proved to be very tender, and the Satsuma, which was supposed to be very hardy, usually suffered as much as the tangerine. When on *Citrus trifoliata* stock, however, the Satsuma is reported to have withstood the cold better.

RESTORATION OF FROZEN ORANGE GROVES.

After it became apparent that most citrus trees were killed back nearly or quite to the ground, the question as to what treatment was best under the existing conditions came to be an important one with

growers. The experience gained in the freeze of 1886 was of little value, as at that time the trees were not, as a rule, severely injured, and the lessons taught by the freeze of 1835 had been largely forgotten and were too indefinite. The result was that many different treatments were followed.

The time and manner of pruning the frozen trees were puzzling questions. From the experience in the freeze of 1835, it was claimed by some growers that if the dead top was not cut off the fermenting sap would pass down and kill the living portion of the trunk and the roots. This belief, however, has been disproved by extensive experience since last winter's freezes. As yet hundreds of groves remain unpruned, and in no case do the trees show any injurious effect that can be traced to this cause. Indeed, many growers claim that the protection and slight shade afforded by the old top has been decidedly beneficial. The sprouts on such trees have unquestionably grown higher than on pruned trees, but are usually slender and unbranched, probably due to the effect of the shade. Trees which were pruned back into the living wood early in the season have made a more general and bushy growth, and will probably ultimately make the best-shaped tops. As a whole, little difference can be seen between early pruned trees and those left unpruned. The sprouts in unpruned trees have grown so large now (November 1, 1895), however, that many will be destroyed or injured by even the most careful pruning. Probably the best practice is to prune the trees as soon as the sprouts have started and show a healthy growth, cutting the trunk below the upper sprouts down to a short distance above where the most healthy, vigorous growth appears. Where the trees were killed to the ground, many cut them off below the soil and covered the cut surface with earth to protect it from the hot rays of the sun. In general this did not prove as satisfactory as allowing the tops to remain until the sprouts started. Where the trees were slow in sprouting, removing the dirt from around the trunk and crown roots, thus exposing them to the sun and air, proved efficient in inducing sprouts to start.

The practice most generally followed throughout the State with trees killed below the buds was to allow sprouts to come up from the base of the trunks or from the roots and bud them as soon as they reached sufficient size. The budding of the sprouts was commenced in May and continued throughout the season as the sprouts attained sufficient size. The buds put in during May have now, as a rule, reached a height of from 4 to 7 feet (fig. 19).

Many growers have allowed all the sprouts to grow that started, intending to dormant bud the largest this fall or bud early next spring. In cases where the trees sprouted early, and the necessary buds could be secured, this would seem to be a waste of valuable time.

The practice of crown grafting trees killed to the ground has been followed to some extent, and when properly done has proved an

excellent method. In this case the trees were cut down below the surface of the soil to where the wood was sound, and the scions inserted. The scions should be of sound, mature wood, about 5 inches long, sharpened by a long, slanting cut on one side, as shown in fig. 20, *a*. Several grafts should be inserted on each stock to make sure that at least one will grow. The grafts should be pushed down between the wood and the bark, as shown in fig. 20, *b*. The best place to insert the grafts is in the concave portions of the trunk, as here the bark can be pressed out without breaking in order to allow the insertion of the scion. The bark will hold the scion firmly against the stock, and in this way no wrapping is required. Moist dirt is then thrown up over the grafts, allowing simply the upper end to protrude. The use of grafting wax on scions inserted in this way is said to be unnecessary. If the trees are not cut below the ground it would probably be desirable to place small strips of waxed cloth over the cavity formed between the bark and the wood.

FIG. 19.—Ruby orange bud, put in May 21, on sprout from old sweet-orange trunk. Photographed October 25, 1895.

In the use of this method, however, many failures have been made, evidently due to cutting the trees too high. Cutting below the soil, even though some of the large crown roots had to be sacrificed, seemed to be the best way. The benefit derived from the use of this method is that of securing in the graft all the growth made. The grafts may be put in promptly after a freeze, or as soon as the bark can be made to part for their insertion. The graft heals on before growth usually starts and has buds formed ready to push in the spring, while if the trees are allowed to start of their own accord adventive buds must be formed before the sprouts start. Grafts properly inserted started earlier than the sprouts, and as a rule made a much larger growth than sprouts which grew from the roots of similar stocks. Cutting back the sprouts to force the buds, in the practice of sprout budding, puts the growth back and again weakens the roots, already nearly dead. This is prevented by grafting, by which means all the growth made is thrown into the grafts which are to

remain. Crown grafts put in immediately after the second freeze are as a whole six months in advance of the best growth made by buds put in on sprouts from the roots, and are fully a year in advance of many of the groves of the State which have been slow to start sprouts and thus could not be budded. Grafts on old and young stocks take equally well (fig. 21).

Nursery stock and small trees killed down by the freeze were apparently built up with the least loss of time by cutting them down below the soil 1 or 2 inches immediately after the freeze, and cleft grafting them by the common method, as illustrated in fig. 22. This method was not practiced sufficiently to warrant a positive statement that it is the quickest. The almost universal practice was to allow sprouts to grow from the roots and to bud them as soon as they had

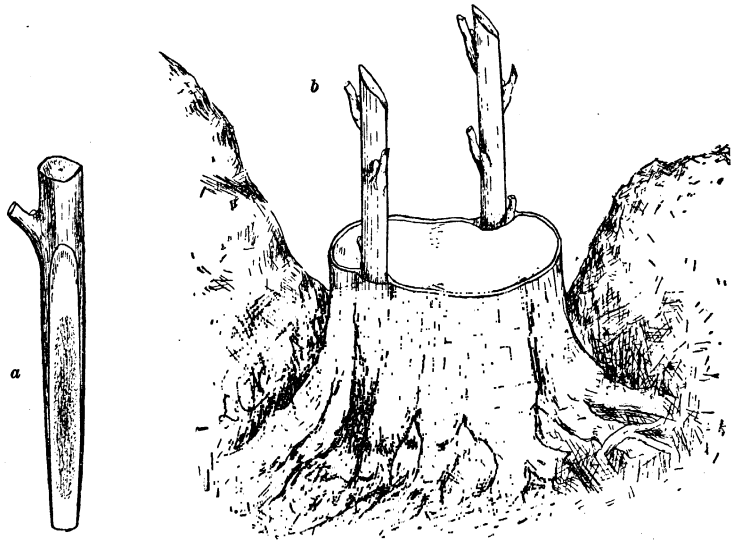

FIG. 20.—Method of crown grafting old orange stocks. *a*, base of scion showing form of slanting cut; *b*, method of inserting scion.

reached sufficient size. The greater handiness of this latter method recommends it in this case, where at best little difference can be expected.

By means of inarching, many growers are throwing the strength of several sprouts into the one which is budded. Although tedious, this practice is desirable to hasten development. It necessitates rather high budding, however, which should be avoided if possible.

DAMAGE WHICH THE FREEZES CAUSED TO PINEAPPLES.

The pineapple industry, which in southern Florida has reached considerable importance and probably ranks second among the fruit industries of peninsular Florida, was also severely injured by the

freezes of last winter. In the northern part of the pineapple section all plants, covered and uncovered, were killed to the ground, and as far south as Biscayne Bay all uncovered plants were injured. The damage to the pineapple industry was proportionally less than to citrus fruits, as at the time of the freezes the pineapple crop had been marketed, and, besides, it does not take the plants so long to recover. Moreover, the expense and delay in budding or grafting necessary in citrus trees are not required in these plants. This season the crop was very small and the fruit formed was of inferior size and quality. During the season of 1894 the Jacksonville, St. Augustine and Indian River, and the Savannah, Florida and Western railroads carried 82,708 whole or barrel crates, while in 1895, the season following the freeze, the same roads carried only 17,093 crates. From present indications the yield of the summer of 1896 will probably be as heavy as ever before. The only loss, however, even in these exceptionally severe freezes, was one crop of fruit and the cultivation for one year.

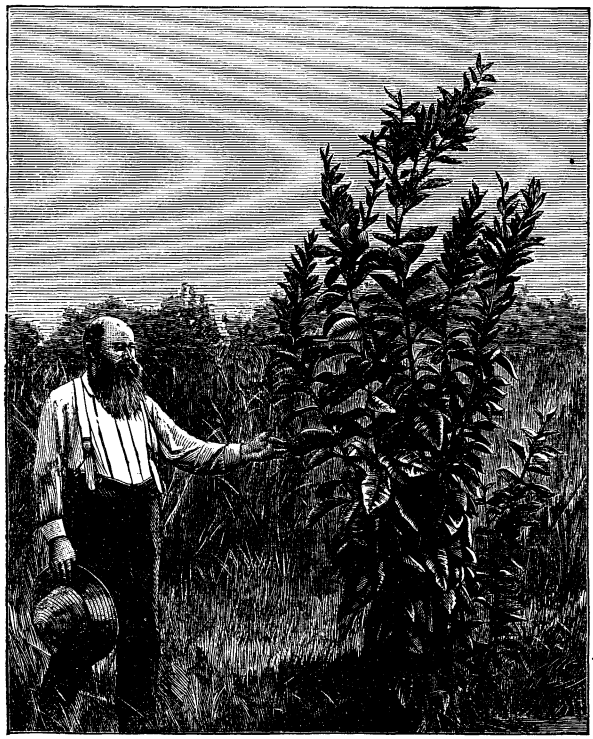

FIG. 21.—Ruby orange graft on old sweet-orange stock, put in March 1 by crown-graft method. Photographed October 23, 1895. (Compare with fig. 19.)

During both freezes ice was formed in the centers of almost all the pineapples as far south as Palm Beach, and the leaves were frozen stiff; most plants grown outside of sheds were killed to the ground as far south as West Palm Beach and Myers. A few localities having extensive water protection, like Sewalls Point, escaped with but little injury. At West Palm Beach plantations bordering on the fresh-water lakes

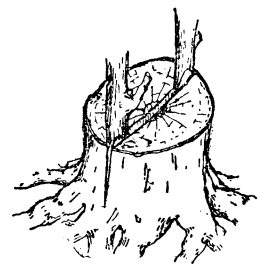

FIG. 22.—Cleft grafting.

of the Everglades were scarcely injured. A quarter of a mile away from the water, however, little benefit could be observed. At Biscayne Bay (25° 45′), nearly one degree south of West Palm Beach, the damage to plants outside of sheds was noticeable, but not serious. The crowns of the fruits were injured and the foliage somewhat damaged, but the development of the fruit was not impaired. Plants grown under sheds were severely injured in the northern part of the pineapple section, but may be said to have practically escaped injury south of the twenty-seventh parallel.

Old pineapple plants which had fruited and suckered, being mainly above the ground, were most seriously injured. The buds of such plants were in most cases killed, but suckers and ratoons[1] were formed from the base, so that the fields were largely replaced without replanting. Plants which had not fruited were much less injured, probably owing to the fact that in plants set out the bud is placed lower in the soil. Such plants did not lose their buds, and in some cases retained a few of the central leaves uninjured. Young plants set in July and August of last season (1894) did not lose their buds. These have grown rapidly this summer, and from their size now (November 1, 1895) it is almost impossible to tell that they were injured.

Little difference could be observed in the hardiness of the different varieties, other than that due to the difference in size. The large plants were usually the least injured. Thus the Porto Rico, the largest variety grown, was probably the least injured. The Abbaka and Spanish probably come next in the order of size and consequent injury, but the difference is very slight.

EXTENT OF INJURY TO OTHER FRUITS.

Guavas (*Psidium guajava*) were greatly injured by the two freezes, being frozen to the ground throughout most of the State. At Myers the plants suffered considerably. On the west side of Lake Worth they were slightly injured, but on the east side of the lake, at Palm Beach, they were generally unharmed. At Biscayne Bay they escaped entirely. The Cattley guava (*P. cattleyanum*), although much hardier than the common guava, was almost as badly killed down in these severe freezes. At Jensen all plants of this variety were killed to the ground, but at Palm Beach they escaped injury. Though one of the tenderest fruits grown, the guava recovers so rapidly from injury that it has been quite generally planted as far north as 29°. All guavas frozen down have sprouted abundantly from the base and have made a vigorous growth this summer (1895). They will bear a fair crop next year, the second season after freezing down.

The cocoanut palm (*Cocos nucifera*), which is grown quite extensively from Eden south, on the east coast of Florida, and at Myers, on

[1] Suckers starting from the old stem from below the soil.

the west coast, suffered severely in the northern parts of these localities. At Eden, Palm Beach, and Myers all the leaves were killed. On most of the trees, however, the buds remained uninjured, so that new leaves were thrown out in the spring and the majority of the plants are rapidly recovering from the damage done. At Palm Beach the buds of about 5 per cent of the plants were killed, so that they have not started (see Pl. III). Like many other monocotyledonous plants, if the apical bud of the cocoanut palm is killed the trunk will die, as it is not able to form a new bud. At Biscayne Bay even the leaves were practically uninjured.

The mango (*Mangifera indica*), which is quite extensively grown in the southern part of the State, was severely injured as far south as Palm Beach and Myers. Here the plants lost most of their leaves and the branches were killed back from 2 to 4 feet. At Eden, Manatee, and St. Petersburg large trees were killed to the ground. The trees, however, have shown great vigor in recovering, sprouting readily from the base of the trunk or from large uninjured limbs.

The banana (*Musa*), sapodilla (*Achras sapota*), sour sop (*Anona muricata*), sweet sop (*A. squamosa*), cherimoya, or Jamaica apple (*A. cherimolia*), Spanish lime (*Melicocca bijuga*), Otaheite gooseberry (*Cicca disticha*), and other strictly tropical fruits were killed almost to the ground at all places in the State other than the extreme southern portions.

EXTENT OF INJURY TO NATIVE VEGETATION.

The native plants of Florida were in general but slightly injured. The plants which suffered severely were principally those of tropical origin, which have spread into southern Florida from the West Indies and Bahamas and thence northward as far as thermal conditions permit. These plants are limited principally to the keys and hammock islands along the coast.

The mangrove (*Rhizophora mangle*), which forms dense thickets on the tide-washed islands and on the shore as far north as Ormond (29° 22′), was killed down as far south as Lake Worth, except in cases where the plants grew on the south side of large bodies of water. At Myers, however, trees bordering on the south side of the Caloosahatchee River were killed. As the mangrove is one of the most valuable honey plants in Florida, its destruction is a great loss to bee keepers. The sea grape (*Coccoloba uvifera*) also suffered severely, large trees being frozen down at Manatee. At Palm Beach, however, they were only slightly injured. The satin leaf (*Chrysophyllum oliviforme*), probably having the most beautiful foliage of any native tree of Florida, was frozen down about Rockledge, its northern limit, and was seriously injured as far south as Palm Beach. Rubber or wild fig trees (*Ficus pedunculata* and *F. brevifolia*), which are abundant in the island and coast hammocks as far north as

COCOANUT GROVE NEAR PALM BEACH, FLORIDA, SHOWING EFFECTS OF FREEZE.

Rockledge, were considerably frozen back as far south as Palm Beach and Myers. The gumbo-limbo (*Bursera gummifera* Jacq.) and satin wood (*Xanthoxylum pterota*) were also among the seriously injured plants. Water lettuce (*Pistia spathulata*) and water hyacinth (*Eichornia speciosa*), which are very abundant in many ponds and sluggish streams, were frozen down to the water level.

Considering the severity of the freezes of last winter, it is indeed remarkable how slightly the majority of the native plants were injured. The plants of Northern origin growing in the high pine lands, flat woods, scrubs, and hammocks of the interior were almost all unharmed.

SUMMARY.

(1) The first freeze, December 27–29, 1894, caused a loss of some 3,000,000 boxes of oranges and lemons, killed many young citrus trees, and seriously injured old trees. Guavas, pineapples, and many tropical fruit trees were frozen down throughout the northern and central portions of the State.

(2) At the time of the second freeze, which culminated on February 8, 1895, the citrus trees which were not killed by the first freeze had started to grow vigorously. The result was that trees of all varieties and sizes were killed to the ground throughout the State, except in the extreme south and in a few protected localities.

(3) The frozen oranges and pomeloes were eaten in great numbers and large quantities were also shipped to Northern markets, and the fact that no injury resulted from the unprecedented comsumption disproves the claims of many physicians and health authorities that such frozen fruit is unhealthful. In the membranes between the segments of frozen oranges white specks were so invariably present as to be satisfactory evidence of freezing.

(4) Where orange and other citrus trees had been banked with earth around the base before the freezes, a portion of the trunk was saved. This practice is thought very desirable in order to protect the point of union in trees budded or grafted near the ground. Budding or grafting trees near the ground or below it is a good preventive against loss by cold, and should be invariably followed, except on low, poorly drained soils, which are subject to foot rot. When the point of union is placed below the soil the bud is generally safe from injury, even in the most severe freezes, and if near the ground it can easily be protected by covering with earth.

(5) Citrus trees having a single main trunk were found to endure the cold much better than trees of the same size having several trunks, and therefore wherever possible trees should be trained so as to form but one trunk as high up as would be consistent with a well-shaped tree. Wind-breaks and forest trees scattered among the fruit trees proved beneficial. Protection of this kind can be provided for when clearing the ground, by leaving strips of the original forest

around plats of, say, 4 or 5 acres, and a tree here and there through the plats. Fires scattered through the groves were also markedly beneficial. Losses from freezing can also be overcome to a slight extent by planting hardy varieties, as some kinds withstand low temperatures better than others.

(6) Little difference was apparent in frozen trees whether pruned soon after the freeze or left unpruned. Apparently no injurious effects resulted from leaving the frozen tops attached, but it is thought that in general early pruning gave rather the best results. Probably the best time to prune the trees is when the sprouts have started and show a healthy growth. The trees should be cut below the upper sprouts down to a short distance above where the most healthy and vigorous growth appears. In restoring orange and lemon groves frozen to the ground, the method of cutting the trees off below the soil and crown grafting has proved much better and quicker than waiting for sprouts to grow from the base and budding them when they had reached sufficient size. What appeared to be the quickest way to build up nursery stock and small trees killed down by the freeze was by immediately cutting them 1 or 2 inches below the soil and cleft grafting them.

(7) Pineapples were injured as far south as Biscayne Bay. Plants which were grown under sheds were not seriously injured south of the twenty-seventh parallel. The pineapple plants will entirely recover from the injuries of the freezes in one year.

(8) Strictly tropical fruits and plants were badly injured in all places in the State except in the extreme southern part, that is, at Biscayne Bay and on the keys. The native vegetation, particularly plants of Northern origin, was but slightly injured.

(9) Large bodies of water afforded great protection to citrus trees growing in their vicinity. Except in the southern part of the State the first freeze killed the foliage on all trees outside of those growing on the south side of large lakes, where the results of the tempering influence was perceptible for half a mile from the water. On Terraceia Island, in Tampa Bay, even lemons escaped unhurt, and orange groves bordering on the mainland of this bay were almost entirely unharmed. The beneficial influence of this large body of water extended 2 miles. Pineapples, guavas, etc., grown in regions having extensive water protection escaped much of the damage sustained by such fruits when grown in the same latitude but away from any body of water.