540-712-30m.

TEXAS AGRICULTURAL EXPERIMENT STATIONS

BULLETIN No. 148. MAY, 1912.

Report on Experiments With Citrus Fruits at The Beeville Sub-Station

BY

A. T. POTTS, Superintendent
Beeville Sub-Station

AUSTIN PRINTING COMPANY
AUSTIN, TEXAS

TEXAS AGRICULTURAL EXPERIMENT STATIONS

GOVERNING BOARD.

(Board of Directors A. & M. College.)

WALTON PETEET, President.....Fort Worth
JOHN I. GUION, Vice-President.....Ballinger
CHAS. DAVIS.....Steele's Store
L. J. HART.....San Antonio
J. ALLEN KYLE.....Houston
R. L. BENNETT.....Paris
D. W. KEMPNER.....Galveston
ED. R. KONE.....Austin

PRESIDENT OF COLLEGE.

R. T. MILNER.....College Station

STATION STAFF.

B. YOUNGBLOOD, M. S.....Director
M. FRANCIS, D. V. S.....Veterinarian
G. S. FRAPS, PH. D.....Chemist
H. NESS, M. S.....Horticulturist
J. C. BURNS, B. S.....Animal Husbandman
WILMON NEWELL, M. S.....Entomologist
A. B. CONNER, B. S.....Agronomist
F. H. BLODGETT, PH. D.....Plant Pathologist and Physiologist
W. L. BOYETT.....State Feed Inspector
HARPER DEAN, B. S.....Assistant Entomologist
J. B. RATHER, M. S.....Assistant Chemist
J. B. KELLY, A. B.....Assistant Chemist
L. C. LUDLUM.....Assistant Chemist
F. B. PADDOCK, B. S.....Assistant Entomologist
H. H. JOBSON, B. S.....Assistant Agronomist
CHAS. A. FELKER.....Chief Clerk
A. S. WARE.....Secretary
J. M. SCHAEDEL.....Stenographer
R. L. SPILLER.....Mailing Clerk

STATE AGRICULTURAL EXPERIMENT STATIONS.

GOVERNING BOARD.

HIS EXCELLENCY GOVERNOR O. B. COLQUITT.....Austin
LIEUTENANT-GOVERNOR A. B. DAVIDSON.....Cuero
COMMISSIONER OF AGRICULTURE HON. ED. R. KONE.....Austin

DIRECTOR OF STATIONS.

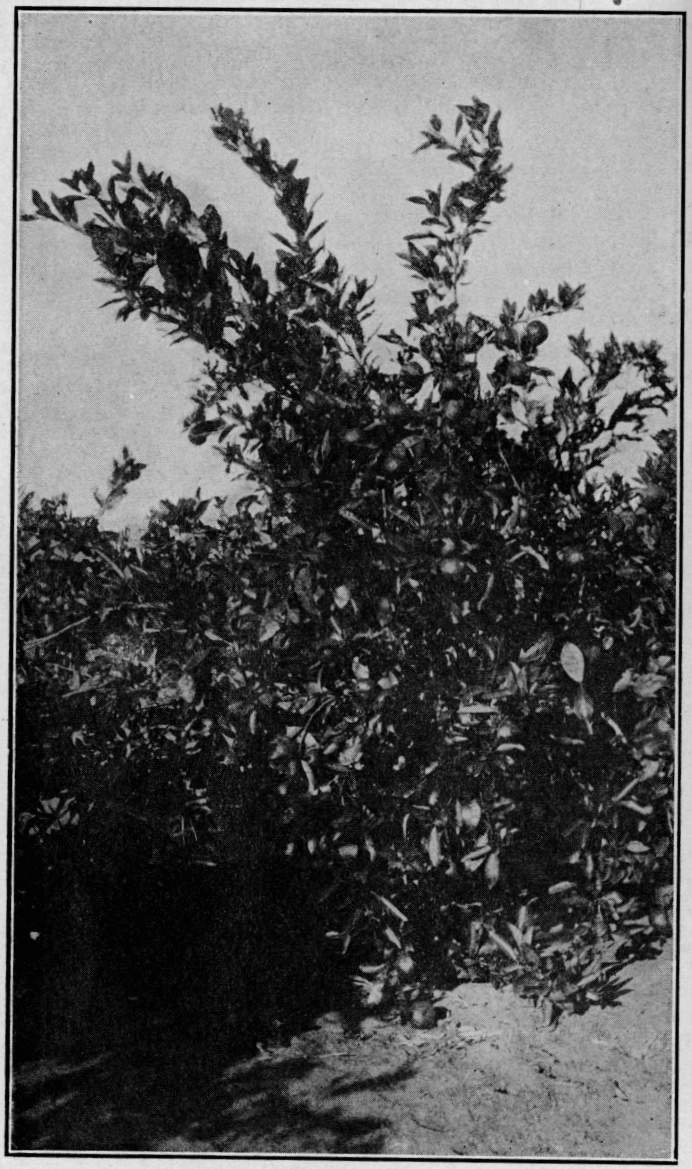
B. YOUNGBLOOD, M. S.....College Station

SUPERINTENDENTS OF SUB-STATIONS.

E. E. BINFORD, Beeville Sub-Station.....Beeville, Bee County
W. S. HOTCHKISS, Troup Sub-Station.....Troup, Smith County
E. M. JOHNSTON, Cooperative Rice Station.....Beaumont, Jefferson County
I. S. YORK, Spur Sub-Station.....Spur, Dickens County
T. W. BUELL, Denton Sub-Station.....Denton, Denton County
A. K. SHORT, Temple Sub-Station.....Temple, Bell County
A. L. PASCHALL, Lubbock Sub-Station.....Lubbock, Lubbock County
P. D. PERKINS, Angleton Sub-Station.....Angleton, Brazoria County
H. C. STEWART, Pecos Sub-Station.....Pecos, Reeves County
G. T. MCNESS, Nacogdoches Sub-Station...Nacogdoches, Nacogdoches County
H. C. HOLMES, Feeding and Breeding Station...College Station, Brazos County

NOTE.—The main station is located on the grounds of the Agricultural and Mechanical College, in Brazos County. The postoffice address is College Station, Texas. Reports and bulletins are sent upon application to the Director. A postal card will bring these publications.

[Blank Page in Original Bulletin]



SATSUMA ORANGE.
A Three-Year-Old Tree.

REPORT ON EXPERIMENTS WITH CITRUS FRUITS AT THE BEEVILLE SUB-STATION.

By A. T. Potts, Superintendent.*

Introduction.

The object of this bulletin is to give a brief resume of the experiments with citrus fruits which have been conducted at the Beeville Sub-Station during the past few years. It will point out the varieties most resistant to cold and call attention to the most approved methods of cultivation,—those which will put the grove in the best possible condition for resisting cold, and for the production of fruit. It also calls attention to a method of protection against frost.

The attempt to grow fruits in the Texas Gulf coast under orchard conditions dates back only a few years. From 1899 to 1910 this section had very little cold weather and it is during this period that the industry was first ventured into on a commercial scale.†

Year.	Minimum temperature in degrees Fahrenheit.
1900, February 18	13.0
1901, December 15	18.0
1902, January 22	24.0
1903, February 22	22.0
1904, January 26	26.0
1905, February 13	17.0
1906, January 24	22.0
1907, February 6	31.0
1908, February 12	22.0
1909, January 11	23.0
1910, January 7	21.0
1911, January 2	13.0
1912, January 6	10.0

Several early plantings came into bearing and the returns were very flattering. This caused a rush of people into the Gulf coast country to go into the citrus business. Many of these were not at all familiar with farming, and especially in the South.

The heavy demands for nursery stock caused the market to be flooded with inferior plants budded onto stocks of doubtful value. Owing to the inexperience of the growers the trees were neither properly cultivated in summer nor protected in winter.

Varieties.

The data relative to the effect of frost on the different kinds of citrus fruits is given in the later paragraphs. It will be sufficient here to state that the results obtained to date indicate that the only varieties which should be used in commercial plantings are the Kumquat and the Satsuma.

*Resigned March 15, 1912.

†Below is shown a table, giving the minimum temperatures from 1900 to 1912, inclusive:

KUMQUATS.

The Citrus Belt.

Starting in with the Sabine river a few miles north of Orange, and extending south and west to the Rio Grande, is the low, flat coastal plain, generally spoken of as "The Texas Citrus Belt." Just how far inland it is reasonably safe to plant citrus fruit has not been determined, but the distance is probably not very great in the eastern portion, gradually becoming wider as we go westward and southward.

Other factors, such as elevation, proximity to bodies of water, air drainage, and windbreaks, probably determine the frost injury in this section, as much as latitude.

Within this belt may be found soils of many kinds, varying from the light sands to heavy, dark clay. Most of it will be found sufficiently fertile to produce a good crop of citrus fruit. Soils containing a very heavy supply of available plant food are not best for citrus fruit. An extra heavy growth of wood is not desirable, because it often is made at the expense of fruit, and it is seldom hardened enough to withstand severe weather. For this reason, trees on poor soil have gone through the winter in better shape than those on heavier types.

Desirable Sites.

If possible, a northern exposure should be selected for the orchard. This will make the trees later starting in the spring and hasten maturity in autumn. Air drainage is of very great importance. The cold air, being the heaviest, tends to flow into the low places, and for this reason frost often occurs in the valleys when it does not upon higher land. The proximity of large or small bodies of water has a tendency to raise the temperature, and should be taken advantage of wherever possible.

Windbreaks Advisable.

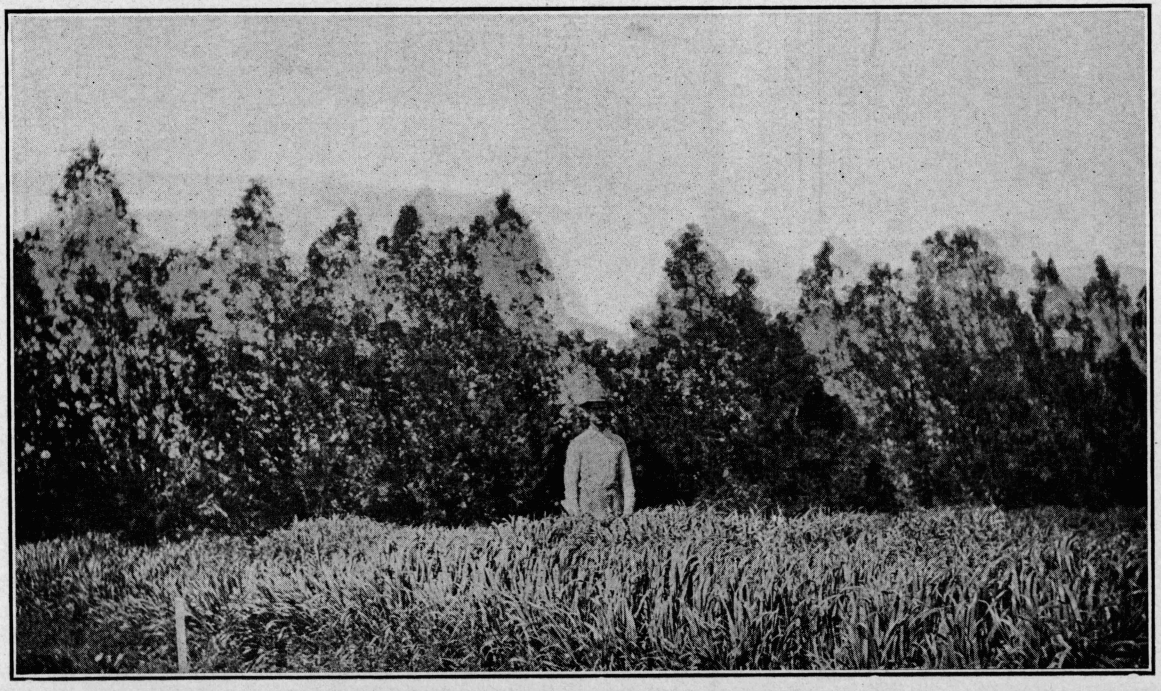
As soon as the site for the grove is selected, plans should be made at once for a windbreak upon the north side. Their full value can only be appreciated by one who has had experience in trying to use orchard heaters in a Texas "norther." While heating in the Beeville grove was carefully tested, thermometers in the same row but one behind a good cedar windbreak, and the other exposed, showed a difference of from one-half to two degrees. There are a number of good plants for the purpose of windbreaks. Among these are Red Cedar, Chinese Arborvitae, Ligustrum Japonicum, and Live Oak.

The Stocks.

With the present information to draw upon, the *Citrus trifoliata* is the best stock obtainable and should be used wherever it is found to do well. On the Beeville Sub-Station trees budded on this stock were injured less from cold. This may be due to several things. The stock doubtless imparts some of its hardiness to the scion. The growth is not so vigorous and sappy, and the general shape of the tree seems closer and more compact. The last two points are of the greatest value in resistance to cold.

Selecting the Trees.

The selection of strong, hardy trees is of very great importance. As previously stated, much inferior stock has been sold and planted. A sick man is in no condition to overcome adversity—neither is a sick tree. The very heavy loss of young trees during the past two winters



OAT COVER CROP AND CEDAR WIND BREAK.

is due as much to the poor physical condition of the plants as to cold weather.

Plant only the very best stock bought from reliable men, and grown under conditions as nearly similar to yours as possible. The best citrus trees for planting are those having three or four-year-old root systems, and a one or two-year-old top, of medium growth.

Planting.

A tree properly grown is of no more value than a poor one unless properly set. In the rush of the last few years to get an orange grove started, many trees have ben set in sod land, poorly broken. Often only a strip for the tree row has been plowed and the middle left unbroken until some time later. Such methods are bound to bring unsatisfactory results. The land should be carefully prepared before time for planting has arrived. Sod land should be given to some culitvated crop during the previous year. If there is any choice in the dimensions of the orchard, the greatest length should be from north to south. This method helps in heating the orchard, and gives more protection to the grove from the strong southerly winds.

The distance the trees should be set will depend largely upon the variety used, but in general, rather close planting is recommended, because of the protection trees planted in this manner will afford each other, and the greater ease experienced in holding the heated air above the grove.

After carefully selecting the tree, it should be cut back to from 12 to 15 inches. This will cause a low head, which is not only desirable in handling the crop, but gives protection to trunks and roots from both heat and cold.

Cultivation.

The entire system of cultivation should be done with a view of getting good medium growth early in the season that will harden up before winter. Many of the poorly attended orchards make a rapid growth in the spring that is checked and hardened by the summer drouth. Early fall rains start another growth that does not have time to harden before winter. Such conditions may not be entirely avoided under the best cultural methods, but the danger of winter injury may be lessened.

As a general thing, double cropping, that is; the planting of other crops between the rows—is not to be recommended. This is especially true if there is any likelihood of the crop hindering early growth or leaving a stubble that will serve to stimulate late fall growth.

Pruning.

Very little pruning will be found necessary with citrus fruits. On sound, healthy trees, about the only use for a pruning knife will be in removing cross limbs and shortening an occasional limb that interferes with cultivation.

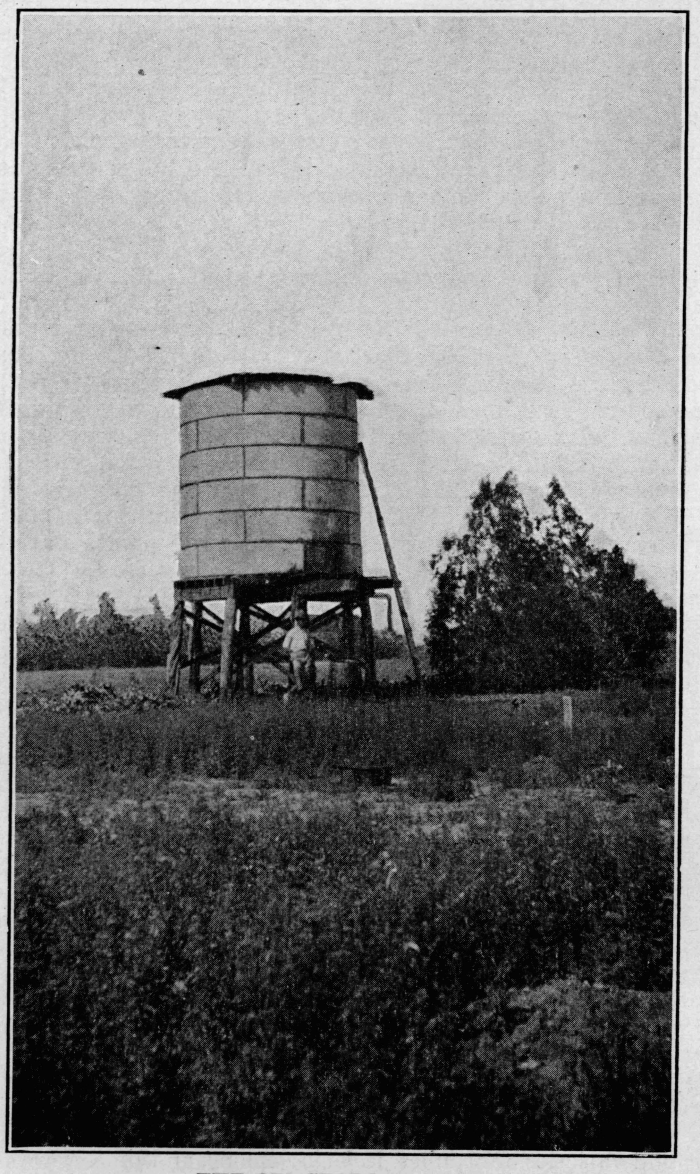
By cutting the trees back at planting, to from 12 to 15 inches, a low headed tree is secured which is better in every way for the Texas

Gulf coast than the high-headed ones. The thick, low branches give great protection to the trunk from cold and serve as a mulch for the roots; they hinder the sweep of the Gulf wind through the grove, and aid in holding the smoke and heat during smudging. The ease and economy in harvesting fruit and combating insects and diseases are also in favor of low-headed trees.

RAPE AS A COVER CROP.

Winter Cover Crops.

In addition to the many benefits the soil may receive from a winter cover crop, they are of great value in causing the trees to become dor-



THE OIL STORAGE TANK.

mant in the fall, preventing growth during warm spells in winter, and retarding growth in the spring.

In the fall the cover crop takes up available plant food and moisture, and cools the ground by shade. During the winter and summer it

keeps the ground cold so that the trees do not start growth with the first warm days. On the Beeville Station, plats in burr clover were from seven to twelve days later starting growth than plats having no cover crop.

Of the legumes tried for winter cover crops at the Beeville Substation, burr clover, crimson clover, vetch and Canada field peas were found to be most satisfactory. Of the non-legumes, oats, rape and kale were good. All of these should be planted by August 1, if their full value is to be obtained.

No cover crop should be used in a citrus orchard that will not readily decay and became largely exhausted before fall. For this reason all crops should be plowed under as early in the spring as it is desirable to cultivate the orchard.

Protection Against Frost.

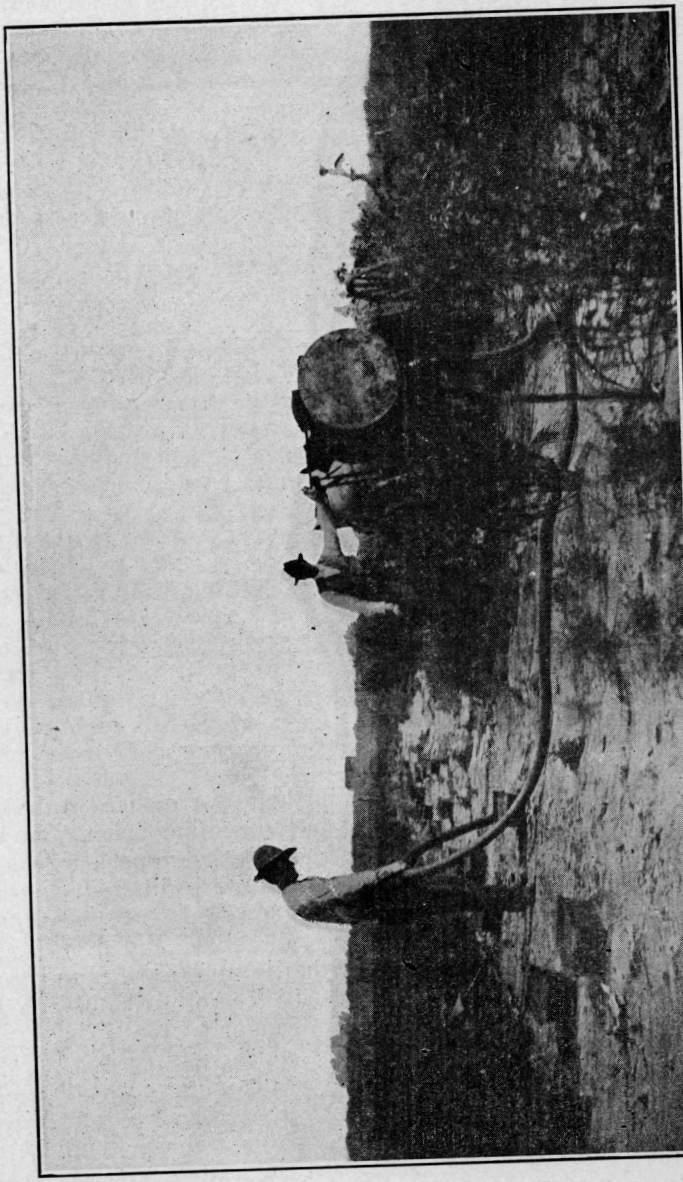
Shortly before cold weather is expected, all varieties of citrus fruits should have clean earth piled about them to a height of from 12 to 18 inches. In case of a severe freeze, this will save all wood covered. During several years preceding 1911 no severe cold weather visited the citrus fruit belt, so that little attention was paid to methods of frost prevention. But the severe freeze in January of that year, and the very severe winter of 1911-1912 has taught the growers that they must be prepared for an occasional winter that will tax to the utmost any system of orchard protection. No extensive plantings should be made without some well defined plan for fighting frost.

Of the various means used for frost protection, the Beeville Sub-Station has tried cord wood fires and oil burning heaters. Cord wood and straw was first tried in the winter of 1909-1910. This method was by no means satisfactory. Either the material was too wet to burn well, or had to be covered with earth to prevent too rapid consumption. The result in raising the temperature was hardly noticeable. In 1910 a few Hamilton Reservoir Orchard Heaters were purchased and placed in the orchard, at the rate of 50 heaters to the acre. The January, 1911, freeze was too severe for this number, and all tender varieties of citrus fruits were killed to the ground.

On February 22 of that year, the heaters were again used at the rate of 50 per acre, and though the trees were putting out new growth at that time, little damage was done. The night was still, and an average rise of three degrees was obtained, which, in this case, was satisfactory.

In the fall of 1911, more equipment was purchased with a view of giving orchard heating a complete test. The heaters were placed at the rate of 125 per acre. Though the results were not entirely satisfactory, they were published with a view of showing the possibilities by this method. The Satsuma orange and Nagami and Marumi Kumquats came through the winter without injury and will fruit in 1912. The round varieties of oranges, Pomelo, lemons, and limes were severely injured, and will not fruit this season. Their injury ranged from losing all foliage and some wood on the Dugat, Jaffa and Washington Navels, to being killed to the ground in the case of lemons and limes.

The plantings on the Beeville Sub-Station are, unfortunately, divided into two different tracts, some distance apart, which makes it more



FILLING THE HEATERS.

difficult to heat the orchard. In fact, the heating of each tract is entirely separate and distinct from the other.

The following table will give the temperatures inside and outside of the heated area; the number of heaters burning at the hour given, and the approximate wind velocity, for November 29, 1911:

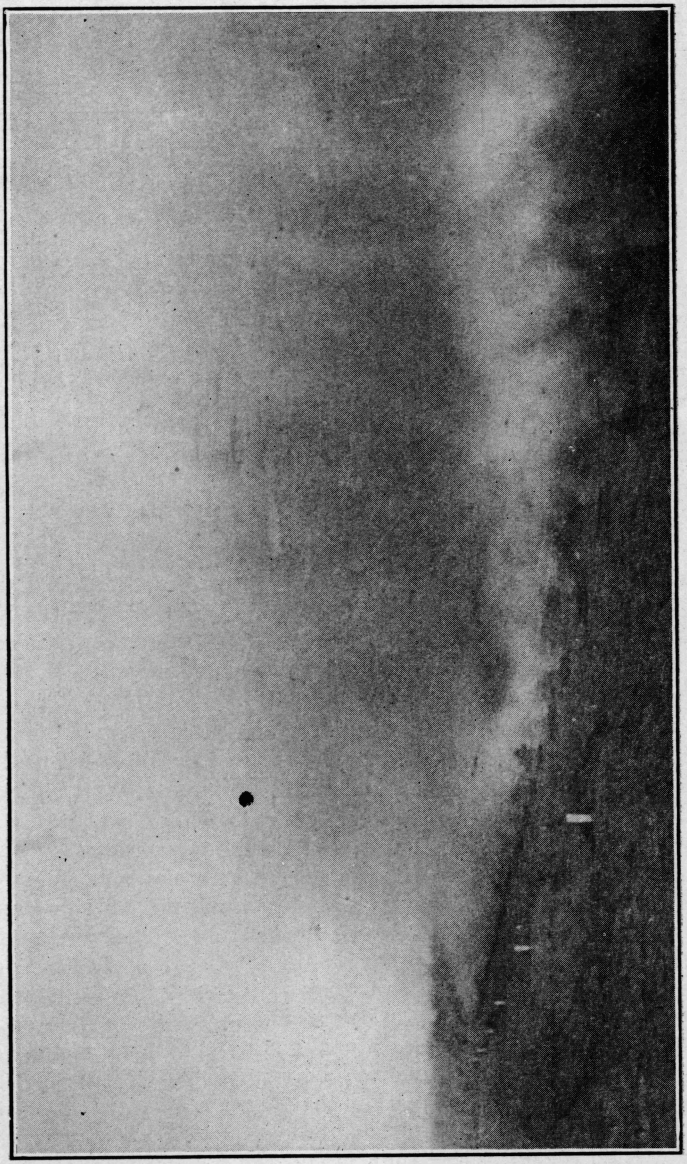
TABLE NO. 1.

	Temperature outside. Average 2 thermometers.	Temperature inside upper orchard. Average of 2 thermometers.	Temperature inside lower orchard. Average of 3 thermometers.	Wind velocity and direction—Miles. Per hour.	Number of heaters burning per acre.	Remarks.
P. M.						
7:00	40			3 N		
9:00	39			3 N		
9:30	36			3 N		
10:00	32			3 N		
10:30	30			3 N		
11:00	30			3 N		
11:30	29			3 N. W		
12:00	26			3 N. W	62	Lighting.
12:30	24	29	27	3 N. W	62	
1:00	23	28	27	3 N. W	62	
1:30	22	28	28	3 N. W	62	
2:00	20	27	24	3 N. W	88	
2:30	19	26	25	3 N. W	88	
3:00	18	26	25½	5 N. W	88	
3:30	18	26	25½	4 N. W	100	
4:00	17	26½	25	3 N. W	100	
4:30	17	26	25	3 N. W	125	
5:00	17	25½	27	3 N. W	125	
5:30	16	24	28	2 S	125	Refilling upper.
6:00	15½	26	23	2 S	125	Refilling lower.
6:30	16	30	25	2 S	125	
7:00	18	30	25	2 S	125	
7:30	24	34	32	2 S	100	Sun up.
8:00	28	39	34	2 S	None	Put out.

The drops noticed at 5:30 o'clock in the upper orchard and at 6:00 o'clock in the lower orchard, were due to refilling when, for a few minutes, the heaters lighted early in the night were not burning.

The lemons and limes in the lower orchard were killed to the ground. (There were none of these in the upper orchard.) Pomelo and the tender varieties of oranges lost nearly all foliage and fifty per cent of the previous year's wood. The more hardy varieties of round oranges lost one-half of their foliage, but very little or no wood. Neither the Satsuma orange nor either variety of Kumquats were injured. The following few weeks were rather warm, which resulted in most of the trees which were defoliated in November starting new growth. Under such conditions it will be seen that their protection was very difficult. A temperature that would not injure mature foliage would be fatal to these tender shoots. For that reason the heaters were started at a temperature of 30 degrees Fahrenheit, on January 6.

The following table will give the temperature on this night:



SMUDGING.

TABLE NO. 2.

	Temperature outside. Average 3 thermometers.	Temperature inside. Average 2 thermometers. Upper orchard.	Temperature inside. Average 3 thermometers. Lower orchard.	Wind velocity and direction. Miles per hour.	Number of heaters burning per acre.	Remarks.
7:00	35			35 N		
9:00	32			35 N		
9:30	30	34	32	35 N	62	Lighting.
10:00	29	33	33	35 N	62	
10:30	28	30	30½	35 N	62	
11:00	26½	28	29½	35 N	62	
11:30	26	27½	29	35 N	90	
12:00	26	28½	27½	27 N	90	
12:30	25	28	27	27 N	90	
1:00	25	27½	27	27 N	90	
1:30	24	28	29	27 N	125	
2:00	24	27½	27	27 N	125	
2:30	24	26	25½	20 N	125	
3:00	23	25	25	20 N	125	
4:00	22½	23	25½	20 N	50	Refilling and lighting.
5:00	22	25	25½	15 N	125	
5:30	22	25½	25	15 N	125	
6:00	22	27	26	15 N	125	
6:30	23	27	26	15 N	125	
7:00	25	28	27	15 N	125	
7:30	27	33	28½	10 N	125	
8:00	30	34	30	10 N	None	Put out.

Though the temperature outside was at no time below 22 degrees Fahrenheit, the injury was much more severe than during the November spell, when it went to 15.5 degrees F. This was due to the activity of the trees and the high winds which made it impossible to hold any heat over the orchard.

The trees which had put out new growth were severely hurt. The new foliage and practically all the old foliage was killed and additional wood lost. The Satsuma orange and the Kumquats were not hurt.

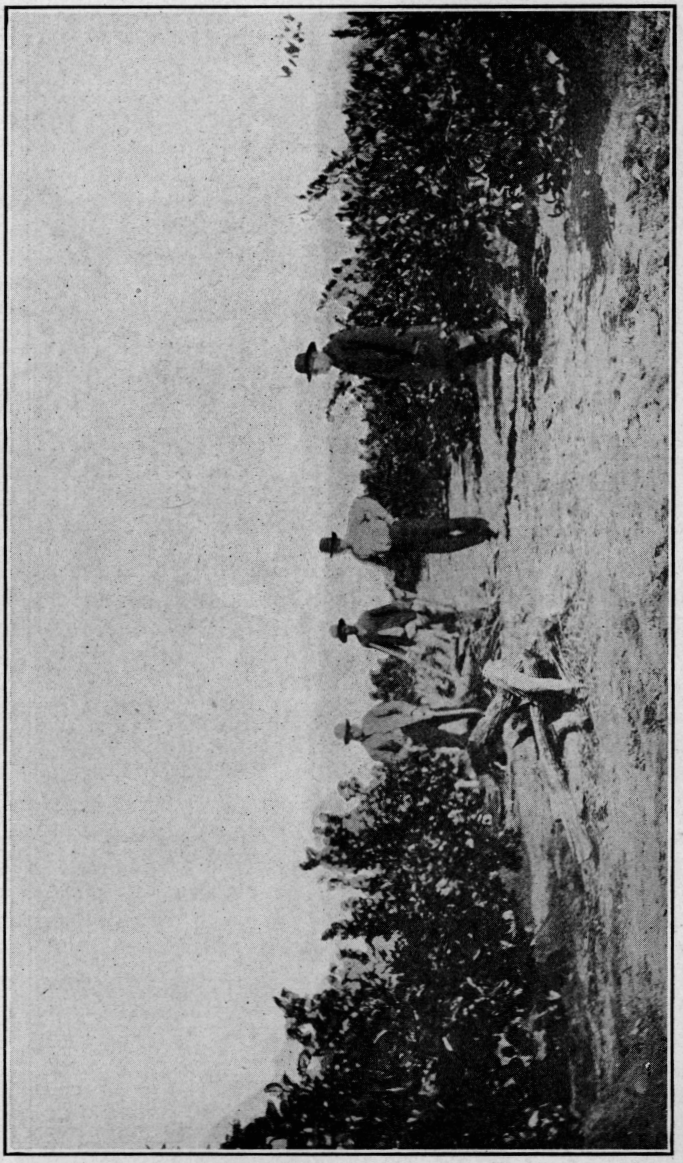
On January 12 and 13 another severe spell of weather was encountered. Owing to the length of time the temperature was below freezing, and the scarcity of oil, this spell was probably more injurious than either of the others. The minimum outside temperature was 18 degrees Fahrenheit on January 13. The minimum temperature, inside, was 22 degrees.

Another freeze occurred on February 5, with a minimum temperature of 22 degrees outside, and 26 degrees in the heated area. These continued freezes had defoliated all varieties of citrus fruits, except the Satsuma orange and the Kumquats. With the exception of a few trees badly injured in January, 1911, these two varieties were not hurt.

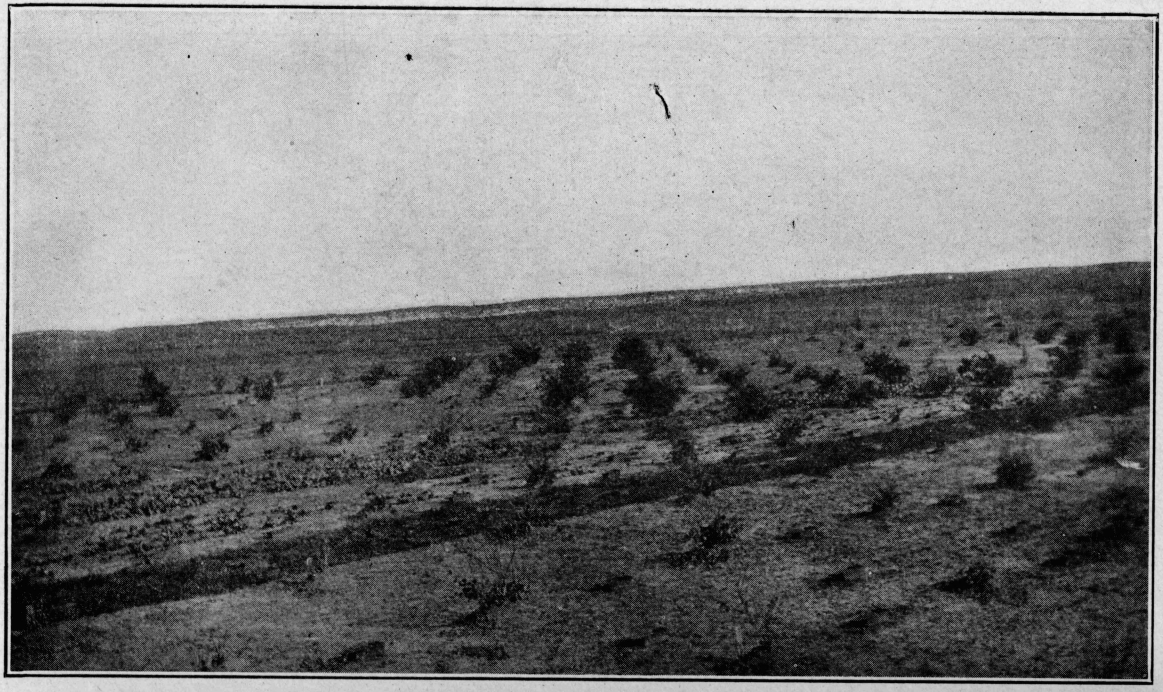
The amount of wood lost on all other varieties was pretty large. The following varieties of oranges seemed most resistant, saving from 40 to 95 per cent of their wood:

Dugat, Jaffa, Washington Navel, Oneca, Ruby, Pineapple.

However, none of these varieties will bear a crop in 1912.



PLACING WOOD IN ORCHARD FOR WINTER FIRES.



PART OF CITRUS ORCHARD WITH HEATERS PLACED.

The Cost of Equipment.

The cost of equipping an orchard for smudging will vary, owing to its age, the price of fuel oil, freight and labor. Below is given the cost of equipping six acres, of four and five year old trees on the Beeville Station, using 125 Hamilton Reservoir Heaters per acre, and buying oil in car lots:

750 heaters at 45c	$337.50
Freight on heaters	15.00
168 barrels of fuel oil at $1.10 per barrel	184.80
7000 gallon oil storage tank and cover	85.00
Platform for storage tank	15.00
Lead pipes, valves and connections	12.50
6 good thermometers	12.00
Labor, hauling and storing oil	18.00
Tank for wagon and hose to fill heaters	18.00
Gasoline for lighting purposes	6.00
Total cost	$710.80

It is possible that some of this equipment may not be required in all cases, but the grower should have at his immediate command sufficient heaters and oil for any emergency. Good thermometers are of the very highest importance. Without them he is at a complete loss as to when to fire or whether his efforts are successful. Buy only carefully tested thermometers and place them in the coldest part of the grove.

Every arrangement should be made weeks before the earliest known freeze. It will then be found that many things have been overlooked. Plenty of labor should be available, because orchard heating is a big and hard job.

Cost of Protection.

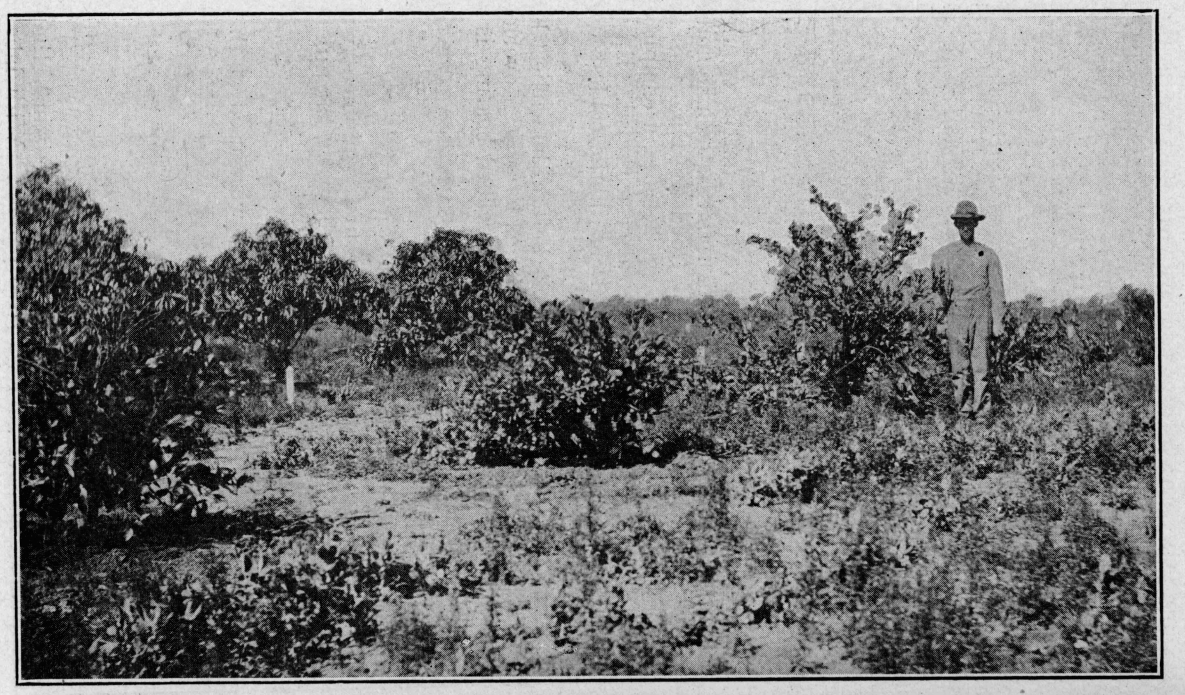
The cost of protecting the grove after the first equipment will depend on the number of times the heaters must be used, the number of degrees of frost to fight, the wind velocity, whether windbreaks are provided, and the condition of the trees.

During the winter of 1911-1912 the heaters were used at the Beeville Station on the following dates:

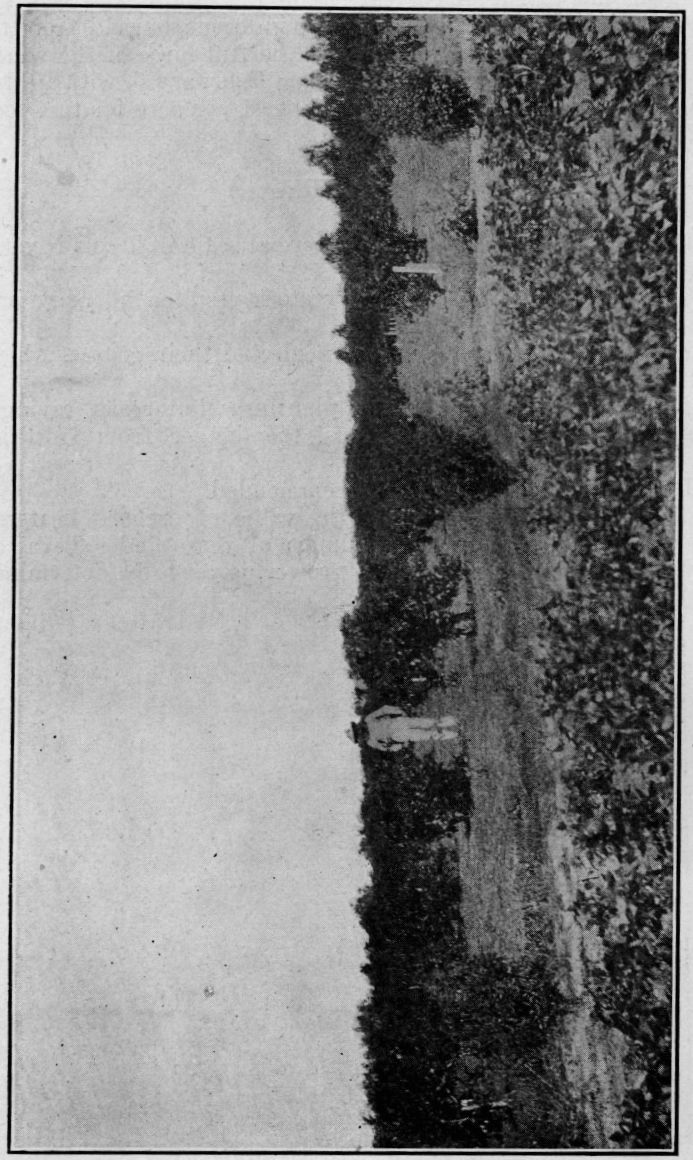
November 29, 1911.
January 6, 1912.
January 12, 1912.
January 13, 1912.
February 5, 1912.

On the night of November 29, 1911, with little wind, the total amount of oil consumed per acre was 375 gallons. With labor and gasoline, this will give a cost of about $8.10 per acre for the eight hours burning. Considering the fact that we were fighting 16.5 degrees of frost, this large consumption of fuel is not surprising.

On January 6 the second severe freeze of the season occurred. This spell was accompanied by a very high wind which greatly added to



SATSUMA ORANGES.
The Grove in 1912.



THE LOWEE CITRUS GROVE.

the expense and discomfort of heating. The heaters were burned 11½ hours, with 10 degrees of frost to fight. The total fuel consumed per acre was 458 gallons. This, together with gasoline for lighting purposes and labor, made the cost $10.50 per acre for the night. On this night the great value of windbreaks was shown. Heaters directly behind a good cedar windbreak burned from two to three times as long as those exposed to the full force of the wind.

The heaters were burned four hours on February 5, with 10 degrees of frost and very little wind. The total cost per acre for this occasion was $2.60.

SUMMARY.

1. Citrus fruit growing on a commercial scale in Texas is yet in its infancy.
2. The great demand for nursery stock resulted in many inferior trees being placed on the market.
3. Many of the growers utterly neglected their groves, which has caused as much loss as frost.
4. By selecting favorable sites, planting windbreaks, giving good cultivation, and sowing cover crops, the danger from frost injury can be greatly reduced.
5. Protection against frost is recommended.
6. There is no question as to the value of orchard heaters, but whether they may be used for a number of years under Texas conditions with a degree of profit to the grower, is yet to be determined.