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Report on Freeze Injury to Citrus Trees for 1916 and 1917, with Notes on Orange Culture in South Alabama

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REPORT ON FREEZE INJURY TO CITRUS TREES FOR 1916 AND 1917, WITH NOTES ON ORANGE CULTURE IN SOUTH ALABAMA

By
O. F. E. Winberg and G. C. Starcher
Assisted by
C. L. Isbell

INTRODUCTION

A few citrus trees have been grown in the yards and around the houses in South Alabama for perhaps fifty years or more. Most of these were seedling sweet or sour oranges and a few seedling lemons.

The introduction of the Mandarin Orange, Satsuma variety, the pomelo, or "grape fruit" Nagami and Marumi varieties of kumquats and the tangerine marked the beginning of the citrus industry in South Alabama on a larger or commercial basis.

Since the introduction of these fruits into South Alabama, the development of the citrus industry has been rapid. Present conditions point to the continuation and acceleration of this development. During this short period of development some growers have made mistakes and in consequence thereof suffered losses. The growers are not altogether, or perhaps not at all to blame for these mistakes nor should they feel too strongly the pain of disappointment which they have suffered, because in any new industry there must be pioneers, mistakes and disappointments out of which success will come. Pioneers in the citrus industry in South Alabama have furnished, together with our experiences, material for this bulletin compiled from tabulated freeze reports and individual tree statistics from Baldwin and Mobile Counties on 1360 orchards or parts of orchards containing 446,746 trees.

The killing and banking graphs as well as some of the general conclusions are drawn from about 55,000 summarized words tabulated under the following topics: The number of trees killed and killed back with dates; time, kind and amount of fertilizer; time, kind and amount of cultivation; elevation and depressions; time of banking and its effect; character of soil;

perfection of both air and soil drainage; nearness to and the effect of bodies of water; the position, kind and effect of wind-breaks.

There were so many trees planted, protected, fertilized and cultivated in so many different ways that we found it impossible to make a correct percentage or graph for any of the above topics, except banking, killed and killed back, and these only for the Satsuma and grape fruit. Lemons, sweet, sour and navel oranges were planted in small areas around dwellings, barns, chicken lots, etc. and under such other varied conditions that no accurate graph could be made. The kumquat was also planted around dwellings, barns, chicken lots, etc. for the turn rows and along fences under such different conditions that no graph could be made.

For the collection of the data from which this bulletin is compiled we are indebted to Dr. R. Van Iderstine, John W. Pace, Colin McDonald, T. F. Johnson, Leonard G. Payne, Robert W. Porter, Robert M. Mahler, and their assistants in the Citrus Canker eradication work and the hundreds of growers who so willingly gave the necessary information.

MAP EXPLANATION

Since the freeze injury reported in this bulletin occurred, it has been the opinion of some of the citrus growers of South Alabama and perhaps is still the general opinion of the casual observer, that trees planted in all hollows and low places suffer much heavier losses from freezes than trees which are on elevated areas. The graphs and maps on pages 7 and 8 are intended to give the growers suggestive corrections for this mistaken idea, especially in a hilly district, whereas in a more level district, swamps may act differently as shown by Plate III and fig. 1 of Plate IV.

Generally speaking, losses from freezes may be heavier in hollows and low areas than on elevated areas. But when these increased losses occur it is generally due to either lack of air drainage or the presence of a wind-break or wind-stop, proximity to a swamp or a combination of these conditions. Cold damp air will settle in low places adjacent to these surroundings. Just so far as this cold damp air extends be it in low or elevated places, those areas will suffer losses in proportion to the dispersement of the cold still damp air. See graph, page 7.

Map No. 1 (page 7)—Field No. 1 is a forty-acre plot set to Satsuma oranges. This plot contains two natural drains; one from the north and the other from the west, which unite near the center of the field to form a larger drain which slopes in a southern and south-easterly direction. Above drain No. 2 the wind from the northwest from which direction most cold waves come, has a free sweep for a long distance. As it enters the head of drain No. 2 it forces the cold, damp air out of this drain, draws it from drain No. 1, sweeps down the main drain, carrying the cold, damp air before it to the creek. Not a tree was lost in this forty acres from the freezes, and there are six other draws on the same plantation showing similar results.

Field No. 2 is a forty-acre plot set to oranges. This plot contains one drain which runs across the north-east corner in a south-easterly direction. There is timber along the north side of this drain which forms a wind-break. The cold, damp air on the south side of this drain No. 3 was not dispersed and the trees are killed to the bank as far up as the still cold air extended (indicated by dotted area). Only banking saved part of this orchard. Concluding from results in field No. 1, had the timber been cut from the north side of brook No. 3, no trees would have been killed to the bank in field No. 2.

Field No. 5 is a forty-acre plot set to oranges, except a small area in the north-west corner which is cut off by a highway. This plot contains two natural drains, No. 4 and No. 5, in the north-eastern portion which slope in a north-western direction, and it also has a general western slope toward the creek on the west. Field No. 4 is a forest which serves as a wind-break for field No. 5. Cold, damp air settling in drains Nos. 4 and 5 and near the creek in the north-west corner killed all the trees in these areas. Also a few trees were killed up to the middle of the forty from the west side of the field. But, comparatively few were killed, as some free wind came through the opening at the bridge as indicated by wind arrows sweeping down the western side with enough force to partially disperse the cold damp air.

The dashed line in field No. 5 indicates the top of the hill beyond which no trees were killed. A similar line in field No. 1 indicates an equal elevation below or above which no trees were killed.

The black irregular line around each drain is a suggestive contour line with equal elevation and slope towards the main creek. Notice that all trees were killed below and some above this line in field No. 5, while in field No. 1 not a tree was lost.

Fields Nos. 6, 7 and 8 are shown only for relative positions. Field No. 3 shows the same general result as shown in Map No. 2, Field No. 1.

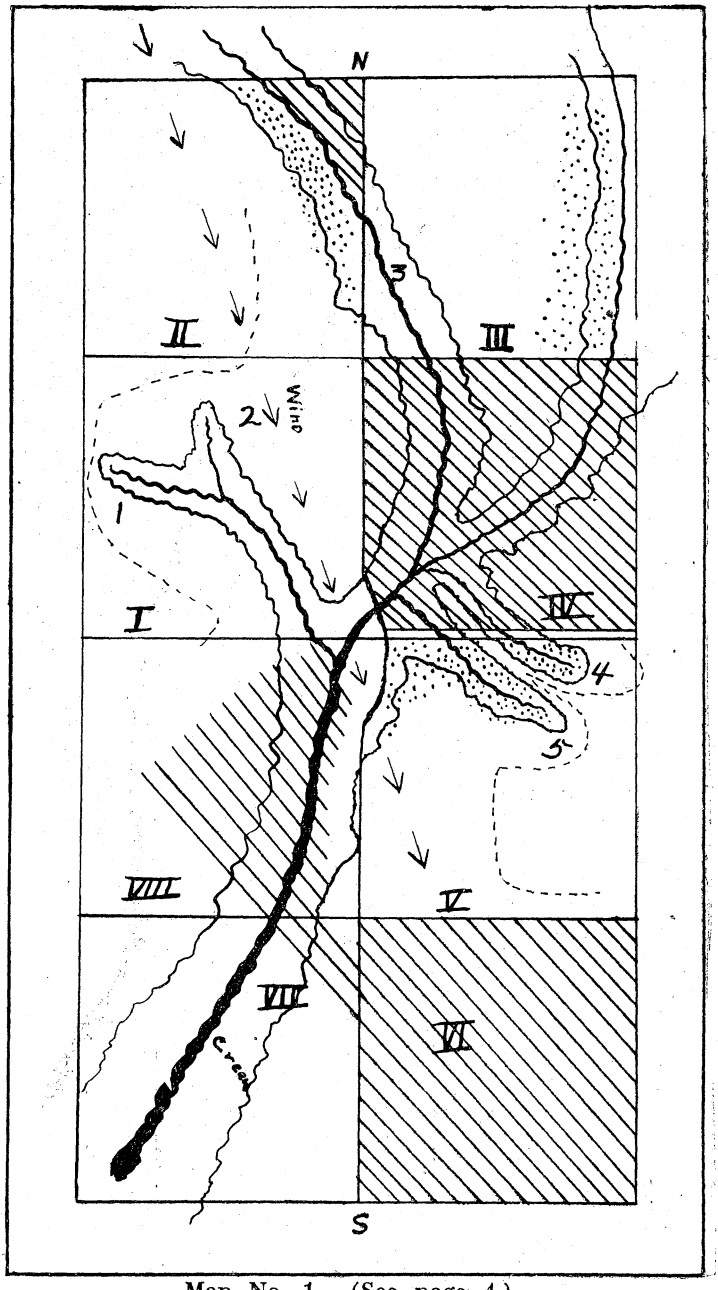
Map No. 2 (page 8)—This map shows 160 acres set to oranges with the exception of a small area in the south-east corner. The area contains one brook in the north-east section and a creek extends across the south-east corner bordering the south. You will note in field No. 2 of this map that 25 per cent. of the trees along the drain were killed. The woods north, east and south of this drain kept the north wind from dispersing the cold damp air which settled and caused freezing.

When there is perfect air drainage for the field as a whole, and the field slopes in the direction of wind-flow, the trees will not be killed on the level area and as far down the hill as the circulating air disperses the cold damp air. In case of a gradual slope of about one or one and one-half inches per foot, where the wind current crossing a valley at right angles, or where there is a forest wind-stop at the foot of the hill, the circulating air does not seem to follow down the hill-side, but passes over at the height of the wind stop or the nearest land elevation beyond, thereby permitting the cold, dense air to settle toward the foot of the hill. In a case of this kind described in map No. 2, field No. 1, a greater per cent. of the trees were killed in each succeeding area from the level area to the draw, creek or lowest areas.

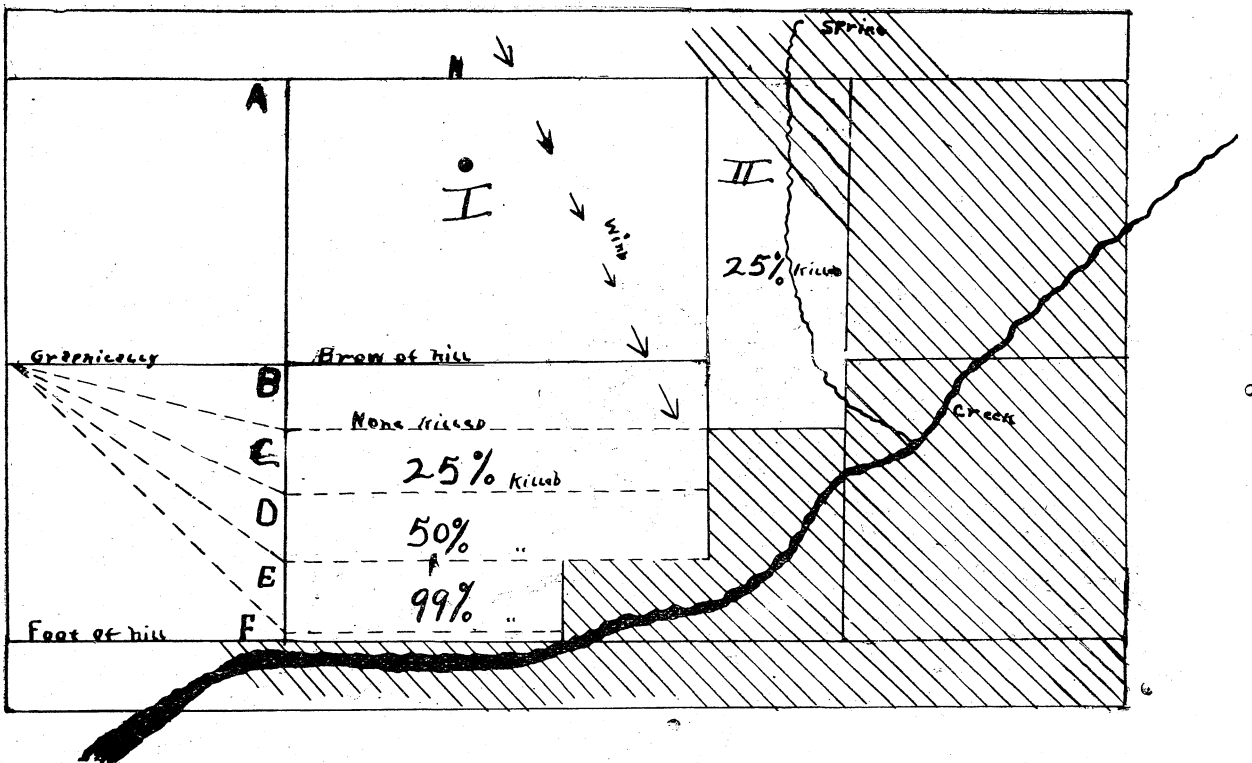
Field No. 1 of map No. 2 shows this condition. The wind coming across the level from A to B will not allow the cold, damp air to settle. No trees are killed as the wind passes B to C. The wind is yet near enough to the surface to disturb the cold, damp air and prevent it from settling. No trees are killed. Farther down the hill circulating air does not come near the ground and the killing increases, as shown in the field drawing and graphically to the left of the map. In this instance there was a forest at the foot of the hill and high land just across the valley.

ORCHARD SITE

Close observation covering a period of several years in South Alabama relating principally to the selection



Map No. 1. (See page 4.)



Map No. 2. (See page 4.)

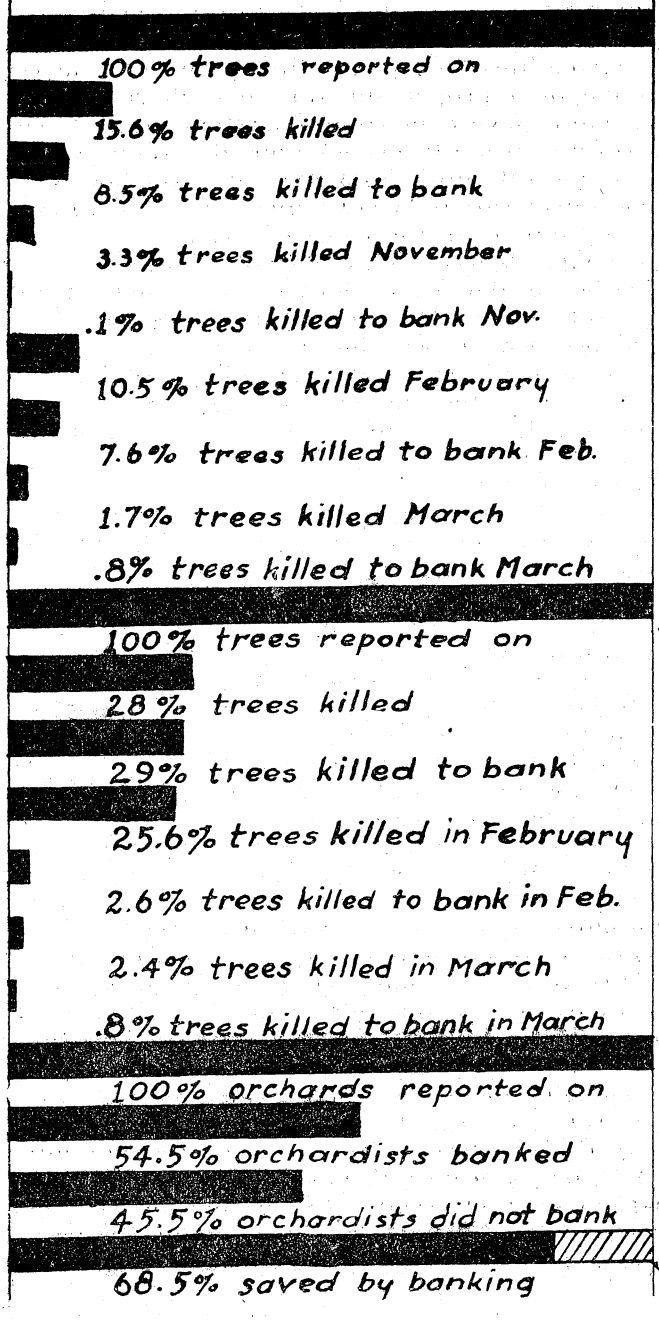
of a site for orange groves, including the data summarized in this bulletin, has led to definite conclusions.

It has been a common error among those not familiar with horticulture to give too little consideration to the selection of a proper site for an orchard except from the point of view of communication, its relative distance from railroad transportation, etc. While these are very important points, they may however be given secondary consideration, because there are other things of more vital importance to be considered.

Some orchardists have believed that an orange grove should not be located on a high elevation where there is no protection against winds from the north-east, north and north-west, but that the best orchard site should have natural barriers against the cold wind. These theories are fundamentally wrong in South Alabama and have been so proved as shown by the maps on pages 7 and 8.

Considering an orange grove as a permanent investment and as an enterprise where considerable capital is involved, it is important that the site be selected on the basis of information contained in this bulletin. This will avoid such losses as many planters suffered in the fall of 1916 and winter and spring of 1917.

The first consideration in selecting the site for an orange grove should be elevation; second, freedom from obstructions on all sides; third, there should be no ponds, swamps or streams adjacent and especially on the north-east, north and north-west sides; fourth, the soil-drainage should be as perfect as possible. If natural drainage does not exist, a tiling system should be provided. However, from the point of frost injury, air drainage is really more important than soil drainage. If there exist natural obstacles, the orange grove will suffer not only a temporary set-back by a freeze, but if the temperature is low enough, the trees may be killed. Where there is a steep southern slope and where the composition of the soil is a light sandy loam the trees will readily respond to warm weather and only a few days are necessary for the trees to begin a vigorous growth. A subsequent low temperature will do considerable injury to such trees and when the temperature is fifteen above zero or less, the trees may not only be set back for a season but may be killed. It is evident that on comparatively level ground where the composition of the soil is rather heavy loam, the trees will not respond to warm weather as quickly and con-



Freeze-Injury Graph. (See page 13.)

sequently low temperature will not have such an injurious effect, unless two or three weeks of warm weather has prevailed followed by a drop in temperature.

Under no consideration should an orchard be located where a small water course, pond or swamp is found in the immediate proximity on the north-east, north or north-west sides because the cold air that is formed in these places under low temperature, instead of being dispersed by the wind will lodge over the surface of the ground in the orchard and cause severe injury to the trees, and if they are not entirely dormant it will kill them. This applies also where the water course is located on the south side and where the slope is rather long and steep. The wind will disperse the cold air from the surface of the ground on the northern part of the slope, but will not do so on the southern part and consequently the trees growing on the lower south side of such slope will suffer from the cold damp air coming off the water course, pond or swamp. It must be remembered that it is not the cold wind that kills the tree, but the cold, damp air that creeps over the surface of the ground and settles. See graph-maps pages 7 and 8.

The future planter of an orange grove should bear the foregoing in mind and select the site for his orchard so that he has as perfect air drainage as possible; that the composition of the soil is not too light; that the slope towards the south is moderate; not over one inch per foot if there is high land across the valley. If the foregoing is followed there will be less frost damage in the future than in the past.

The reason for the greater part of the damage sustained in November, 1916, and February and March, 1917, was in each case due to the fact that prior to such low temperature the weather was warm and the trees had begun to grow. The sudden drop of temperature under conditions described in graphs on pages 7 and 8 was mainly responsible. If the trees had been dormant prior to the low temperature, there would have been no damage.

On the 15th of November, 1916, the temperature was high, the thermometer registering about 80 degrees above zero; on the morning of the 16th the temperature had dropped down to 27 degrees above zero. This sudden drop was responsible for the serious losses sustained at that time, both to the small as well as to the larger trees.

Prior to the low temperature in February, 1917, warm weather prevailed for sometime and the trees were in a sappy condition at the time of the low temperature (15 degrees above zero). From the effects of the low temperature the trees were completely defoliated except in a few instances where the trees were very vigorous because of proper cultivation and fertilization.

Prior to the low temperature (March 5, 1917) the warm weather had caused the trees to put forth a vigorous growth. This, together with the devitalization, caused by the November and February injuries, was mainly responsible for the losses at this particular time.

Defoliation took place practically everywhere, but killing occurred only on improper sites as described in the foregoing paragraphs and where improper cultivation and fertilization had been practiced the previous season.

According to the Government Local Weather Station at Bay Minette, Ala., the lowest temperature during the month of November, 1916, occurred on the 16th, the thermometer showing 27 degrees above zero. On February 3rd, 1917, the thermometer showed 15 degrees above zero and on March 5th, 1917, it showed 26 degrees above.

During the month of December, 1917, the temperature went down to 17 degrees above zero. This low temperature however caused no damage to the orange trees in Alabama because comparatively cold weather had prevailed for at least two weeks prior to this low temperature, causing the trees to become thoroughly dormant. In some orchards we find partial defoliation as a result of this low temperature; in others no defoliation is noticeable. This difference is due to cultivation and fertilization. The orchards well cultivated and fertilized being more vigorous showed no effect from the cold whatever. (See comparative photographs on Plates I and III.)

FREEZE PROTECTION BY BANKING

The only protection we are acquainted with in this State is BANKING (see Plate VII, fig. 1), that is, hilling up dirt around the tree as high at least as twelve inches from the ground. This is done for the purpose of protecting the bud and should there be any freeze damage it may be possible to save some part of the tree above the bud from which a new tree will develop in a comparatively short time. This banking, in order to be effective, should be done between the 1st and 15th of November.

Fifty-four and one-half per cent. of the growers did not practice banking. Forty-five and one-half per cent. practiced banking to a greater or less extent and reported that sixty-eight and one-half per cent. of the trees which otheriwse would have been damaged were saved. See graph on page 10.

THE EFFECT OF LOW TEMPERATURE ON THE FRUIT

The grower should bear in mind that nearly every year we have a cold spell in the middle or latter part of November, the temperature going down to 28 and some times as low as 25 degrees above zero. Every effort should be made to have the fruit harvested before that time. The Satsuma in the green state will suffer when the temperature goes down to 29 degrees above zero and it thus becomes unsuited for consumption. If the temperature goes below 27 degrees the ripe fruit will be damaged.

The effect of low temperature above referred to is not immediate. A week or ten days will elapse from the time of low temperature till the effect is noticeable. Evaporation follows and the fruit becomes soft and spongy and one or more segments dry up. For example, if an orange is cut open two weeks after it has suffered from above low temperature one or two segments may be dry and the balance beginning to decay, although the outside appearance would be normal except that it is soft. If fruit in this condition is wrapped in tissue paper and packed in the usual manner and shipped to a market requiring four or five days in transit, it is unfit for human consumption when it arrives at destination.

In order to prevent the first fruit being frozen, the grower should in the first place have his orchard in a good state of cultivation in the previous fall; apply the fertilizer early in the spring and cultivate frequently through the summer as described in paragraph on cultivation. If this method be pursued the fruit will reach maturity early in the fall and it will be possible to have it harvested before any serious damage from cold weather occurs.

The fruit of the kumquat will stand a lower temperature than the Satsuma. The green fruit will suffer at 24 above zero, while the ripe fruit will become soft from the effect of low temperature (22 above) but in from ten days to two weeks may again be normal.

CULTIVATION

The cultivation of an orchard is of the utmost importance. While it has formerly been held that cultivation should begin in the spring and extend over a period of three to four months after which time the orchard should be left alone, our data proved that this system is wrong and cannot be recommended to those engaged in orange culture nor to the prospective grower in South Alabama.

There are several reasons: Aeration is absolutely necessary for the plant to assimilate plant food. Again, the vigor instilled into the plant during the first part of the summer when proper cultivation was maintained is seriously reduced by ceasing cultivation the latter part of July or the first of August. Furthermore, it is evident that the plant cannot avail itself of and assimilate nourishment to the fullest extent when a hard crust is formed on the surface. Moreover the question resolves itself into one of economy as to whether the plant food in the form of fertilizer should be consumed by weeds or by the trees for which purpose it was applied.

Aside from the foregoing the lack of cultivation in the latter part of the season has a very serious effect on the trees and considerably reduces their resistance against cold. The weeds growing in the orchards around the trees retain moisture and consequently the low temperature will more seriously affect such orchards than where clean cultivation is practiced. We would not advise any orchardist now engaged in orange culture nor any prospective grower to follow the

system of non-cultivation during the latter part of the growing season.

The orchard should be cultivated from spring up to as late as October 1st. Where it is necessary to plant legumes between the trees in order to get nitrogen as well as humus into the soil, they should be planted as late as possible in the season, say in the middle of July, and space left on either side of the tree rows sufficient for cultivation.

In cultivating an orchard properly it is very important that suitable implements be used. The plow should not be used in an orchard except in the fall when it is desirable to turn under cowpeas, velvet beans or grass grown for the purpose of increasing the humus in the soil. When the plow is used care should be taken not to plow too deep in an old orchard; in fact, after the trees are three years old the plow should not go deeper than three or four inches.

Small feeding roots extend from five to ten feet from the tree and if plowing is more than four inches deep the feeding roots are cut off and the normal development of the tree is seriously interfered with. This is often the cause of the fruit dropping in the spring as the feeding roots have been cut off and the tree has not sufficient strength to produce fruit and new growth at the same time.

A disc-harrow is a very desirable implement to use in an orchard. This implement should be used alternately with a spring tooth harrow. For example, if an orchard is cultivated one week with the disc-harrow, a spring-tooth harrow should be used the following week going in the opposite direction. By this method it is possible to keep the weeds under control and likewise keep the orchard in a good state of cultivation. The disc-harrow should be the so-called extension harrow so that one side can be extended to go under the limbs of the tree and as near the trunk as possible in order to eliminate hoeing. Another good implement is the so-called California orchard plow or extension disc-harrow, the discs being twelve inches in diameter, making it possible to cultivate under the low-growing branches of the Satsuma orange trees.

The system of hoeing as employed in many orchards, both large and small, from two to three times in a season for the purpose of keeping the weeds away from the trees, is entirely inadequate and should not be depended upon. We recommend complete, clean cul-

tivation in order that the trees may receive the full benefit of the fertilizer applied. It does not receive this benefit when hoeing alone is practiced.

Modern machinery should be used. This is not only because of the labor situation at present, but because of the more efficient way in which cultivation can be carried on. We refer now most particularly to the use of a tractor in the orchard. It is more economical than horse power and does more satisfactory work. (See photograph of tractor at work, Plate VI, fig. 2.)

FERTILIZATION

Fertilizer should be applied in the orchard early in the season, say January or February. The amount to be applied should be governed by the size and age of the trees. The quality of the soil should also be considered. Where legumes have been planted the previous season the amount of nitrogen should be considerably reduced. For example, if a fertilizer containing three per cent. of nitrogen is applied in an orchard where legumes have not been previously grown, the per cent. of nitrogen can be reduced where legumes have been grown the previous season to one per cent. instead of three.

The reason for the early application of fertilizer is that the fertilizer material used should have time to become available for assimilation by the time the tree begins to grow in the spring. This is particularly important in a bearing orchard as the trees will need considerable plant food at the time of setting fruit. It must be remembered that in order for the tree to have the full benefit of the fertilizer applied, there must be humus present and in order to have this necessary factor in the soil, legumes should be planted as often as may be necessary without getting an excess of nitrogen into the ground.

In years past when potash was obtainable at moderate prices it was persistently advocated that from eight to twelve per cent. of potash should be applied to orange trees. The present shortage of this material has proved that equally as good fruit and as large crops can be grown with four to five per cent. as formerly with from eight to twelve per cent. In fact, during the last two years, potash has been reduced in the fertilizer formulas used in orange groves to even less than four per cent. but the quality of the fruit has

been equally as good as before. However, it would not be a sound policy to advocate the continuation of so low a percentage as above stated when the material can be obtained at the same reasonable figure as formerly prevailed. Therefore, when potash again becomes obtainable on the market at from forty to fifty dollars per ton we advise the following formula: 10 per cent. Phosphoric Acid, 3 per cent nitrogen, and 6 per cent. potash. The potash to be derived from Sulphate of Potassium; the nitrogen from sulphate of ammonia, nitrate of soda or dried blood. As has been pointed out above, legumes should be grown in the orchard not only as a cheap source of nitrogen, but also to increase the humus in the soil, and when this system is practiced, the grower should be guided by conditions in his orchard and reduce the per cent. of nitrogen in his fertilizer from three to two and down to one per cent.

Fertilizer experiments in orange groves in recent years with late applications of nitrate of soda (August 1st) have proved very beneficial. The reason for a late application in bearing orchards is as follows: The nitrogen derived from legumes planted the previous season or from nitrogenous fertilizer applied in the spring, will be largely exhausted before the fruit reaches maturity. The result is that the fruit becomes rather stunted, small in size and the sugar content below normal, although a sufficient supply of potassium may be present.

From an economic and commercial point of view, it should be our aim to improve our fruit in quality and size to conform with the demand of the northern and eastern markets which in the future as in the past will be the principal consumers. Many orchardists believe that the small fruit has a thinner skin and a finer texture and therefore suits their taste better. While this may be true, we are not growing fruit mainly for our own consumption but for the distant markets and the taste of the consumer should be considered.

Since the Satsuma orange growers first began to ship fruit to the northern market in 1914, it has been brought home to them each year that the sizes 120, 144 and 168 per box sell at from thirty to fifty per cent. higher than the sizes 192, 216 and 240 per box. Now there is no reason why the orchardist should not be willing to use every effort to make a tree produce two

boxes of the sizes first named and get as much as fifty per cent. more than to produce two boxes of the smaller sizes.

From practical experiments and careful observation covering a number of years, we have reached the conclusion that it will be possible to grow larger sized fruit without injuring the quality.

PRUNING

The Satsuma orange tree is naturally a dwarf and must be treated as such. High heading should not be practiced as it results in the ends of the branches turning and growing toward the ground. When these branches become older and heavily laden with fruit they will be drawn nearer the ground, the fruit injured and the branches split under the strain of hard rains, winds and storms which we sometimes have near the coast.

The Satsuma naturally puts out branches on the inner parts of the tree in more or less upright bunches, several of which come close together. Often cross branches appear. As the outer upright branches become older they tend to grow away from the center of the tree and the ends may, and perhaps will, later push outward and downward toward the ground. There are usually some small upright branches on the leaders. In this case a careful pruner will take off the end of the leader, thereby throwing the growing material to the smaller upright branches making them strong and tending to keep the tree in a bunchy, stiff, upright mass which is desirable. Even if the outward down tending end of a branch does not show the presence of a smaller upward tending branch, it is better to cut it off, because there is almost sure to be either a dormant or an adventitious bud which will show up and serve the same purpose as the small upward branch. (See Plate V, figs. 1 and 2 and Plate VI, fig. 1 for careful and careless pruning.)

We do not have much practical experience with cross branches and their value as braces during heavy winds and rains because most of the orange trees in South Alabama are young. Such cross branches, in addition to acting as an ordinary brace, often form natural cross grafts which literally tie the main branches into one, as shown in Plate IV, fig. 2. Of course, some times a cross branch may be ill formed and cause rubbing injury to other branches. In cases of this kind, they should be removed at once.

Branches which have been broken during storms and cultivation should be immediately removed. A very serious mistake in pruning, "or not pruning," is the failure to remove dead wood caused from freezes, storms, etc. Many growers believe this dead wood will not effect the tree in any way if left. It is sometimes left until some convenient time when there is no other work to be done. We believe when the growers learn the following facts, they will not again make this mistake.

When trees are partially killed by freezing, if the frozen branches are pruned off as soon as the extent of killing can be determined, new vigorous branches will put out near the cut and thus in a measure save the former desirable shape and vigor of the tree. If the dead branches are left, new branches may sprout out just below the extent of the killed area. These branches will however be inclined to be weak and will either die soon or dwindle along and die later, or if they live will be stunted and susceptible to future fungus and insect attacks. If the dead wood is left, new sprouts may not put out near the lower area of the freeze injury. In this case the tree will put out numerous branches in the crotch near where the tree was headed resulting in a deformed tree consisting of a mass of sprouts.

Practical observations and experiments on the part of the writers show that orchards pruned as soon after freezing as the injury can be determined will give a vigorous growth; those pruned later will give fair results; and those neglected will give poor results. (See photograph on Plate II for dead wood which has not been pruned out.)

After young trees are transplanted from the nursery to the field, the top often dies back for a few or several inches. This dying back may be caused by either freezes or weakened condition from transplanting. It is highly important that this dried portion be pruned off as early in the spring as its extent can be determined. If it is not taken off an insect often enters the dead branch, makes its way into the heart and begins eating downward. It does not stop its downward movement when the live tissue is reached, but continues until it has eaten the heart out of the tree where the bud was inserted and the tree is destroyed.

In the spring of 1917, some growers were late getting the young trees pruned. Many died back from the effects of the freezes resulting in serious setbacks from insect injury. Even though young trees do not show much dying back, it is well to cut them back the second year if they show a tendency to head too high. This will encourage several branches to put out from near one point which will give a more desirably shaped tree, and one in which natural grafts are more likely to appear.

When Citrus trifoliata stock is used, more or less Citrus trifoliata sprouts will continue to come until the trees grow older. The number of such sprouts is largely determined by the pruning methods practiced. If the pruner leaves stubs, each stub will put out a number of shoots which will increase the number each year. But if the sprouts are cut close up to the stock with a smooth pruning instrument, they will soon cease to appear. The Citrus trifoliata sprout is a rapid grower and that means a heavy feeder as well. The sprouts sometimes reaching four to ten feet and one-quarter to three-quarters of an inch in diameter in a single year. Three or four sprouts may appear. It is, therefore, important to prevent these useless sprouts from receiving plant food which the orange tree should receive.

VARIETIES

Since the beginning of citrus fruit culture in the Gulf Coast section of Alabama, the question is often asked, "Why confine ourselves to growing Satsumas when we can grow other varieties of citrus fruits?" We take this opportunity to answer this question. There is no citrus fruit better adapted to our climate and soil conditions than the Satsuma. For this reason, we should confine ourselves to this particular variety and use every effort to improve its quality, thereby establishing this fruit on the market, rather than to divide our efforts with probably a minimum of success in growing a number of varieties.

The Washington Navel orange has been planted by a number of growers in South Alabama with fairly good success and it must be admitted that the quality of the fruit is equally as good as the California Navel. We find that the Washington Navel survived the low temperature in the winter of 1917 just as well as the Satsuma. However, we have made this observation,

that while the Satsuma orange trees survived and recuperated sufficiently to bear a crop, the Washington Navel orange, on account of its coming into blossom as early as the latter part of February under conditions like the winter of 1917 when the temperature went down rather low, it is evident that these trees cannot bear a crop. In fact, we have found that if the Navel orange produces a crop every third year, it is all we can expect. Therefore, as a commercial proposition, this fruit should not be considered in this section.

The tangerine, when grafted on Citrus trifoliata, is equally as hardy as the satsuma. It comes into blossom about the same time. It is a regular bearer. The quality of the fruit produced in this section is equally as good as that produced elsewhere. But it is a known fact among the orchardists of South Alabama and the consumers in the North and East (as the Satsuma becomes more known) that the Satsuma is far superior in quality to the Tangerine. This is in our judgment sufficient reason why we should not divide our efforts by raising tangerines.

With reference to other varieties, such as the Creole Sweet, the Imperial Navel, etc., etc., we find that when grafted on Citrus trifoliata they do equally as well as the Washington Navel. But what we have said about the Washington Navel also applies to the varieties just named and we recommed only planting one or two trees for home use if desired.

At the beginning of the citrus industry on a commercial scale in South Alabama, nearly all the growers planted from five to twenty-five per cent. in grape fruit, particularly the Duncan variety. This variety is very hardy when grafted on Citrus trifoliata and the quality of the fruit produced here is excellent, but as a commercial proposition it is not to be recommended because we do not believe that this section can produce grape fruit and compete with South Florida, the Isle of Pines and other sections. Another reason is that the grape fruit has been found to be the most susceptible of all Citrus trees grown in Alabama to Citrus Canker and the sooner the planting of grape fruit (except for home use) is discontinued the better it will be for the orange industry.

The lemon has no place in the orchards in South Alabama. Lemon trees planted in 1912 have borne fruit twice. In 1915, 1916 and 1917 they were damaged by cold weather. They are not sufficiently hardy for our

section, even if grafted on Citrus trifoliata stock and we cannot recommend the planting of this fruit even as a novelty.

The Kumquat grafted on Citrus trifoliata stock is equally as hardy as the Satsuma. It grows well in this section; it comes into bearing early (second and third year from planting); it is profitable as well as ornamental and can be planted as a border along the fence. The variety preferred by the preserve factories in the North, as well as for decorative purposes, is the oblong, (Nagami) variety. It brings fifty per cent. higher price than the small round variety (Marumi). We do not recommend the planting of kumquats in whole orchard blocks for the reason that it is a fruit that necessarily must be used for preserves and decorative purposes and consequently the demand of the market is rather limited. When planted in a limited way it is a profitable investment.

SPRAYING

Sour Scab

This is a fungous disease that attacks the young fruit. If not combatted in time small wart-like growths are formed on the fruit, making it very unattractive and unsuited for the market. In order to prevent scab on the fruit it should be sprayed immediately after it has been formed, i. e., when the petals have fallen. A weak Bordeaux solution should be used, which is prepared as directed in spray calendar, page 25.

In spraying care should be taken to cover the young fruit with the spray as thoroughly as possible. As all the petals do not fall at the same time, it is necessary that the spraying be repeated two weeks later in order to spray the fruit the petals of which have fallen after the first spray was made. The same mixture and the same strength as above should be used.

White Fly

Spray in May as soon as the White Fly has disappeared. The object of this spraying after the adult fly has disappeared is to kill as far as possible the first brood. The materials to be used are Schnarr's Insecticide, Pinewold Insecticide and Pratt's Scalecide. Where the White Fly is abundant during the summer, another spray may be necessary in the middle of the season

after the apearance of the second brood, which is usually in July. The grower should be guided by the conditions on his own premises and if he finds the White Fly very abundant at this time another spraying should be made with the same material as recommended before. Then another spray should be made the latter part of August, not later than about the first of September. The object of spraying at this time is to kill the White Fly larvae which is the progeny of the third and last brood. It is this brood which causes most of the damage from the White Fly. See infested foliage, Plate VII, fig. 2.

Rust Mite and Red Spider

By the first of June spraying should be made with Lime Sulphur testing 32 degrees Baume, at the rate of one gallon of stock solution to 75 gallons of water. Care should be taken that the fruit is thoroughly covered with the solution and of course the foliage as well. We recommend that another spraying with Lime Sulphur solution be made during the month of July and another in August to prevent any russeting of the fruit.

Soft Scale

Some seasons the Soft Scale attacks the orange trees rather severely. During the summer of 1917, the growers had a very hard time to control this insect. We saw orchards where the trees, both foliage and fruit, were literally covered with the black mold which grows on the honey dew produced by the insects. The scales are usually found on the under side of the leaf and young twigs. They sap the strength out of the tree and prevent its normal development.

If the insects are not combatted in time the result is the fruit is nearly black at the time of ripening and washing the fruit becomes necessary before it can be marketed. It is evident that it is more economical to spray the tree in order to prevent the formation of black mold than it is to wash the fruit after it has been picked.

Spraying material for the control of Soft Scale is the same as used for the White Fly, excepting that three or four pounds of whale oil soap should be added to every fifty gallons of spraying solution, as we find that neither Scnarr's Insecticide Pinewold Insecticide nor Scalecide are sufficiently strong to control this insect. Trees should be examined at least every two weeks to ascertain whether or

not Soft Scale is present and if found in even small numbers, the tree should be sprayed.

Purple Scale

Purple Scale attacks the tree as well as the fruit and if left alone will kill a young tree in one or two seasons. The insect is controled in the same manner and with the same spraying material we have recommended for Soft Scale.

In the fall after the fruit has been gathered, every orchard should be given a thorough spraying with one of the three oil emulsions mentioned with the addition of three or four pounds of whale oil soap to every fifty gallons of spraying solution.

If Rust Mite and Red Spider have been much in evidence during the growing season, another spraying with Lime Sulphur should be made during the winter, strength 1 to 35.

SPRAYERS

Wherever possible a power sprayer should be used in order to get the necessary pressure from 150 to 200 pounds. The small knapsack sprayer or any other small sprayer that can be carried around is unsatisfactory for the reason that not as high pressures are obtained to carry the spraying material in a fine mist. If the orchard is not large enough to warrant the owners investing in a power sprayer, several small orchard owners may combine and buy a power sprayer together. In this case care should be exercised; if any communicable disease is present in an orchard the sprayer, wagon, team and men should be disinfected before leaving such orchard with either formalin solution 1 to 120 or with bichloride of mercury solution 1 to 1 000.

SPRAY CALENDAR
CITRUS FRUITS

Spraying	Disease or Insect	Time of Application	Spray Materials for 50 Gal. Solution
First	Sour scab.	Immediately after petals have fallen. Repeat two weeks later.	Bordeaux mixture made as follows: Dissolve 3 lbs. of sulphate of Copper and 3 lbs. of unslacked lime separately in 10 gallons water for each; after being so dissolved pour the two solutions together into the spray barrel containing 30 gals. of water, making 50 gals. spraying solution.
Second	White Fly.	Spray in May as soon as fly has quit swarming; repeat in July after the appearance of the second brood; a third spraying should be given in August if White Fly is present in abundance.	Use Schnarrs Insecticide, Pinewold Scalo Insecticide or Scalecide. The above materials have been found to be of equal value. See direction for use on containers.
Third	Rust mite and red spider	Spray June 1st, July 1st, Aug. 1st, and the middle of September.	Use lime-sulphur solution, 1 to 50, testing 32 degrees Baume.
Fourth	Soft scale	Spray at the time you spray for White Fly.	Use the same spraying solution as for White Fly with the addition of 3 to 4 lbs. of whaleoil soap.
Fifth	Purple scale	Spray at the time you spray for White Fly.	Use the same spraying solution as for White Fly with the addition of 3 to 4 lbs. of whaleoil soap.

SUMMARY

The orchard site must be chosen with reference to favorable air drainage, air currents and freedom from wind breaks, swamps and wind stops.

The most resistant trees to freeze were those which were most perfectly cultivated and fertilized and, therefore, most vigorous.

The Satsuma is undoubtedly the most desirable of all citrus fruits for Alabama planting when considered for their commercial value and freeze resistence.

A freeze which merely causes complete defoliation may not seriously affect the season's crop immediately following.

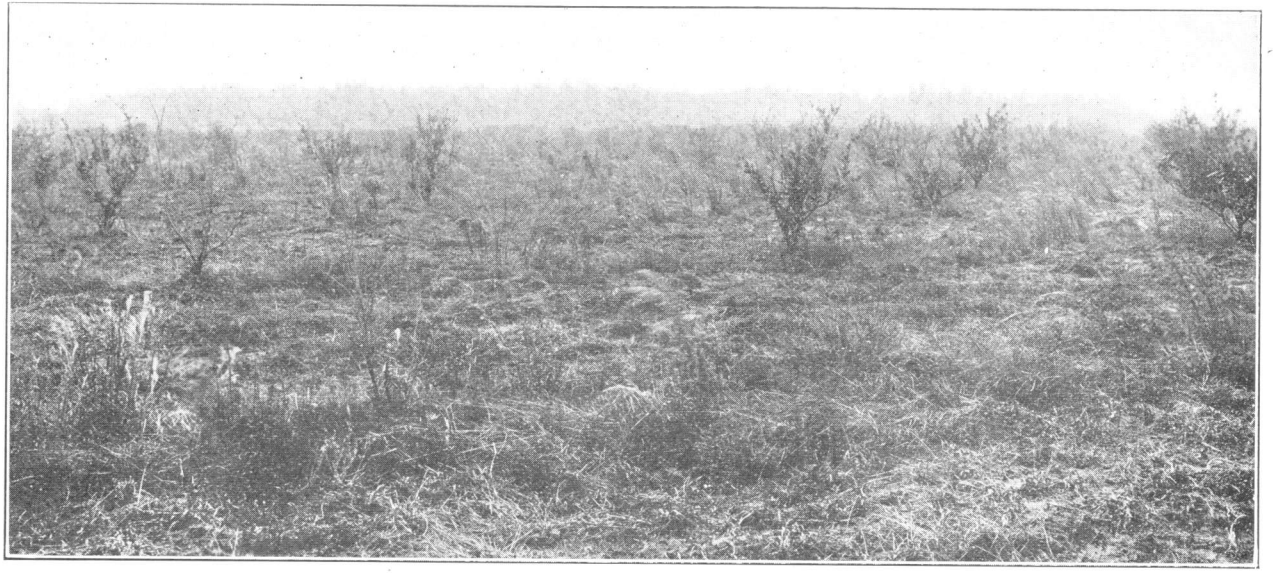
Banking in most cases proved effective. Banking should be done in early November but many orchards were saved by banking as late as January, the most damaging freeze of 1916-17 having occurred February 3rd, 1917.

The final success of the orchard depends on proper spraying.

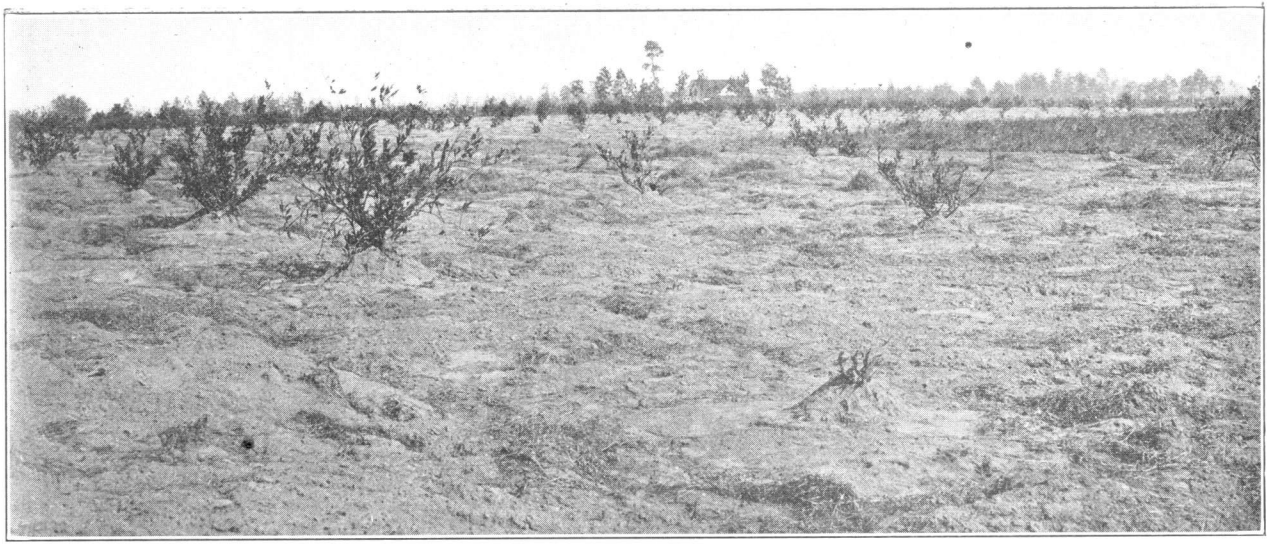
The grove in the foreground was given clean cultivation throughout the year 1916. The February freeze of 1917 did not even cause defoliation. The grove in the background beyond the road is older than the one in the foreground. It did not receive late clean cultivation during the year 1916. The grove was completely defoliated and some trees killed by the February freeze of 1917. Late clean cultivation is a protection against freezes.

PLATE I.

PLATE II.



Note the dead wood, lack of cultivation and general devitalized condition of the trees. Freezes, insects and diseases cause heavy losses in neglected groves like this.



In practically level areas in February, 1917, killing was much heavier near swamps. Note heavy cover of grass just turned under, and falling foliage. The falling foliage is due to lack of cultivation during 1917, and the December freeze of 1917.

PLATE IV.

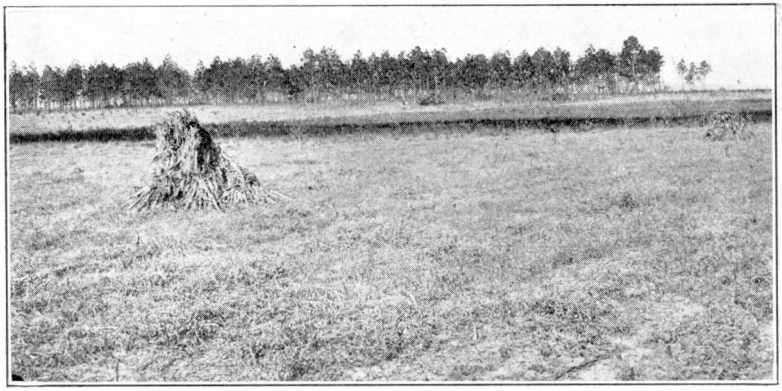


Fig. 1. Heavy losses from February freeze, 1917, caused by wind break on the northwest and swamp on the north. Where corn shocks are seen Satsuma trees were killed. Only two Satsuma and a few persimmon trees appear in the picture.

Fig. 2. Low heading encourages symmetry and natural grafts, which give great bracing strength to the tree during storms and heavy fruiting periods. Note the five points of contact of the natural grafts.

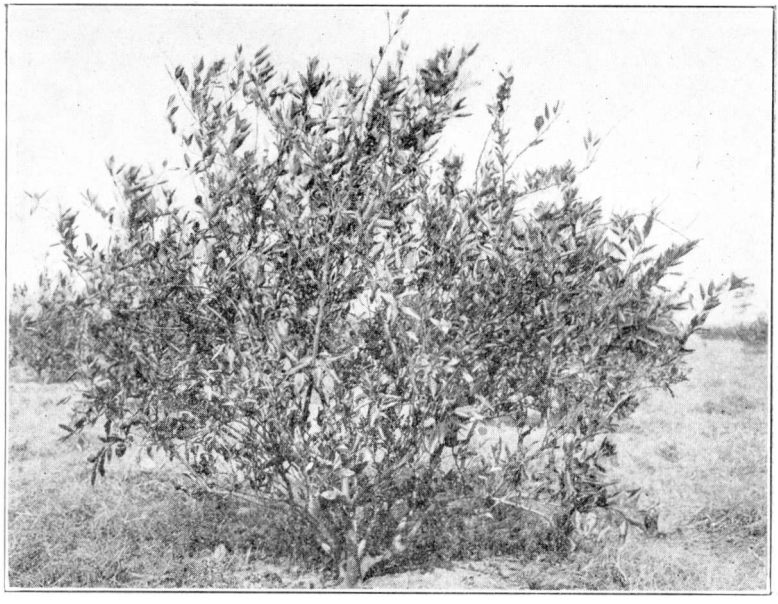


Fig. 1. This tree was properly planted and given a desirable low head as was Fig. 2. In addition it has had careful pruning. Note the uniform thickness of the tree throughout; also, its tendency to stand erect and carry a general symmetrical shape. This tree can safely carry a much heavier crop of fruit than can Fig. 2. Careful pruning is the only difference between the two trees.

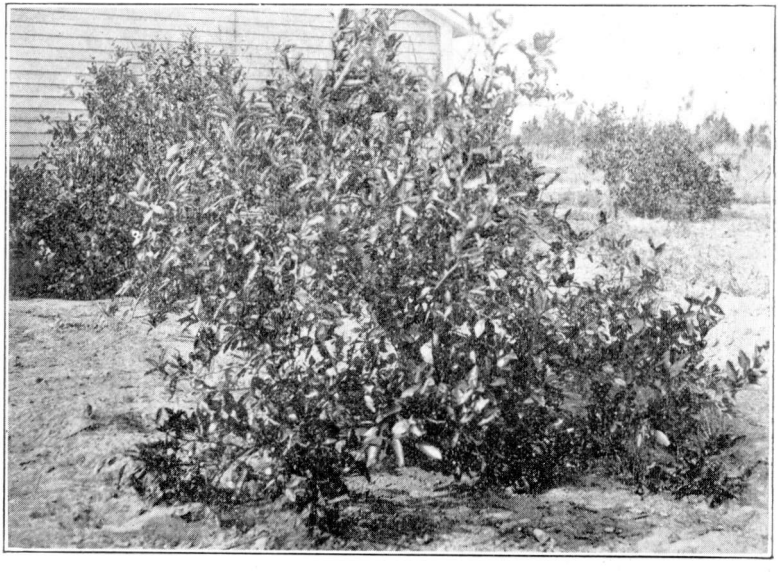


Fig. 2. This tree was properly planted and given a desirable low head, but it has not been carefully pruned. Note the branches on the back side of the tree are high, thin, and irregular and will not carry a heavy crop of fruit. Note also the branches in the foreground resting on the ground. Fruit on these branches is easily soiled during rainy or windy weather and if tree is near the house fowls may destroy the fruit.

Fig. 1. High headed Satsuma trees are undesirable. They are not strong or symmetrical and cannot safely carry heavy crops. They are not likely to develop cross grafts.

Fig. 2. This photograph shows an orange grove that was cultivated one way with a tractor in December and is being cultivated the other way in January. The first row of trees to the right of the tractor shows the thoroughness of the work. This is an efficient and economical method of cultivation for the orange groves. The tractor may be used to follow the late fall and winter plowing where a heavy growth of velvet beans has been turned under, or where peanuts (as in the picture) or a moderate growth of cowpeas are to be turned under. It may precede or take the place of the plow.

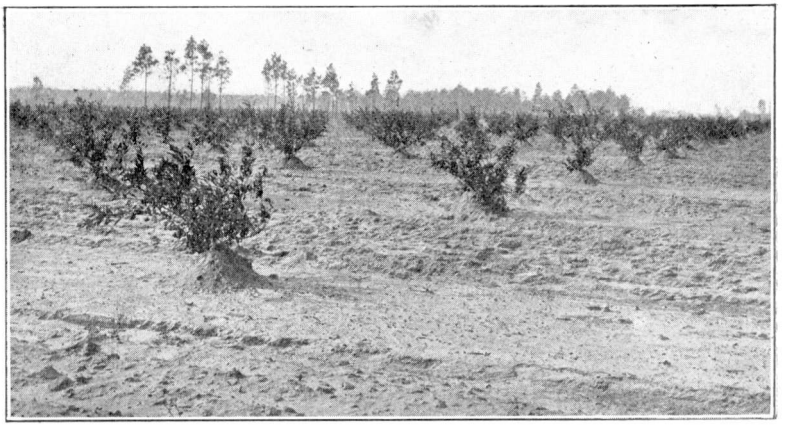


Fig. 1. Note perfect foliage due to clean cultivation throughout the year of 1917. This field is adjacent to field shown in Plate III. The pictures were made on the same date, January 8, 1918. Note also method of banking.

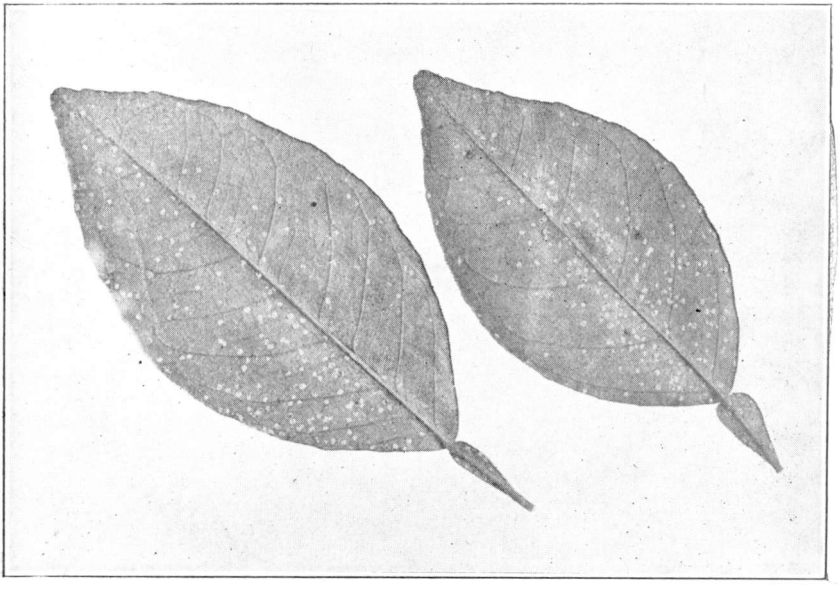


Fig. 2. Characteristic appearance of foliage infested with White Fly.